



# FLUID EQUIPMENT

A COGENT COMPANY

## City of Wichita Re-Use Water Pump Station 46 33 13 Sodium Hypochlorite Generating Equipment Watson Marlow Dosing Skid Only July, 2015

### Project: City of Wichita Re-Use Water Pump Station

#### Submitted to:

Wildcat Construction Co., Inc.  
3219 W May  
Wichita, KS 67213

#### Engineer:

MKEC  
411 N. Webb Rd  
Wichita, KS 67206

#### Submitted by:

Fluid Equipment  
500 W. 5<sup>th</sup> Street  
Kansas City, MO 64105

Date Received: 8/15/16

A – Approved

B – Approved as Noted

C – Partial Approval, Resubmit as needed

D – Revise and Resubmit

E – For Reference/No Acceptance

500 W. 5<sup>th</sup> Street, Kansas City, MO 64105  
Ph: 816.795.8511 F: 816.795.8926

#### MKEC ENGINEERING, INC.

411 North Webb Road – Wichita, KS 67206

Reviewed  Reviewed As Noted

Revise and Resubmit  Rejected

Not Required by the Contract Documents

Reviewed for conformance with the design concept of the project and compliance with the information given in the contract documents. Contractor is responsible for: dimensions to be confirmed and correlated at the job site; information that pertains solely to the fabrication process or to techniques of construction; and coordination of work of all other trades. If "Resubmit" or "Rejected" are not checked resubmission is neither desired or required.

By: Keith Scarberry Date: 08/25/2016

To: Keith Scarberry  
From: Ambarneil Roy – Applications Engineer, Watson-Marlow, Inc.  
Tanim Ahmed – Documentation Coordinator, Watson-Marlow, Inc.  
Date: August 1, 2016  
Re: City of Wichita, KS  
Specification Section M6.1- 46 33 13.F.9- Sodium Hypochlorite General Equip-  
ment/Sodium Hypochlorite Dosing Pumps  
Submittal Review Comments

Keith Scarberry,

In regards to the submittal review comments from City of Wichita, KS, received on August 1, 2016, Watson Marlow has the following responses:

**Watson-Marlow, Inc.**  
37 Upton Technology Park  
Wilmington, MA 01887  
Tel: 978-658-6168  
Fax: 978-658-0041

[support@wmbpumps.com](mailto:support@wmbpumps.com)  
[www.watson-marlow.com](http://www.watson-marlow.com)

1. **Provide NEMA 4X toggle type disconnect switch for each motor, mounted on skid and pre-wired.**

Response: confirmed

2. **Provide NEMA 1 VFDs, not mounted to skid, for field wiring in MCC room. Coordinate communication protocols and cards with Pedrotti.**

Response: confirmed

3. **Need cut sheets for ball valves. Hayward ported true union valves are specified.**

Response: Confirmed, will be provided

4. **Skid should be made of corrosion resistant materials, such as stainless steel or fiberglass, not galvanized carbon steel.**

Response: Skid will be made from 316SS

NOTED

5. **Pulsation dampener wetted materials shall not be carbon steel and shall be compatible with pumped fluids.**

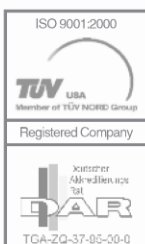
Response: PVDF wetted material Pulsation dampener is provided.

NOTED

6. **Provide projected pump hose life.**

Response: Watson Marlow does not project pump hose life as that depends on various factors.

PROVIDE BEST ESTIMATE BASED ON DESIGN CONDITIONS RUNNING 24/7. THIS IS FOR OWNER TO PROJECT REPLACEMENT SCHEDULE, AND NOT LOOKING FOR A GUARANTEE.



If you have any other questions, please don't hesitate to ask.

Best Regards,

## Ambarneil Roy

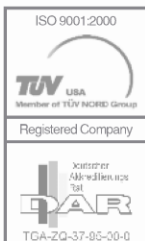
Ambarneil Roy  
Applications Engineer  
Watson-Marlow Fluid Technology Group  
Tel: 949-371-2487  
[Ambarneil.Roy@wmftg.com](mailto:Ambarneil.Roy@wmftg.com)

## Tanim Ahmed

Tanim Ahmed  
Documentation Coordinator  
Watson-Marlow Fluid Technology Group  
Tel: 978-988-5325  
[Tanim.Ahmed@wmftg.com](mailto:Tanim.Ahmed@wmftg.com)

**Watson-Marlow, Inc.**  
37 Upton Technology Park  
Wilmington, MA 01887  
Tel: 978-658-6168  
Fax: 978-658-0041

[support@wmbpumps.com](mailto:support@wmbpumps.com)  
[www.watson-marlow.com](http://www.watson-marlow.com)



# SHOP DRAWINGS

**PROJECT NAME:** City of Wichita, KS

**PROJECT LOCATION:** Wichita, KS

**PO NUMBER:** 2199444

**WMFTG JOB NUMBER:** S013091

**SECTION NUMBER** M6.1- 46 33 13.F.9- Sodium Hypochlorite General Equipment/Sodium Hypochlorite Dosing Pumps

**EQUIPMENT:** One (1) Bredel 25 Duplex (Duty/Standby) Skid System Sodium Hypochlorite Dosing Pumps

**ENGINEER:** Consulting Engineer

**CONTRACTOR:** Wildcat Construction

**MANUFACTURER:** Watson-Marlow Fluid Technology Group  
37 Upton Technology Drive  
Wilmington, MA 01887  
Tel: 800-282-8823  
Fax: 978-658-0041

**MANUFACTURER'S CONTACT:** Ambarneil Roy

**MFG. REPRESENTATIVE:** Fluid Equipment Co.  
2535 S Leonine  
Wichita, KS 67217  
Tel: 316-630-0075  
Fax: 316-634-1613

**SUBMITTAL NUMBER:** M6.1-46 33 13.F.9-002-02

**NUMBER OF COPIES:** 1 EC

**SUBMITTED** 8/15/2016

# **TABLE OF CONTENTS**

## **PART 1: DESIGN PARAMETERS AND OUTLINE SPECIFICATION**

- I. Contact Information
- II. Design Parameters & Scope of Supply
- III. Engineering Comments
- IV. Equipment Outline Specifications

## **PART 2: CHEMICAL METERING SKID**

- I. Bredel 25 Duplex (Duty/Standby) Skid Assembly Drawings

## **PART 3: BREDEL 25 HOSE PUMP SPECIFICATION AND PERFORMANCE**

- I. Pump Specification Sheets
- II. Outline Recommended Operation and Installation Instructions
- III. Operation, Maintenance & Parts List
- IV. Paint Specification
- V. High Lubricant Level Sensor
- VI. Lubricant Material Safety Data Sheet

## **PART 4: GEAR REDUCER**

- I. Gear Reducer Specifications
- II. Installation and Maintenance Instruction

## **PART 5: MOTOR**

- I. Product Information Packet
- II. Installation and Maintenance Manual

**PART 6: VARIABLE FREQUENCY DRIVE**

- I. Variable Frequency Drive Datasheet
- II. Installation & Maintenance Manual

**PART 7: CALIBRATION COLUMN**

- I. Data Sheet with Installation Guidelines

**PART 8: PRESSURE RELIEF VALVE**

- I. Data Sheet with Installation Guidelines

**PART 9: PRESSURE GAUGE AND DIAPHRAGM SEAL**

- I. Pressure Gauge Data
- II. Diaphragm Seal Data

**PART 10: PULSATION DAMPENER**

- I. Datasheet
- II. Installation & Maintenance Manual

**PART 11: TRUE UNION VENTED BALL VALVES**

- I. Data Sheet with Installation Guidelines

**PART 12: DISCONNECT SWITCHES**

- I. Data Sheet with Installation Guidelines

# PART 1: DESIGN PARAMETERS AND OUTLINE SPECIFICATION

## CONTACT INFORMATION

The following points of contact are available if you have any questions regarding the associated support categories.

### **Equipment Inquiry Support**

Ambarneil Roy  
[Ambarneil.Roy@wmftg.com](mailto:Ambarneil.Roy@wmftg.com)  
Tel: 949-371-2487

### **Submittals, Response Letters, Resubmittal Requests**

Tanim Ahmed  
[Tanim.Ahmed@wmftg.com](mailto:Tanim.Ahmed@wmftg.com)  
Tel: 978-988-5325

### **O&M Manuals, Lesson/Training Plans, Warranty Statements, Miscellaneous Documentation**

Rebecca Whalen  
[Rebecca.Whalen@wmftg.com](mailto:Rebecca.Whalen@wmftg.com)  
Tel: 978-658-4381

### **Customer Support, New Orders, Order Status, Shipping, Insurance Requests, W-9 Forms, Contract Review**

Georgette Cabrera  
[Georgette.Cabrera@wmftg.com](mailto:Georgette.Cabrera@wmftg.com)  
Tel: 949-613-7823

### **Schedule Field Service**

Marilyn Trinidad  
[Marilyn.Trinidad@wmftg.com](mailto:Marilyn.Trinidad@wmftg.com)  
Tel: 949-613-7333

### **Ordering Spare Parts**

Fluid Equipment Co.  
2535 S Leonine  
Wichita, KS 67217  
Tel: 316-630-0075  
Fax: 316-634-1613

### **Post-Sale Technical Engineer**

Eric Coulombe  
[Eric.Coulombe@wmftg.com](mailto:Eric.Coulombe@wmftg.com)  
Tel: 978-988-1426

## DESIGN PARAMETERS

**Scope**

Watson-Marlow, as the contracted tubing pump manufacturer, is pleased to submit its Shop Drawings for review detailing all items supplied by Watson-Marlow under Section M6.1- 46 33 13.F.9-Sodium Hypochlorite General Equipment/Sodium Hypochlorite Dosing Pumps. Watson-Marlow’s intended scope of supply, as offered in our Bid Date Scope Letter and described below is based upon requirements listed by the above specification section.

This proposal includes only equipment mentioned herein and does not include, nor inferences inclusion of, any additional equipment, piping, valves, wiring, services, testing, etc. regardless of its relation to the listed equipment. Such services and equipment are to be supplied by the Contractor.

| WATSON-MARLOW SCOPE OF EQUIPMENT SUPPLY / BILL OF MATERIALS |          |   |
|---|----------|---|
| Item Number   | Quantity | Description   |
| 1   | 1        | Bredel 25 Duplex (Duty/Standby) Skid System <ul style="list-style-type: none"> <li>• (2) Bredel 25 Hose Pump Assembly</li> <li>• (1) PVC Calibration Column</li> <li>• (1) Pressure Relief Valve</li> <li>• (1) Pressure Gauge/Diaphragm Seal Assembly</li> <li>• (1) Pulsation Dampener</li> <li>• (8) True Union Ball Valves</li> </ul> |
| 2   | 2        | ABB ACS 150 Component Drives  |
| 3   | 4        | Bredel 25 EPDM Hose   |
| 4   | 4        | Bredel Hose Lubricant   |
| 5   | 2        | Disconnect Switches   |

## ENGINEERING COMMENTS MADE AT TIME OF BID

The following comments were issued at the time of bid and are again listed below for your consideration.

| SPECIFICATION | COMMENTS  |
|---------------|---|
| General       | Watson-Marlow is an equipment supplier, not a contractor and assumes no roles of the contractor.  |
| Section F.9   | Watson-Marlow takes exception to the back pressure valves listed under this section. The Bredel 25 pumps do not require the use of back pressure valves for proper operation. |

## EQUIPMENT OUTLINE SPECIFICATION

### STAINLESS STEEL 304 PLUMBED SKID SYSTEM WITH PLUMBED BACK PANEL (QUANTITY: 1)

|                  |   |
|------------------|---|
| Type/Model       | Bredel 25 Duplex (Duty/Standby) Skid Assembly |
| Skid Material    | Stainless Steel 304                           |
| Pipe             | Schedule 80 PVC                               |
| Pipe Fittings    | Schedule 80 PVC                               |
| Isolation Valves | True Union Ball Valve-Vented- 1" NPT, PVC     |
| Design           | See Drawing                                   |

### BREDEL 25 HOSE PUMP (QUANTITY: 2)

|                           |   |
|---------------------------|---|
| Name of Pump Manufacturer | Watson-Marlow, Inc.   |
| Model, P/N                | Bredel 25, 225US3   |
| Flow/Revolution           | 0.300 L/Rev (0.079 G/Rev)   |
| Pump Speed                | 31 RPM  |
| Nominal Flow              | 5,250 L/hr (23.1 GPH) pressure up to 16 Bar (232 psi)   |
| Port Sizes                | 25mm  |
| Hose/Insert Material      | EPDM Hose/ PVDF Hose Insert   |
| Construction              | <u>Pump Supports:</u> Galvanized Steel<br><u>Pump Hardware and Hose Clamp:</u> Galvanized Steel<br><u>Flanges &amp; Flange Brackets:</u> Galvanized Steel |
| Assembly Details          | See Drawings  |
| Paint                     | Bredel Red  |
| Port Position             | 2   |
| Net Weight of Pumphead    | 39 kg (85.98 lbs)   |

### GEAR REDUCER (QUANTITY: 1)

|                          |                 |
|--------------------------|-----------------|
| Name of Manufacturer     | Nord            |
| Model, P/N               | SK373.1F-56C-32 |
| Speed                    | 32 RPM          |
| Gearing Ratio            | 54.00           |
| Number of Gearing Stages | 3- Stage        |
| Gearbox Frame            | 56C             |
| Paint                    | Bredel Red      |
| Net Weight of Gearing    | 26 lbs          |

### MOTOR (QUANTITY: 1)

|                      |             |
|----------------------|-------------|
| Name of Manufacturer | Baldor      |
| Model, P/N           | VEM3546     |
| Horsepower           | 1 HP        |
| Enclosure/Turndown   | TEFC        |
| Voltage              | 208-230/460 |

|                           |            |
|---------------------------|------------|
| Service Factor            | 1.15       |
| Nominal Efficiency Rating | 85.5       |
| Synch RPM                 | 1800       |
| Frame Size                | 56C        |
| Insulation                | F          |
| Paint                     | Bredel Red |
| Weight                    | 39 lbs     |
| NEMA Design Code          | B          |
| Full Load Amperage        | 1.5        |

| <b>VARIABLE FREQUENCY DRIVE<br/>(QUANTITY: 2)</b> |                                       |
|---|---------------------------------------|
| Name of Manufacturer                              | ABB Component Drives                  |
| Model, P/N  | ACS150, ACS150-03X-04A7-2             |
| Type  | ACS150, 0.37-4 Kw/ 0.5-5 HP, R1 Frame |
| Input Voltage                                     | 200-240 VAC Input                     |
| Output Voltage (to Motor)                         | 230 VAC Output                        |
| Enclosure   | NEMA 1                                |
| Design  | See Drawing                           |

| <b>CALIBRATION COLUMN<br/>(QUANTITY: 1)</b> |              |
|---|--------------|
| Name of Manufacturer                        | Griffco      |
| Model, P/N                                  | CC10000-S    |
| Material                                    | PVC          |
| Diameter                                    | 6.95"        |
| Length                                      | 25"          |
| Capacity                                    | 10,000mL     |
| Scale                                       | 100mL/ 5 GPH |
| Connections                                 | 2" Threaded  |
| Design                                      | See Drawing  |

| <b>PRESSURE RELIEF VALVE<br/>(QUANTITY: 1)</b> |                 |
|--|-----------------|
| Name of Manufacturer                           | Griffco         |
| Model, P/N                                     | PRG100-PV       |
| Body Material                                  | PVC             |
| Seal Material                                  | Viton Diaphragm |
| Connection Size                                | 1" NPT Threaded |
| Pressure Adjustment                            | 10-150 psi      |

| <b>PRESSURE GAUGE WITH DIAPHRAGM SEAL<br/>(QUANTITY: 1)</b> |                    |
|---|--------------------|
| Name of Manufacturer  | Pilgrim Instrument |
| Model, P/N  | WMP-0139           |

|                |   |
|----------------|---|
| Pressure Gauge | Ashcroft 25 1009SL 02L 160# Pressure Gauge, 2.5" Dial, Stainless Steel Glycerin Filled Case, 316 Stainless Steel Tube and Socket, 160 psig Range, ¼" Lower Process Connection |
| Diaphragm Seal | Plast-O-Matic GGTS1-PV Diaphragm Seal, Teflon Diaphragm, PVC Lower Housing, 1" NPT Process Connection, Halocarbon System Fill   |

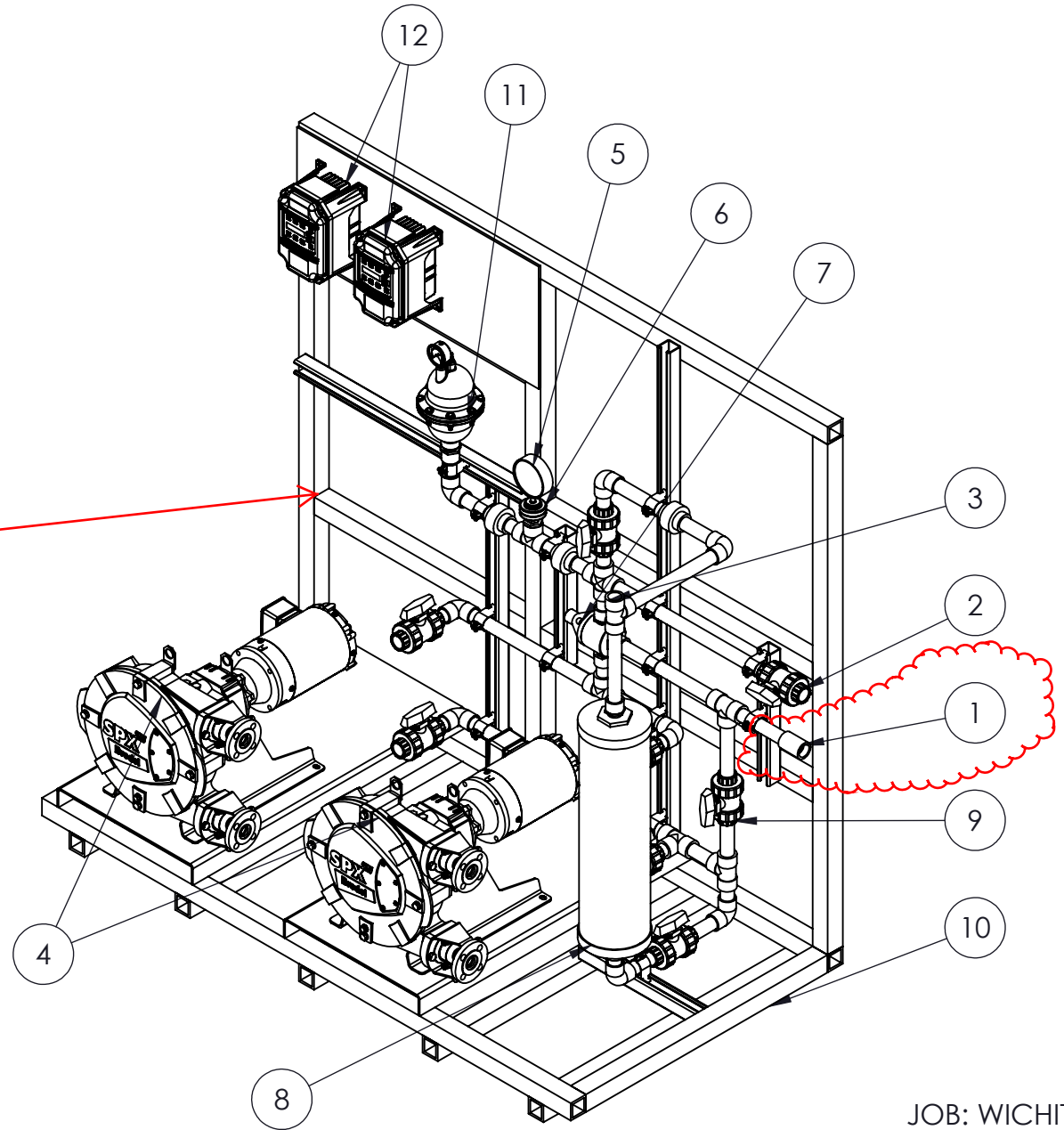
| <b>PULSATION DAMPENER<br/>(QUANTITY: 1)</b> |                             |
|---|-----------------------------|
| Name of Manufacturer                        | Blacoh                      |
| Model, P/N                                  | C421NDF                     |
| Air Control                                 | CHARGE                      |
| Bladder Material                            | EPDM                        |
| Capacity                                    | 85 Cubic inches/ 1.4 Liters |
| Inlet Size                                  | 1" Flange, US, 150# CLASS   |
| Max Pressure                                | 150 PSI/10.3 BAR            |
| Nonwetted Housing                           | PVDF                        |
| Wetted Housing                              | PVDF                        |
| Weight                                      | 11 lbs                      |

| <b>ANCILLARY EQUIPMENT/CONTRACTED SPARES</b> |          |                       |                 |
|--|----------|-----------------------|-----------------|
| ITEM   | QUANTITY | DESCRIPTION           | PART NUMBER     |
| 1  | 4        | Bredel 25 EPDM Hose   | 28-025020       |
| 2  | 4        | Bredel Hose Lubricant | 28-911143       |
| 3  | 2        | Disconnect Switches   | EDS-416-ABS-LRY |

# PART 2: CHEMICAL METERING SKID


| ITEM NO. | DESCRIPTION                                  | QUANTITY |
|----------|--|----------|
| 1        | SUCTION - 1" NPT, PVC                        | 1        |
| 2        | DISCHARGE - 1" NPT, PVC                      | 1        |
| 3        | VENT   | 1        |
| 4        | PUMP - BREDEL 25 PUMP                        | 2        |
| 5        | PRESSURE GAUGE - 1/4" NPT                    | 1        |
| 6        | DIAPHRAM SEAL - 1" NPT X 1/4" NPT            | 1        |
| 7        | PRESSURE RELIEF VALVE - 1" NPT, PVC          | 1        |
| 8        | CALIBRATION COLUMN - 10,000 mL               | 1        |
| 9        | TRUE UNION BALL VALVE - VENTED - 1" NPT, PVC | 8        |
| 10       | SS 304 SKID                                  | 1        |
| 11       | PULSATION DAMPENER                           | 1        |
| 12       | VFD  | 2        |

Move Inlet/Suction Connection to Left End of Skid



JOB: WICHITA, KS  
QTY: 1

1 ISO VIEW

3rd ANGLE PROJECTION   
DO NOT SCALE  
All rights reserved. This drawing is to be used for reference purposes only and no part may be reproduced, stored in a retrieval system or used by a third party for any other purpose without written permission from WATSON-MARLOW LIMITED.

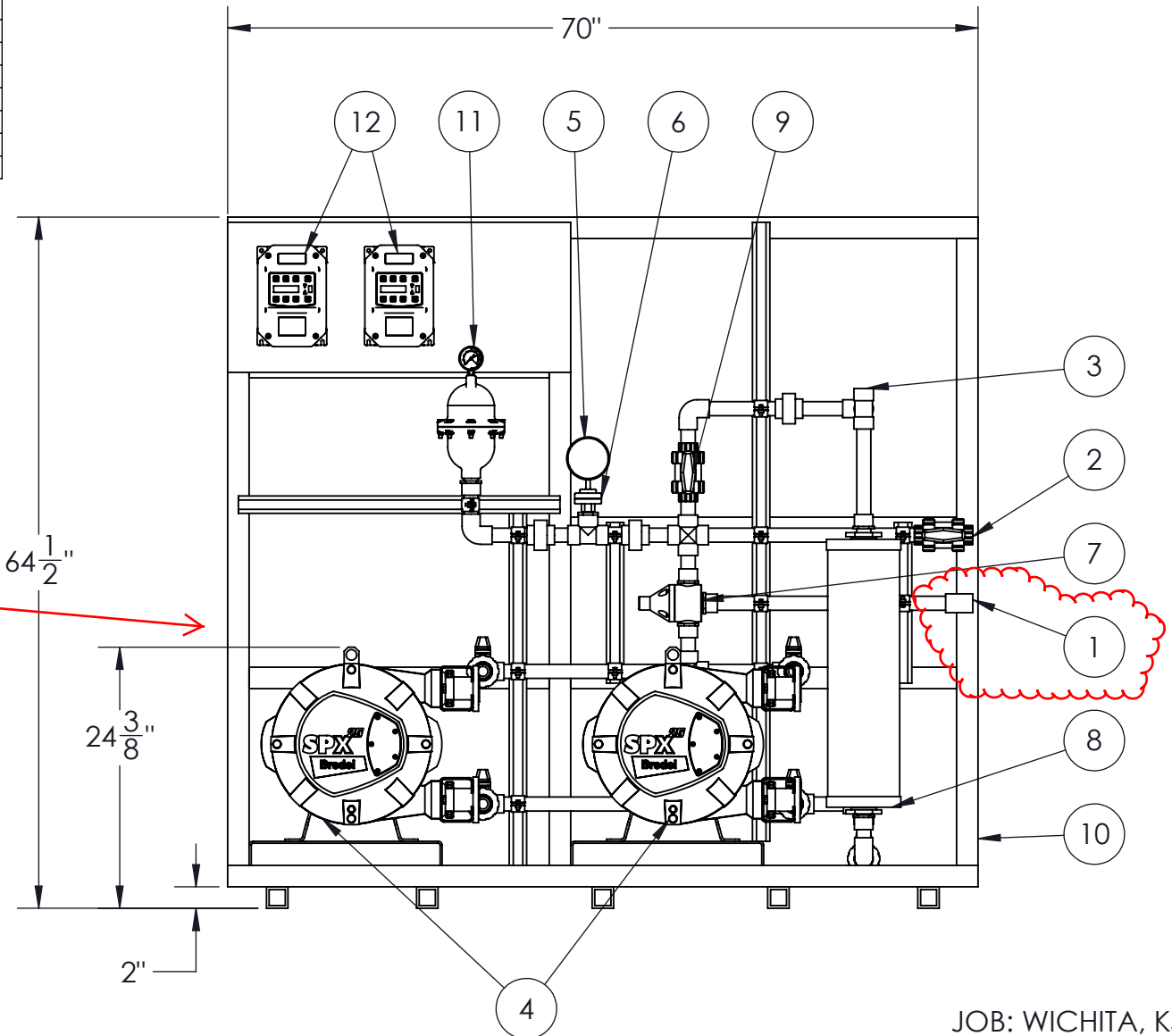
ORIGINAL SHT. SIZE ANSI A  
ORIGINAL SCALE 1:16  
DIMENSIONS IN INCHES  
TOLERANCES UNLESS OTHERWISE STATED  
MILLIMETRES ±XX ANGULAR ± 0°  
ONE DECIMAL ±XX  
TWO DECIMAL ±XX  
HOLES ±XX

Watson-Marlow Pumps Group  
37 Upton Technology Park, Wilmington, MA 01887  
Tel: 800-282-8823  
Fax: 978-658-0041  
TITLE  
DUTY-STANDBY  
BREDEL 25 DUPLEX CHEMICAL METERING SKID

|               |                  |      |          |
|---------------|------------------|------|----------|
| DRAWN         | WWW              | DATE | 07/07/16 |
| RELEASED      |                  | DATE |          |
| FIRST USED ON |                  |      |          |
| SIMILAR TO    |                  |      |          |
| SUPERSEDES    |                  |      |          |
| SHEET         | 1                | OF   | 4        |
| DRAWING NO.   | BREDEL25DPLXSKID |      |          |


CRITICAL DIMENSIONS ARE MARKED ▼

| ITEM NO. | DESCRIPTION                                  | QUANTITY |
|----------|--|----------|
| 1        | SUCTION - 1" NPT, PVC                        | 1        |
| 2        | DISCHARGE - 1" NPT, PVC                      | 1        |
| 3        | VENT   | 1        |
| 4        | PUMP - BREDEL 25 PUMP                        | 2        |
| 5        | PRESSURE GAUGE - 1/4" NPT                    | 1        |
| 6        | DIAPHRAM SEAL - 1" NPT X 1/4" NPT            | 1        |
| 7        | PRESSURE RELIEF VALVE - 1" NPT, PVC          | 1        |
| 8        | CALIBRATION COLUMN - 10,000 mL               | 1        |
| 9        | TRUE UNION BALL VALVE - VENTED - 1" NPT, PVC | 8        |
| 10       | SS 304 SKID                                  | 1        |
| 11       | PULSATION DAMPENER                           | 1        |
| 12       | VFD  | 2        |



Move Inlet/Suction  
Connection to Left End  
of Skid

**2 FRONT VIEW**

3rd ANGLE PROJECTION   
DO NOT SCALE  
All rights reserved. This drawing is to be used for reference purposes only and no part may be reproduced, stored in a retrieval system or used by a third party for any other purpose without written permission from WATSON-MARLOW LIMITED.

ORIGINAL SHT. SIZE ANSI A  
ORIGINAL SCALE 1:16  
DIMENSIONS IN INCHES  
TOLERANCES UNLESS OTHERWISE STATED  
MILLIMETRES ±XX ANGULAR ± 0°  
ONE DECIMAL ±XX  
TWO DECIMAL ±XX  
HOLES ±XX

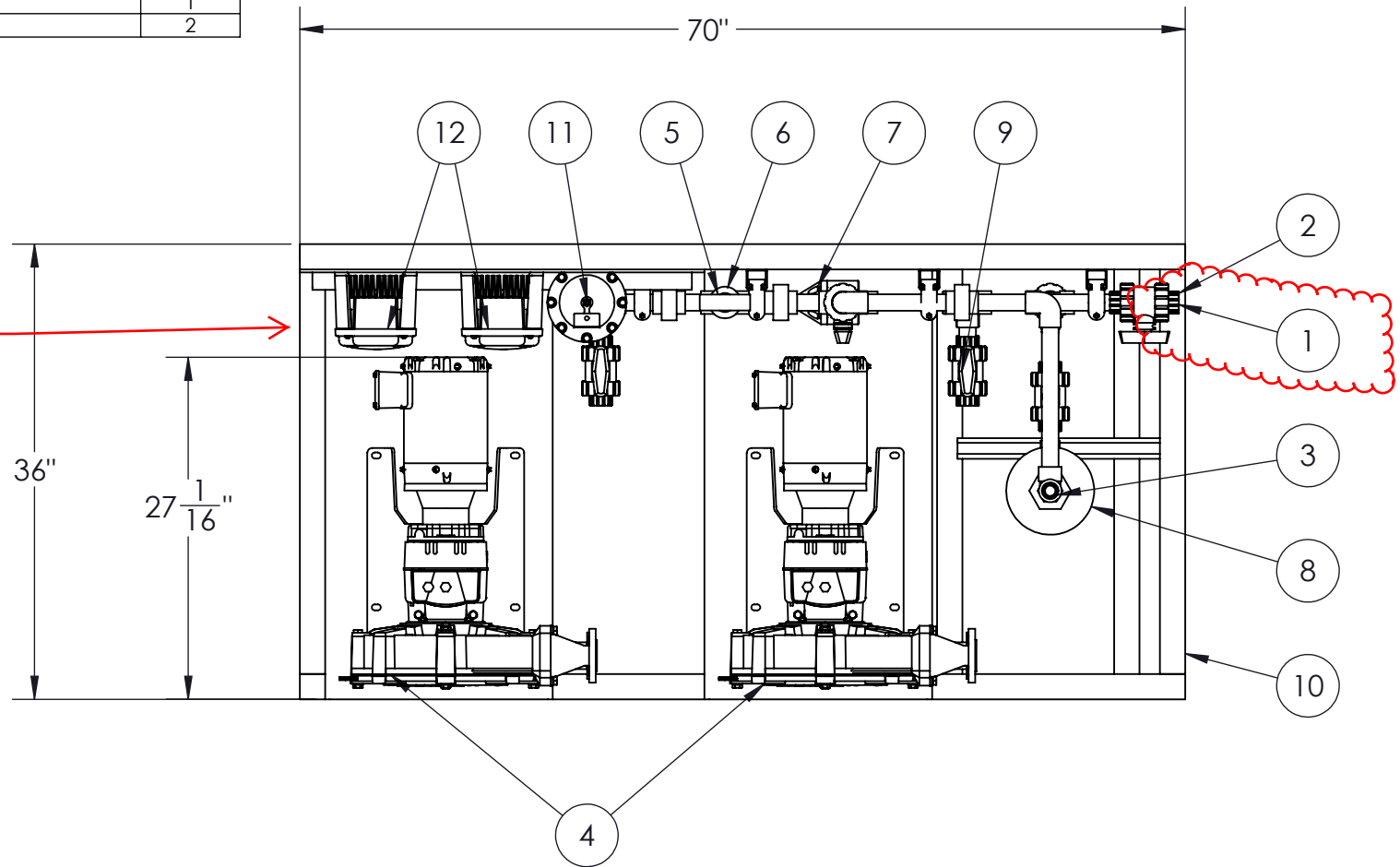
Watson-Marlow Pumps Group  
37 Upton Technology Park, Wilmington, MA 01887  
Tel: 800-282-8823  
Fax: 978-658-0041  
TITLE  
DUTY-STANDBY  
BREDEL 25 DUPLEX CHEMICAL METERING SKID

JOB: WICHITA, KS  
QTY: 1  
DRAWN WWW DATE 07/07/16  
RELEASED DATE  
FIRST USED ON  
SIMILAR TO  
SUPERSEDES  
SHEET 2 OF 4  
DRAWING NO.  
BREDEL25DPLXSKID

CRITICAL DIMENSIONS ARE MARKED ▼


| ITEM NO. | DESCRIPTION                                  | QUANTITY |
|----------|--|----------|
| 1        | SUCTION - 1" NPT, PVC                        | 1        |
| 2        | DISCHARGE - 1" NPT, PVC                      | 1        |
| 3        | VENT   | 1        |
| 4        | PUMP - BREDEL 25 PUMP                        | 2        |
| 5        | PRESSURE GAUGE - 1/4" NPT                    | 1        |
| 6        | DIAPHRAM SEAL - 1" NPT X 1/4" NPT            | 1        |
| 7        | PRESSURE RELIEF VALVE - 1" NPT, PVC          | 1        |
| 8        | CALIBRATION COLUMN - 10,000 mL               | 1        |
| 9        | TRUE UNION BALL VALVE - VENTED - 1" NPT, PVC | 8        |
| 10       | SS 304 SKID                                  | 1        |
| 11       | PULSATION DAMPENER                           | 1        |
| 12       | VFD  | 2        |

Move Inlet/Suction Connection to Left End of Skid



JOB: WICHITA, KS  
QTY: 1

3 TOP VIEW

3rd ANGLE PROJECTION 

DO NOT SCALE

All rights reserved. This drawing is to be used for reference purposes only and no part may be reproduced, stored in a retrieval system or used by a third party for any other purpose without written permission from WATSON-MARLOW LIMITED.

|                                    |
|------------------------------------|
| ORIGINAL SHT. SIZE ANSI A          |
| ORIGINAL SCALE 1:14                |
| DIMENSIONS IN INCHES               |
| TOLERANCES UNLESS OTHERWISE STATED |
| MILLIMETRES ±XX ANGULAR ± 0°       |
| ONE DECIMAL ±XX                    |
| TWO DECIMAL ±XX                    |
| HOLES ±XX                          |

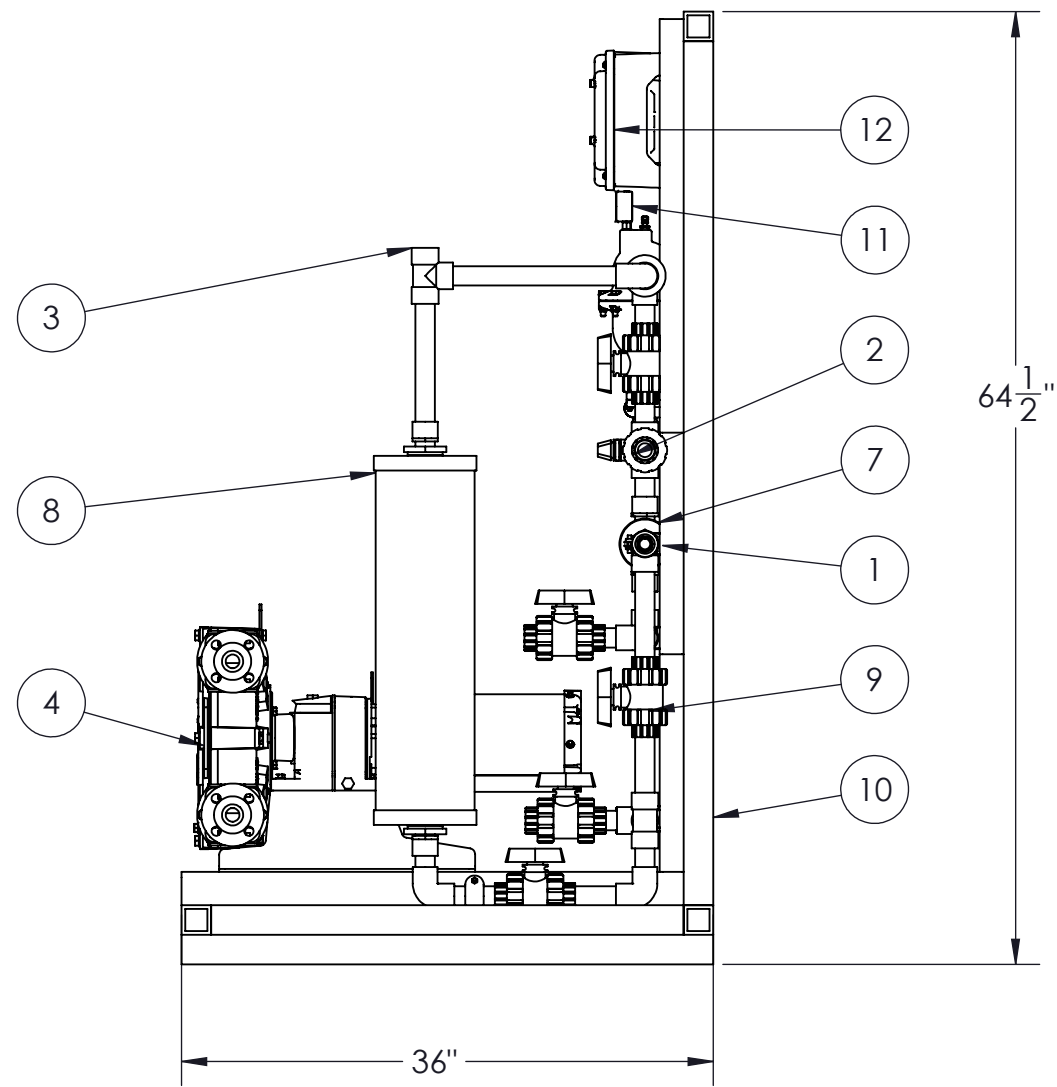
Watson-Marlow Pumps Group  
37 Upton Technology Park, Wilmington, MA 01887  
Tel: 800-282-8823  
Fax: 978-658-0041

TITLE  
DUTY-STANDBY  
BREDEL 25 DUPLEX CHEMICAL METERING SKID


|               |                  |
|---------------|------------------|
| DRAWN WWW     | DATE 07/07/16    |
| RELEASED      | DATE             |
| FIRST USED ON |                  |
| SIMILAR TO    |                  |
| SUPERSEDES    |                  |
| SHEET 3 OF 4  |                  |
| DRAWING NO.   | BREDEL25DPLXSKID |

CRITICAL DIMENSIONS ARE MARKED ▼

| ITEM NO. | DESCRIPTION                                  | QUANTITY |
|----------|--|----------|
| 1        | SUCTION - 1" NPT, PVC                        | 1        |
| 2        | DISCHARGE - 1" NPT, PVC                      | 1        |
| 3        | VENT   | 1        |
| 4        | PUMP - BREDEL 25 PUMP                        | 2        |
| 5        | PRESSURE GAUGE - 1/4" NPT                    | 1        |
| 6        | DIAPHRAM SEAL - 1" NPT X 1/4" NPT            | 1        |
| 7        | PRESSURE RELIEF VALVE - 1" NPT, PVC          | 1        |
| 8        | CALIBRATION COLUMN - 10,000 mL               | 1        |
| 9        | TRUE UNION BALL VALVE - VENTED - 1" NPT, PVC | 8        |
| 10       | SS 304 SKID                                  | 1        |
| 11       | PULSATION DAMPENER                           | 1        |
| 12       | VFD  | 2        |



**4 SIDE VIEW**

3rd ANGLE PROJECTION  DO NOT SCALE

All rights reserved. This drawing is to be used for reference purposes only and no part may be reproduced, stored in a retrieval system or used by a third party for any other purpose without written permission from WATSON-MARLOW LIMITED.

ORIGINAL SHT. SIZE ANSI A  
 ORIGINAL SCALE 1:13  
 DIMENSIONS IN INCHES  
 TOLERANCES UNLESS OTHERWISE STATED  
 MILLIMETRES ±XX ANGULAR ± 0°  
 ONE DECIMAL ±XX  
 TWO DECIMAL ±XX  
 HOLES ±XX

Watson-Marlow Pumps Group  
 37 Upton Technology Park, Wilmington, MA 01887  
 Tel: 800-282-8823  
 Fax: 978-658-0041

TITLE  
 DUTY-STANDBY  
 BREDEL 25 DUPLEX CHEMICAL METERING SKID

|               |                  |      |          |
|---------------|------------------|------|----------|
| DRAWN         | WWW              | DATE | 07/07/16 |
| RELEASED      |                  | DATE |          |
| FIRST USED ON |                  |      |          |
| SIMILAR TO    |                  |      |          |
| SUPERSEDES    |                  |      |          |
| SHEET         | 4                | OF   | 4        |
| DRAWING NO.   | BREDEL25DPLXSKID |      |          |

JOB: WICHITA, KS  
 QTY: 1

CRITICAL DIMENSIONS ARE MARKED ▼

# PART 3: BREDEL 25 HOSE PUMP SPECIFICATION AND PERFORMANCE

# Bredel 25

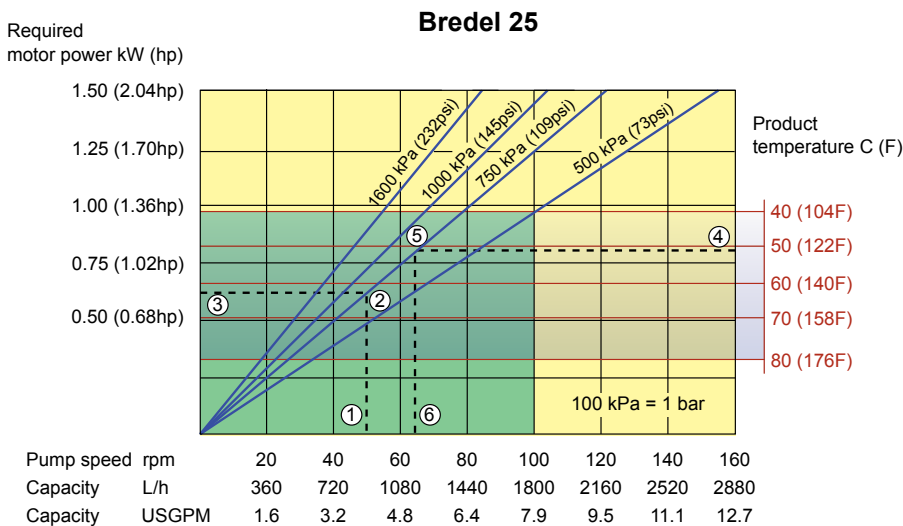
# Bredel SERIES Bredel Hose Pumps

## FEATURES AND BENEFITS

- Sealless, valveless pumping principle for reliable, low maintenance metering, dosing and transfer
- Flow rates up to 5,250 L/hr (23.1 USGPM) and pressures up to 16bar (232 psi)
- Dry running and self-priming, with up to 9.5 meters (30 foot) suction lift capability
- Robust design for aggressive chemicals or abrasives
- Compact direct coupled design to maximise gearbox life
- Simple hose change decreases cost of ownership, downtime and need for parts inventory



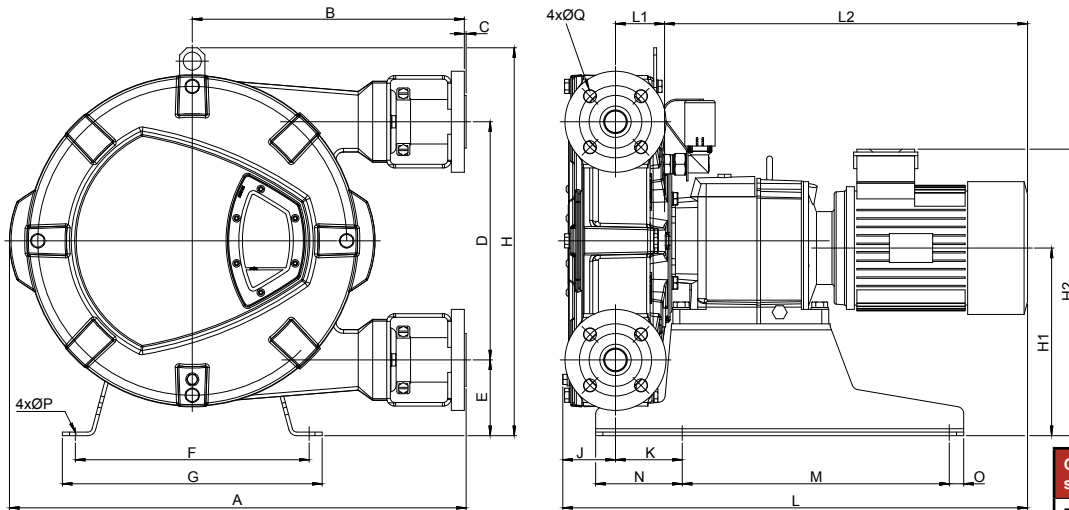
## PERFORMANCE



1. Flow required indicates pump speed
2. Calculated discharge pressure
3. Net motor power required
4. Product temperature
5. Calculated discharge pressure
6. Maximum recommended pump speed

Note: The area of continuous operation diminishes with increased product temperatures.  
For product temperatures >40C (104F), the area of continuous operation is limited by the corresponding red temperature line.

## DIMENSIONS



| Connector sizes | ANSI 150# | EN DIN | JIS  |
|-----------------|-----------|--------|------|
| Bredel 25       | 1"        | 25mm   | 25mm |

| Type               | A    | B   | C    | D    | E   | F   | G    | H    | H1  | H2max | J   | K   | Lmax | L1  | L2max | M   | N   | O   | ØP   | ØQ  | R   |
|--------------------|------|-----|------|------|-----|-----|------|------|-----|-------|-----|-----|------|-----|-------|-----|-----|-----|------|-----|-----|
| Bredel 25 (mm)     | 521  | 304 | 2.5  | 264  | 98  | 279 | 315  | 460  | 222 | 359   | 66  | 97  | 592  | 58  | 468   | 305 | 120 | 15  | 12   | 14  | 85  |
| Bredel 25 (inches) | 20.5 | 12  | 0.09 | 10.4 | 3.9 | 11  | 12.4 | 18.1 | 8.7 | 14.1  | 2.6 | 3.8 | 23.3 | 2.3 | 18.4  | 12  | 4.7 | 0.6 | 0.47 | 0.6 | 3.3 |

## TECHNICAL SPECIFICATIONS

| Bredel 25                   |                                 |
|-----------------------------|---------------------------------|
| Flow range                  | up to 2,880 L/hr (12.7 USGPM)   |
| Capacity                    | 0.300 L/rev (0.079 G/rev)       |
| Minimum starting torque     | 115Nm (1018 inch-lbs)           |
| Hose lubricant required     | 2 litres (0.53 USG)             |
| Pumphead weight             | 39kg (85.98lbs)                 |
| Max inlet pressure          | 3.5 bar abs (51 psia)           |
| <b>Common features</b>      |                                 |
| Suction pressure            | 0.05bar abs (0.73 psia)         |
| Maximum discharge pressure  | 1600 kPa (16 bar) (232psi)      |
| Product temperature range*  | -10C up to 80C (14F up to 176F) |
| Ambient temperature range** | -20C up to 45C (-4F up to 113F) |

\*Please consult your Bredel representative for lower or higher temperature operation.

\*\*Allowable ambient temperature is based on pump capabilities and may be further limited by gearbox ambient capabilities

## MATERIALS OF CONSTRUCTION

| Components     | Materials           |
|----------------|---------------------|
| Pump housing   | Cast iron           |
| Rotor          | Cast iron           |
| Pressing shoes | Aluminium or epoxy  |
| Cover          | Cast iron           |
| Brackets       | Galvanized steel    |
| Flanges        | Galvanized steel    |
| Inserts        | PVC                 |
| Support frame  | Galvanized steel    |
| Hose clamps    | Galvanized steel    |
| Seals          | Neoprene or nitrile |

| Options                                     | Features  |
|---|---|
| Available hose materials                    | EPDM  |
| Available flanges                           | ANSI  |
| Available inserts                           | Bredel standard or with sanitary connectors                         |
| High+low level float switch                 | Max. 2A, 230 V AC/DC, max. 40VA<br>ATEX: max. 50 mA, max. 28V AC/DC |
| Integrated FI for stand alone speed control | Factory programmable from 12-80 Hz                                  |
| Revolution counter                          | For maintenance and /or metering                                    |

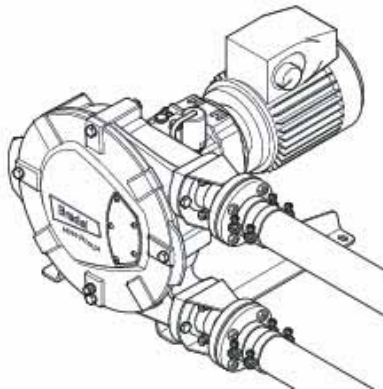
The information contained in this document is believed to be correct at the time of publication, but Watson-Marlow Bredel BV accepts no liability for any error it contains, and reserves the right to alter specifications without prior notice. All mentioned values in this document are values under controlled circumstances at our test bed. Actual flow rates achieved may vary because of changes in temperature, viscosity, inlet and discharge pressures and/or system configuration. APEX, DuCoNite®, Bioprene® and Bredel are registered trademarks.

**Bredel**  
Hose Pumps

wmpg.com  
+44 (0)1326 370 370  
info@wmpg.com

# Hose pump series Bredel 25

## Manual



© 2013 Watson-Marlow Bredel B.V.

All rights reserved.

The information provided herein may not be reproduced and/or published in any form, by print, photoprint, microfilm or any other means whatsoever (electronically or mechanically) without the prior written authorization of Watson-Marlow Bredel B.V.

Information within this manual is subject to change without notice. Neither Watson-Marlow Bredel B.V. nor any other representatives will be liable for damages arising out of or in connection with the use of this manual. This is a comprehensive limitation of liability that applies to all damages of any kind, including (without limitation) compensatory, direct, indirect or consequential damages, loss of data, income or profit, loss of or damage to property and claims of third parties

Watson-Marlow Bredel B.V. is providing this manual and its contents on an "as is" basis and makes no representations or warranties of any kind with respect to this manual or its contents. Watson-Marlow Bredel B.V. disclaims all such representations and warranties. In addition Watson-Marlow Bredel B.V. does not represent or warrant that the information accessible via this manual is accurate, complete or current.

Names, trade names, brands, etc. used by Watson-Marlow Bredel B.V. may not, as per the legislation concerning the protection of trade names, be considered as available.

---

**CONTENTS****1 GENERAL**

|     |  |   |
|-----|--|---|
| 1.1 | <i>How to use this manual</i> .....            | 8 |
| 1.2 | <i>Original instructions</i> .....             | 8 |
| 1.3 | <i>Other supplied documentation</i> .....      | 8 |
| 1.4 | <i>Service and support</i> .....               | 8 |
| 1.5 | <i>Environment and disposal of waste</i> ..... | 9 |

**2 SAFETY**

|     |   |    |
|-----|---|----|
| 2.1 | <i>Symbols</i> .....                                  | 10 |
| 2.2 | <i>Intended use</i> .....                             | 10 |
| 2.3 | <i>Use in potentially explosive atmospheres</i> ..... | 11 |
| 2.4 | <i>Responsibility</i> .....                           | 11 |
| 2.5 | <i>Qualification of the user</i> .....                | 12 |
| 2.6 | <i>Regulations and instructions</i> .....             | 12 |

**3 WARRANTIES****4 DESCRIPTION**

|       |   |    |
|-------|---|----|
| 4.1   | <i>Identification of the product</i> .....                | 14 |
| 4.1.1 | <i>Identification of the product</i> .....                | 14 |
| 4.1.2 | <i>Identification of the pump</i> .....                   | 14 |
| 4.1.3 | <i>Identification of the gearbox</i> .....                | 14 |
| 4.1.4 | <i>Identification of the electric motor</i> .....         | 15 |
| 4.1.6 | <i>Identification of the pump hose</i> .....              | 15 |
| 4.2   | <i>Construction of the pump</i> .....                     | 16 |
| 4.3   | <i>Operation of the pump</i> .....                        | 17 |
| 4.4   | <i>Pump hose</i> .....                                    | 18 |
| 4.4.1 | <i>General</i> .....                                      | 18 |
| 4.4.2 | <i>Hose compression force adjustment (shimming)</i> ..... | 20 |
| 4.4.3 | <i>Lubrication and cooling</i> .....                      | 20 |
| 4.5   | <i>Gearbox</i> .....                                      | 20 |
| 4.6   | <i>Electric motor</i> .....                               | 21 |
| 4.8   | <i>Available options</i> .....                            | 21 |

|          |  |    |
|----------|--|----|
| <b>5</b> | <b>INSTALLATION</b>                                      |    |
| 5.1      | <i>Unpacking</i> .....                                   | 22 |
| 5.2      | <i>Inspection</i> .....                                  | 22 |
| 5.3      | <i>Installation conditions</i> .....                     | 22 |
|          | 5.3.1 Ambient conditions .....                           | 22 |
|          | 5.3.2 Set-up .....                                       | 22 |
|          | 5.3.3 Pipework .....                                     | 23 |
| 5.4      | <i>Lifting and moving the pump</i> .....                 | 25 |
| 5.5      | <i>Placing the pump</i> .....                            | 26 |
| <b>6</b> | <b>COMMISSIONING</b>                                     |    |
| 6.1      | <i>Preparations</i> .....                                | 27 |
| 6.2      | <i>Commissioning</i> .....                               | 28 |
| <b>7</b> | <b>MAINTENANCE</b>                                       |    |
| 7.1      | <i>General</i> .....                                     | 29 |
| 7.2      | <i>Maintenance and periodic inspections</i> .....        | 29 |
| 7.3      | <i>Cleaning the pump hose</i> .....                      | 31 |
| 7.4      | <i>Changing lubricant</i> .....                          | 32 |
| 7.5      | <i>Changing oil in gearbox</i> .....                     | 33 |
| 7.6      | <i>Replacing pump hose</i> .....                         | 34 |
|          | 7.6.1 Removing pump hose .....                           | 34 |
|          | 7.6.2 Cleaning the pump head .....                       | 36 |
|          | 7.6.3 Fitting the pump hose .....                        | 37 |
| 7.7      | <i>Exchanging replacement parts</i> .....                | 40 |
|          | 7.7.1 General .....                                      | 40 |
|          | 7.7.2 Replacing pressing shoes .....                     | 40 |
|          | 7.7.3 Replacing seal ring, bearings and wear ring .....  | 42 |
| 7.8      | <i>Adjusting hose compression force (shimming)</i> ..... | 46 |
| 7.9      | <i>Fitting options</i> .....                             | 48 |
|          | 7.9.1 Fitting a high-level float switch .....            | 48 |
|          | 7.9.2 Fitting a high and low level float switch .....    | 50 |
|          | 7.9.3 Replacing the revolution counter .....             | 51 |
| <b>8</b> | <b>STORAGE</b>   |    |
| 8.1      | <i>Hose pump</i> .....                                   | 53 |
| 8.2      | <i>Pump hose</i> .....                                   | 53 |

---

**9 TROUBLESHOOTING****10 SPECIFICATIONS**

|        |                                      |    |
|--------|--------------------------------------|----|
| 10.1   | <i>Pump head</i> .....               | 59 |
| 10.1.1 | Performance .....                    | 59 |
| 10.1.2 | Materials .....                      | 60 |
| 10.1.3 | Surface treatment .....              | 61 |
| 10.1.4 | Lubricant table pump .....           | 61 |
| 10.1.5 | Weights .....                        | 62 |
| 10.1.6 | Torque figures .....                 | 63 |
| 10.1.7 | Shims specifications .....           | 65 |
| 10.2   | <i>Lubricant table gearbox</i> ..... | 66 |
| 10.3   | <i>Gearbox</i> .....                 | 67 |
| 10.4   | <i>Electric motor</i> .....          | 68 |
| 10.6   | <i>Parts list</i> .....              | 69 |
| 10.6.1 | Overview .....                       | 69 |
| 10.6.2 | Cover assembly .....                 | 70 |
| 10.6.3 | Rotor assembly .....                 | 71 |
| 10.6.4 | Pump housing assembly .....          | 72 |
| 10.6.5 | Support assembly .....               | 73 |
| 10.6.6 | Flange assembly .....                | 74 |
| 10.6.7 | Revolution counter assembly .....    | 75 |
| 10.6.8 | Lubricant .....                      | 75 |

---

## 1 GENERAL

### 1.1 How to use this manual

This manual is intended as a reference book by means of which qualified users are able to install, commission and maintain the hose pumps mentioned on the front cover.

### 1.2 Original instructions

The original instructions for this manual have been written in English. Other language versions of this manual are a translation of the original instructions.

### 1.3 Other supplied documentation

Documentation of components such as electric motors, gearboxes, etc. is normally not included in this manual. But if additional documentation is supplied, you must follow the instructions in this additional documentation.

### 1.4 Service and support

For information with respect to specific adjustments, installation, maintenance or repair jobs which fall beyond the scope of this manual, contact your Bredel representative. Make sure you have the following data at hand:

- Serial number hose pump
- Article number pump hose
- Article number gearbox
- Article number electric motor
- Article number frequency controller

You will find these data on the identification plates or stickers of the pumphead, the pump hose, the gearbox and the electric motor. Refer to § 4.1.1.

## 1.5 Environment and disposal of waste

**CAUTION**


Always observe the local rules and regulations with respect to processing (non reusable) parts of the hose pump.


Inquire within your local government about the possibilities for reuse or environment-friendly processing of packaging materials, (contaminated) lubricant and oil.


## 2 SAFETY


### 2.1 Symbols

In this manual the following symbols are used:

|  |  |
|--|--|
|  | <b>WARNING</b><br>Procedures which, if not carried out with the necessary care, may result in serious damage to the hose pump or in serious bodily harm. |
|--|--|

|  |   |
|--|---|
|  | <b>CAUTION</b><br>Procedures which, if not carried out with the necessary care, may result in serious damage to the hose pump, the surrounding area or the environment. |
|--|---|

|   |                                  |
|---|----------------------------------|
|  | Remarks, suggestions and advice. |
|---|----------------------------------|

|  |   |
|--|---|
|  | <b>WARNING</b><br>Procedures, remarks, suggestions or advice which refer to use in potentially explosive atmospheres in accordance with the ATEX Directive 94/9/EC. |
|--|---|

### 2.2 Intended use

The hose pump is exclusively designed for pumping suitable products. Every other or further use is not in conformance with the intended use.

The "Intended use" as laid down in EN 292-1 is "... the use for which the technical product is intended in accordance with the specifications of the manufacturer, inclusive of his indications in the sales brochure". In case of doubt it is the use which appears to be its intended use judging from the construction, execution

and function of the product. Observing the instructions in the user's documentation also belongs to intended use.

Only use the pump in accordance with the intended use described above. The manufacturer cannot be held responsible for damage or harm resulting from misuse. If you want to change the application of your hose pump, contact your Bredel representative first.

### 2.3 Use in potentially explosive atmospheres

The *pump head* and *gearbox* mentioned in this manual are suitable for use in a potentially explosive atmosphere. The pumps mentioned meet the requirements as stated in the European Directive 94/9/EC (ATEX Directive).

The pumps belong to:

- Group II Appliances, category 2 GD ck T4

### 2.4 Responsibility

The manufacturer does not accept any responsibility for damage or harm caused by not (strictly) observing the safety regulations and instructions in this manual and the also supplied documentation, or by negligence during installation, use, maintenance and repair of the hose pumps mentioned on the front cover. Depending on the specific working conditions or accessories used, additional safety instructions can be required.

Immediately contact your Bredel representative, if you noticed a potential danger while using your hose pump.



#### **WARNING**

The user of the hose pump is always fully responsible for observing the local valid safety regulations and directives. Observe these safety regulations and directives when using the hose pump.

## **2.5 Qualification of the user**

The installation, use and maintenance of the hose pump should only be performed by well-trained and qualified users. Temporary staff and persons in training may use the hose pump only under the supervision and responsibility of trained and qualified users.

## **2.6 Regulations and instructions**

- Everyone who works with the hose pump must be aware of the contents of this manual and observe the instructions with great care.
- Never change the order of the actions to be carried out.
- Always store the manual near the hose pump.

### **3 WARRANTIES**

The manufacturer offers a two-year warranty on proper workmanship of all parts of the hose pump. Exclusion is made for normal wear and tear of consumables such as pump hoses, lubricant, hose clamps, pressing shoes, ball bearings, wear rings, seals and rubber bushes, or parts which have been misused or damaged through negligence.

This manufacturer's warranty is null and void for any user who has substituted the parts of an alternate manufacturer into a Watson-Marlow Bredel (hereafter called Bredel) hose pump.

Damaged parts may be returned to the manufacturer for warranty analysis. If failure was determined caused by faulty workmanship, the manufacturer will repair or replace the faulty component.

The parts must be accompanied by a fully completed and signed health and safety form, as present in the back of this manual. The form must be applied to the outside of the shipping carton.

Parts which have been contaminated or which have been corroded by chemicals or other substances that can pose a health risk must be cleaned before they are returned to the manufacturer. Furthermore, it should be indicated on the health and safety form, which specific cleaning procedure has been followed, and it should be indicated that the equipment has been decontaminated. The safety form is required at all items, even if the parts have not been used.

Warranties purporting to be on behalf of Bredel made by any person, including representatives of Bredel, its subsidiaries, or its distributors, which do not accord with the terms of this warranty shall not be binding upon Bredel, unless expressly approved in writing by a Director or Manager of Bredel.

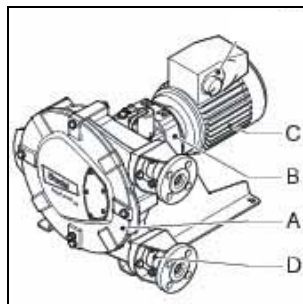
## 4 DESCRIPTION

### 4.1 Identification of the product

#### 4.1.1 Identification of the product

The hose pump can be identified based on the identification plates or stickers on:

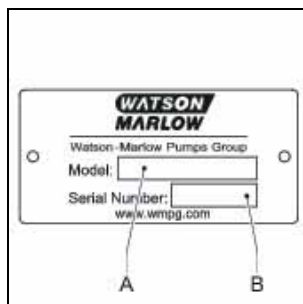
- A: Pump head
- B: Gearbox
- C: Electric motor
- D: Pump hose



#### 4.1.2 Identification of the pump

The identification plate on the pump head contains the following data:

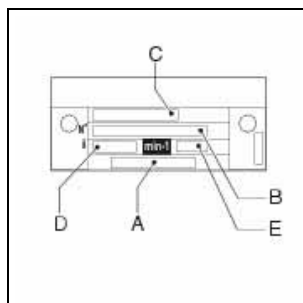
- A: Pump model
- B: Serial number



#### 4.1.3 Identification of the gearbox

The identification plate on the gearbox contains the following data:

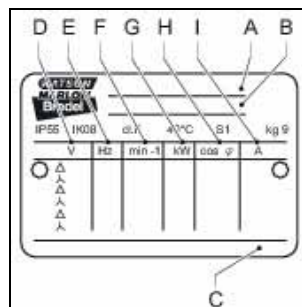
- A: Article number
- B: Serial number
- C: Type number
- D: Reduction ratio
- E: Number of revolutions per minute



#### 4.1.4 Identification of the electric motor

The identification plate on the electric motor contains the following data:

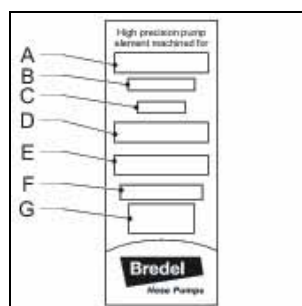
- A:** Type number
- B:** Serial number
- C:** Article number
- D:** Mains
- E:** Frequency
- F:** Speed
- G:** Power
- H:** Power factor
- I:** Current

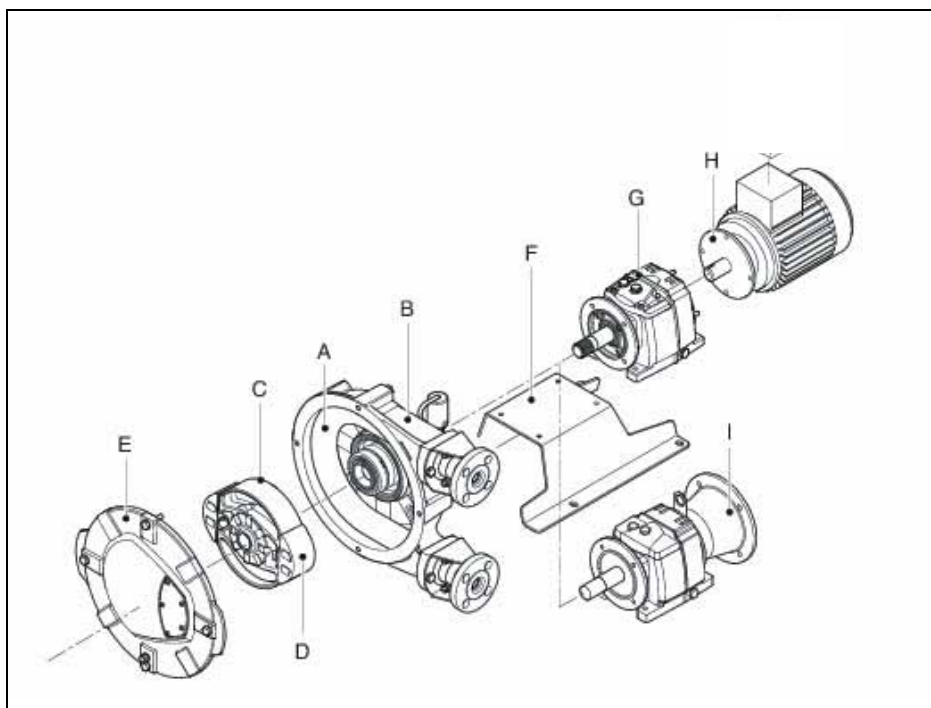


#### 4.1.6 Identification of the pump hose

The identification sticker on the pump hose contains the following data:

- A:** Pump type
- B:** Reorder number
- C:** Internal diameter
- D:** Type of material of inner liner
- E:** Remarks, if applicable
- F:** Maximum permissible working pressure
- G:** Production code



**4.2 Construction of the pump**

- A:** Pump hose
- B:** Pump housing
- C:** Rotor
- D:** Pressing shoes
- E:** Cover
- F:** Support
- G:** Gearbox
- H:** Electric motor
- I:** Adapter without motor (option)

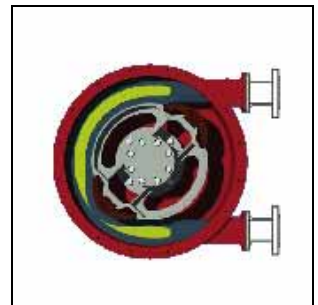
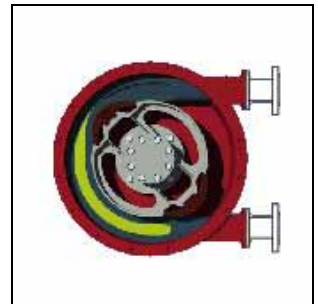
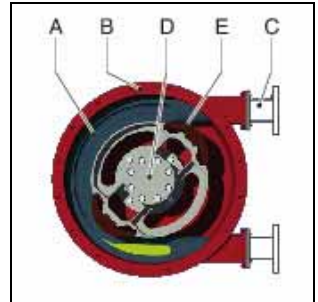
### 4.3 Operation of the pump

The heart of the pump head consists of a specially constructed pump hose (A) which lies contorted against the inside of the pump housing (B). Both ends of the hose are connected to the suction and discharge lines by means of a flange construction (C). A bearing-mounted rotor (D) with two facing pressing shoes (E) is in the center of the pump head.

In phase 1 the lower pressing shoe compresses the pump hose by the rotational movement of the rotor, forcing the fluid through the hose. As soon as the pressing shoe has passed, the hose recovers to its original shape due to the mechanical properties of the material.

In phase 2 the product is drawn into the hose by the (continuous) turning motion of the rotor.

In phase 3, the second pressing shoe will subsequently compress the pump hose. Due to the continuous rotating movement of the rotor not only new product is sucked in, but also the already present product is pressed out by the pressing shoe. When the first pressing shoe runs from the pump hose, the second pressing shoe has already closed the pump hose and the product is prevented from flowing back. This method of liquid displacement is also known as the "positive displacement principle".

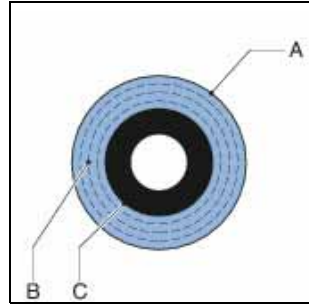


## 4.4 Pump hose

### 4.4.1 General

The pump hose is made of special rubbers, reinforced with nylon cords and is constructed as follows:

- A:** Outer extruded layer made of natural rubber
- B:** Four nylon reinforcement layers
- C:** Inner extruded liner



The pump hose liner material should be chemically resistant with the product to be pumped. Dependent on the specific requirements of your application a corresponding pump hose must be selected. For each pump model various hose types are available.

The material of the inner liner of the pump hose determines the hose type. Each hose type is marked by a unique color code.

| Hose type | Material       | Color code |
|-----------|----------------|------------|
| NR        | Natural rubber | Purple     |
| NBR       | Nitrile rubber | Yellow     |
| EPDM      | EPDM           | Red        |
| CSM       | CSM            | Blue       |

#### Natural Rubber\*

Always the first choice hose. A highly dynamic material, which has excellent abrasion resistance and mechanical strength, and is generally resistant to diluted acids and alcohols.

Max. liquid temperature 80 °C (175 °F).

Min. temperature -20 °C (-5 °F).

#### Nitrile rubber\*

A highly abrasion proof and wear resistant material that is generally resistant to oils, fats, alkaline, and detergents. Suitable for a wide range of food handling and meets FDA and 3A standards.

Max. liquid temperature 80 °C (175 °F).

Min. temperature -10 °C (15 °F).

**EPDM\***

Good chemical resistance especially to concentrated acids, ketones, and alcohols.

Max. liquid temperature 90 °C (195 °F).

Min. temperature -10 °C (15 °F).

Consult Bredel technical services for details on higher temperature operation, up to 90 °C (195 °F) with EPDM.

**CSM\***

Good chemical resistance for strong oxidizing products like concentrated acids and oxygen generating substances.

Max. liquid temperature 80 °C (175 °F).

Min. temperature -10 °C (15 °F)

Consult Bredel technical services for RPM limitations when using CSM.



\* Consult your Bredel representative for more detailed information about the chemical and temperature resistance of pump hoses.

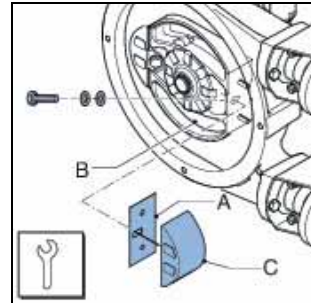
The Bredel pump hoses have been carefully machined, therefore there are minimum tolerances in wall thickness. This is very important to guarantee the correct compression of the pump hose, because:

- When the compression is too high, it creates a load on the pump and pump hose that is too high, which may result in a reduction of the life of the pump hose and bearings.
- When the compression is too low this will result in high velocity backflow (slip). Backflow results in a reduction of pump performance, hydraulic efficiency, and negatively impact the life of the pump hose.

#### 4.4.2 Hose compression force adjustment (shimming)

In order to achieve optimal life of the pump hose, the compression force of the pump hose can be adjusted by placing a number of shims under the pressing shoes. The shims (A) are fitted between the rotor (B) and the pressing shoe (C). The number of shims will vary for each discharge pressure situation.

The paragraph 7.8 describes how to select and install the shims.



#### 4.4.3 Lubrication and cooling

The pump head, in which the rotor and pump hose can be found, is filled with Bredel Genuine Hose Lubricant. This lubricant lubricates the movement between the hose and the pressing shoes and dissipates the generated heat via the pump housing and the cover.

The lubricant is food grade. See § 10.1.4 for the required quantity and NSF registration.

|  |  |
|--|--|
|  | Consult your Bredel representative for lubrication recommendations when operating the hose pump below 2 rpm. |
|--|--|

#### 4.5 Gearbox

The hose pump types described in this manual use co-axial gearbox units.

The gearboxes are fitted with a foot rest. The outgoing shaft has been fitted with a spline.

#### 4.6 Electric motor

If the electric motor has been standard supplied by the manufacturer, it is an integrated standardized squirrel-cage motor. Refer to § 10.4 for specifications. If the pump is to be used in potentially explosive atmospheres, contact your Bredel representative.

#### 4.8 Available options

The following options are available for the hose pump:

- High (lubricant) level float switch
- Low (lubricant) level float switch
- Revolution counter
- Epoxy pressing shoes
- Stainless steel 316 flanges, flange brackets, hose clamps, support and mounting articles
- Pump support for non-standard gearbox types
- Special configuration for use in potentially explosive atmospheres.



The high level float switch is mandatory for use in potentially explosive atmospheres. If the pump is to be used in potentially explosive atmospheres, contact your Bredel representative.

## **5 INSTALLATION**

### **5.1 Unpacking**

When unpacking carefully follow the instructions as given on the packaging or on the hose pump.

### **5.2 Inspection**

Check that your delivery is correct and check it for any transport damage. Refer to § 4.1.1. Report any damage immediately to your Bredel representative.

### **5.3 Installation conditions**

#### **5.3.1 Ambient conditions**

Make sure that the hose pump is in an area where the ambient temperature during operation is not lower than -20 °C (-4 °F) and not higher than +45 °C (+113 °F).

#### **5.3.2 Set-up**

- The pump materials and protective layers are suitable for indoor set-up and a protected outdoor set-up. Under certain conditions the pump is suitable for limited outdoor set-up or a salty or aggressive atmosphere. Consult your Bredel representative for more information.
- Make sure that the floor surface has a maximum slope of 10 mm per meter (0.12 inch per foot).
- Make sure that there is sufficient room around the pump to carry out the necessary maintenance.
- Make sure that the room is sufficiently ventilated, so that the heat developed by the pump and drive can be dissipated. Keep some distance between the ventilation cover of the electric motor and the wall to allow the supply of cooling air.

### 5.3.3 Pipework

When determining and connecting suction and discharge lines consider the following points:

- **Do** keep delivery and suction lines as short and direct as possible.
- Keep the piping at a minimum equal to or greater than the bore size of the pump. Increase the bore size of the pipe work when the duty fluid has a high velocity or inertia. This will help keep friction and impulse losses to a minimum. Where critical velocities are a concern consult your Bredel representative.
- **Do** limit the presence of sharp bends in the process lines. Make sure that the radius of any bends is as large as possible ( $R=4d$  to  $5d$ ). It is recommended to use Y-connections instead of T-connections.
- Consult your Bredel representative for recommendations on mounting pulsation dampening devices. A pulsation dampener and/or inlet pulse accumulator may be necessary if the relative density and pump speed is high and the line lengths are long.
- The self-priming and positive displacement nature of peristaltic pumps means that valves are not required. If for whatever reason, valves are fitted into the system, they must have a straight fluid path and cause minimum restriction to flow in the pumping circuit. Note that check valves directly in the process stream may increase pulsation and negatively impact hose life.
- For ease of hose changing and some pulsation suppression, it is recommended to use a segment of flexible hose between the pump flange and hard piping of the suction and/or discharge line. A segment of three quarters ( $3/4$ ) of the pump hose length for the flexible pipe work is recommended. Bredel also recommends installing an isolation valve and

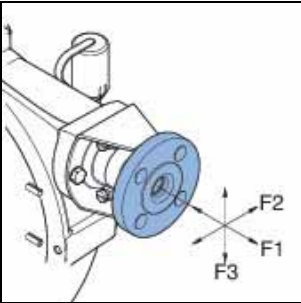
pipe-drain in the suction and discharge pipe work to allow fluid isolation and drainage from the pump during maintenance. Following these recommendations will help minimize process fluid exposure by maintenance personnel.

- For the flexible hoses select compatible materials and ensure the installation is suited for the design pressure of the system.
- Prevent any possibilities of exceeding the maximum working pressure of the hose pump. Refer to § 10.1.1. If necessary install a pressure relief valve or shutdown switch. Consult your Bredel representative for more detailed information.

|  |  |
|--|--|
|  | <p><b>CAUTION</b></p> <p>Consider the maximum permissible working pressure on the discharge side. Exceeding the maximum working pressure may lead to serious damage to the pump.</p> |
|--|--|

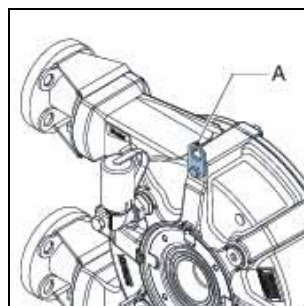
- Make sure that the maximum forces on the flanges are not exceeded. The permissible loads are given in the following table.

| Maximum permissible loads on the pump flange |      |           |
|--|------|-----------|
| Force  | Unit | Bredel 25 |
| F1   | N    | 600       |
|  | lbf  | 135       |
| F2   | N    | 500       |
|  | lbf  | 112       |
| F3   | N    | 200       |
|  | lbf  | 45        |



#### 5.4 Lifting and moving the pump

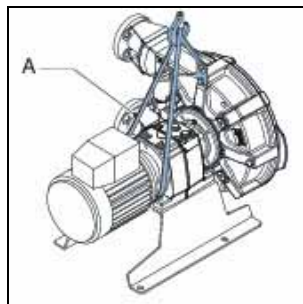
For lifting and moving the *pump head*, it has been fitted with a lifting strip. This lifting strip (A) is fitted on the rear of the pump head. For the weights, refer to § 10.1.5.



The complete hose pump, i.e. pump head, gearbox and electric motor, must be lifted using the lifting strip of the pump head plus additional support using suitably rated straps or slings (A). For the weights, refer to § 10.1.5.

**WARNING**

If the pump is to be lifted ensure that all standard lifting practices are adhered to and carried out by qualified personnel only.

**5.5 Placing the pump**

Position the pump on a horizontal surface. Use suitable anchor bolts to attach the pump to the floor surface.

## 6 COMMISSIONING

### 6.1 Preparations

**WARNING**

A Bredel VFD that is fitted *without the control switch* starts automatically when power is applied.

**WARNING**

Disconnect and lock the power supply to the pump drive before any work is carried out.  
In case the motor is fitted with a frequency controller and has a single-phase power supply, wait two minutes to make sure that the capacitors have discharged.

1. Connect the electric motor and, if present, the frequency controller in conformance with the locally applicable rules and regulations. Refer to § 5.3.4. Have the electrical installation work be carried out by qualified personnel.
2. Check that the lubricant level is above the minimum level line in the inspection window. If necessary refill Bredel Genuine Hose Lubricant via the breather/vent plug. See also § 7.4.
3. Check the rotation of the rotor. The rotational direction of the rotor must match the configuration of suction and discharge piping.
4. Check that the correct number of shims corresponds with your application. Refer to § 10.1.7.  
For adjusting the compression force of the hose, refer to § 7.8.

---

## 6.2 Commissioning

1. Connect the pipework.
2. Make sure that there are no obstructions such as closed valves.
3. Switch on the hose pump.
4. Check the rotation of the rotor.
5. Check the capacity of the hose pump. If the capacity differs from your specification, follow the instructions in chapter 9 or consult your Bredel representative.
6. Check the capacity range of the frequency controller. In case of any deviations consult the documentation of the supplier.
7. Check the hose pump in accordance with points 2 to 4 of the maintenance table from § 7.2.

## 7 MAINTENANCE

### 7.1 General

**WARNING**

Disconnect and lock the power supply to the pump drive before any work is carried out.

In case the motor is fitted with a frequency controller and has a single-phase power supply, wait two minutes to make sure that the capacitors have discharged.

**WARNING**

Only use original Bredel parts when maintaining the hose pump. Bredel cannot guarantee correct operation and any consequential damage that occurs from the use of non-original Bredel components.

See also chapters [2](#) and [3](#).

### 7.2 Maintenance and periodic inspections

The following maintenance scheme shows the maintenance and periodic inspections that need to be carried out on the hose pump to guarantee an optimal safety, operation and life of the pump.

| Point | Action  | To be carried out  | Remark  |
|-------|---|--|---|
| 1     | Check the lubricant level.  | Before startup of the pump and on a scheduled interval during operation.   | Make sure that the lubricant level is above the minimum level line in the inspection window. If necessary refill the lubricant. See also § 7.4. |
| 2     | Check the pump head for any leakage of lubricant around the cover, the flanges and the rear of the pump head. | Before startup of the pump and on a scheduled interval during operation.   | See § 9.  |
| 3     | Check the gearbox on any leakage.   | Before startup of the pump and on a scheduled interval during operation.   | In case of leakage consult your Bredel representative.  |
| 4     | Check pump for deviating temperature or strange noises.   | On a scheduled interval during operation.  | See § 9.  |
| 5     | Check pressing shoes for excessive damage.  | When replacing the pump hose.  | See § 7.6.  |
| 6     | Internal cleaning of the pump hose.   | Cleaning of the system or product change.  | See § 7.3.  |
| 7     | Replacing pump hose.  | Preventive, this means after 75% of the hose life of the first hose.   | See § 7.6.  |
| 8     | Changing lubricant.   | After every 2 <sup>nd</sup> hose change or after 5,000 service hours, whichever comes first or after hose rupture. | See § 7.4   |
| 9     | Changing oil in gearbox.  | Refer to lubricant table in § 10.2.  | See § 7.5.  |
| 10    | Replacing pump seal.  | If necessary.  | See § 7.7.3.  |
| 11    | Replacing wear ring.  | If necessary.  | See § 7.7.3.  |

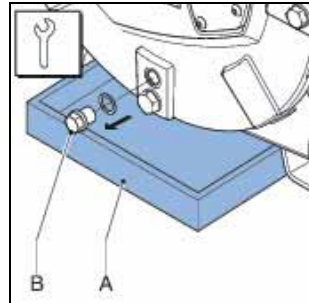
| Point | Action                    | To be carried out  | Remark   |
|-------|---------------------------|--|--|
| 12    | Replacing pressing shoes. | Wear on the running surface.   | See § 7.7.2.   |
| 13    | Replacing bearings.       | If necessary.  | See § 7.7.3.   |
|       |                           | In potentially explosive atmospheres preventive after 20,000 hrs. service or when damage is suspected. | See § 7.7.2.<br>Exclusively applicable in potentially explosive atmospheres (Group II Appliances, category 2 GD c k T4). |
| 14    | Cleaning the hose pump.   | In potentially explosive (dust) atmospheres, the dust must be removed regularly.                       | Exclusively applicable in potentially explosive atmospheres (Group II Appliances, category 2 GD c k T4).                 |

### 7.3 Cleaning the pump hose

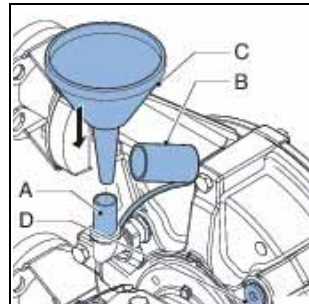
Running the pump with clean water can clean the inside of the pump hose. If a cleaning fluid is added to the water, attention must be given to its compatibility with the hose liner material, and also the temperature at which the cleaning procedure will be performed. Sometimes a cleaning sponge can be very helpful. With many products, it is necessary to clean the pump hose immediately once the pump is stopped to avoid sedimentation and/or hardening of the product within the hose that can cause damage upon restart.

### 7.4 Changing lubricant

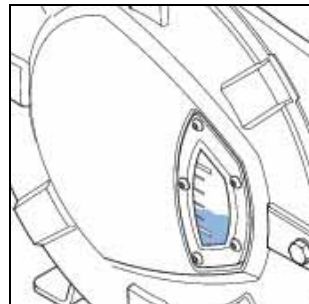
1. Place a tray (A) under the drain plug in the cover of the pump. Remove the drain plug (B). Catch the lubricant from the pump housing in the tray. Position the drain plug and tighten it firmly.




2. The pump housing can be filled with lubricant via the breather/vent (A) on the rear of the pump housing. For this purpose remove the breather cap (B) and position a funnel (C) in the breather. In order to facilitate the filling with lubricant the breather cap (D) on the rear of the pump housing can be removed. Pour the lubricant in the pump housing via the funnel.



3. Keep on pouring until the lubricant level has risen at least until just above the minimum level line in the inspection window.



|  |  |
|--|--|
|  | For the required quantity of lubricant, refer to § 10.1.4. |
|--|--|

## 7.5 Changing oil in gearbox

1. Isolate the pump from the electrical supply.
2. Remove plug (A) and let the oil run out of the gearbox.
3. The plug (A) is magnetically loaded. In this way metal particles in the oil are pulled to the plug. Clean the plug and remove any metal particles if necessary. Check that the sealing ring is not damaged and replace it if necessary. Place the plug back in the gearbox and tighten it firmly.
4. Remove level plug (B) and filling plug (C) and position a funnel in the hole and fill the gearbox with oil until the oil just comes out of the level plug hole (B). Wait shortly to let out any entrapped air. Place plug (B) and filling plug (C) back and tighten them firmly.

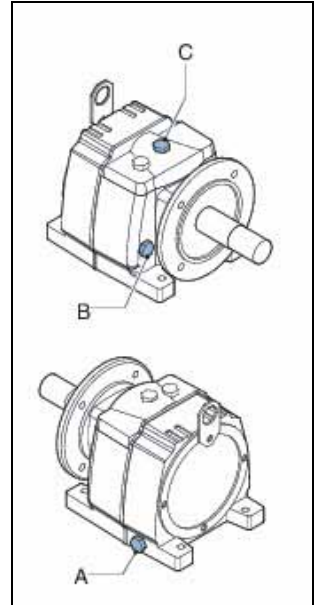


For the required lubricant, refer to § 10.2.



### WARNING

To prevent damage to the gears, do not operate the pump unless proper volume of oil is filled into the gearbox.



5. Switch on the electrical supply to the pump.

## 7.6 Replacing pump hose

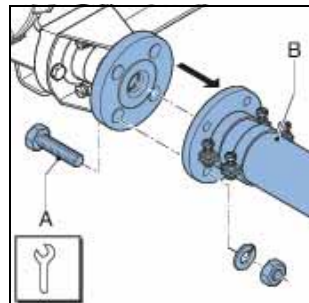
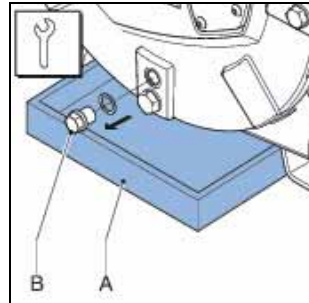
### 7.6.1 Removing pump hose



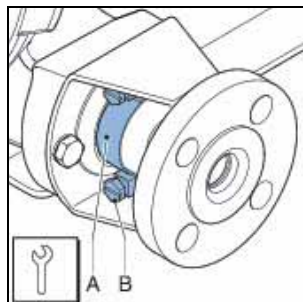
**CAUTION**

For all weight and torque adjustment, please refer to the technical information section at the rear of this manual.

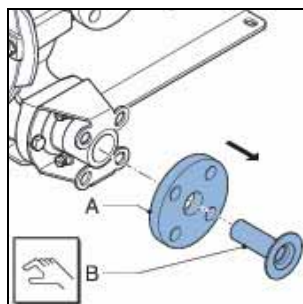
1. Isolate the pump from the electrical supply.
2. Close any shut-off valves in both the suction and discharge line to minimize product loss.
3. Place a tray (A) under the drain plug in the bottom of the pump head. The tray must be large enough to contain the lubricant, possibly contaminated with product fluid, from the pump head. Remove the drain plug (B). Catch the lubricant from the pump housing in the tray. Check that the breather vent mounted on the rear is not obscured. Position the drain plug and tighten it firmly.
4. Loosen the retaining bolts (A) of both the suction and discharge line (B). Disconnect the suction and discharge lines.



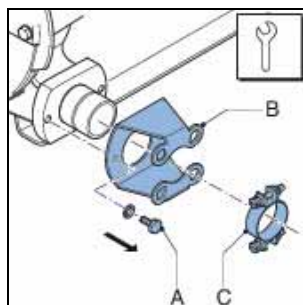
5. Loosen hose clamp (A) of both the inlet and outlet ports by loosening retaining bolt (B).



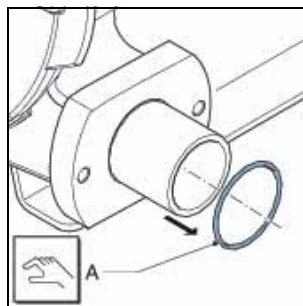
6. Pull the insert (B) from the hose and remove the flanges (A). Carry out this procedure both for the inlet and outlet ports.




7. Loosen the retaining bolts (A) of the flange bracket (B) and remove the bolts. Slide the flange bracket and the hose clip (C) off the hose. Carry out this procedure both for the inlet and outlet ports.




8. Slide off the sealing ring (A). Check that the sealing ring is not deformed or damaged and replace it if necessary. Carry out this procedure both for the inlet and outlet ports.

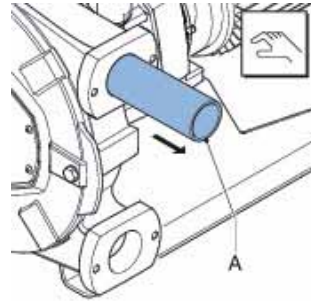


- Switch on the electrical supply.

|  |  |
|--|--|
|  | <p><b>WARNING</b><br/>Removal of the hose is a powered process and requires rotation of the pump. Ensure body and tools are clear from moving parts prior to proceeding with hose removal.</p> |
|--|--|

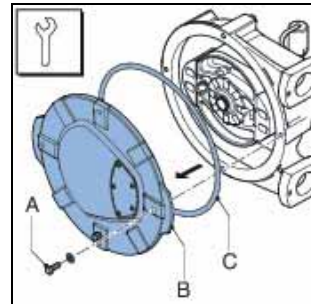
- Power out the hose (A) from the pump chamber by jogging the drive motor.

|  |   |
|--|---|
|  | <p><b>WARNING</b><br/>During jogging the drive:</p> <ul style="list-style-type: none"> <li>- Do not stand in front of the pump ports.</li> <li>- Do not try to guide the hose by hand.</li> </ul> |
|--|---|



### 7.6.2 Cleaning the pump head

- Isolate the pump from the electrical supply.
- Remove the cover (B) by loosening the retaining bolts (A).
- Check the sealing ring (C) and replace it if necessary.
- Rinse the pump head with clean water and remove all residues. Make sure that no rinsing water remains in the pump head.



5. Check the pressing shoes for wear or damage and replace them if necessary. Refer to § 7.7.2. Also see the maintenance scheme in § 7.2.

**CAUTION**

When the pressing shoes are worn the compression force of the hose decreases. If the compression force is too low, this results in a loss of capacity by the backflow of the liquid to be pumped. Backflow results in a reduction of the life of the pump hose.

6. Replace the cover and fasten the retaining bolts with the correct torque. Refer to § 10.1.6.
7. Switch on the electrical supply to the pump.

### 7.6.3 Fitting the pump hose

**WARNING**

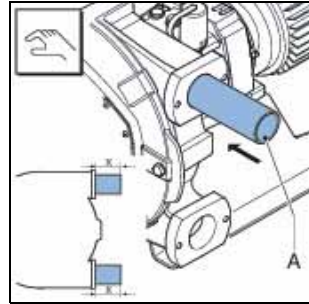
Fitting the pump hose is a powered process and requires pump rotation. Ensure the pump cover is properly fitted and that body and tools are clear from moving parts.


**WARNING**

For all weight and torque adjustment, please refer to the technical information section at the rear of this manual.

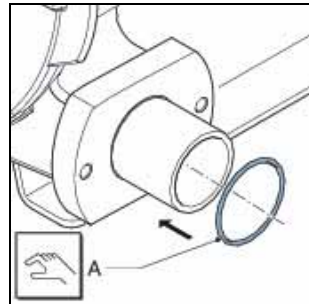
1. Clean the (new) pump hose on the outside and fully lubricate it with Bredel Genuine Hose Lubricant.
2. Turn on the pump and note the direction of the pump rotation.

3. Fit the pump hose (A) via one of the ports – whichever is the suction based on rotation direction. Feed the hose into the port and allow the pressing shoe to draw the hose in the pump housing. The rotor will move the hose.

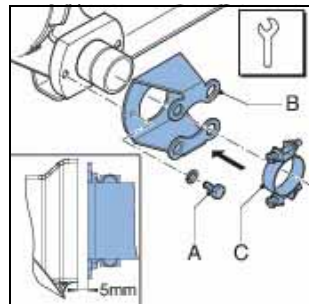


|  |  |
|--|--|
|  | <p><b>WARNING</b></p> <p>During jogging the drive:</p> <ul style="list-style-type: none"> <li>- Do not stand in front of the pump ports.</li> <li>- Do not try to guide the hose by hand.</li> </ul> |
|--|--|

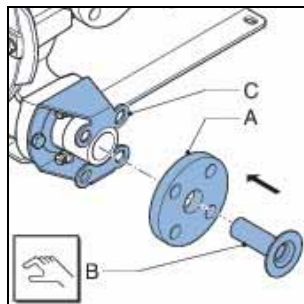
4. Stop the motor when the hose sticks out equally from both sides of the pump housing.
5. First fit the inlet port. Fit the sealing ring. Before mounting, check that the sealing ring (A) is not deformed or damaged and replace it if necessary.



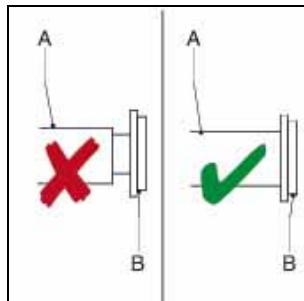
6. Before fitting check that the hose clamp is not damaged and replace it if necessary. Slide the flange bracket (B) and the hose clamp (C) over the hose together. Align the holes in the flange bracket with the ones at the front of the port. Position the two retaining bolts (A) and tighten them until they are approx. 5 mm (3/16") from the port, so that the gap between the flange bracket and the port remains.



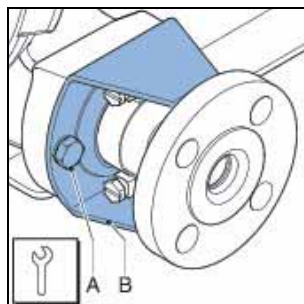
7. Slide insert (B) in flange (A) and press the insert in the hose. If necessary lubricate the insert with Bredel Genuine Hose Lubricant in order to simplify mounting. Make sure that the holes in flange (A) are aligned with the holes in flange bracket (C). Check that the insert is in the correct place. If the insert is not positioned correctly the product to be pumped may leak or the lubricant may leak.



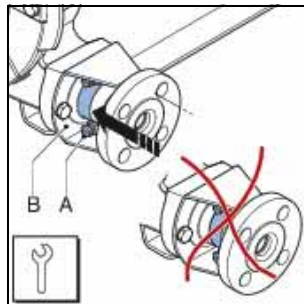
8. Turn the rotor in such a way that the hose (A) is pressed firmly against the flange surface (B).



9. Now fully tighten the retaining bolts (A) of the flange bracket (B). Make sure the bolts are tightened with the correct torque. Refer to § 10.1.6.



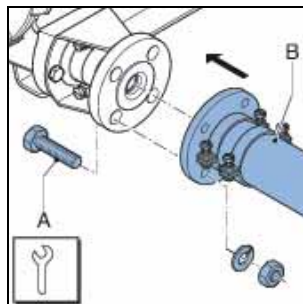
10. Position hose clamp (A) against O-ring chamber of the flange bracket (B) and fasten the retaining bolt. Make sure the bolts are tightened with the correct torque. Refer to § 10.1.6.



11. Now fit the other port. For this port proceed in the same way as described above for the inlet port.

12. Fill the pump housing with Bredel Genuine Hose Lubricant. Refer to § 7.4.

13. Fit the suction and discharge lines (B) and the retaining bolts (A). Tighten the retaining bolts with the correct torque. Refer to § 10.1.6.



## 7.7 Exchanging replacement parts

### 7.7.1 General

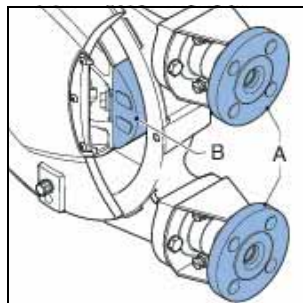


#### **CAUTION**

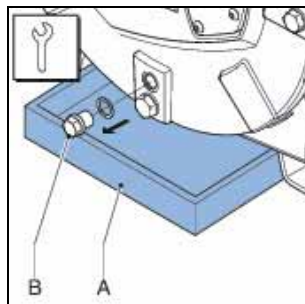
Items may be heavy. For all weight and torque adjustments for replacement procedures under this section, please refer to the technical information in chapter 10.

### 7.7.2 Replacing pressing shoes

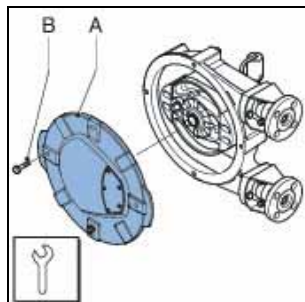
1. Jog the motor until the pressing shoe (B) is positioned between the inlet and outlet port (A).
2. Isolate the pump from the electrical supply.



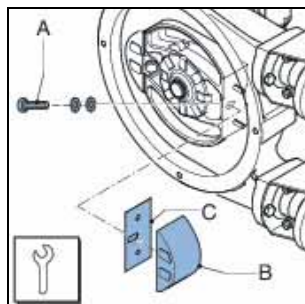
3. Place a tray (A) under the drain plug in the cover of the pump. Remove the drain plug (B). Catch the lubricant from the pump housing in the tray. Position the drain plug and tighten it firmly.



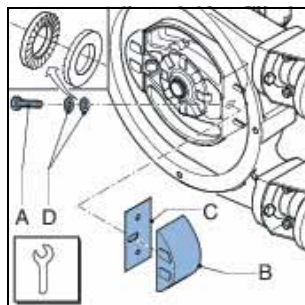
4. Remove the cover (A) by loosening the four retaining bolts (B).



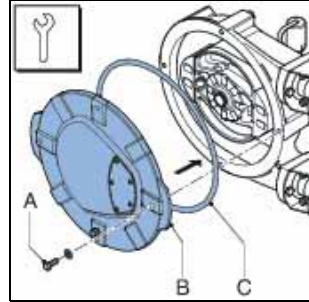
5. Loosen the retaining bolt (A) of the pressing shoe (B) and remove the shoe. Remove the shims (C) if present.



6. Fit the removed shims (C) again. Position the (new) pressing shoe (B), check that the Nord-Lock® rings (D) have been positioned correctly and tighten the retaining bolt(s) (A) a few turns. Refer to § 10.1.6.

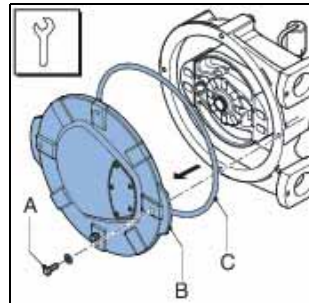


7. Check the gasket (C) for damage and replace if necessary. Refit the cover (B). Make sure that the 4 bolts (A) are refitted and that they are tightened in the correct order, diagonally opposite each other. Refer to § 10.1.6.
8. Switch on the electrical supply.
9. Jog the motor until the second pressing shoe is positioned between the inlet and outlet port.
10. Isolate the pump from the electrical supply.
11. Repeat the procedure for removing and fitting this second pressing shoe by repeating steps 4 through 8.
12. Refill the lubricant. Refer to § 7.4.

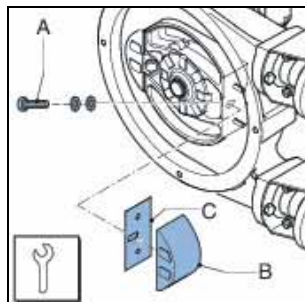


**7.7.3 Replacing seal ring, bearings and wear ring**

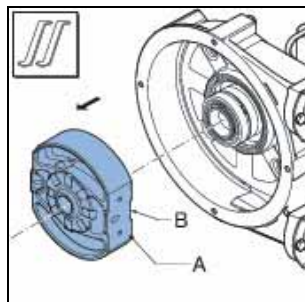
1. Remove the pump hose. Refer to § 7.6.1.
2. Isolate the pump from the electrical supply.
3. Remove the cover (B) by loosening the retaining bolts (A).
4. Check the sealing ring (C) and replace it if necessary.



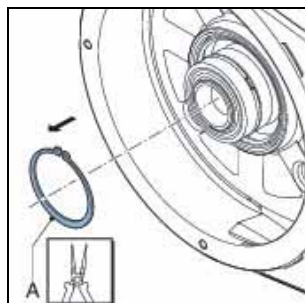
5. Loosen the retaining bolt (A) of both pressing shoes (B). Remove the shims (C) if present.



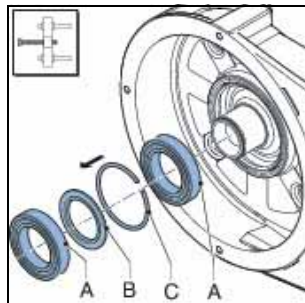
6. Use two crow bars to remove rotor (A). Position both crow bars behind the recesses (B) in the rotor and push the rotor from the hub.



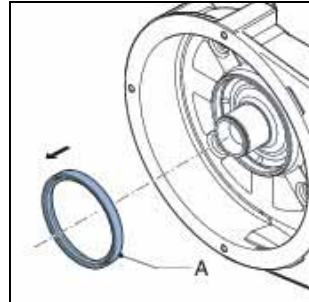
7. Dismount the retaining circlip (A) with the correct tool.



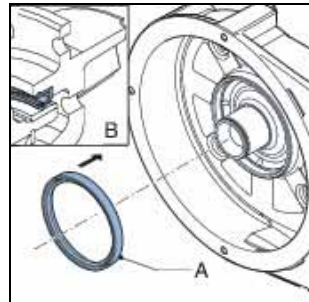
8. Dismount the bearings (A) with the correct tool, the spacer ring (B) and the retaining circlip (C).



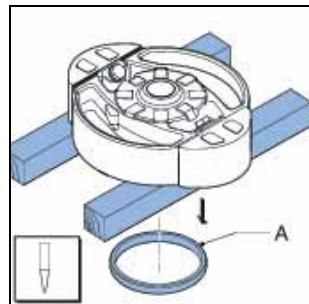
9. Remove the seal (A). Clean and degrease the bore.



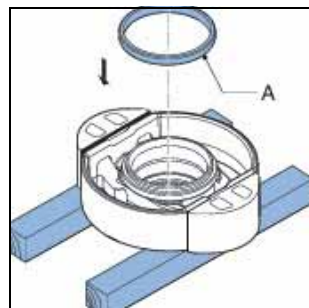
10. Fit a new seal (A) using good engineering practises. The seal must be fitted in the correct orientation (B). Make sure that the open side points to the pump cover.



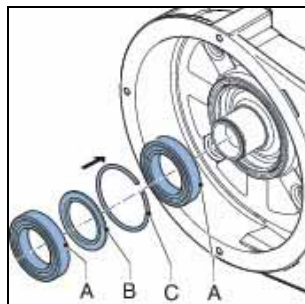
11. Support the rotor with wooden blocks at 90° to the spokes, with the ring (A) facing down. Position a suitable punch against the rear of the glued wear ring. Prevent damage to the wear ring seat or other parts.



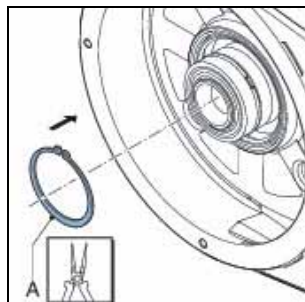
12. Turn the rotor over. Make sure that the seats of the new wear ring (A) and rotor are clean, dry and free of grease. Apply Loctite® type 641 or 603 both on the rotor and the wear ring. Position the new wear ring with the tapered edge facing up. Use a plastic hammer to fit the ring on the rotor until it touches the rotor completely.



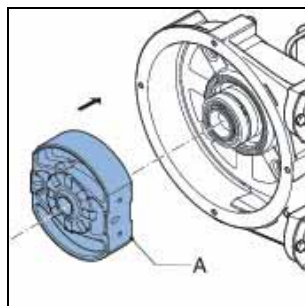
13. Check that the hub is clean and free of grease. Fit the bearings and the rings now. The bearings are placed on the hub with a slight interference fit. Use a pressing tool to press the bearings on the hub.



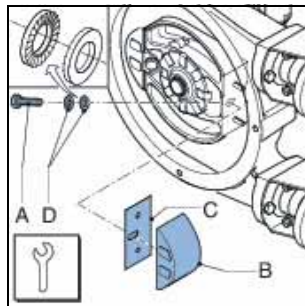
14. Mount the retaining circlip (A).



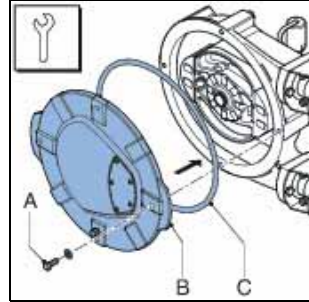
15. Fit rotor (A). The rotor is placed on the bearings with a loose fit. Press the rotor on the hub until it sticks.



16. Fit the removed shims (C) again. Position the (new) pressing shoe (B), check that the Nord-Lock® rings (D) have been positioned correctly and tighten the retaining bolt(s) (A) a few turns. Refer to § 10.1.6.





17. Check the gasket (C) for damage and replace if necessary. Refit the cover (B). Make sure that the 4 bolts (A) are refitted and that they are tightened in the correct order, diagonally opposite each other. Refer to § 10.1.6.
18. Switch on the electrical supply to the pump.
19. Fit the (new) pump hose. Refer to § 7.6.3.



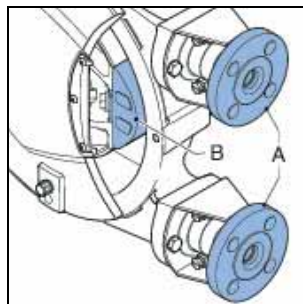
### 7.8 Adjusting hose compression force (shimming)

Remove the pump cover before fitting and removing shims. In order to determine the correct number of shims for your specific application refer to § 10.1.7.

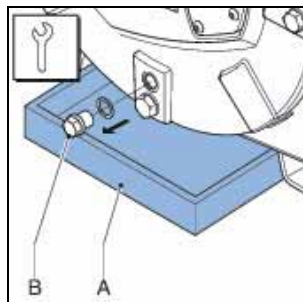
|  |   |
|--|---|
|  | <p><b>CAUTION</b></p> <p>Too many shims, this means a too high compression force on the pump hose, will create a too high load on the pump head and pump hose, which may result in a reduction of the life of the pump hose and bearings.</p> |
|--|---|

|  |   |
|--|---|
|  | <p><b>CAUTION</b></p> <p>Too few shims, this means a too low compression force on the pump hose, create a loss of yield and slip or backflow. Backflow results in a reduction of the life of the pump hose.</p> |
|--|---|

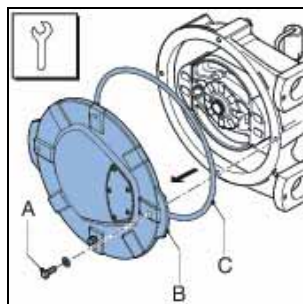
1. Jog the motor until the pressing shoe (B) is positioned between the inlet and outlet port (A).
2. Isolate the pump from the electrical supply.



3. Place a tray (A) under the drain plug in the cover of the pump. Remove the drain plug (B). Catch the lubricant from the pump housing in the tray. Position the drain plug and tighten it firmly.

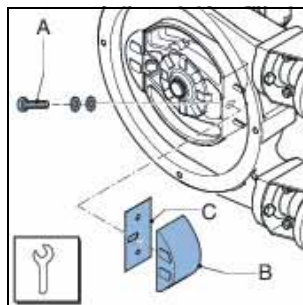


4. Remove the cover (B) by loosening the retaining bolts (A).

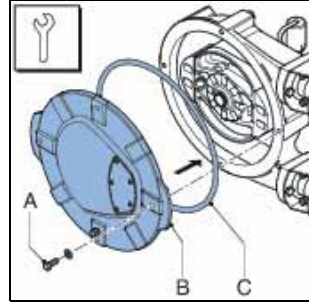


5. Loosen the retaining bolt (A) of the pressing shoe (B). Fit the shims (C) or remove them, until the correct number of shims is present. Refer to § 10.1.7.

Fasten the retaining bolt of the pressing shoe with the correct torque. Refer to § 10.1.6.



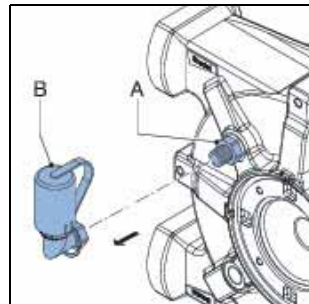
6. Refit the cover (B). Check the gasket (C) for damage and replace if necessary. Make sure that all bolts (A) are refitted and that they are tightened in the correct order, diagonally opposite each other. Refer to § 10.1.6.
7. Switch on the electrical supply.
8. Jog the rotor until the second pressing shoe is positioned between the inlet and outlet port.
9. Isolate the pump from the electrical supply.
10. Repeat the procedure for this pressing shoe by repeating steps 4, 5, 6 and 7.
11. Refill the lubricant via the breather. Refer to § 7.4.



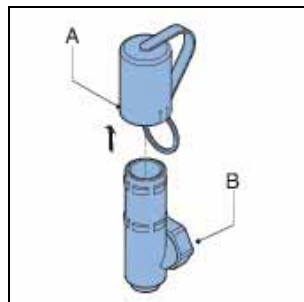
## 7.9 Fitting options

### 7.9.1 Fitting a high-level float switch

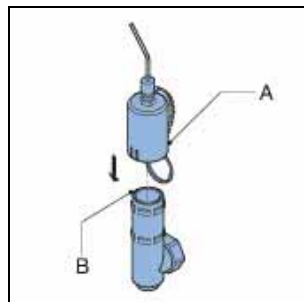
1. Remove the standard breather (B) on the rear of the pump, by removing it from crimp connector (A).



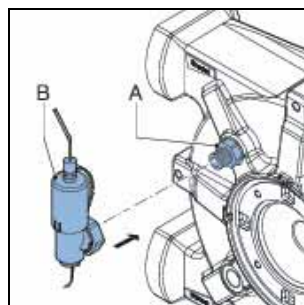
- Slide the standard breather cap (A) from breather (B).



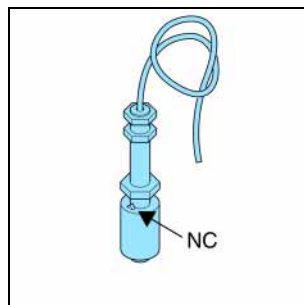
- Replace the standard breather cap with the breather cap with high level float switch (A) and slide it over breather (B).



- Mount the breather (B) on the rear of the pump, by mounting it on crimp connector (A).



- Connect the high-level float switch to the auxiliary power circuit via the 2 meter (6.5 feet) long PVC cable (2 x 0.34 mm<sup>2</sup>, 2 x 22 AWG). Bear in mind that the electrical contact of the float switch is normally closed (NC). The knob is upwards for normally closed operation. When the lubricant level is (too) high the contact will open.



| <b>Specifications*</b> |                  |
|------------------------|------------------|
| Voltage:               | Max. 230 V AC/DC |
| Current:               | Max. 2 A         |
| Power:                 | Max. 40 VA       |

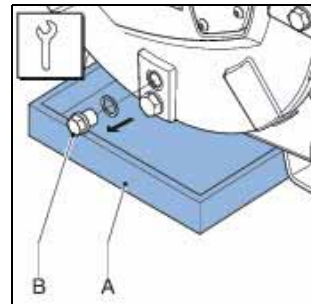
\* For use in non-explosive atmospheres

|          |   |
|----------|---|
| <b>i</b> | Where the floater is constructed to stop the equipment, operating has to be arranged so that the stop function locks-out, preventing the equipment from being re-started without re-setting. Check if the floater is mounted with the NC sign at the top. |
|----------|---|

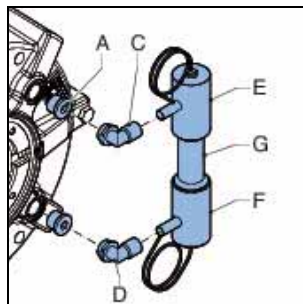
### 7.9.2 Fitting a high and low level float switch

|          |                                       |
|----------|---------------------------------------|
| <b>i</b> | For specifications, refer to § 7.9.1. |
|----------|---------------------------------------|

1. If the pump is filled with lubricant this must be removed first. Place a tray (A) under the drain plug in the cover of the pump. Remove the drain plug (B). Catch the lubricant from the pump housing in the tray. Position the drain plug and tighten it firmly.



2. Remove the plugs (A) and (B) on the rear of the pump head.  
Position the quick couplings (C) and (D) in both openings.  
Clamp both connection tubes (E) and (F) on the riser pipe (G) and the quick links (C, D).



3. Connect the high and low-level float switch to the electrical supply. Bear in mind that the electrical contact of the float switch is normally closed (NC).

This means that:

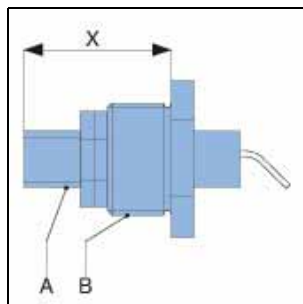
- the contact of the high level float switch opens at a (too) high lubricant level;
- the contact of the low level float switch opens at a (too) low lubricant level.

4. Make sure the lubricant returns to the prescribed level. Refer to § 7.4.

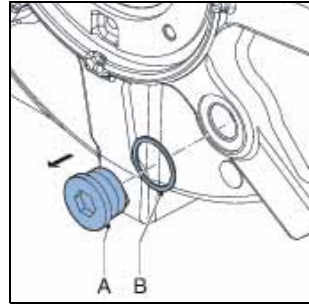
### 7.9.3 Replacing the revolution counter

1. Fit the inductive sensor (A) in stop (B) and adjust it to dimension "X" as indicated in the table below. Tighten the adjusting nuts with a torque of 25 Nm (220 lbf in).

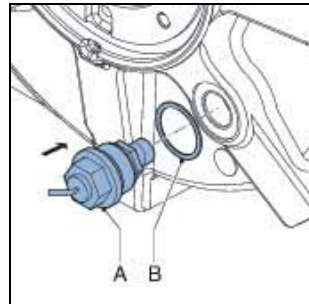
| Dimension "X" ± 0.1 mm (± 0.004 inch) |  |
|---------------------------------------|--|
| <b>Bredel 25</b>                      |  |
| 26 mm (1.02 inch)                     |  |



- Remove stop (A) which is on the horizontal center line at the rear of the pump housing. Check that the sealing ring (B) is not damaged and replace it if necessary.



- Fit the stop with the inductive sensor (A) together with sealing ring (B) on the pump housing.

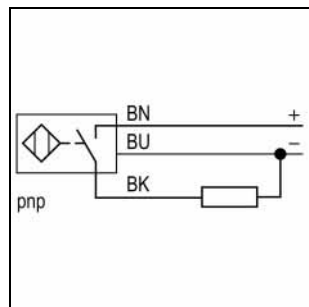


- Connect the sensor via the 2-meter (6.5-feet) long PVC cable (3 x 0.34 mm<sup>2</sup>, 3 x 22 AWG).

| Specifications* |             |
|-----------------|-------------|
| Voltage:        | 10...30 VDC |
| Current:        | Max. 150 mA |

\* For use in non-explosive atmospheres

- Make sure the lubricant returns to the prescribed level. Refer to § 7.4.



## **8 STORAGE**

### **8.1 Hose pump**

- Store the hose pump or pump parts in a dry area. Make sure that the hose pump or pump parts are not exposed to temperatures lower than  $-40\text{ }^{\circ}\text{C}$  ( $-104\text{ }^{\circ}\text{F}$ ) or higher than  $+70\text{ }^{\circ}\text{C}$  ( $158\text{ }^{\circ}\text{F}$ ).
- Cover the openings of the inlet and outlet ports.
- Prevent corrosion of untreated parts. For this purpose use the correct protection or packaging means.
- After a long period of standstill or storage (i.e. pump is idle for a period of longer than one continuous month), the static load on the pump hose may cause permanent deformation, which will reduce the life of the pump hose and may cause difficulty in starting.

To prevent deformation of the hose, pump motor should be jogged on a monthly basis to allow repositioning of the shoe on the hose.

If motor jogging is not possible and long term shutdown is expected, remove a pressing shoe and turn the rotor so far that the second pressing shoe is in front of the inspection window. In this way there is no load put on the pump hose. When startup is again expected, replace the pressing shoes, the proper number of shims, and the lubricant.

### **8.2 Pump hose**

- Store the pump hose in a cool and dark room. After two years the hose material will age, which will reduce the life of the hose.

## 9 TROUBLESHOOTING

**WARNING**

Disconnect and lock the power supply to the pump drive before any work is carried out.

In case the motor is fitted with a frequency controller and has a single-phase power supply, wait two minutes to make sure that the capacitors have discharged.

If the hose pump does not function (correctly), consult the following checklist to see if you can remedy the error yourself. If this is not the case, contact your Bredel representative.

| Problem                    | Possible cause  | Correction   |
|----------------------------|---|--|
| <b>Failure to operate.</b> | No voltage.   | Check that the supply power switch is on.  |
|                            |   | Check the electrical supply is available at the pump.  |
|                            |   | Check current limit of electrical source to pump.  |
|                            | Stalled rotor.  | Check that hose and lubricant are loaded properly and pressing shoes are shimmed properly.   |
|                            | Lubricant level monitoring system has been activated. | Check that the lubricant level monitoring system has stopped the pump. Check the lubricant level and proper functioning of the level switch(es). |

| Problem                       | Possible cause   | Correction   |
|-------------------------------|--|--|
| <b>High pump temperature.</b> | Non-standard hose lubricant used.  | Consult the Bredel representative for the correct lubricant.   |
|                               | Low lubricant level.   | Add Bredel Genuine Hose Lubricant. For the required amount of lubricant refer to § 10.1.4.   |
|                               | Product temperature too high.  | Consult the Bredel representative about the maximum temperature range of the product.  |
|                               | Internal friction on the hose caused by blocked or poor suction characteristics. | Check pipework/valves for blockages. Ensure that the suction pipework is as short as possible and that the diameter is large enough. |
|                               | Over-shimming of the pump rotor shoes.   | Consult the diagram. Refer to § 10.1.7. Remove excess shims.   |
|                               | High pump speed.   | Reduce pump speed to a minimum. Consult with your Bredel pump representative for advice on optimum pump speeds.                      |

| Problem                                    | Possible cause  | Correction  |
|--|---|---|
| <b>Low capacity / pressure.</b>            | Shut-off valve in the suction line (partly) closed.   | Fully open the shut-off valve.  |
|  | Under shimming of the pressing shoes.   | Check shimming. Refer to § 10.1.7. Fit the correct number of shims.   |
|  | Hose failure or badly worn hose.  | Replace hose. Refer to § 7.6.   |
|  | Partial blockage of the suction line or too little product on the suction side.                                   | Ensure that the suction line is clear of blockages and that sufficient product is available.  |
|  | Connections and hose clamps not correctly mounted, which allows the pump to draw in air.                          | Tighten connections and hose clamps.  |
|  | You are starving the pump because the speed is too high for your suction pressure.                                | Consult your Bredel representative for a recommendation.  |
| <b>Vibration of the pump and pipework.</b> | Suction and discharge lines are not secured correctly.  | Check and secure pipework.  |
|  | High pump speed with long suction and discharge lines or high relative density or a combination of these factors. | Reduce pump speed. Reduce the line lengths on both suction and discharge where possible. Consult your Bredel representative for a recommendation. |
|  | Too narrow diameter of suction and/or discharge line.   | Increase the diameter of the suction/discharge lines.   |

| Problem                           | Possible cause  | Correction   |
|-----------------------------------|---|--|
| <b>Short hose life.</b>           | Chemical attack of the hose.  | Check the compatibility of the hose material with the product to be pumped. Consult your Bredel representative for correct hose selection.   |
|                                   | High pump speed.  | Reduce pump speed.   |
|                                   | High discharge pressures.   | It is recommended that the pressure on the discharge of the pump does not exceed 1600 kPa (232 psi). Check that the discharge line is not blocked, the shut-off valves are fully opened and the pressure relief valve functions properly (if present in the discharge line). |
|                                   | High product temperature.   | Consult your Bredel representative for correct hose selection.   |
|                                   | High pulsations.  | Restructure the discharge and inlet conditions.  |
| <b>Hose pulled into the pump.</b> | Insufficient or no hose lubricant in the pump head.                     | Add extra lubricant. Refer to § 7.4.   |
|                                   | Incorrect lubricant: no Bredel Genuine Hose Lubricant in the pump head. | Consult the Bredel representative for the correct lubricant.   |
|                                   | Extremely high inlet pressure - larger than 300 kPa (43.5 psi).         | Reduce the inlet pressure.   |

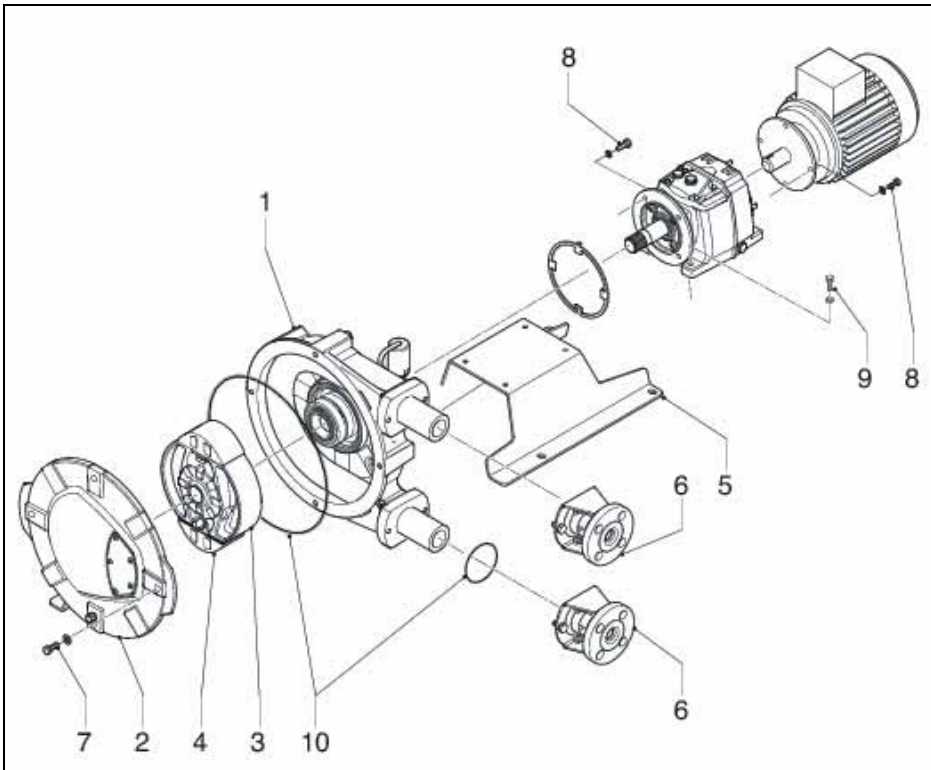
| <b>Problem</b>  | <b>Possible cause</b>   | <b>Correction</b>  |
|---|---|--|
| <b>Lubricant leakage at flange bracket.</b>                     | Hose blocked by an incompressible object in the hose. The hose cannot be compressed and will be pulled into the pump housing. | Remove hose, check for blockages and replace if necessary.   |
|   | Bolts of flange bracket loose.  | Tighten to the specified torque settings. Refer to § 10.1.6. |
|   | Bolts of hose clamps loose.   | Tighten to the specified torque settings. Refer to § 10.1.6. |
| <b>Leakage from the rear of the pump housing "Buffer zone".</b> | Damaged sealing ring.   | Replace sealing ring.  |

**10 SPECIFICATIONS**
**10.1 Pump head**
**10.1.1 Performance**

| Description                     | Unit              | Bredel 25   |
|---------------------------------|-------------------|-------------|
| Max. capacity, continuous       | m <sup>3</sup> /h | 1.80        |
|                                 | GPM               | 7.92        |
| Max. capacity, intermittent*    | m <sup>3</sup> /h | 2.88        |
|                                 | GPM               | 12.68       |
| Capacity per revolution         | l/rev             | 0.300       |
|                                 | Gal/rev           | 0.079       |
| Max. permissible discharge      | kPa               | 1600        |
|                                 | PSI               | 232         |
| Permissible ambient temperature | °C                | -20 to +45  |
|                                 | °F                | -4 to +113  |
| Permissible product temperature | °C                | -10 to +80  |
|                                 | °F                | +14 to +176 |
| Sound level on 1 m              | dB(A)             | 70          |

\* Intermittent duty: "Let the pump stand still to cool down for at least 1 hour after 2 hours of operation".

**10.1.2 Materials**



| Pos | Description                       | Material                |
|-----|-----------------------------------|-------------------------|
| 1   | Pump housing                      | Cast-iron               |
| 2   | Cover                             | Cast-iron               |
| 3   | Pump rotor                        | Cast-iron               |
| 4   | Pressing shoe                     | Aluminum                |
| 5   | Pump support                      | Mild steel, galvanized* |
| 6   | Flange bracket                    | Mild steel, galvanized* |
| 7   | Mounting material of pump cover   | Mild steel, galvanized* |
| 8   | Mounting material of drive system | Mild steel, galvanized* |
| 9   | Mounting material of pump support | Mild steel, galvanized* |
| 10  | Seals                             | Neoprene or Nitrile     |

\* Available in Stainless Steel upon request.

**10.1.3 Surface treatment**


- After surface preparation, one layer of two-component acrylate is used for surface protection. Standard color is RAL 3011, however other colors are optional. Contact your Bredel representative for details on surface treatment.
- All galvanized parts, exclusive of mounting articles, have been provided with an electrolytic zinc layer of 15 - 20 microns (0.6 - 0.8 mil).

**10.1.4 Lubricant table pump**

|                   | Unit    | Bredel 25                     |
|-------------------|---------|-------------------------------|
| Lubricant         | -       | Bredel Genuine Hose Lubricant |
| Required quantity | Liters  | 2                             |
|                   | Gallons | 0.5                           |

Bredel Genuine Hose Lubricant is registered at NSF: NSF Registration N° 123204; Category Code H1. See also: [www.NSF.org/USDA](http://www.NSF.org/USDA).

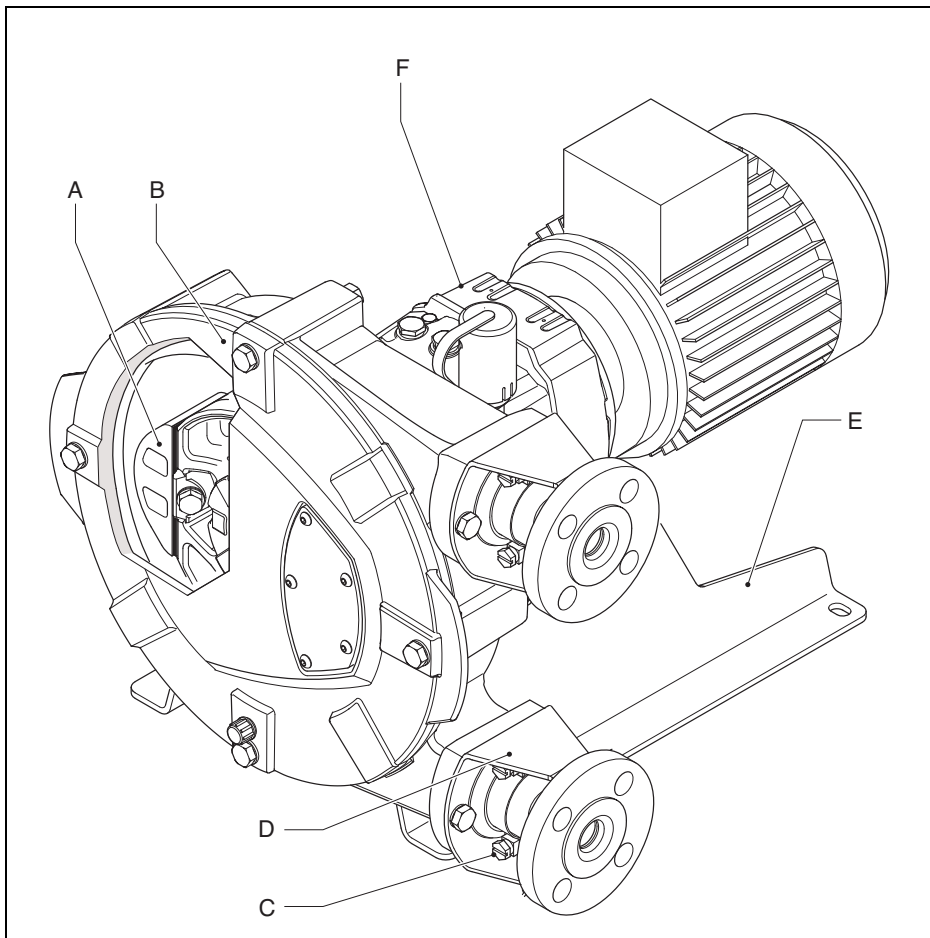
The relative density of Bredel Genuine Hose Lubricant is 1.245.

|   |  |
|---|--|
|  | Should you require additional information with respect to the safety data sheet, consult your Bredel representative. |
|---|--|

**10.1.5 Weights**

| Description                             | Weight [kg/lbs] |              |
|---|-----------------|--------------|
|   | Bredel 25       |              |
| Unit                                    | kg              | lbs          |
| Pump head                               | 39              | 86           |
| Flange connection (2x), without inserts | 3.72            | 8            |
| Stainless steel insert (2x)             | 0.26            | 0.6          |
| Hose                                    | 2               | 4.4          |
| Lubricant                               | 2.5             | 5.5          |
| <b>Sub total pump head</b>              | <b>47.5</b>     | <b>104.5</b> |
| Pump support                            | 5.7             | 12.6         |
| Mounting material gearbox-pump head     | 0.3             | 0.7          |
| Gearbox (model B3-B5)                   | 15.5            | 34.2         |
| Electric motor                          | 17.3            | 38.1         |
| Varmeca                                 | 3               | 6.6          |
| <b>Total weight of unit</b>             | <b>89.3</b>     | <b>196.9</b> |
| Pump cover (with inspection window)     | 9.4             | 20.7         |
| Rotor                                   | 5.4             | 11.9         |
| Pressing shoe                           | 0.4             | 0.9          |

**10.1.6 Torque figures**



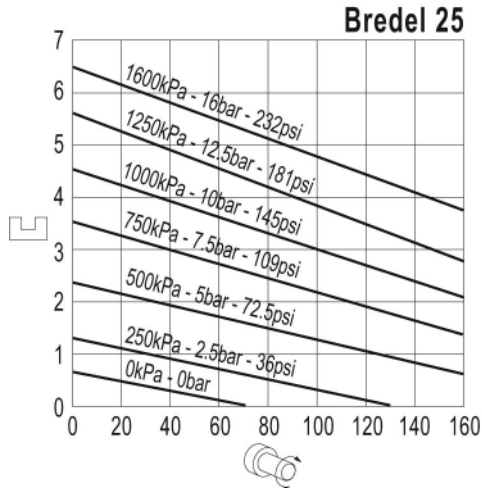
| Pos | Description   | Unit   | Bredel 25 |
|-----|---------------|--------|-----------|
| A   | Pressing shoe | Nm     | 50        |
|     |               | lbf in | 440       |
| B   | Cover         | Nm     | 50        |
|     |               | lbf in | 442       |
| C   | Hose clamp    | Nm     | 25        |
|     |               | lbf in | 220       |

| Pos | Description    | Unit   | Bredel 25 |
|-----|----------------|--------|-----------|
| D   | Flange bracket | Nm     | 50        |
|     |                | lbf in | 442       |
| E   | Support        | Nm     | 25        |
|     |                | lbf in | 221       |
| F   | Gearbox        | Nm     | 25        |
|     |                | lbf in | 221       |

| Pos | Description    | Thread, A/F |       |
|-----|----------------|-------------|-------|
|     |                | Bredel 25   |       |
| A   | Pressing shoe  | M10         | 17 mm |
| B   | Cover          | M10         | 17 mm |
| C   | Hose clamp     | M8          | 13 mm |
| D   | Flange bracket | M10         | 17 mm |
| E   | Support        | M8          | 13 mm |
| F   | Gearbox        | M8          | 13 mm |

**10.1.7 Shims specifications**

- When the product temperatures are above 60 °C (140 °F) always use one shim less than indicated in the diagrams.
- Always round up the number of shims.



**10.2 Lubricant table gearbox**

Below is an overview of some of the recommended lubricants for the *co-axial gearbox*. In the majority of the cases, a mineral oil ISO VG 220 is recommended. In case of extreme ambient temperatures or a relatively wide range of ambient temperatures, a synthetic oil is recommended. Contact your Bredel representative for advice.

| <b>Recommended lubricants for the Bredel co-axial gearboxes</b> |                      |                         |                      |
|---|----------------------|-------------------------|----------------------|
| Oil type  | Mineral oil          | Synthetic oil           |                      |
| Change oil every  | 5000 hours           | 20,000 hours            |                      |
| Ambient temperature   | -10 °C to +40 °C     | -40 °C to +80 °C        | -30 °C to +60 °C     |
|   | 14 °F to 104 °F      | -40 °F to 176 °F        | -22 °F to 140 °F     |
| DIN (ISO)   | CLP (CC)             | CLP HC                  | CLP HC               |
| ISO, NLGI   | VG220                | VG220                   | VG150                |
| Mobil   | Mobilgear 630        | Mobil SHC 630           | Mobil SHC 629        |
| Shell   | Shell Omala 220      | Shell Omala 220 HD      |                      |
| Klüber  | Klüberoil GEM 1-220  | Klübersynth GH4-220     | Klübersynth EG 4-150 |
| Aral  | Aral Degol BG 220    | Aral Degol PAS220       |                      |
| BP  | BP Energol GR-XP 220 |                         |                      |
| Tribol  | Tribol 1100/220      | Tribol 1510/220         |                      |
| Texaco  | Meropa 220           | Pinnacle EP220          | Pinnacle EP150       |
| Optimol   | Optigear BM 220      | Optigear Synthetic A220 |                      |
| Fuchs   | Renolin CLP 220      | Renolin Unisyn CLP220   |                      |

| <b>Recommended lubricants for the Bredel co-axial gearboxes</b> |                  |                  |                  |
|---|------------------|------------------|------------------|
| Oil type  | Synthetic oil    |                  |                  |
| Change oil every  | 20,000 hours     |                  |                  |
| Ambient temperature   | -30 °C to -10 °C | -30 °C to +60 °C | -30 °C to +40 °C |
|   | -22 °F to 14 °F  | -22 °F to 140 °F | -22 °F to 104 °F |
| DIN (ISO)   | CLP HC           | HCE              | E                |
| ISO, NLGI   | VG32             | VG460            | VG460            |

| Recommended lubricants for the Bredel co-axial gearboxes |                          |                            |                    |
|--|--------------------------|----------------------------|--------------------|
|  |                          | Foodgrade *                | Biology **         |
| Mobil  | Mobil SHC 624            |                            |                    |
| Shell  |                          | Shell Cassida Fluid GL 460 |                    |
| Klüber   | Klüber-Summit HySyn FG32 | Klüber oil 4UH1-460        | Klüberbio CA2-460  |
| Aral   |                          | Aral Eural Gear 460        | Aral Degol BAB 460 |
| Texaco   | Cetus PAO 46             |                            |                    |
| Optimol  |                          | Optileb GT 460             | Optisynt BS460     |

\* For use in the foodstuffs industry. Meets the requirements of the USDA (United States Department of Agriculture): lubricant is suited for unforeseen contact with foodstuffs.

\*\* Lubricant for use in agricultural areas and nature reserves.


### 10.3 Gearbox

Co-axial gearbox with helical gears. Standard as a 2 and 3 stage version.

|                        |  |
|------------------------|--|
| Mounting position      | IM 2001 (IM B35) foot flange gearbox with splined shaft in horizontal position.                                  |
| Motor adapter          | Electric motor has been integrated in the gearbox housing, by which the smallest possible dimension is achieved. |
| Optional motor adapter | Adapters in conformance with IEC-B5 or NEMA TC.  |

**10.4 Electric motor**

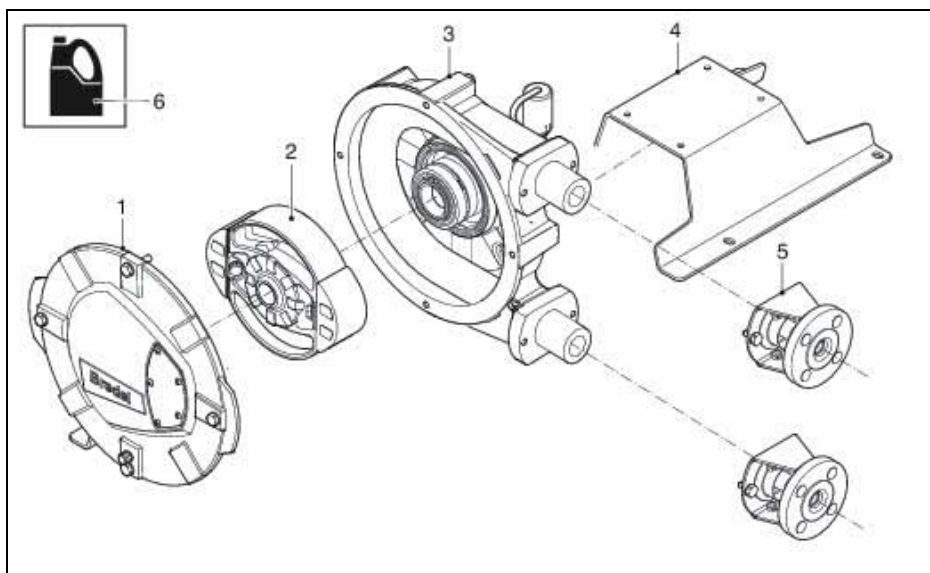
Standard electric motor design is an enclosed three-phase asynchronous motor. A thermal safety device to prevent motor overload is optional.

|   |   |
|---|---|
|  | In case of doubt about the local applicable regulations for the drive connection, contact your Bredel representative. |
|---|---|

|                         |   |
|-------------------------|---|
| Protection class        | IP55/IK08   |
| Insulation class        | F   |
| Increase in temperature | Within class B  |
| Voltage/frequency       | 230/400 V - 3 phases - 50 Hz or<br>230/460 V - 3 phases - 60 Hz |

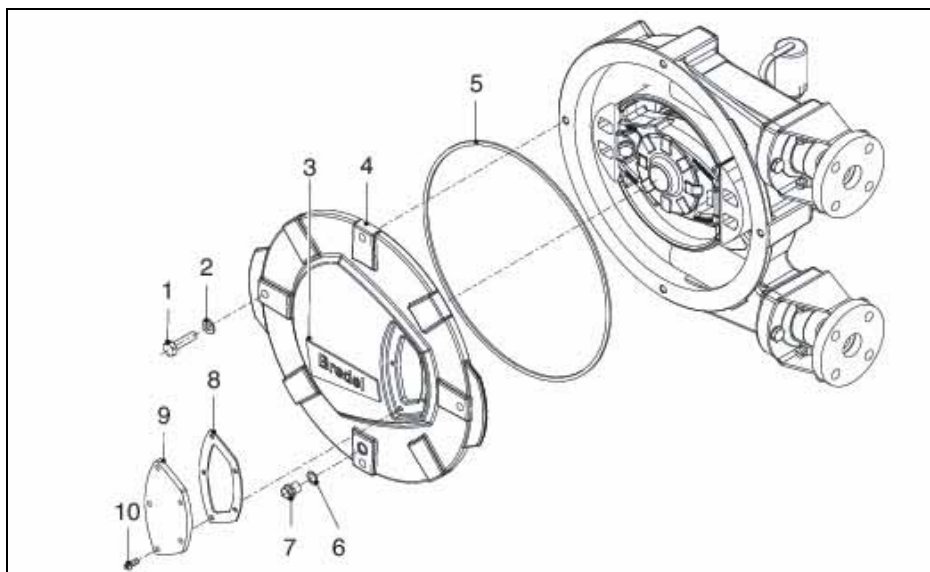
## 10.6 Parts list

## 10.6.1 Overview



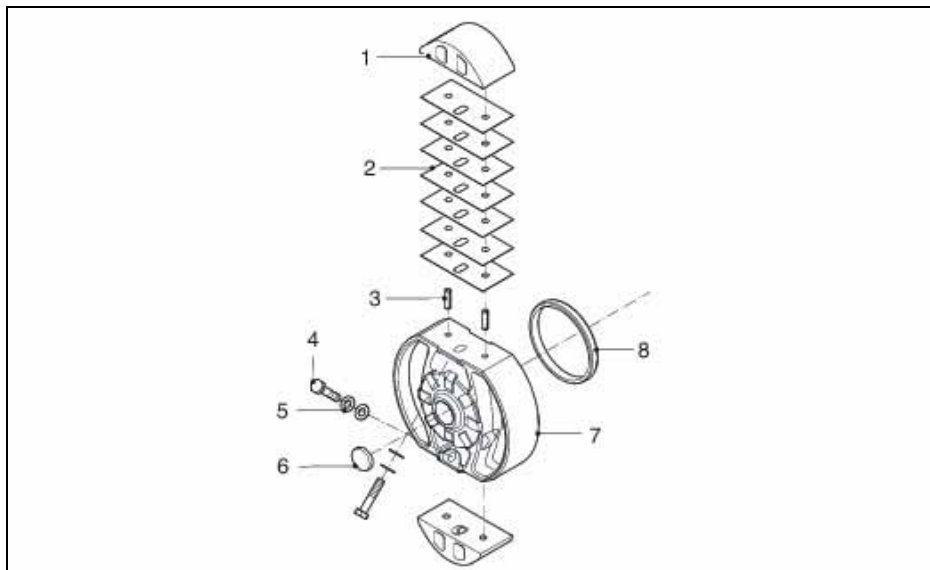
| Pos. | Description                               |
|------|---|
| 1    | Cover assembly. Refer to § 10.6.2.        |
| 2    | Rotor assembly. Refer to § 10.6.3.        |
| 3    | Pump housing assembly. Refer to § 10.6.4. |
| 4    | Pump support assembly. Refer to § 10.6.5. |
| 5    | Flange assembly. Refer to § 10.6.6.       |
| 6    | Lubricant. Refer to § 10.6.8.             |

### 10.6.2 Cover assembly



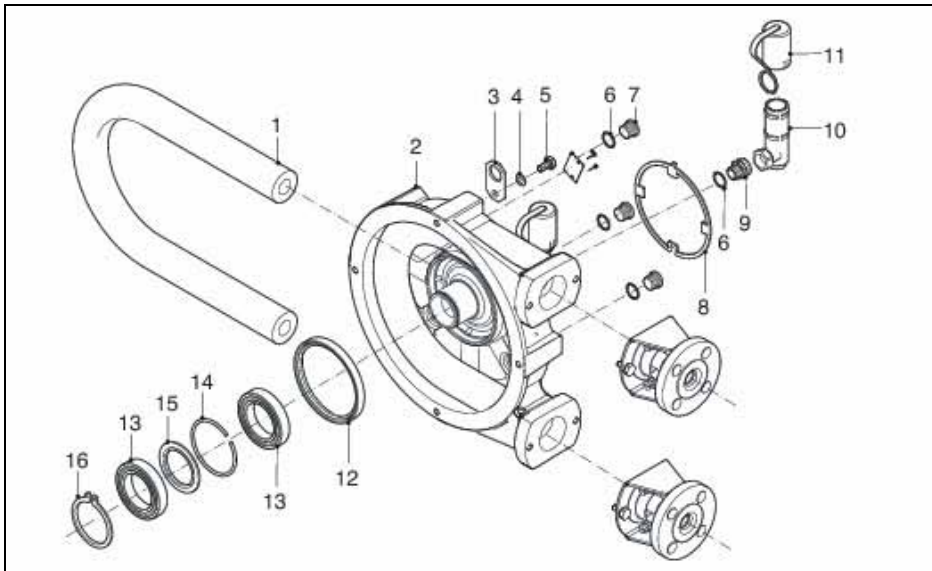
| Pos. | Qty. | Description       | Product codes for parts of pump type |  |
|------|------|-------------------|--------------------------------------|--|
|      |      |                   | Bredel 25                            |  |
| 1    | 4    | Bolt, hex. head   | F101058                              |  |
| 2    | 4    | Washer            | F322013                              |  |
| 3    | 1    | Sticker           | 225238                               |  |
| 4    | 1    | Cover             | 225102                               |  |
| 5    | 1    | Quad ring         | 225123                               |  |
| 6    | 1    | Gasket            | F342019                              |  |
| 7    | 1    | Drain cap         | F911502                              |  |
| 8    | 1    | Gasket            | 225156                               |  |
| 9    | 1    | Inspection window | 225155                               |  |
| 10   | 5    | Round head screw  | F552036                              |  |
|      | 6    |                   |                                      |  |

**10.6.3 Rotor assembly**



| Pos. | Qty. | Description          | Product codes for parts of pump type |  |
|------|------|----------------------|--------------------------------------|--|
|      |      |                      | Bredel 25                            |  |
| 1    | 2    | Pressing shoe        | 225110                               |  |
| 2    | 14   | Shim                 | 225107                               |  |
|      | 10   |                      |                                      |  |
| 3    | 4    | Spiral clamping bush | F415084                              |  |
| 4    | 2    | Bolt, hex. head      | F101060                              |  |
| 5    | 2    | Nord-Lock ring       | F349006                              |  |
| 6    | 1    | Sealing cap          | S417007                              |  |
| 7    | 1    | Rotor                | 225103                               |  |
| 8    | 1    | Wear ring            | 29120202                             |  |

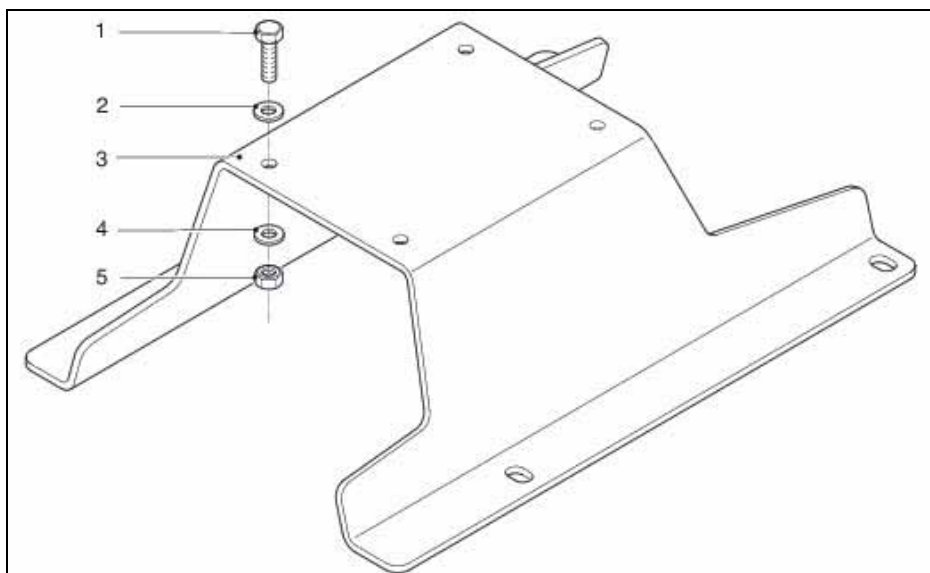
**10.6.4 Pump housing assembly**



| Pos. | Qty. | Description         | Product codes for parts of pump type |  |
|------|------|---------------------|--------------------------------------|--|
|      |      |                     | Bredel 25                            |  |
| 1    | 1    | NR                  | 025020                               |  |
|      | 1    | NBR                 | 025040                               |  |
|      | 1    | CSM                 | 025070                               |  |
|      | 1    | EPDM                | 025075                               |  |
| 2    | 1    | Pump housing        | 225101                               |  |
| 3    | 1    | Lifting strip       | 29065361                             |  |
| 4    | 1    | Washer, Spring Lock | F336012                              |  |
| 5    | 1    | Bolt                | F111096                              |  |
| 6    | 4    | Gasket              | F342027                              |  |
| 7    | 3    | Stop                | F901004                              |  |
| 8    | 1    | Seal                | 225114                               |  |
| 9    | 1    | Crimp connector     | F602504                              |  |
| 10   | 1    | Breather            | 29095146                             |  |
| 11   | 1    | Breather cap        | 29065223                             |  |
| 12   | 1    | Seal                | S212411                              |  |

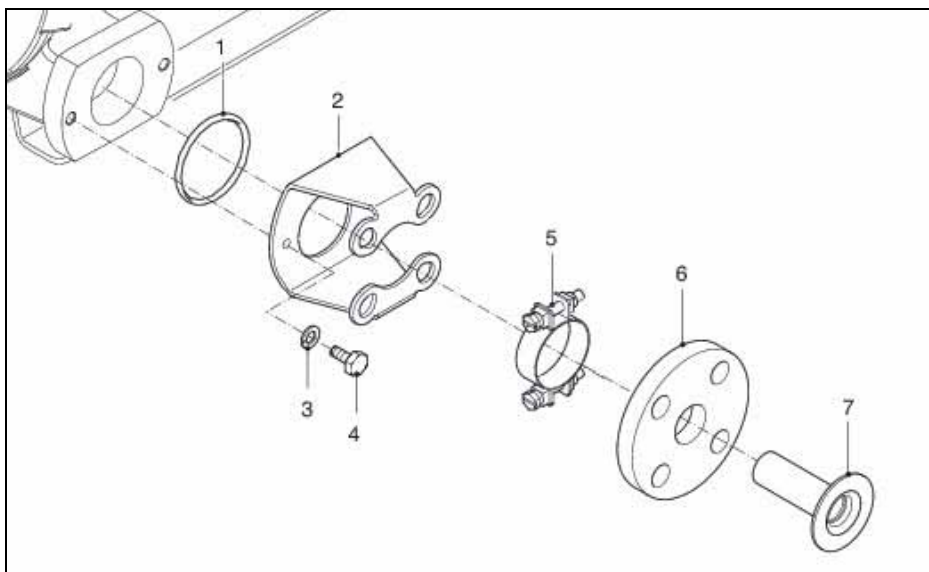
| Pos. | Qty. | Description       | Product codes for parts of pump type |  |
|------|------|-------------------|--------------------------------------|--|
|      |      |                   | Bredel 25                            |  |
| 13   | 2    | Bearing           | B141260                              |  |
| 14   | 1    | Retaining circlip | 29095297                             |  |
| 15   | 1    | Spacer ring       | 29085201                             |  |
| 16   | 1    | Retaining circlip | F343049                              |  |

### 10.6.5 Support assembly

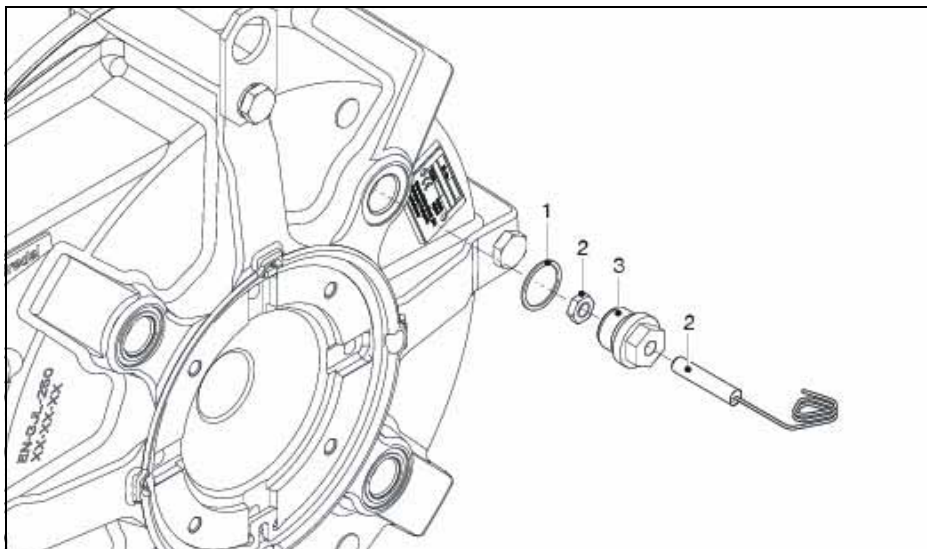


| Pos. | Qty. | Description             | Product codes for parts of pump type |  |
|------|------|-------------------------|--------------------------------------|--|
|      |      |                         | Bredel 25                            |  |
| 1    | 4    | Bolt                    | F111076                              |  |
| 2    | 4    | Washer                  | F322012                              |  |
| 3    | 1    | Pump support (standard) | 225106                               |  |
| 4    | 4    | Spring washer           | F336011                              |  |
| 5    | 4    | Nut                     | F301006                              |  |

### 10.6.6 Flange assembly



| Pos. | Qty. | Description           | Product codes for parts of pump type |  |
|------|------|-----------------------|--------------------------------------|--|
|      |      |                       | Bredel 25                            |  |
| 1    | 2    | O-ring                | S112231                              |  |
| 2    | 2    | Flange bracket, Steel | 225197                               |  |
|      | 2    | Flange bracket, SS    | 225197A                              |  |
| 3    | 4    | Washer, Spring Lock   | F336012                              |  |
| 4    | 4    | Bolt                  | F111096                              |  |
| 5    | 2    | Hose clamp            | C122004                              |  |
| 6    | 2    | Flange, DIN Steel     | 025198                               |  |
|      | 2    | Flange, DIN SS        | 225199                               |  |
|      | 2    | Flange, ANSI Steel    | 025198A                              |  |
|      | 2    | Flange, ANSI SS       | 225199A                              |  |
| 7    | 2    | Insert, SS            | 025186                               |  |
|      | 2    | Insert, PVC           | 025187                               |  |
|      | 2    | Insert, PP            | 025189                               |  |
|      | 2    | Insert PVDF           | 025190                               |  |

**10.6.7 Revolution counter assembly**


| Pos. | Qty. | Description        | Product codes for parts of pump type |  |
|------|------|--------------------|--------------------------------------|--|
|      |      |                    | Bredel 25                            |  |
| 1    | 1    | Gasket             | F342027                              |  |
| 2    | 1    | Revolution counter | 29040462                             |  |
| 3    | 1    | Adapter            | 29027248                             |  |

**10.6.8 Lubricant**

| Pos. | Qty. | Description  | Product codes for parts of pump type |  |
|------|------|--|--------------------------------------|--|
|      |      |  | Bredel 25                            |  |
| 1    | 1    | 2 l (0.5 gal) can Bredel Genuine Hose Lubricant    | 902143                               |  |
|      | 1    | 3 l (0.8 gal) can Bredel Genuine Hose Lubricant    | -                                    |  |
|      | 1    | 0.5 l (0.13 gal) can Bredel Genuine Hose Lubricant | -                                    |  |

**SAFETY FORM**

**Product Use and Decontamination Declaration**

In compliance with the **Health and Safety Regulations**, the user is required to declare those substances that have been in contact with the item(s) you are returning to Watson-Marlow Bredel B.V. or any of its subsidiaries or distributors. Failure to do so will cause delays in servicing the item or in issuing a response. Therefore, **please complete this form** to make sure we have the information before receipt of the item(s) being returned. A completed copy must be attached to **the outside of the packaging** containing the item(s). You, the user, are responsible for cleaning and decontaminating the item(s) before returning them.

Please complete a separate Decontamination Certificate for each item returned. **RGA/KBR no**.....

1 Company .....

Address .....

Postal code.....

Telephone ..... Fax number .....

2 Product ..... 3.4 Cleaning fluid to be used if residue of chemical is found during servicing;

2.1 Serial Number .....

2.2 Has the Product been used? a) .....

YES  NO  b) .....

If yes, please complete all the following paragraphs. c) .....

If no, please complete paragraph 5 only d) .....

3 Details of substances pumped 4 I hereby confirm that the only substances(s) that the equipment specified has pumped or come into contact with are those named, that the information given is correct, and the carrier has been informed if the consignment is of a hazardous nature.

3.1 Chemical Names 5 Signed .....

a) ..... Name .....

b) ..... Position .....

c) ..... Date .....

d) .....

3.2 Precautions to be taken in handling these substances: **Note:**

a) ..... **To assist us in our servicing please describe any fault condition you have witnessed.**

b) ..... .....

c) ..... .....

d) ..... .....

3.3 Action to be taken in the event of human contact:

a) ..... .....

b) ..... .....

c) ..... .....

d) ..... .....

Watson-Marlow Pumps Group  
37 Upton Technology Park  
Wilmington, MA 01887  
USA

Telephone: 800 - 282 - 8823  
978 - 658 - 6168

Fax: 978 - 658 - 0041

Internet: [www.wmpg.com](http://www.wmpg.com)

E-mail: [support@wmpg.us](mailto:support@wmpg.us)



© 2013 Watson-Marlow Bredel B.V.

**BREDEL TECHNICAL SPECIFICATION**

|  |    |        |                          |                  |
|--|----|--------|--------------------------|------------------|
| Subject:<br><b>General paint specification</b> |    |        | Code:<br><b>TS07-004</b> | Rev.<br><b>E</b> |
| Designed:                                      | ON | Datum: | 12-9-07                  | Ref.:            |
| Checked:                                       | DS | Datum: | 12-9-07                  |                  |

**Paint specification for Breidel Hose Pumps: Breidel series**

**Surface preparation**

1. Sandblasting, material conditions conform A Sa 2½
2. Impermeable coating, oxylane based

**Housing outside and Cover**

Coating: 1 layer of 2 component high solid polyurethancoating based on acrylate – isocyanate combination.  
Dry film thickness: DFT 60 – 80 micron  
Colour: RAL 3011, Red

**Housing inside / Rotor / Hub**

Coating: 1 layer of 2 component high solid polyurethancoating based on acrylate – isocyanate combination.  
Dry film thickness: DFT 30 – 40 micron  
Colour: RAL 3011, Red

**BREDEL TECHNICAL SPECIFICATION**

|  |    |        |                          |                  |
|--|----|--------|--------------------------|------------------|
| Subject:<br><b>General paint specification</b> |    |        | Code:<br><b>TS07-004</b> | Rev.<br><b>E</b> |
| Designed:                                      | ON | Datum: | 12-9-07                  | Ref.:            |
| Checked:                                       | DS | Datum: | 12-9-07                  |                  |

**Paint specification for Breidel Hose Pumps: APEX series**

**Surface preparation**

1. Sandblasting, material conditions conform A Sa 2½
2. Impermeable coating, oxylane based

**Housing outside**

Coating: 1 layer of 2 component high solid polyurethancoating based on acrylate – isocyanate combination.  
Dry film thickness: DFT 60 – 80 micron  
Colour: RAL 3011, Red

**Housing inside**

Coating: 1 layer of 2 component high solid polyurethancoating based on acrylate – isocyanate combination.  
Dry film thickness: DFT 30 – 40 micron  
Colour: RAL 3011, Red

**BREDEL TECHNICAL SPECIFICATION**

|  |    |        |                          |                  |
|--|----|--------|--------------------------|------------------|
| Subject:<br><b>General paint specification</b> |    |        | Code:<br><b>TS07-004</b> | Rev.<br><b>E</b> |
| Designed:                                      | ON | Datum: | 12-9-07                  | Ref.:            |
| Checked:                                       | DS | Datum: | 12-9-07                  |                  |

**Paint specification for BredeI Hose Pumps: BredeI CIP series**

**Surface preparation**

1. Sandblasting, material conditions conform A Sa 2½
2. Impermeable coating, oxylane based

**Housing outside and Cover**

Coating: 1 layer of 2 component acrylate – isocyanate combination coating contains additional pigments based on zinc phosphate  
Thickness: DFT 60 – 80 micron  
Colour: RAL 9010, White

**Housing inside / Rotor / Hub**

Coating: 1 layer of 2 component acrylate – isocyanate combination coating contains additional pigments based on zinc phosphate  
Thickness: DFT 30 – 40 micron  
Colour: RAL 9010, White

**BREDEL TECHNICAL SPECIFICATION**

|  |    |        |         |                          |                  |
|--|----|--------|---------|--------------------------|------------------|
| Subject:<br><b>General paint specification</b> |    |        |         | Code:<br><b>TS07-004</b> | Rev.<br><b>E</b> |
| Designed:                                      | ON | Datum: | 12-9-07 | Ref.:                    |                  |
| Checked:                                       | DS | Datum: | 12-9-07 |                          |                  |

**Paint specification for Breidel Discharge pulsation damper PD series**

**Surface preparation**

1. Sandblasting, material conditions conform A Sa 2½ except machined parts
2. Impermeable coating, oxylane based

**Housing outside**

Coating: 1 layer of 2 component acrylate – isocyanate combination coating contains additional pigments based on zinc phosphate  
 Thickness: DFT 60 – 80 micron  
 Colour: RAL 3011, Red

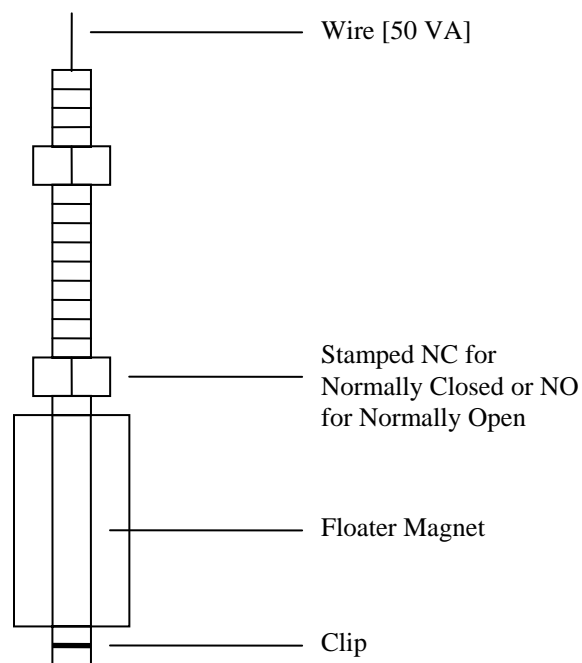
| Rev. | Description                                 | Changed | Checked | Date       |
|------|---|---------|---------|------------|
| A    | Specification updated to 1 layer system     | VM      | --      | 30-03-2009 |
| B    | Specification updated                       | VM      | RZ      | 12-08-2009 |
| C    | Specification *** added                     | DH      | PVDS    | 13-10-2011 |
| D    | Specification APEX added                    | VM      | PVDS    | 04-11-2011 |
| E    | SPX rebranded to Breidel; spec. *** removed | AK      | PvdS    | 27-08-2013 |

## HIGH LUBRICANT LEVEL SENSOR

### FLOAT SWITCHES FOR HOSE PUMPS:

Note: If float switch is to be used in an explosion proof environment, an intrinsically safe relay is required (relay is not the responsibility of Watson-Marlow/Bredel Pumps)

High level switches are devices used for sensing the lubricant level inside the pump casing. Upon hose failure, product being pumped will enter the pump housing through the damaged hose. The pumped product will mix with the hose lubricant causing the level in the pump to rise. A high level float switch installed near the top of the pump casing through the vent cap and will sense the failure which, if wired to the motor starter or speed controller, will shut the pump down. This becomes critical if the pump is left unattended for long periods of time. If the pump is allowed to run with an abrasive product in the pump housing, the pressing shoes or housing can be damaged.



### SPECIFICATION

The high level switch is, as standard, configured in the NORMALLY CLOSED position. Converting the switch to NORMALLY OPEN is a simple matter of removing the “clip” and “flipping over” the floater magnet. The floater magnet has a NO stamped on one end and an NC on the other. The easy way of determining if the switch is NO or NC is to look at the designation closest to the connecting wires.

The switch is rated for the following maxima:

Current Max: 1A

Voltage Max: 250V

Power Max: 50VA

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 1 – Identification of the substance / preparation and of the company**

Product identifier / product name: LUBRICANT/COOLANT for BREDEL HOSEPUMP  
"Genuine Hose Lubricant", 'FOOD GRADE'  
NSF Registration No123204, Category Code H1

Relevant identified use: Lubricant, Coolant

Details of the supplier of the SDS: Watson-Marlow Bredel B.V.  
Sluisstraat 7, 7491 GA tel.: +31 74 3770000  
P.O.Box 47, 7490 AA fax.: +31 74 3761175  
DELDEN, the Netherlands

Information provided by: Tel.: +31 (0)74 3770000  
E-mail: hosepumps@wmpg.com

Emergency information:: Tel.: +31 (0)74 3770000

**Section 2 – Hazards identification**

Classification of the substance/mixture:  
According to Directive 67/548/EEC or 199/45/EC: not classified  
According to regulation (EC) No 1272/2008 (CLP): not classified

Information concerning particular hazards for human and the environment: not applicable

NFPA-Ratings for USA: Health = 0; Fire = 1; Reactivity = 0

The product does not have to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

**Section 3 – Composition / information on ingredients**

Chemical Characterization: Mixture of substances

| Ingredient Name      | CAS No. | EINECS No. | % w/w  | REACH registration number |
|----------------------|---------|------------|--------|---------------------------|
| Glycerol             | 56-81-5 | 200-289-5  | 50-100 | Not applicable            |
| 1,2-Propylene Glycol | 57-55-6 | 200-338-0  | 2.5-10 | 01-2119456809             |

Remark Glycerol: REACH not applicable according to Annex V of the REACH regulation EC 1907/2006

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 4 – First aid measures**

|              |  |
|--------------|--|
| General      | No special measures required.  |
| Inhalation   | Remove victim into fresh air.  |
| Skin contact | Remove contaminated clothing. Rinse skin immediately with plenty of water. (shower if necessary).                    |
| Eye contact  | Remove contact lenses, if present.<br>Rinse immediately thoroughly and long (at least 15 min.) with plenty of water. |
| Ingestion    | Rinse mouth with water.<br>Seek medical attention.   |

**Section 5 – Fire fighting measures**

|                              |  |
|------------------------------|--|
| Suitable extinguishing media | Powder, water spray, foam, carbon dioxide.   |
| Special procedures           | Apply water spray or fog to cool nearby equipment. Avoid fire-fighting water to enter environment. |
| Special exposure hazards     | Fire may liberate carbon monoxide (CO) and smoke.  |
| Special protective equipment | Wear fully protective suit.  |

**Section 6 – Accidental release measures**

|                           |   |
|---------------------------|---|
| Personal precautions      | Not required.   |
| Environmental precautions | Dilute with plenty of water.  |
| Methods for cleaning up   | Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).<br>Dispose of the material collected according to regulations. |

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 7 – Handling and storage**

## Handling:

|   |                               |
|---|-------------------------------|
| Information for safe handling                             | No special measures required. |
| Information about protection against explosions and fires | No special measures required. |

## Storage:

|  |   |
|--|---|
| Requirements to be met by storerooms and receptacles     | Suitable material for receptacles: stainless and carbon steel and plastics. |
| Information about storage in one common storage facility | Not required.   |
| Further information about storage conditions             | This product is hygroscopic. Protect product from humidity and water.       |

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 8 – Exposure controls / personal protection**

|  |  |
|--|--|
| Component <b>Glycerol</b> with limit values that require monitoring at the workplace                     | Indicative limit:<br>Long-term value: 10 mg/m <sup>3</sup> (mist particulates).  |
| Component <b>1,2-Propylene Glycol</b> with limit values that require monitoring at the workplace:        | Indicative limit:<br>Long-term value: 50 mg/m <sup>3</sup> (mist particulates).  |
| REACH DNEL (derived no effect level)   | For Glycerol no DNEL valid.<br>For 1,2-Propylene Glycol<br>Systemic effects: Long-term value: 168 mg/m <sup>3</sup><br>Local effects: Long-term value: 10 mg/m <sup>3</sup><br>Remark: The product does not contain any relevant quantities of materials with respect to values that should be monitored at the workplace. |
| Additional information   | The lists valid during the making were used as basis.  |
| General protective measures  | The usual precautionary measures are to be adhered to when handling chemicals.   |
| Breathing equipment  | Not required.  |
| Protection of hands  | Safety gloves recommended:<br>Neoprene<br>Nitrile rubber, NBR<br>Fluorocarbon rubber (Viton)   |
| Penetration time of glove material   | The determined penetration times according to EN 374 part III are not performed under practical conditions. Therefore a maximum wearing time, which corresponds to 50% of the penetration time, is recommended.  |
| For the permanent contact of a maximum of 15 minutes gloves made of the following materials are suitable | Butyl rubber.  |
| Eye protection   | Goggles recommended.   |
| Hygiene measures   | When using, do not eat, drink or smoke.  |

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 9 – Physical and chemical properties**

|                             |  |
|-----------------------------|--|
| Form                        | Fluid.   |
| Colour                      | Clear green.   |
| Odor                        | Odorless.  |
| Boiling point/Boiling range | 260 °C (500°F).  |
| Solidification point        | -30 °C (-22 °F).   |
| Flash point                 | >100 °C (>212 °F) (ASTM D6450).  |
| Ignition temperature        | ~ 370 °C (~698 °F).  |
| Danger of explosion         | Product is not explosive. However, formation of explosive air/vapor mixtures are possible. |
| Explosion limits: lower     | 2.6 Vol %.   |
| Explosion limits: high      | 11.3 Vol %.  |
| Vapour pressure at 20°C     | 1.3 hPa (130 Pa; 1 mm Hg).   |
| Density at 20°C             | ~ 1.245 g/cm <sup>3</sup> (ISO 2811-2).  |
| Water solubility            | Fully miscible.  |
| Ethanol solubility          | Fully miscible.  |
| pH                          | Neutral.   |
| Viscosity (20°C)            | 600-700 mPa·s (ASTM D2196).  |

**Section 10 – Stability and reactivity**

|  |   |
|--|---|
| Thermal decomposition /<br>Conditions to avoid | No decomposition if used according to specifications. |
| Materials to avoid                             | Oxidizing agents.                                     |
| Hazardous decomposition<br>products            | Fire may liberate carbon monoxide (CO) and smoke.     |

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 11 – Toxicological information**

Acute toxicity:

|  |  |
|--|--|
| Oral (LD50)                                  | Glycerol (100%): >12000mg/kg (rat, literature).<br>1,2 Propylene Glycol (100%): 20000mg/kg (rat, literature).  |
| Primary irritant effect: skin<br>Skin (LD50) | No irritant effect.<br>Glycerol (100%) >10000mg/kg (rabbit, literature).<br>1,2-Propylene Glycol (100%):>20000mg/kg (rabbit,literature).   |
| Primary irritant effect: skin                | No irritant effect.  |
| Primary irritant effect: eyes                | No irritating effect.  |
| Sensitization:                               | No sensitizing effects known.  |
| Additional toxicological information:        | The product is not subject to classification according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version.<br>When used and handled according to specifications, the product does not have any harmful effects to our experience and the information provided to us. |

**Section 12 – Ecological information**

|   |  |
|---|--|
| Information about elimination (persistence and degradability) | Easily biodegradable<br>Biodegradability: > 85%.   |
| Aquatic toxicity:<br>fish toxicity:                           | LC50: > 5000 mg/l, literature.   |
| Behaviour in sewage processing plants                         | In case of judicious use the product does not cause disturbances in water purification plants, according to experiences made so far.   |
| General notes   | Water hazard class 1 (German Regulation) (Self-assessment): slightly hazardous for water.<br>Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.<br>Classification according VwVwS dated May 1999. (German legislation) |

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 13 – Disposal considerations**

## Product:

Recommendation

Must not be disposed together with household garbage. Do not allow product to reach sewage system.

## Uncleaned packaging

Recommendation

With due observance of local regulations, for instance transport to refuse incinerator.

Recommended cleansing agent

Water, if necessary together with cleansing agents.

**Section 14 – Transport information**

Transport/Additional information

Not dangerous according to the ADR/RID, IMDG and ICAO/IATA and DOT specifications.

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 15 -- Regulatory information**

Carcinogenicity categories:

|   |                                    |
|---|------------------------------------|
| EPA<br>(Environmental Protection Agency)                          | None of the ingredients is listed. |
| IARC (International Agency for Research on Cancer)                | None of the ingredients is listed. |
| NTP<br>(National Toxicology Program)                              | None of the ingredients is listed. |
| TLV<br>(Threshold Limit Values established by ACGIH)              | None of the ingredients is listed. |
| MAK<br>(German Maximum Workplace Concentration)                   | None of the ingredients is listed. |
| NIOSH-Ca<br>(National Institute for Occupational Safety & Health) | None of the ingredients is listed. |
| OSHA-Ca<br>(Occupational Safety & Health Administration)          | None of the ingredients is listed. |

|                                    |   |
|------------------------------------|---|
| Product related hazard information | Observe the general safety regulations when handling chemicals.<br>The product is not subject to identification regulations according to directives on hazardous materials. |
| Water hazard class                 | Water hazard class 1 (Self-assessment): slightly hazardous for water.   |

Safety Data Sheet  
[According to ISO/DIS 11014]

printing date: 18.08.2015

revision date: 18-08-2015

**Section 16 – Other information****Disclaimer**

Disclaimer of liability: the information in this SDS was obtained from sources which we believe are reliable.

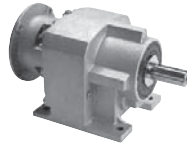
However, the information is provided without any warranty, express or implied, regarding its correctness. The conditions or methods of handling, storage, use or disposal of the product are beyond our control and may be beyond our knowledge.

For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This SDS was prepared and is to be used only for this product.

If the product is used as a component in another product, this SDS information may not be applicable.

# PART 4: GEAR REDUCER



# SK 373.1 NEMA C + W Ratings & Combinations

| Model Type | Gear Ratio<br>$i_{tot}$ | Output Speed<br>$n_2$<br>[rpm] | Output Torque<br>$T_{2max}$<br>[lb-in] | Maximum input power <sup>◇</sup> |      |      | Input Shaft<br>W | NEMA C-Face*<br>Available Combinations |  |  |  |  |
|------------|-------------------------|--------------------------------|--|----------------------------------|------|------|------------------|--|--|--|--|--|
|            |                         |                                |  | [hp]                             | [hp] | [hp] |                  | 56C                                    |  |  |  |  |

SK 373.1

|       |    |      |      |      |      |   |   |  |  |  |  |  |  |
|-------|----|------|------|------|------|---|---|--|--|--|--|--|--|
| 54.00 | 32 | 1859 | 0.96 | 0.63 | 0.48 | X | X |  |  |  |  |  |  |
|-------|----|------|------|------|------|---|---|--|--|--|--|--|--|

|                                    |     |      |             |          |         |   |   |                                     |      |      |       |       |       |
|------------------------------------|-----|------|-------------|----------|---------|---|---|-------------------------------------|------|------|-------|-------|-------|
| 343.92                             | 5.1 | 1682 | 0.14        | 0.09     | 0.07    | X | X |                                     |      |      |       |       |       |
| Based upon 1750 rpm<br>Input Speed |     |      | 1750 rpm    | 1150 rpm | 875 rpm |   |   | 1 hp                                | 2 hp | 5 hp | 10 hp | 20 hp | 30 hp |
|                                    |     |      | Input Speed |          |         |   |   | Cface Adapter Maximum Input Power * |      |      |       |       |       |

◇ The maximum input power limit shown is the largest motor power typically combined with the gear unit. These values shown are not the mechanical limit and often may be increased through discussion with our sales or engineering department.

\* The NEMA C-face power limit must also be considered when selecting a reducer. The C-face Adapter's Maximum Input Power values are displayed under the Available combinations and based on a 1750 rpm motor.

|          | W  | 56C | 140TC |
|----------|----|-----|-------|
| SK 373.1 | 26 | 24  | 24    |





# GENERAL INSTRUCTIONS



## 1. Importance of the operating instructions

These operating instructions are intended to provide general information and safety guidelines. It is the responsibility of the buyer, machine builder, installer and user of the NORD product to make sure that all the proper safety notes and operating instructions have been reviewed and understood. If the contents of this instruction or any applicable operating instructions are not understood, please consult NORD.

|  |                |  |
|--|----------------|--|
|  | <b>WARNING</b> |  |
| <p>Electric motors, gearmotors, electrical brakes, variable frequency drives, and gear reducers contain potentially dangerous high-voltage, rotating-components and surfaces that may become hot during operation. All work involved in the transport, connection, commissioning and maintenance of any NORD product must be carried out by qualified and responsible technicians.</p> |                |  |

## 2. Inspect incoming freight

Before accepting shipment from the freight company, thoroughly inspect the NORD equipment for any shipping and handling damage. If any goods called for in the bill of lading or express receipt are damaged, or if the quantity is short, do not accept until the freight express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight carrier or express agent at once, and request a formal review of your claim.

Claims for loss or damage in shipment must not be deducted from the NORD invoice, nor should payment of the NORD invoice be withheld awaiting adjustment of such claims, as the carrier guarantees safe delivery. NORD will try to assist in collecting claims for loss or damage during shipment; however, this willingness on our part does not remove the transportation company's responsibility in reimbursing you for collection of claims or replacement of material.

## 3. Obtaining detailed operating instructions

One can receive the detailed installation and maintenance instructions by entering a serial number (or NORD order number) at the appropriate location on the NORD web site.

- i. Record the serial number from your gearmotor, gear reducer, or motor nameplate, or record the serial number found on your order confirmation.
- ii. Go to [www.nord.com/docs](http://www.nord.com/docs) to download the appropriate operating instructions.

### EXAMPLE: [www.nord.com/docs](http://www.nord.com/docs)

### Unit documentation

Gear unit installation and maintenance instructions can be found by entering the sales order number in the search field below. The sales order number can be found on the gear unit's nameplate (see illustration) or on the order confirmation.

**Sales Order Number** 200836833-400  
**Model Type** SK9382AZSH-180MH/4 TW RD VZ  
**Mounting Position** M4

| Type | Name   | Pages | Size        |
|------|--|-------|-------------|
|      | U10000 - General Instructions                                  | 2     | (51.97 KB)  |
|      | U10040 - Storage   | 1     | (36.77 KB)  |
|      | U10060 - Unit Installation                                     | 2     | (60.94 KB)  |
|      | U10270 - Keyed Hollow Shaft                                    | 2     | (70.52 KB)  |
|      | U10750 - Helical and Bevel Reducer Lubrication                 | 2     | (75.66 KB)  |
|      | U11000 - Helical and Bevel Lubrication Types                   | 2     | (58.10 KB)  |
|      | U11900 - Lubrication Capacity - Clincher Shaft Mounted         | 1     | (894.56 KB) |
|      | U14200 - Oil Plug and Vent Locations - Clincher Parallel Shaft | 1     | (125.83 KB) |
|      | U15200 - Parts List - Clincher Parallel Shaft                  | 12    | (519.50 KB) |
|      | Complete Manual for 200836833-400 (PDF Format)                 | 31    | (2.25 MB)   |
|      | All Manuals for 200836833-400 (ZIP Format)                     |       | (2.01 MB)   |

## 4. Intended use

NORD is a supplier of electric motors, gearmotors, reducers, electromechanical brakes, mechanical variators, and electrical variable frequency drives that are intended for commercial installations on larger systems and machines.

|  |                |  |
|--|----------------|--|
|  | <b>WARNING</b> |  |
| <p>NORD does not accept any liability for damage or injury caused by:</p> <ul style="list-style-type: none"> <li>• Inappropriate use, operation or adaptation of the drive system.</li> <li>• Unauthorized removal of housing covers, safety and inspection covers, guarding, etc.</li> <li>• Unauthorized modifications to the drive system.</li> <li>• Improper servicing or repair work on the drive system.</li> <li>• Damage caused during shipment or transportation.</li> <li>• Disregard of the important Safety Notes or Operating Instructions.</li> </ul> |                |  |





## 5. Notes concerning warranty and liability

All units are supplied according to the terms described in our standard "Conditions of Sale." The unit limited warranty is also defined in our "Conditions of Sale" and is located in the back of our product catalogs as well as the back of your order invoice.

All NORD Safety Notes and all related NORD Operating instructions shall be considered up-to-date at the time in which they were compiled by the buyer, machine builder, installer or user. NORD reserves the right to incorporate technical modifications and information updates to any safety/operating instructions that are within the scope of providing additional knowledge or clarification, communicating design changes, or product enhancements. Information updates may include any NORD product, or subsequent products purchased and supplied by NORD; No specific claims can be derived from the information or illustrations and descriptions contained in the safety notes or related operating instructions.

## 6. Checklist for installation and operation

- Verify that the purchased NORD product has been supplied with the expected accessories & options. Check the received goods and packing slip to make sure items are properly received.
- Make sure that you have all of the required Operating Instructions for your NORD electric motor, gearmotor, reducer, electromechanical brake, mechanical variable speed drives, or electrical variable frequency drives.
- Consult NORD if you feel you are missing any documentation or if you have questions.

|  <b>WARNING</b>    |
|--|
| NORD assumes no liability for personal injury, equipment damage or malfunctions resulting from failure to comply with any installation safety notes. The applicable national, regional, and local work regulations and safety requirements must also be complied with. Failure to comply with any safety notes or regulations may result in serious injury, damage to property, or even death. |



## 1. Safety & information symbols

All work including transportation, storage, installation, electrical connection, commissioning, servicing, maintenance and repair must be performed **only by qualified specialists or personnel**. It is recommended that repairs to NORD Products are carried out by the NORD Service Department. Instructions related to operational safety will be emphasized as shown.

| Symbol | Meaning  |
|--------|--|
|        | <b>General Warning or Hazard</b> - Severe risk or danger of personal injury or death by working around dangerously high electrical voltage or moving machinery. Proper safety precautions must be taken. |
|        | <b>Possible Harmful Situation</b> - Care must be taken to avoid the possibility of damaging the drive unit, driven machine, or the environment.  |
|        | <b>Important Note</b> - Useful note or tip to help assure trouble-free operation.  |
|        | <b>Material Disposal Note</b> - Important note concerning suggested material disposal.   |

## 2. Safety warnings

| GENERAL WARNINGS  |  |
|---|--|
| <ul style="list-style-type: none"> <li>All work involved in the transport, connection, commissioning and maintenance of any NORD product must be carried out by qualified and responsible technicians. All applicable national, regional, and local work regulations and safety requirements must also be complied with. <b>NORD assumes no liability for personal injury, accidental death, or equipment damage and malfunctions resulting from failure to comply with installation or operating instructions, safety notes, or any work regulations and laws!</b></li> <li>Gear unit installation and maintenance work may only be performed when no power is available to the prime mover or motor. Electric motors, electrical brakes, and variable frequency drives, contain potentially dangerous high-voltage. Prior to installation or maintenance, shut down the power at the circuit breaker or power switch. <b>While working on the drive, make sure the power from the prime mover is isolated or secured on "lock-out" to prevent accidental start-up and to safeguard against injury!</b></li> <li>Surfaces of motors and gear units may become hot during operation or shortly after start-up. In some instances additional protection against accidental contact may be necessary. <b>Use caution to avoid burns or serious injury!</b></li> </ul> |  |

## 3. Observe published performance range & nameplate data

| HARMFUL SITUATION   |  |
|---|--|
| Observe the data on all reducer nameplates and verify published ratings for the NORD item/s in question. Do not operate any NORD equipment outside the published performance range. Failure to comply may result in damage to the drive unit, driven machine, or the environment. |  |

### U.S. Nameplate

|  |       |
|--|-------|
| NORD GEAR CORPORATION-USA / WWW.NORD.COM |       |
| SK ①                                     |       |
| S/N ②                                    |       |
| RATIO ③                                  | SF ④  |
| TORQUE ⑤                                 | LB-IN |
| SPEED ⑥                                  | RPM   |
| ⑦ MTG POS                                |       |
| FOR GEAR LUBRICATION SEE MANUAL          |       |

- ① Model/Type
- ② Serial Number
- ③ Gear Ratio
- ④ Service Factor
- ⑤ Torque Rating
- ⑥ Output Speed RPM
- ⑦ Mounting Position

### European Nameplate

|  |                     |
|--|---------------------|
| Getriebebau NORD<br>GrbH&Co KG<br>D - 22934 Bargteheide                                  |                     |
| Type   | SK ①                |
| No.  | ②                   |
| i=   | ③                   |
| n2=  | ④ min <sup>-1</sup> |
| Siehe Wartungsanleitung<br>See maintenance instructions<br>Voir instructions d'entretien |                     |

- ① Model/Type
- ② Serial Number
- ③ Gear Ratio
- ④ Speed

## 4. Transportation and handling

Make sure that all eyebolts and lifting lugs are tight and lift only at designed points. Protect the mounting surface from possible damage during transportation.

| WARNING  |  |
|--|--|
| Do not attach other machinery or loads to the NORD assembly, since the supplied lifting bolts are not designed for this purpose. |  |

If the gearmotor or assembly is equipped with two suspension eye bolts, then both locations should be used for transportation and placement of the unit; in this case the tension force of the slings must not exceed a 45° angle.



In some instances it may be appropriate to use additional lifting straps or slings in order to assure safe transportation of the assembly. Always use sufficiently rated handling equipment and ensure that adequate safety measures are taken to protect personnel from injury during transportation. Once the NORD assembly is properly installed, remove the transportation fixtures.



# SAFETY NOTES



## 7. DISPOSAL

|  |                          |   |
|--|--------------------------|---|
|   | <i>MATERIAL DISPOSAL</i> |  |
| <p>Properly dispose of all used gear units and internal parts in accordance with all local regulations. In particular, all lubricants must be properly collected and disposed.</p> |                          |   |

For confirmation of specific materials used in a specific reducer or gearmotor assembly, please consult NORD with the appropriate unit identification or serial number.

| Components   | Material  |
|--|---|
| Gear wheels, shafts, rolling bearings, parallel keys, snap rings, spacers, shims, etc. | Steel   |
| Gear housing and housing components  | Cast iron or Aluminum (depending on type and size)            |
| Worm gears   | Bronze alloy  |
| Radial seals, sealing caps, and rubber components                                      | Elastomers with some steel                                    |
| Coupling components  | Plastic or Elastomer with Steel                               |
| Housing gaskets and flat oil seals   | Asbestos-free sealing or gasket material (various types used) |
| Gear Oil   | Mineral, SHC-Synthetic or PG-Synthetic (can vary)             |



## 1. Storage



### IMPORTANT NOTE



For storage periods longer than 9 months, or for storage in less than desirable conditions, please consult NORD for recommendations.

Storage for up to 9 months is possible, so long as the following conditions are observed:

- Store the gear unit in its actual mounting position in accordance with the specified oil fill-level, in a clean and dry temperature controlled area. Avoid temperature fluctuations within the range of 0°C and 40°C (32°F to 104°F) and avoid relative humidity conditions in excess of 60%.
- Protect all exposed or unpainted shaft and flange surfaces with an anti-corrosion agent or grease.
- Store in a location free from shock and vibration, to avoid false brinelling of bearing elements and raceways.
- Whenever possible, rotate the shafts periodically, by hand if necessary, to help prevent brinelling (bearing damage) and to help keep the shaft seals pliable.
- Avoid direct exposure to the sun or UV light and aggressive or corrosive materials in the environment (ozone, gases, solvents, acids, caustic solutions, salts, radioactivity, etc.

## 2. Commissioning

Prior to gear unit start-up, complete the following:

- Check the lubricant and be sure the gear unit is filled with the proper oil type, to the proper level, as determined by the mounting position.



### IMPORTANT NOTE



Some smaller gear units are supplied as maintenance free/lubricated for life gear units. Oil level may not be checked on some of these units.

- Check the condition of all shaft seals and all assembled flange gasket areas. If any change is detected in the shape, color, hardness or permeability, or if any leaks are detected, the corresponding shaft seals and/or gaskets must be replaced.
- Remove all anti-corrosive metal protectant from otherwise bare metal surfaces. Follow product manufacturers directions and warnings during surface protection removal.
- Check the resistance of all motor and brake windings to verify the integrity of the winding insulation and inspect all terminal box openings and wire connection areas to verify that all components are dry and free of corrosion.

## 3. Long-Term Storage

By taking special precautions, problems such as seal leakage and reducer failure due to the lack of lubrication, improper lubrication quantity, or contamination can be avoided. The following precautions will protect gear reducers during periods of extended storage:

- Store the gear unit in its actual mounting position in accordance with the specified oil fill-level, in a clean and dry temperature controlled area. Avoid temperature fluctuations within the range of 0°C and 40°C (32°F to 104°F) and avoid relative humidity conditions in excess of 60%.
- Fill the reducer full with oil that is compatible with the product normally used or recommended during service.
- Apply grease to all unpainted or unprotected shafts, bores, keyways, flange surfaces, tapped holes, and to the exterior of all oil seals.
- Store in a location free from shock and vibration, to avoid false brinelling of bearing elements and raceways.
- Once every few months rotate the input shaft approximately 10-20 revolutions to redistribute the weight of gears and shafts and to prevent brinelling of the bearings and drying of the seal track.
- Avoid direct exposure to the sun or UV light and aggressive or corrosive materials in the environment (ozone, gases, solvents, acids, caustic solutions, salts, radioactivity, etc.)

## 4. Commissioning After Long-Term Storage

- Remove all anti-corrosive metal protectant from otherwise bare metal surfaces. Follow product manufacturers directions and warnings during surface protection removal.
- Drain the reducer and refill it with the proper type and amount of lubricant.
- Observe start-up and initial operation to make sure there are no seal or gasket leaks, or unusual sounds, vibration or heat rise during operation.
- Check the resistance of all motor and brake windings to verify the integrity of the winding insulation and inspect all terminal box openings and wire connection areas to verify that all components are dry and free of corrosion.



# UNIT INSTALLATION



## 1. Installation site

Drives must be properly installed if they are to produce the rated torque. Improper installation may lead to oil leaks, reduced life, or even catastrophic failure. NORD gear drives and motors are intended to be installed at a suitable mounting site under the following conditions:

- Unimpeded airflow to and around the units.
- Accessibility to oil drain, level and breather plugs.
- On brakemotors, allow adequate space for removing the fan guard and replacing and adjusting the brake.
- Mounting surfaces must be flat, torsionally rigid, and dampened against vibration.
- Unless special measures are taken, the immediate vicinity around the gear drive or motor should not be exposed to any aggressive or corrosive substances, contaminated air, ozone, gases, solvents, acids, alkalis, salts, radioactivity, etc.

## 2. Mounting position

Reducer mounting position charts illustrate the standard mounting positions for horizontal and vertical mounting. All gear units are assembled with the oil fill-level, oil-drain and vent plugs installed in their proper locations, **according to the customer-specified mounting position**. For mounting orientations other than shown consult NORD Gear.

Table 1: Recommended Straightness and Flatness of Customer-Supplied Support Foundation

| Above (in) | To & Including (in) | General Tolerance on Straightness & Flatness ISO 2768-2, Tolerance Class K |
|------------|---------------------|--|
| 0.00       | 0.39                | +/- 0.002 in   |
| 0.39       | 1.18                | +/- 0.004 in   |
| 1.18       | 3.9                 | +/- 0.008 in   |
| 3.9        | 11.8                | +/- 0.016 in   |
| 11.8       | 39                  | +/- 0.024 in   |
| 39         | 118                 | +/- 0.031 in   |

| Above (mm) | To & Including (mm) | General Tolerance on Straightness & Flatness ISO 2768-2, Tolerance Class K |
|------------|---------------------|--|
| 0          | 10                  | +/- 0.05 mm  |
| 10         | 30                  | +/- 0.1 mm   |
| 30         | 100                 | +/- 0.2 mm   |
| 100        | 300                 | +/- 0.4 mm   |
| 300        | 1000                | +/- 0.6 mm   |
| 1000       | 3000                | +/- 0.8 mm   |

**Straightness:** Based upon the length of the corresponding line.  
**Flatness:** Based upon the longer lateral surface or the diameter of the circular surface.

STOP
*HARMFUL SITUATION*
STOP

The gear reducer may not receive proper lubrication if the unit is not mounted in the position for which it is designed. Observe the mounting position designated on the reducer nameplate, or specified in the order acknowledgement. Consult NORD prior to changing mounting position in the field. While it is often possible to simply relocate the oil fill-level and vent locations, and adjust the oil fill amount, in some cases, different mounting positions may lend themselves to different internal construction features.

STOP
*HARMFUL SITUATION*
STOP

The responsibility for the design and construction of the support foundation is with the user. The foundation must be adequate to withstand normal operating loads and possible overloads while maintaining alignment to attached system components under such loads. **Motors and drive components mounted on prefabricated base plates can become misaligned during shipment. Always check alignment after installation.**

## 3. Reducer mounting

- The support foundation must be straight, level and flat. Whether the gear unit is foot-mounted or flange-mounted, NORD recommends that the straightness and flatness of the customer-supplied support foundation follow **Table 1**.
- The gear unit must be properly aligned with the driven shaft of the machine in order to prevent additional stress or load forces from being imposed upon the gear unit.
- To facilitate oil drainage it may be desirable to elevate the gear box foundation above the surrounding support structure.
- All bolting surfaces must be clean and free from contamination and corrosion.

## 4. Steel foundation

An engineered structural steel foundation should be designed to provide adequate rigidity and prevent loads from distorting the housing or causing misalignment of internal gears and shafts. When foot-mounting the gear reducer, a base plate or sole plate with suitable thickness (generally equal or greater than the thickness of the drive feet) should be securely bolted to steel supports and extend under the entire gear drive assembly. When flange-mounting the gear unit, the bulk head plate must be engineered to minimize buckling distortions and support the cantilevered weight of the gear unit or gear motor.

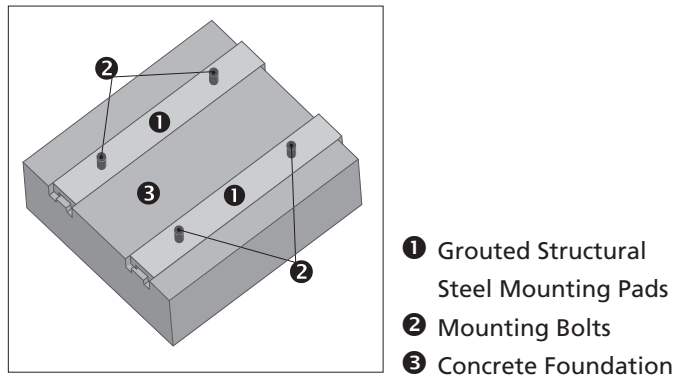
STOP
*HARMFUL SITUATION*
STOP

Do not weld on the gear unit or use the gear unit as an earth or ground connection for any welding procedure as this may cause permanent damage to the bearings and gears.

## 5. Concrete foundation

If a concrete foundation is used, allow the concrete to set firmly before bolting down the gear drive. Grout structural steel mounting pads and bolts of sufficient size into the concrete, to adequately distribute the load stress onto the concrete foundation.

Figure 1: Concrete Foundation



## 6. Bolt connections for footed & flange mounted units

NORD footed reducers and flange-mount reducers (with B5 flange) have clearance designed into the mounting holes to allow for some minor adjustments in alignment. Bolt size, strength and quantity should be verified to insure proper torque reaction capacity whatever the mounting arrangement. Tightening torque for gear reducer mounting bolts, and recommended fastener grades, are provided in Table 2.

Table 2A: Tightening Torque for Inch Reducer Mounting Bolts

| Thread Size<br>(in) | Grade SAE 5 /<br>ASTM A449 |      | Grade SAE 8 |       |
|---------------------|----------------------------|------|-------------|-------|
|                     | (lb-ft)                    | (Nm) | (lb-ft)     | (Nm)  |
| 1/4-20              | 7.1                        | 9.6  | 10.0        | 13.6  |
| 5/16-18             | 16                         | 21   | 22          | 30    |
| 3/8-16              | 28                         | 37   | 39          | 53    |
| 1/2-13              | 69                         | 93   | 98          | 132   |
| 5/8-11              | 138                        | 188  | 195         | 264   |
| 3/4-10              | 247                        | 334  | 348         | 472   |
| 7/8-9               | 396                        | 537  | 558         | 757   |
| 1-8                 | 592                        | 802  | 833         | 1,130 |
| 1 1/8-7             | -                          | -    | 1,233       | 1,672 |
| 1 1/4-7             | -                          | -    | 1,717       | 2,327 |
| 1 3/8-6             | -                          | -    | 2,267       | 3,073 |
| 1 1/2-6             | -                          | -    | 2,983       | 4,045 |
| 1 3/4-5             | -                          | -    | 4,458       | 6,045 |

- Calculated tightening torques are based a conventional 60°, clean and dry (un-lubricated) thread, with thread-friction and head-friction equal to 0.15.
- When using inch-fasteners, NORD recommends a minimum Grade SAE 5 (ASTM A-449) for sizes up to 1-8 UNC, and Grade SAE 8 for all larger sizes.

Table 2B: Tightening Torque for Metric Reducer Mounting Bolts

| Above<br>(mm) | ISO Grade 8.8 |       | ISO Grade 10.9 |       | ISO Grade 12.9 |        |
|---------------|---------------|-------|----------------|-------|----------------|--------|
|               | (lb-ft)       | (Nm)  | (lb-ft)        | (Nm)  | (lb-ft)        | (Nm)   |
| M4            | 2.4           | 3.2   | 3.5            | 4.7   | 4.1            | 5.5    |
| M5            | 4.7           | 6.4   | 6.9            | 9.3   | 8.1            | 11     |
| M6            | 8             | 11    | 12             | 16    | 14             | 19     |
| M8            | 20            | 27    | 29             | 39    | 34             | 46     |
| M10           | 39            | 53    | 58             | 78    | 67             | 91     |
| M12           | 68            | 92    | 100            | 135   | 110            | 155    |
| M14           | 107           | 145   | 159            | 215   | 180            | 250    |
| M16           | 170           | 230   | 247            | 335   | 290            | 390    |
| M18           | 240           | 325   | 343            | 465   | 400            | 540    |
| M20           | 339           | 460   | 487            | 660   | 570            | 770    |
| M22           | 465           | 630   | 664            | 900   | 770            | 1,050  |
| M24           | 583           | 790   | 848            | 1,150 | 960            | 1,300  |
| M27           | 848           | 1,150 | 1,217          | 1,650 | 1,440          | 1,950  |
| M30           | 1,180         | 1,600 | 1,660          | 2,250 | 1,950          | 2,650  |
| M36           | 2,050         | 2,780 | 2,884          | 3,910 | 3,470          | 4,710  |
| M42           | 3,297         | 4,470 | 4,639          | 6,290 | 5,560          | 7,540  |
| M48           | 4,940         | 6,700 | 7,010          | 9,500 | 8,260          | 11,200 |

- Calculated tightening torques are based on a conventional 60°, clean and dry (un-lubricated) thread, with thread-friction and head-friction equal to 0.15.
- When using metric-fasteners, NORD recommends a minimum ISO Grade 8.8 bolt.

## 7. Mounting the prime mover

When the motor is not flange mounted or integrally mounted to the gearbox, it is important to properly secure and align the gear drive with respect to the driven machine before attempting to align the prime mover or motor.

- After the main gear drive is properly aligned and bolted in place, align the prime mover with respect to the reducer input shaft.
- Use shims under the feet of the prime mover as needed, and secure in place with the proper mounting bolts. Dowel pins may be field-installed to help prevent misalignment and ensure proper realignment if removed for service.



### IMPORTANT NOTE



When using a high speed coupling connection between the prime mover and the reducer, check alignment per the coupling manufacturers recommendations. If the coupling is misaligned, the reducer alignment or shimming is incorrect. Re-align the gear reducer and re-check the high-speed coupling alignment before re-aligning the motor.

## 1. Solid shaft diameter tolerance

Reducer input and output shaft extensions have a diameter tolerance as specified in Table 1.

Table 1: Solid Shaft Diameter Tolerance

| Above<br>ø (in) | To & Including<br>ø (in) | Tolerance<br>(in) |
|-----------------|--------------------------|-------------------|
| 0.375           | 1.750                    | +0.0000 / -0.0005 |
| 1.750           | 7.500                    | +0.0000 / -0.0010 |

| Above<br>ø (mm) | To & Including<br>ø (mm) | Tolerance<br>(mm) | ISO 286-2<br>Fit Class |
|-----------------|--------------------------|-------------------|------------------------|
| 10              | 18                       | +0.012 / +0.001   | k6                     |
| 18              | 30                       | +0.015 / +0.002   | k6                     |
| 30              | 50                       | +0.018 / +0.002   | k6                     |
| 50              | 80                       | +0.030 / +0.011   | m6                     |
| 80              | 120                      | +0.035 / +0.013   | m6                     |
| 120             | 180                      | +0.040 / +0.015   | m6                     |
| 180             | 190                      | +0.046 / +0.017   | m6                     |

## 2. Fitting drive elements onto the reducer solid shaft

Solid input and output shaft extensions are provided with a drill and tap feature as indicated in Table 2. When installing drive elements such as coupling hubs, pulleys, sprockets, or gears, NORD recommends using the threaded hole in the end of the shaft, along with a suitable assembly device fitted into the threaded hole.

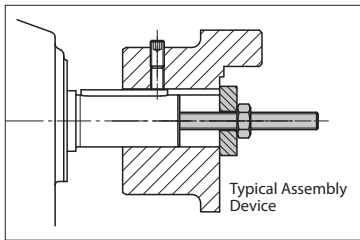


Table 2: Solid Shaft End - Threaded Holes

| Above<br>ø (in) | To & Including<br>ø (in) | Tap size & Depth<br>(in) |
|-----------------|--------------------------|--------------------------|
| 0.375           | 0.500                    | 10-24 x 0.43 in          |
| 0.500           | 0.875                    | 1/4-20 x 0.59 in         |
| 0.875           | 0.938                    | 5/16-18 x 0.71 in        |
| 0.938           | 1.100                    | 3/8-16 x 0.87 in         |
| 1.100           | 1.300                    | 1/2-13 x 1.10 in         |
| 1.300           | 1.875                    | 5/8-11 x 1.42 in         |
| 1.875           | 3.500                    | 3/4-10 x 1.73 in         |
| 3.500           | 5.125                    | 1-8 x 2.63 in            |
| 5.125           | 7.500                    | 1 1/4 - 7 x 3.15         |

| Above<br>ø (mm) | To & Including<br>ø (mm) | Tap Size & Depth<br>(mm) |
|-----------------|--------------------------|--------------------------|
| 10              | 13                       | M4 x 10 mm               |
| 13              | 16                       | M5 x 12.5 mm             |
| 16              | 21                       | M6 x 16 mm               |
| 21              | 24                       | M8 x 19 mm               |
| 24              | 30                       | M10 x 22 mm              |
| 30              | 38                       | M12 x 28 mm              |
| 38              | 50                       | M16 x 36 mm              |
| 50              | 85                       | M20 x 42 mm              |
| 85              | 130                      | M24 x 50 mm              |
| 130             | 190                      | M30 x 60 mm              |

**NORD Gear Limited**

Toll Free in Canada: 800.668.4378

**NORD Gear Corporation**

Toll Free in the United States: 888.314.6673



### HARMFUL SITUATION



**DO NOT DRIVE** or **HAMMER** the coupling hub, pulley, sprocket, or gear into place. An endwise blow to the reducer shaft can generate damaging axial forces and cause damage to the reducer housing, bearings or internal components.



### WARNING



To avoid serious injury the user must provide suitable safety guards for all rotating shafts and shaft components such as couplings, chain drives, belt drives, etc. All guarding must adhere to local regulations and safety standards.

## 3. Installing interference-fit hubs to the reducer shaft

Prior to installing any interference-fit hubs to the reducer shaft, consult with the manufacturer to determine proper assembly and fit. Interference-fits usually require heating the coupling, sprocket or gear hub, per the manufacturer's recommendations. Coupling hub installation typically follows ANSI/AGMA 9002-A86. Always make sure the reducer shaft seals are protected from the heat source. Apply uniform heat to the drive element hub to prevent distortion. NORD does not recommend heating the drive element hub beyond 212°F to 275°F (100°C to 135° C).



### WARNING



When using heat to mount a drive element hub, do not use open flame in a combustible atmosphere or near flammable materials. Use suitable protection to avoid burns or serious injury.



### HARMFUL SITUATION



When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close to the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tighten the belts or chains.

## 4. Coupling installation

The performance and life of any coupling depends upon how well it is installed. Coupling hubs are typically mounted flush with the shaft ends, unless specifically ordered for overhung mounting. Shaft couplings should be installed according to the coupling manufacturer's recommendations for gap, angular and parallel alignment. To help obtain critical shaft alignment coupling hubs may be installed to the machine shafts prior to final shimming or tightening of the foundation bolts. Proper coupling alignment allows for thermal and mechanical shaft movement during operation and ensures that only torque (no radial load) is transmitted between the mating shafts.

### Coupling gap and angular alignment

The shaft gap must be sufficient to accommodate any anticipated thermal or mechanical axial movement. When setting the coupling gap, insert a spacer or shim stock equal to the required spacing or gap between the coupling hub faces. Measure the clearance using feeler gauges at 90-degree intervals, to verify the angular alignment.

### Parallel (or offset) alignment

Mount a dial indicator to one coupling hub, and rotate this hub, sweeping the outside diameter of the other hub. The parallel or offset misalignment is equal to one-half of the total indicator reading. Another method is to rest a straight edge squarely on the outside diameter of the hubs at 90° intervals and measure any gaps with feeler gauges. The maximum gap measurement is the parallel or offset misalignment.

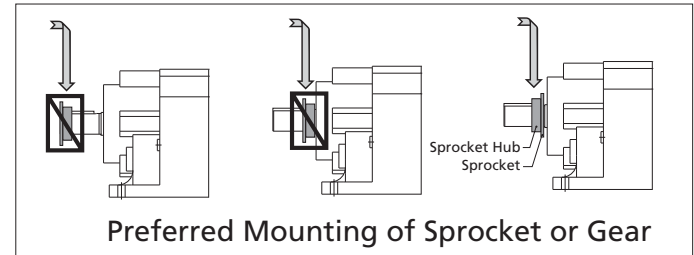
### Check alignment

After both angular and parallel alignments are within specified limits, tighten all foundation bolts securely and re-check critical alignment. If any of the specified limits for alignment are exceeded, realign the coupling.

## 5. Installing sheaves (pulleys), sprockets and gears



To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, gears, etc.) so that the applied load center is as close to the gear housing as possible, as shown in **Figure 2**.

**Figure 2: Sprocket or Gear Mounting**



Align the driver sheave or sprocket with the driven sheave or sprocket by placing a straight-edge length-wise across the face of the sheaves or sprockets. Alignment of bushed sheaves and sprockets should be checked only after bushings have been tightened. Check horizontal shaft alignment by placing one leg of a square or a level vertically against the face of the sheave or sprocket.

Always check component alignment and tension any belts or chains per the manufacturer's recommendation. The ideal belt or chain tension allows proper wrap of the driver and driven wheels, while maintaining the lowest possible tension of the belts or chain, so that no slipping occurs under load conditions. Check belt or chain tension frequently over the first 24 to 48 hours of operation.

|  <span style="font-weight: bold; font-size: 1.2em;">HARMFUL SITUATION</span>   |
|--|
| <p>When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tension the belts or chains.</p> |

## 6. Outboard pinion gear alignment

Align outboard pinion gears and adjust the gear tooth clearance according to the manufacturer's recommendations, checking for acceptable outboard pinion tooth contact. The foundation bolts may have to be loosened and the gear unit moved slightly to obtain proper gear tooth contact. After the unit is moved to correct tooth contact, the prime mover may need to be realigned.



# REDUCER MOUNTING FOOTED & FLANGE MOUNT GEAR UNITS



## 1. Foot-mounted reducers

When installing the foot-mounted gear unit, observe the flatness specifications and bolt tightening torque guidelines provided in U10060 and make sure the mating mounting surface and reducer feet are clean and free of debris. Use of shims under the feet of the gear unit may be required in order to align the output shaft to the driven equipment. Make sure that all feet are supported so that the housing will not distort when it is bolted down. Improper shimming will cause mis-alignment and may reduce the life of the gear unit or cause component failure. Dowel pins may be field-installed to help prevent misalignment and ensure proper realignment if removed for service.

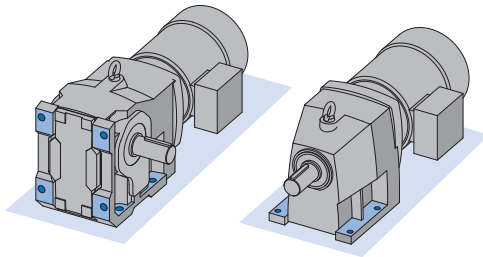


Table : Flange Pilot Tolerance

| Above<br>ø (in) | To & Including<br>ø (in) | Tolerance<br>(in) | ISO 286-2<br>Fit Class |
|-----------------|--------------------------|-------------------|------------------------|
| 1.969           | 3.150                    | +0.0005 / -0.0003 | j6                     |
| 3.150           | 4.724                    | +0.0005 / -0.0004 | j6                     |
| 4.724           | 7.087                    | +0.0006 / -0.0004 | j6                     |
| 7.087           | 9.055                    | +0.0000 / -0.0005 | h6                     |
| 9.055           | 9.843                    | +0.0000 / -0.0011 | h6                     |
| 9.843           | 12.402                   | +0.0000 / -0.0013 | h6                     |
| 12.402          | 15.748                   | +0.0000 / -0.0014 | h6                     |
| 15.748          | 19.685                   | +0.0000 / -0.0016 | h6                     |

| Above<br>ø (mm) | To & Including<br>ø (mm) | Tolerance<br>(mm) | ISO 286-2<br>Fit Class |
|-----------------|--------------------------|-------------------|------------------------|
| 50              | 80                       | +0.012 / -0.007   | j6                     |
| 80              | 120                      | +0.013 / -0.009   | j6                     |
| 120             | 180                      | +0.014 / -0.011   | j6                     |
| 180             | 230                      | +0.000 / -0.013   | h6                     |
| 230             | 250                      | +0.000 / -0.029   | h6                     |
| 250             | 315                      | +0.000 / -0.032   | h6                     |
| 315             | 400                      | +0.000 / -0.036   | h6                     |
| 400             | 500                      | +0.000 / -0.040   | h6                     |

**i**
**IMPORTANT NOTE**
**i**

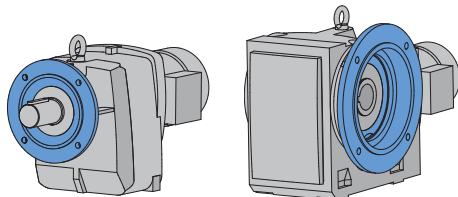
Gear units may be subjected to radial loads or side pull, caused by external chain drives or belt drives. In these instances it is recommended that the mounting base be designed with a slide-plate adjustment to accommodate extra slack in the chain or the belt after the feet are loosened. When using an external chain or belt drive, make sure the reducer is sized so that the shaft and bearings have adequate capacity.

When installing the flange mounted gear unit, observe the flatness specifications and bolt tightening torque guidelines provided in U10060. Make sure the mating mounting surface and reducer flange are clean and free of debris. Use a straight edge or parallel bar to check for high spots on the mating mounting surface and remove any raised material around the mounting holes.

Set the gear unit into place and tighten the bolts until they are snug. Before final bolt-tightening check for any material gaps between the mating surfaces and if shimming is required, use "U" shaped shims at least 2 times the width of the bolt. Avoid over shimming a very irregular surface as this will make it very difficult to achieve proper alignment.

## 2. Flange-mounted reducers (with B5 flange)

When using the B5 flange to mount the gear unit, the bulk head plate must be engineered to minimize buckling distortions and support the cantilevered weight of the gear reducer or gearmotor. On the B5 mounting flange NORD provides a pilot register or and the flange pilot tolerance as listed per Table 1. When the mating hole is designed with the proper fit, the flange pilot tenon provides a means of accurately positioning the reducer while the hold-down bolts are properly secured; once the reducer is secured, the tenon helps prevent movement of the reducer and it helps locate the center of the reducer output shaft.



**i**
**IMPORTANT NOTE**
**i**

For heavy shock applications, it is advisable to field-install dowel pins through the mounting flange connection (in addition to the mounting bolts). This will help control flange movement or flange rotation and relieve the mounting bolts from this additional stress.

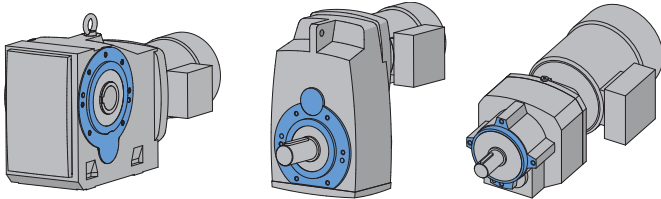


# REDUCER MOUNTING FOOTED & FLANGE MOUNT GEAR UNITS



### 3. Flange-mounted reducers (with B14 flange)

When using the B14 flange to mount the gear unit, the bulk head plate must be engineered to minimize buckling distortions and support the cantilevered weight of the gear reducer or gearmotor. When properly installed, the output flange of the reducer housing is designed to enable the permissible torques and radial forces to be reliably transmitted by the bolt connections.

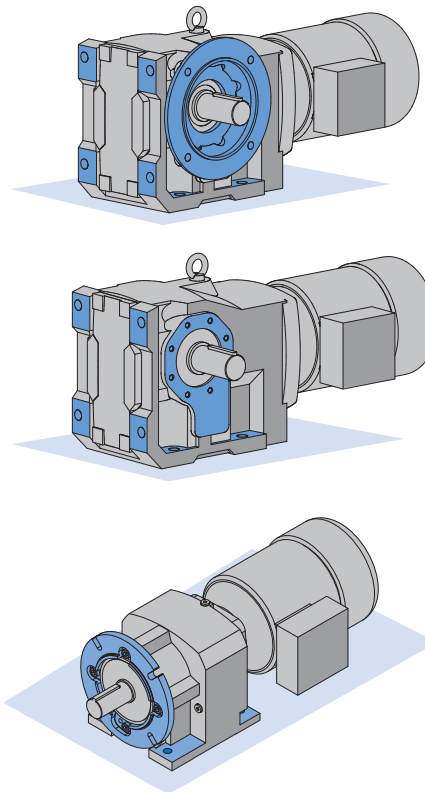


|  |                       |  |
|--|-----------------------|--|
|  | <b>IMPORTANT NOTE</b> |  |
| <p>When using the B14 flange-face for mounting, if dowel pin holes are provided in addition to the threaded holes, then it is advisable to also use the proper dowel pins, to help control flange movement or flange rotation and relieve the mounting bolts from this additional stress. This is especially important for heavy shock applications.</p> |                       |  |

### 4. Foot & flange reducer housings

Some gear reducer housings are available with a foot and an output flange. Units with a foot and a B5 Flange are designated with the suffix XF after the primary model number and units with a B14 face-flange are designated with the suffix XZ after the primary model number. When a gear unit is provided with both a foot and a flange, the foot is considered the primary mounting surface. The flange is generally considered to be the secondary mounting option and it is intended that this surface be used for auxiliary add on elements that place minimal load stress on the reducer housing.

|   |                          |  |
|---|--------------------------|--|
|   | <b>HARMFUL SITUATION</b> |  |
| <p>To prevent overstress on the main gear unit housing, never tighten the reducer mounting feet and the mounting flange against one-another. Auxiliary add-on elements that are mounted to the reducer flange, must not transmit excessive force, torque or vibration to the main gear housing.</p> |                          |  |





# HELICAL & BEVEL REDUCER LUBRICATION



## 1. Importance of proper lubrication

Proper gearbox lubrication is essential in order to reduce friction, heat, and component wear. Lubricants reduce heat and wear by inserting a protective "fluid boundary" between mating parts and preventing direct metal to metal contact. Lubricants also help prevent corrosion and oxidation, minimize foam, improve heat transfer, optimize reducer efficiency, absorb shock loads and reduce noise.

Most NORD reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position.

## 2. Standard oil type

The following tables indicate the standard oil fill type used. Please see user manual U11000 for more specific information and for optional helical and bevel gear lubricants:

| Serviceable Gear Units     |   |
|----------------------------|---|
| Helical In-line            | Standard Oil Fill:<br>ISO VG 220, Mineral Oil |
| Clincher Parallel-Shaft    |   |
| Right-Angle Bevel          |   |
| NORDBLOC® Series In-line   |   |
| NORDBLOC®.1 Series In-line |   |
| Standard Series In-line    |   |

**IMPORTANT NOTE**

For shipping purposes, the following large Clincher™ gear units are supplied without oil:

- Clincher™ Sizes SK11282, SK11382 and SK12382

| Maintenance-free / Lubricated For Life Gear Units         |  |
|---|--|
| Clincher™ sizes SK0182NB, SK0282NB & SK1382NB             | Standard Oil Fill:<br>ISO VG220 SHC/PAO<br>Synthetic Oil |
| NORDBLOC® Sizes SK172, SK272, SK371F, SK372, SK373, SK320 |  |

**IMPORTANT NOTE**

Maintenance-free units are supplied as sealed units with no vent-plug. Consult NORD prior to ordering if interested in ordering any of the above sizes as serviceable gear units.

**IMPORTANT NOTE**

Consult the sticker adjacent to the fill plug to determine the type of lubricant installed at the factory. Some units have special lubricants designed to operate in certain environments or intended to extend the service life or service temperature range of the lubricant. If in doubt about which lubricant is needed for a certain application, please contact NORD Gear.

## 3. Lubrication replacement

If the gear unit is filled with mineral oil, the lubricant should be replaced at least after every 10,000 operating hours or after every two years. If the gear unit is filled with synthetic oil, the lubricant should be replaced at least after every 20,000 operating hours or after every four years. Often gear reducers are exposed to extreme ambient conditions, hostile environments, wet conditions, or dirty and dusty operating areas. Especially in these situations, it is important to establish a condition-based oil service interval.

## 4. Oil viscosity

Viscosity, or the oil's resistance to shear under load, is often considered the single most important property of any gear oil.

- Often one will consider making a viscosity correction to the oil to improve the performance when operating the gear unit at low temperature or high temperature.
- In cases of extreme load conditions, gear pairs and antifriction bearings may be more susceptible to sliding or scuffing wear. In these operating conditions, it may also be beneficial to consider an increased lubrication viscosity and/or a lubrication with improved antiwear additive packages.

**IMPORTANT NOTE**

The user should consult with their primary lubrication supplier before considering changes in oil type or viscosity.

## 5. Maximum oil sump temperature limit

To prevent reducer overheating, the reducer's maximum oil sump temperature limit must not be exceeded for prolonged periods of operation (up to 3 hours continuous operation depending upon reducer size).

| Oil Type  | Maximum Oil Temperature Limit |               |
|-----------|-------------------------------|---------------|
|           | NORD                          | AGMA 9005-D94 |
| Mineral   | 80-85°C (176-185°F)           | 95°C (203°F)  |
| Synthetic | 105°C (220°F)                 | 107°C (225°F) |

**IMPORTANT NOTE**

Use caution when specifying gear reducers for high temperature service. If there is concern about exceeding the allowable safe operating temperatures, please consult NORD to discuss alternatives.

## 6. The importance of routine oil analysis

Routine oil analysis, sound lubrication practices, and good tracking of oil performance trends will help establish proper lubrication maintenance and change-out intervals. To maximize equipment reliability, NORD Gear generally recommends a condition-based lubrication maintenance program. One may take exceptions to this general recommendation on sealed-for-life or maintenance-free gear units or smaller and less costly gear units. In these instances, the replacement cost of the gear unit is often small compared to the costs associated with this type of oil analysis program.

|  |                          |      |
|--|--------------------------|------|
| STOP   | <b>HARMFUL SITUATION</b> | STOP |
| <p>NORD suggests replacing the gear oil if oil analysis indicates any of the following:</p> <ul style="list-style-type: none"> <li>• Viscosity has changed by approximately 10% or more.</li> <li>• Debris particles (silicon, dust, dirt or sand) exceed 25 ppm.</li> <li>• Iron content exceeds 150-200 ppm.</li> <li>• Water content is greater than 0.05% (500 ppm).</li> <li>• The total acid number (TAN) tests indicate a significant level of oxidative break-down of the oil, and a critical reduction in performance; If the TAN number measured changes by more than 5% over the new oil, then an oil change would be recommended.</li> </ul> |                          |      |

## 7. Mounting position and oil fill quantity

All NORD Gear reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position. **For additional information, please see the separate mounting position diagrams and the corresponding oil fill quantity tables for the specified gear unit.**

The gearbox nametag will indicate the mounting position that was provided. **For mounting orientations other than shown in the mounting position charts, please consult NORD Gear.**

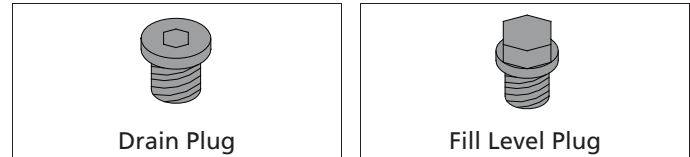
|  |                          |      |
|--|--------------------------|------|
| STOP   | <b>HARMFUL SITUATION</b> | STOP |
| <p>Actual oil volume can vary slightly depending upon the gear case size, mounting and ratio. Prior to commissioning the reducer, check the oil-fill level using the reducer's oil-level plug and drain or add additional oil as needed. The minimum acceptable oil level is 0.15 in (4mm) below the oil level hole.</p> |                          |      |

## 8. Oil plug locations

All gear units are assembled with the oil fill-level, oil-drain and vent plugs installed in their proper locations, according to the specified mounting position. All standard plugs are metric and utilize sealing gaskets between the head of the plug and the reducer housing.

## 9. Drain and fill-level plugs

All reducer drain plugs are metric socket head cap screws. For easier identification, it is NORD's standard practice to provide a hex-head screw for the fill-level plug. For ease of draining the used oil from the gear reducer, use the socket head screw located at the lowest part of the gearbox.

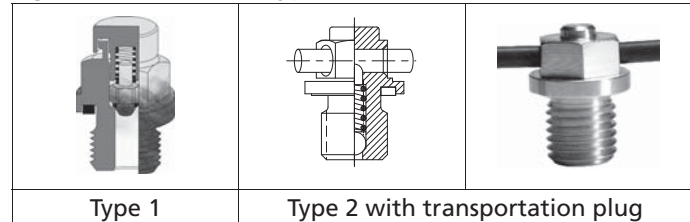


## 10. Vent plug locations

Reducer venting allows for air pressure differences that occur during operation, between the inner space of the reducer and the atmosphere, while ensuring leak-free operation. The AUTOVENT™ is standard for all vented gear units, unless otherwise noted.

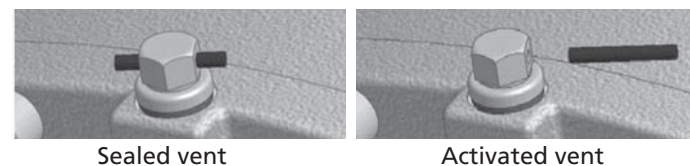
**AUTOVENT™** - The AUTOVENT™ helps prevent bearing and gear damage by behaving like a check valve to block the entry of foreign material (water, dust, corrosives, etc.). The breather opens at approximately 2-3 psi during operation and closes tightly as the gearbox cools. This option is perfect for humid conditions and wash-down environments, helping to maintain proper oil cleanliness, and reducing foaming and oxidation. NORD may choose to offer one of two style options as shown in Figure 1. The Type 2 AUTOVENT™ comes closed upon delivery with a transportation sealing plug (see Warning).

Figure 1 AUTOVENT™ Types



**Open Vent** - An optional open vent can be supplied by NORD. The open vent comes closed upon delivery with a transportation sealing plug (see Warning).

|  |                |   |
|--|----------------|---|
| ⚠  | <b>WARNING</b> | ⚠ |
| <p>To prevent build-up of excessive pressure, sealed vents must be activated as shown prior to gear unit start up.</p> |                |   |



**Filtered Vent** - NORD may offer an optional filtered vent, which allows gases to permeate, but does not allow dust and debris to pass through the vent.



# HELICAL & BEVEL REDUCER LUBRICATION TYPES



DRIVESYSTEMS

RETAIN FOR FUTURE USE

U11000 - 1 of 2

## Lubrication Tables – Helical and Bevel Gear Units

### Standard Oil Lubricants

| ISO Viscosity | Oil Type | Ambient Temperature Range  | Manufacturer Brand/Type | Notes |
|---------------|----------|----------------------------|-------------------------|-------|
| VG220         | MIN-EP   | 0 to 40°C (32 to 104°F)    | Mobilgear 600XP220      | ♣①    |
|               | PAO      | -35 to 60°C (-31 to 140°F) | Mobil SHC630            | ♣②    |
|               | FG       | -5 to 40°C (23 to 104°F)   | Fuchs FM220             | ♣     |

### Optional Oil Lubricants

| ISO Viscosity | Oil Type | Ambient Temperature Range  | Manufacturer Brand/Type | Notes |
|---------------|----------|----------------------------|-------------------------|-------|
| VG460         | PAO      | -35 to 80°C (-31 to 176°F) | Mobil SHC 634           | -     |
|               | FG-PAO   | -35 to 80°C (-31 to 176°F) | Mobil/Cibus SHC460      | -     |
| VG220         | FG-PAO   | -35 to 60°C (-31 to 140°F) | Mobil/Cibus SHC220      | -     |
| VG150         | PAO      | -35 to 25°C (-31 to 77°F)  | Mobil SHC629            | -     |

### Grease Options (applied to greased bearings and seal cavities)

| NLGI Grade | Grease Type/Thickener   | Ambient Temperature Range  | Manufacturer Brand/Type | Notes |
|------------|-------------------------|----------------------------|-------------------------|-------|
| NLGI 2     | Standard (Li-Complex)   | -30 to 60°C (-22 to 140°F) | Mobil Grease XHP222     | ♣①    |
|            | High Temp (Polyurea)    | -25 to 80°C (-13 to 176°F) | Mobil Polyrex EP 2      | ♣②    |
|            | Food-Grade (AL-Complex) | -25 to 40°C (-13 to 104°F) | Mobil Grease FM222      | ♣     |

♣ Stocked Lubricants

① Standard product on serviceable gear units

② Standard product on maintenance free gear units

| <b>IMPORTANT NOTES</b>  |
|---|
| <ul style="list-style-type: none"> <li>The “Ambient Temperature” is intended to be an operation guideline based upon the typical properties of all the lubricant. The viscosity and other properties of the lubricant change based upon load, speed, ambient conditions, and reducer operating temperatures. The user should consult with their lubrication supplier &amp; NORD gear before considering changes in oil type or viscosity.</li> <li>To prevent reducer overheating, observe the maximum operating oil temperature limits:<br/>Mineral Oil: 80-85 °C (176 – 180 °F).<br/>Synthetic Oil: 105 °C (225 °F).</li> <li>In the following instances, please consult NORD for specific recommendations:               <ul style="list-style-type: none"> <li>√ Gear units will operate in high ambient temperature conditions exceeding 40 °C (104 °F).</li> <li>√ Gear units will operate in cold ambient temperature conditions approaching 0 °C (32 °F) or lower.</li> <li>√ Lower than an ISO VG100 viscosity oil is being considered for a cold-temperature service.</li> <li>√ Fluid grease is required for lubricating the gear unit.</li> </ul> </li> <li>Observe the general lubrication guidelines outlined in user manual U10750.</li> </ul> |

### Oil Formulation Codes

|        |   |  |
|--------|---|--|
| MIN-EP | - | Mineral Oil with EP Additive                   |
| PAO-EP | - | Synthetic Polyalphaolefin Oil with EP Additive |
| PAO    | - | Synthetic Polyalphaolefin Oil                  |
| PG     | - | Synthetic Polyglycol Oil                       |
| FG     | - | Food-Grade Oil                                 |
| FG-PAO | - | Food-Grade, Synthetic Polyalphaolefin Oil      |
| FG-PG  | - | Food-Grade, Synthetic Polyglycol Oil           |

### Lubrication Notes

- Avoid using (EP) gear oils in worm gears that contain sulfur-phosphorous chemistries, as these additives can react adversely with bronze worm gears and accelerate wear.
- Food grade lubricants must be in compliance with FDA 212 CFR 178.3570 and qualify as a NSF-H1 lubricant. Please consult with lubrication manufacturer for more information.
- When making a lubrication change, check with the lubrication supplier to assure compatibility and to obtain recommended cleaning or flushing procedures.
- Do not to mix different oils with different additive packages or different base oil formulation types. Polyglycol (PG) oils are not miscible with other oil types and should never be mixed with mineral oil or polyalphaolefin (PAO) synthetic oil.

**NORD Gear Limited**

Toll Free in Canada: 800.668.4378

**NORD Gear Corporation**

Toll Free in the United States: 888.314.6673



# HELICAL & BEVEL REDUCER LUBRICATION TYPES



DRIVESYSTEMS

RETAIN FOR FUTURE USE

U11000 - 2 of 2

Oil Cross-reference Chart

| ISO Viscosity | Oil Type | Ambient Temperature Range    | Mobil              | Shell        | Castrol        | FUCHS                | KLÜBER LUBRICATION     |
|---------------|----------|------------------------------|--------------------|--------------|----------------|----------------------|------------------------|
| VG150         | MIN-EP   | 0 to 25°C (32 to 77°F)       | Mobilgear 600XP150 | Omala 150    | Alpha SP150    | Renolin EP150        | Klüberoil GEM 1-150N   |
|               | PAO-EP   | -30 to 25 °C (-22 to 77 °F)  | Mobilgear SHC150   | Omala HD 150 | Alphasyn EP150 | Gearmaster SYN150/NA | Klübersynth EG 4-150   |
|               | PAO      | -30 to 25 °C (-22 to 77 °F)  | Mobil SHC629       | Omala RL 150 | Alphasyn T150  | Gerallyn SF150       | Klübersynth GEM 4-150N |
|               | PG       | -25 to 25 °C (-13 to 77 °F)  | Mobil Glygoyle 150 | Tivela S150  | Alphasyn PG150 | Renolin PG150        | Klübersynth GH 6-150   |
|               | FG       | 0 to 25 °C (32 to 77 °F)     | Mobil DTE FM 150   | N/A          | N/A            | N/A                  | N/A                    |
|               | FG-PAO   | -25 to 25 °C (-13 to 77 °F)  | N/A                | N/A          | N/A            | Cassida GL150        | Klüberoil 4 UH 1-150N  |
|               | FG-PG    | -25 to 25 °C (-13 to 77 °F)  | Mobil Glygoyle 150 | N/A          | N/A            | N/A                  | Klübersynth UH1 6-150  |
| VG220         | MIN-EP   | 0 to 40°C (32 to 104°)       | Mobilgear 600XP220 | Omala 220    | Alpha SP220    | Renolin EP220        | Klüberoil GEM 1-220N   |
|               | PAO-EP   | -30 to 60 °C (-22 to 140 °F) | Mobilgear SHC220   | Omala HD220  | Alphasyn EP220 | Gearmaster SYN220/NA | Klübersynth EG 4-220   |
|               | PAO      | -30 to 60 °C (-22 to 140 °F) | Mobil SHC630       | Omala RL220  | Alphasyn T220  | Gerallyn SF220       | Klübersynth GEM 4-220N |
|               | PG       | -25 to 60 °C (-13 to 140 °F) | Mobil Glygoyle 220 | Tivela S220  | Alphasyn PG220 | Renolin PG220        | Klübersynth GH 6-220   |
|               | FG       | 0 to 40°C (32 to 104°F)      | Mobil DTE FM 220   | N/A          | N/A            | Fuchs FM220          | N/A                    |
|               | FG-PAO   | -25 to 60 °C (-13 to 140 °F) | Mobil/Cibus SHC220 | N/A          | N/A            | Cassida GL220        | Klüberoil 4 UH 1-220N  |
|               | FG-PG    | -25 to 60°C (-13 to 140°F)   | Mobil Glygoyle 220 | N/A          | N/A            | Cassida WG220        | Klübersynth UH 16-220  |
| VG460         | MIN-EP   | 0 to 40 °C (32 to 104 °F)    | Mobilgear 600XP460 | Omala 460    | Alpha SP460    | Renolin EP460        | Klüberoil GEM 1-460N   |
|               | PAO-EP   | -20 to 80 °C (-4 to 176 °F)  | Mobilgear SHC460   | Omala HD460  | Alphasyn EP460 | Gearmaster SYN460/NA | Klübersynth EG 4-460   |
|               | PAO      | -20 to 80 °C (-4 to 176 °F)  | Mobil SHC 634      | Omala RL460  | Alphasyn T460  | Gerallyn SF460       | Klübersynth GEM 4-460N |
|               | PG       | -20 to 80 °C (-4 to 176 °F)  | Mobil Glygoyle 460 | Tivela S460  | Alphasyn PG460 | Renolin PG460        | Klübersynth GH 6-460   |
|               | FG       | 0 to 40 °C (32 to 104 °F)    | Mobil DTE FM460    | N/A          | N/A            | Fuchs FM460          | N/A                    |
|               | FG-PAO   | -20 to 80 °C (-4 to 176 °F)  | Mobil/Cibus SHC460 | N/A          | N/A            | Cassida GL460        | Klüberoil 4 UH 1-460N  |
|               | FG-PG    | -20 to 80 °C (-4 to 176 °F)  | Mobil Glygoyle 460 | N/A          | N/A            | Cassida WG460        | Klübersynth UH1 6-460  |

Low-end service temperature limit may vary for a specific lubricant; Please also see the important notes on Page 1.



# NORDBLOC®.1 FOOTED OIL FILL QUANTITIES



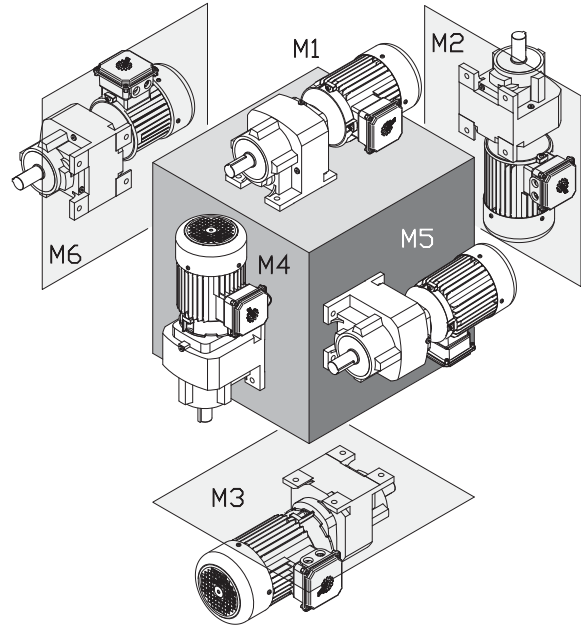
DRIVESYSTEMS

RETAIN FOR FUTURE USE

U12900 - 1 of 1

## NORDBLOC®.1 footed lubrication

The following NORD Gear reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position. For additional information, please refer to the "Oil Plug & Vent Locations" documentation for your gear unit.



|   |                          |      |
|---|--------------------------|------|
| STOP  | <b>HARMFUL SITUATION</b> | STOP |
| <p>Actual oil volume can vary slightly depending upon the gear case size, mounting and ratio. Prior to commissioning the reducer, check the oil-fill level using the reducer's oil level plug and drain or add additional oil as needed. The minimum acceptable oil level is 0.15 in (4mm) below the oil level hole.</p> <p>For mounting orientations other than shown please consult NORD Gear. Reducer modifications may be required.</p> |                          |      |

| Type     | M1     |        | M2     |        | M3     |        | M4     |        | M5     |        | M6     |        |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|          | Quarts | Liters | Quarts | Liters | Quarts | Liters | Quarts | Liters | Quarts | Liters | Quarts | Liters |
| SK 373.1 | 0.480  | 0.450  | 1.11   | 1.05   | 0.791  | 0.750  | 1.06   | 1.000  | 0.630  | 0.600  | 0.690  | 0.650  |



# NORDBLOC®.1 FLANGED OIL FILL QUANTITIES



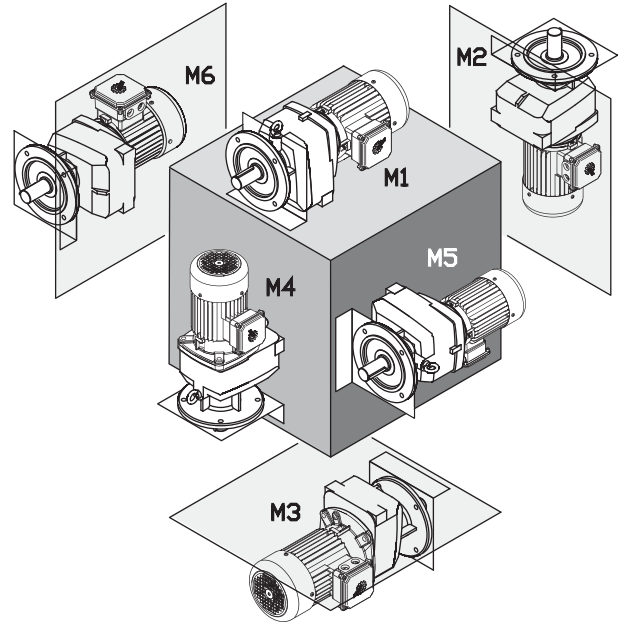
DRIVESYSTEMS

RETAIN FOR FUTURE USE

U13000 - 1 of 1

## NORDBLOC®.1 flanged lubrication

The following NORD Gear reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position. For additional information, please refer to the "Oil Plug & Vent Locations" documentation for your gear unit.



|   |                          |      |
|---|--------------------------|------|
| STOP  | <b>HARMFUL SITUATION</b> | STOP |
| <p>Actual oil volume can vary slightly depending upon the gear case size, mounting and ratio. Prior to commissioning the reducer, check the oil-fill level using the reducer's oil level plug and drain or add additional oil as needed. The minimum acceptable oil level is 0.15 in (4mm) below the oil level hole.</p> <p>For mounting orientations other than shown please consult NORD Gear. Reducer modifications may be required.</p> |                          |      |

| Type       | M1     |        | M2     |        | M3     |        | M4     |        | M5     |        | M6     |        |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|            | Quarts | Liters | Quarts | Liters | Quarts | Liters | Quarts | Liters | Quarts | Liters | Quarts | Liters |
| SK 373.1 F | 0.480  | 0.450  | 1.11   | 1.05   | 0.791  | 0.750  | 1.06   | 1.000  | 0.630  | 0.600  | 0.690  | 0.650  |

# PART 5: MOTOR

# **BALDOR**® • ***RELIANCE***

## **Product Information Packet**

# **VEM3546**

**1HP,1760RPM,3PH,60HZ,56C,3519M,TEFC,F1,N**

| Part Detail |      |                |       |             |          |               |            |
|-------------|------|----------------|-------|-------------|----------|---------------|------------|
| Revision:   | H    | Status:        | PRD/A | Change #:   |          | Proprietary:  | No         |
| Type:       | AC   | Prod. Type:    | 3519M | Elec. Spec: | 35WGM492 | CD Diagram:   | CD0005     |
| Enclosure:  | TEFC | Mfg Plant:     |       | Mech. Spec: | 35J302   | Layout:       | 35LYJ302   |
| Frame:      | 56C  | Mounting:      | F1    | Poles:      | 04       | Created Date: | 08-05-2010 |
| Base:       | N    | Rotation:      | R     | Insulation: | F        | Eff. Date:    | 03-12-2014 |
| Leads:      | 9#18 |                |       |             |          | Replaced By:  |            |
| Literature: |      | Elec. Diagram: |       |             |          |               |            |

| Nameplate NP1259L |              |                |      |     |   |    |   |
|-------------------|--------------|----------------|------|-----|---|----|---|
| CAT.NO.           | VEM3546      |                |      |     |   |    |   |
| SPEC.             | 35J302M492G1 |                |      |     |   |    |   |
| HP                | 1            |                |      |     |   |    |   |
| VOLTS             | 208-230/460  |                |      |     |   |    |   |
| AMP               | 3.1-3/1.5    |                |      |     |   |    |   |
| RPM               | 1760         |                |      |     |   |    |   |
| FRAME             | 56C          | HZ             | 60   | PH  | 3 |    |   |
| SER.F.            | 1.15         | CODE           | L    | DES | B | CL | F |
| NEMA-NOM-EFF      | 85.5         | PF             | 71   |     |   |    |   |
| RATING            | 40C AMB-CONT |                |      |     |   |    |   |
| CC                |              | USABLE AT 208V | 3.1  |     |   |    |   |
| DE                | 6205         | ODE            | 6203 |     |   |    |   |
| ENCL              | TEFC         | SN             |      |     |   |    |   |
|                   |              |                |      |     |   |    |   |

| Parts List     |  |          |
|----------------|--|----------|
| Part Number    | Description                              | Quantity |
| SA200982       | SA 35J302M492G1                          | 1.000 EA |
| RA188287       | RA 35J302M492G1                          | 1.000 EA |
| 34FN3002B01    | EXTERNAL FAN, PLASTIC, .637/.639 HUB W/  | 1.000 EA |
| S/P107-000-001 | SUPER E PROC'S-FS & WS PLTS-POLYREX EM G | 1.000 EA |
| NS2512A01      | INSULATOR, CONDUIT BOX X                 | 1.000 EA |
| 35CB3007       | 35 CB CASTING W/.88 DIA. LEAD HOLE       | 1.000 EA |
| 36GS1000SP     | GASKET-CONDUIT BOX, .06 THICK #SV-330 LE | 1.000 EA |
| 51XB1016A07    | 10-16 X 7/16 HXWSSLD SERTYB              | 2.000 EA |
| 11XW1032G06    | 10-32 X .38, TAPTITE II, HEX WSHR SLTD U | 1.000 EA |
| HW3001B01      | 003SS CUP WASHER, FOR #8 SCREW           | 1.000 EA |
| 35EP3100M02    | FREP TEFC 203 BRG W/O GRSR (RAISED FH MT | 1.000 EA |
| HW5100A03SP    | WAVY WASHER (W1543-017)                  | 1.000 EA |
| 35EP3300A33    | SPL FACE MTD EP -ENCL-205 BRG            | 1.000 EA |
| 51XN1032A20    | 10-32 X 1 1/4 HX WS SL SR                | 2.000 EA |
| XY1032A02      | 10-32 HEX NUT DIRECTIONAL SERRATION      | 4.000 EA |
| 51XB1214A16    | 12-14X1.00 HXWSSLD SERTYB                | 1.000 EA |
| 35FH4005A32SP  | IEC FH NO GRSR W/3 HOLES - W/AUTOPHERETI | 1.000 EA |
| 51XW1032A06    | 10-32 X .38, TAPTITE II, HEX WSHR SLTD S | 3.000 EA |
| 35CB4521GX     | CONDUIT BOX LID KIT                      | 1.000 EA |
| 51XW0832A07    | 8-32 X .44, TAPTITE II, HEX WSHR SLTD SE | 4.000 EA |
| HW2501D13SP    | KEY, 3/16 SQ X 1.375                     | 1.000 EA |
| HA7000A01      | KEY RETAINER 7/8" DIA SHAFT              | 1.000 EA |
| 85XU0407S04    | 4X1/4 U DRIVE PIN STAINLESS              | 2.000 EA |
| HW3001B01      | 003SS CUP WASHER, FOR #8 SCREW           | 1.000 EA |

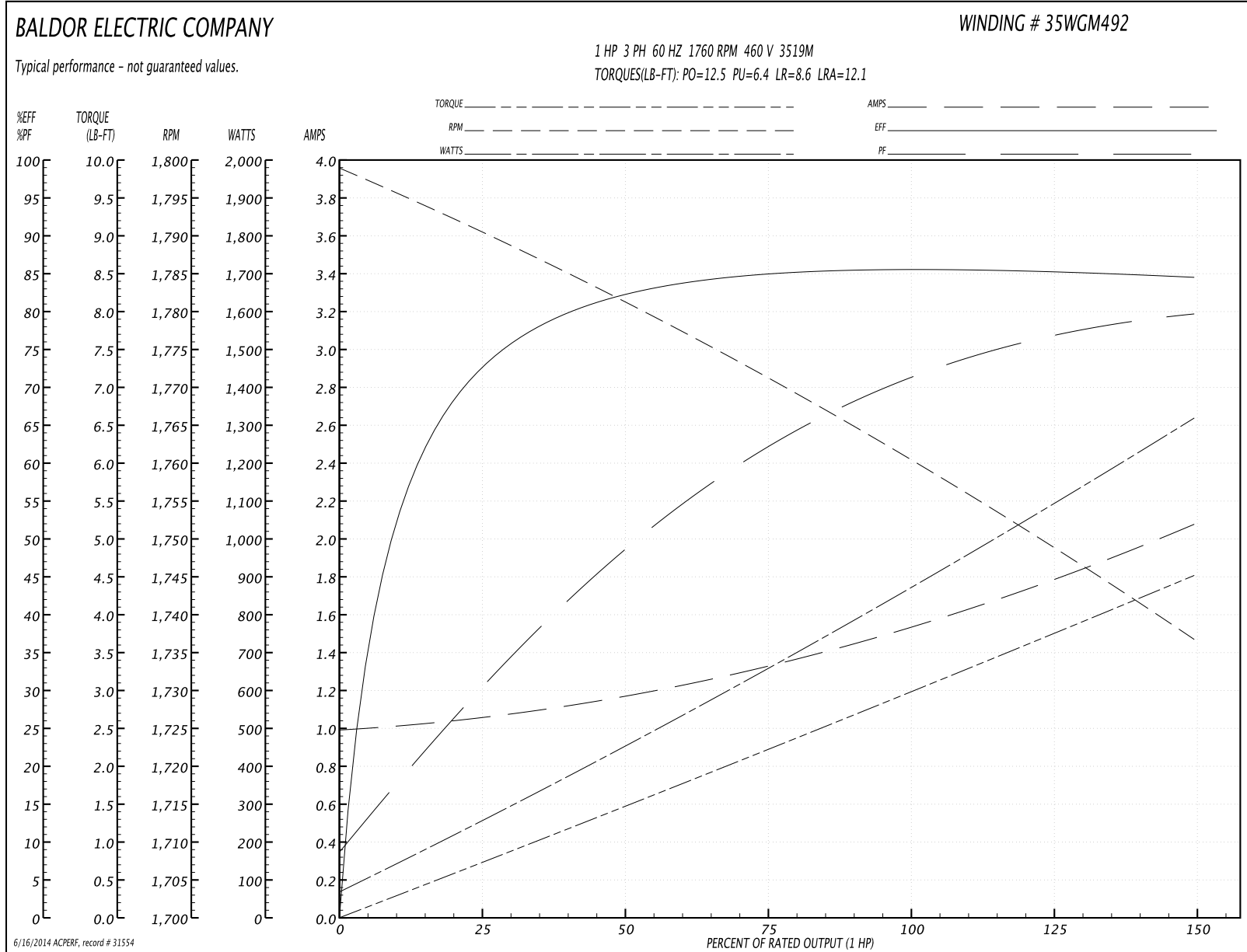
| Parts List (continued) |  |          |
|------------------------|--|----------|
| Part Number            | Description                              | Quantity |
| MJ1000A75              | GREASE, POLYREX EM EXXON (USe 4824-15A)  | 0.050 LB |
| MG1000Y03              | MUNSELL 2.53Y 6.70/ 4.60, GLOSS 20,      | 0.017 GA |
| HA3100A12              | THRUBOLT 10-32 X 7.375                   | 4.000 EA |
| LB1125C02              | SUPER-E (STOCK CTN LABEL SUPER-E WITH FL | 1.000 EA |
| LC0005E01              | CONN.DIA./WARNING LABEL (LC0005/LB1119)  | 1.000 EA |
| NP1259L                | ALUM SUPER-E UL CSA-EEV CC NEMA PREMIUM  | 1.000 EA |
| 35PA1066               | PACKING GROUP COMBINED PRINT             | 1.000 EA |
| PK3082                 | STYROFOAM CRADLE                         | 1.000 EA |
| LB1506                 | LABEL "AMERICAN MADE" 1.50 X 1.00        | 1.000 EA |
| MN416A01               | TAG-INSTAL-MAINT no wire. (100/bx) 8/12  | 1.000 EA |

**Performance Data at 460V, 60Hz, 1.0HP (Typical performance - Not guaranteed values)**

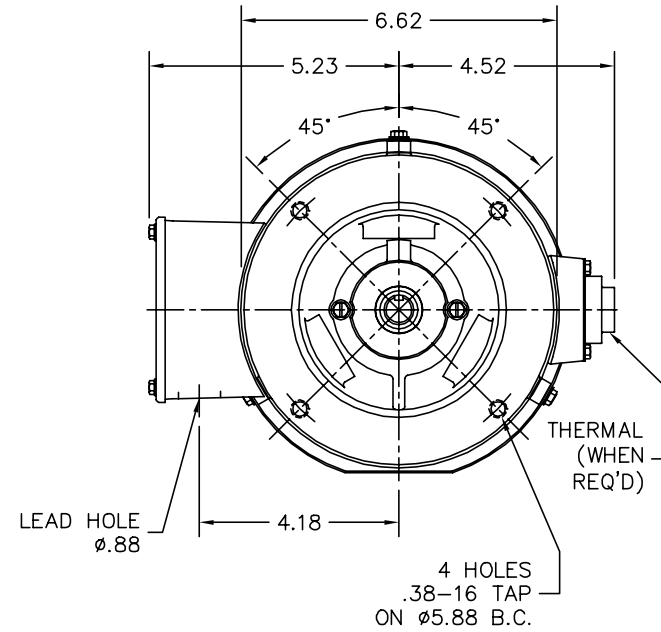
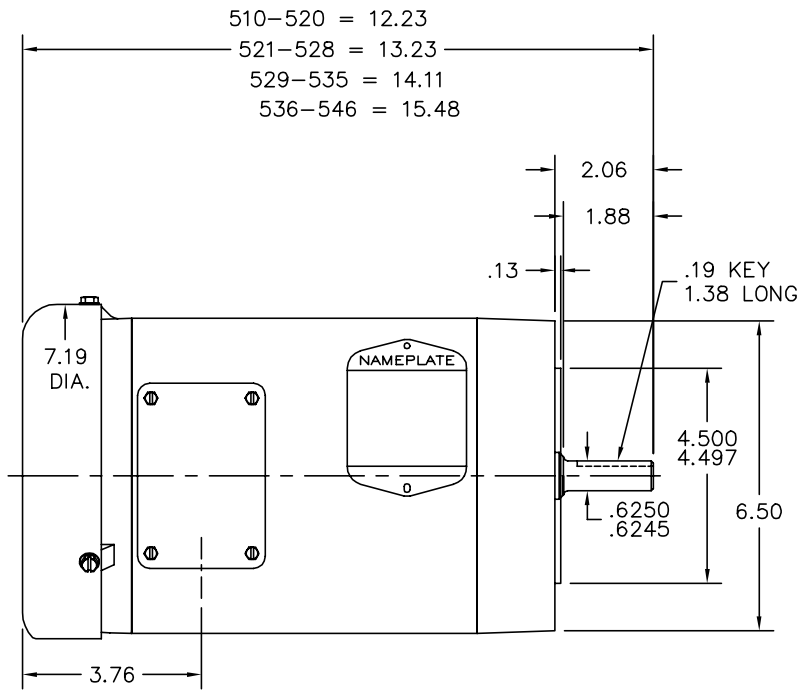
| General Characteristics  |                                 |                      |            |
|--------------------------|---------------------------------|----------------------|------------|
| Full Load Torque:        | 2.97 LB-FT                      | Start Configuration: | DOL        |
| No-Load Current:         | 1.0 Amps                        | Break-Down Torque:   | 12.5 LB-FT |
| Line-line Res. @ 25°C.:  | 16.05 Ohms A Ph / 0.0 Ohms B Ph | Pull-Up Torque:      | 6.4 LB-FT  |
| Temp. Rise @ Rated Load: | 36 C                            | Locked-Rotor Torque: | 8.6 LB-FT  |
| Temp. Rise @ S.F. Load:  | 43 C                            | Starting Current:    | 12.1 Amps  |

| Load Characteristics |        |        |        |        |        |        |        |
|----------------------|--------|--------|--------|--------|--------|--------|--------|
| % of Rated Load      | 25     | 50     | 75     | 100    | 125    | 150    | S.F.   |
| Power Factor:        | 31.0   | 49.0   | 62.0   | 71.0   | 77.0   | 80.0   | 75.0   |
| Efficiency:          | 72.2   | 82.1   | 84.8   | 85.6   | 85.3   | 84.4   | 85.4   |
| Speed:               | 1790.9 | 1781.2 | 1771.5 | 1760.7 | 1749.1 | 1736.6 | 1754.0 |
| Line Amperes:        | 1.05   | 1.15   | 1.33   | 1.54   | 1.79   | 2.07   | 1.69   |

Performance Graph at 460V, 60Hz, 1.0HP Typical performance - Not guaranteed values



35LYJ302



CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.

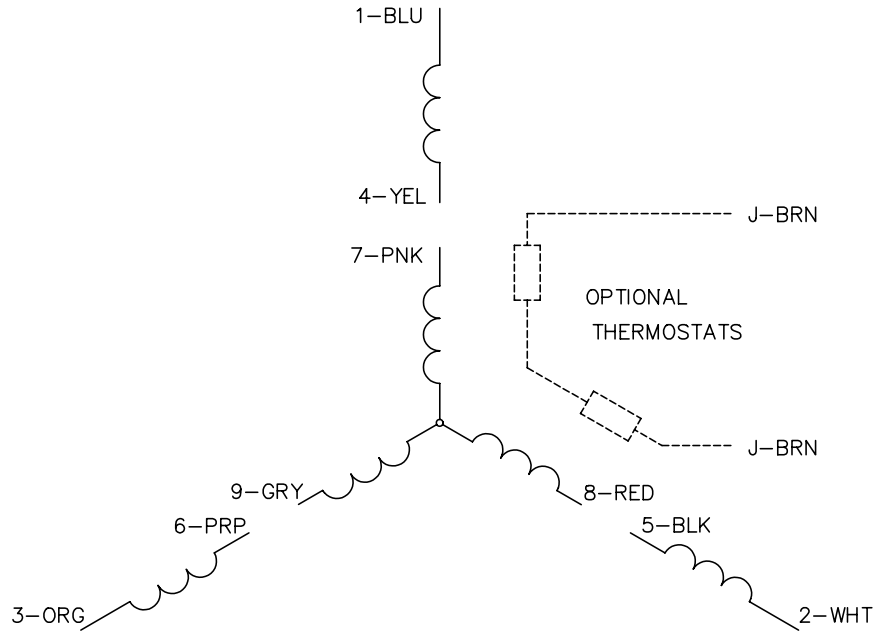
|                              |             |                              |
|------------------------------|-------------|------------------------------|
| REV. DESC: UPDATE DRWG PARTS |             |                              |
| REV. LTR: C                  | VERSION: 02 | TDR: 000000738205            |
| FILE: \AAA\00041\631         |             | REVISED: 02:09:50 03/15/2012 |
| MTL: -                       |             | BY: ENBENBO                  |

**BALDOR**

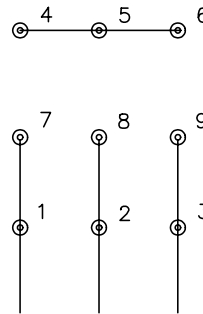
VERT 56C TEFC 35M SUPER-E  
 SH 1 of 1

35LYJ302

CD0005

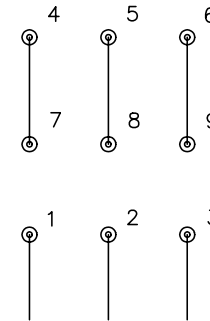


LOW VOLTAGE  
(2Y)



LINE

HIGH VOLTAGE  
(1Y)



LINE

NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

|   |         |                         |              |
|---|---------|-------------------------|--------------|
| REV. DESC: REVISE TO SHOW OPTIONAL COLORS |         |                         |              |
| REV. LTR: E                               | BY: JLP | REVISED: 01/19/99 10:15 | TDR: 0171435 |
| 900003                                    |         | FILE: AAA00005140       | MDL: -       |
|   |         | MTL: -                  |              |

**BALDOR ELECTRIC Co.**

3PH, DV, 9 LEADS

CD0005

**BALDOR • RELIANCE**



**Integral Horsepower  
AC Induction Motors**

**Installation & Operating Manual**

Any trademarks used in this manual are the property of their respective owners.

# Table of Contents

---

|  |     |
|--|-----|
| <b>Section 1</b>   |     |
| <b>General Information</b> .....                           | 1-1 |
| Overview .....   | 1-1 |
| Limited Warranty .....                                     | 1-1 |
| Safety Notice .....  | 1-1 |
| Receiving .....  | 1-2 |
| Handling .....   | 1-2 |
| Storage .....  | 1-3 |
| Removal From Storage .....                                 | 1-4 |
| <b>Section 2</b>   |     |
| <b>Installation &amp; Operation</b> .....                  | 2-1 |
| Overview .....   | 2-1 |
| Location .....   | 2-1 |
| Mounting .....   | 2-1 |
| Alignment .....  | 2-1 |
| Doweling & Bolting .....                                   | 2-2 |
| Guarding .....   | 2-2 |
| Power Connection .....                                     | 2-2 |
| Conduit Box .....  | 2-2 |
| AC Power .....   | 2-2 |
| Rotation .....   | 2-3 |
| First Time Start Up .....                                  | 2-4 |
| Coupled Start Up .....                                     | 2-4 |
| Jogging and Repeated Starts .....                          | 2-4 |
| <b>Section 3</b>   |     |
| <b>Maintenance &amp; Troubleshooting</b> .....             | 3-1 |
| General Inspection .....                                   | 3-1 |
| Relubrication & Bearings .....                             | 3-1 |
| Type of Grease .....                                       | 3-1 |
| Relubrication Intervals .....                              | 3-1 |
| Relubrication Procedure .....                              | 3-3 |
| Troubleshooting Chart .....                                | 3-4 |
| Suggested bearing and winding RTD setting guidelines ..... | 3-5 |



# Section 1

## General Information

---

**Overview** This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

**Important:** **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

### Limited Warranty

[www.baldor.com/support/warranty\\_standard.asp](http://www.baldor.com/support/warranty_standard.asp)

**Safety Notice:** This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

**WARNING:** **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

**WARNING:** **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

**WARNING:** **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

**WARNING:** **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

**WARNING:** **Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. When installing, protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.**

**WARNING:** **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

**WARNING:** **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

**WARNING:** **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

**WARNING:** **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

**WARNING:** **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

**WARNING:** **Thermostat contacts automatically reset when the motor has slightly cooled down. To prevent injury or damage, the control circuit should be designed so that automatic starting of the motor is not possible when the thermostat resets.**

---

**Safety Notice** Continued

- WARNING:** UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.
- WARNING:** Pacemaker danger – Magnetic and electromagnetic fields in the vicinity of current carrying carrying conductors and permanent magnet motors can result result in a serious health hazard to persons with cardiac pacemakers, metal implants, and hearing aids. To avoid risk, stay way from the area surrounding a permanent magnet motor.
- WARNING:** Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.
- WARNING:** Use only UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust.
- WARNING:** Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo. Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.
- WARNING:** Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.
- Caution:** To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.
- Caution:** Do not over-lubricate motor as this may cause premature bearing failure.
- Caution:** Do not over tension belts. Excess tension may damage the motor or driven equipment.
- Caution:** Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.
- Caution:** If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.
- Caution:** To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.
- Caution:** If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.
- If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

**Receiving**

Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

**Handling**

The motor should be lifted using the lifting lugs or eye bolts provided.

- Caution:** Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.
1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WP11 motor.
  2. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed). The packing provides insulation from temperature changes during transportation.
  3. When lifting a WP11 (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only. A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.

- 
4. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation.

Do not lift the assembly using the motor lugs or eye bolts provided. Lugs or eye bolts are designed to lift motor only. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

## **Storage**

Storage requirements for motors and generators that will not be placed in service for at least six months from date of shipment.

Improper motor storage will result in seriously reduced reliability and failure. An electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to develop rust in the bearings or rust particles from surrounding surfaces may contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failure.

A wooden crate "shell" should be constructed to secure the motor during storage. This is similar to an export box but the sides & top must be secured to the wooden base with lag bolts (not nailed as export boxes are) to allow opening and reclosing many times without damage to the "shell".

Minimum resistance of motor winding insulation is 5 Meg ohms or the calculated minimum, whichever is greater. Minimum resistance is calculated as follows:  $R_m = kV + 1$

where: (Rm is minimum resistance to ground in Meg-Ohms and  
kV is rated nameplate voltage defined as Kilo-Volts.)

Example: For a 480VAC rated motor  $R_m = 1.48$  meg-ohms (use 5 MΩ).

For a 4160VAC rated motor  $R_m = 5.16$  meg-ohms.

## **Preparation for Storage**

1. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold the shaft firmly in place against the bearing before the motor is moved.
2. Store in a clean, dry, protected warehouse where control is maintained as follows:
  - a. Shock or vibration must not exceed 2 mils maximum at 60 hertz, to prevent the bearings from brinelling. If shock or vibration exceeds this limit vibration isolation pads must be used.
  - b. Storage temperatures of 10°C (50°F) to 49°C (120°F) must be maintained.
  - c. Relative humidity must not exceed 60%.
  - d. Motor space heaters (when present) are to be connected and energized whenever there is a possibility that the storage ambient conditions will reach the dew point. Space heaters are optional.  
Note: Remove motor from containers when heaters are energized, reprotect if necessary.
3. Measure and record the resistance of the winding insulation (dielectric withstand) every 30 days of storage.
  - a. If motor insulation resistance decreases below the minimum resistance, contact your Baldor District office.
  - b. Place new desiccant inside the vapor bag and re-seal by taping it closed.
  - c. If a zipper-closing type bag is used instead of the heat-sealed type bag, zip the bag closed instead of taping it. Be sure to place new desiccant inside bag after each monthly inspection.
  - d. Place the shell over the motor and secure with lag bolts.
4. Where motors are mounted to machinery, the mounting must be such that the drains and breathers are fully operable and are at the lowest point of the motor. Vertical motors must be stored in the vertical position. Storage environment must be maintained as stated in step 2.

- 
5. Motors with anti-friction bearings are to be greased at the time of going into extended storage with periodic service as follows:
    - a. Motors marked "Do Not Lubricate" on the nameplate do not need to be greased before or during storage.
    - b. Ball and roller bearing (anti-friction) motor shafts are to be rotated manually every 3 months and greased every 6 months in accordance with the Maintenance section of this manual.
    - c. Sleeve bearing (oil lube) motors are drained of oil prior to shipment. The oil reservoirs must be refilled to the indicated level with the specified lubricant, (see Maintenance). The shaft should be rotated monthly by hand at least 10 to 15 revolutions to distribute oil to bearing surfaces.
    - d. "Provisions for oil mist lubrication" – These motors are packed with grease. Storage procedures are the same as paragraph 5b.
    - e. "Oil Mist Lubricated" – These bearings are protected for temporary storage by a corrosion inhibitor. If stored for greater than 3 months or outdoor storage is anticipated, connected to the oil mist system while in storage. If this is not possible, add the amount of grease indicated under "Standard Condition" in Section 3, then rotate the shaft 15 times by hand.
  6. All breather drains are to be fully operable while in storage (drain plugs removed). The motors must be stored so that the drain is at the lowest point. All breathers and automatic "T" drains must be operable to allow breathing and draining at points other than through the bearings around the shaft. Vertical motors should be stored in a safe stable vertical position.
  7. Coat all external machined surfaces with a rust preventing material. An acceptable product for this purpose is Exxon Rust Ban # 392.

#### **Non-Regreaseable Motors**

Non-regreasable motors with "Do Not Lubricate" on the nameplate should have the motor shaft rotated 15 times to redistribute the grease within the bearing every 3 months or more often.

#### **All Other Motor Types**

Before storage, the following procedure must be performed.

1. Remove the grease drain plug, if supplied, (opposite the grease fitting) on the bottom of each bracket prior to lubricating the motor.
2. The motor with regreasable bearing must be greased as instructed in Section 3 of this manual.
3. Replace the grease drain plug after greasing.
4. The motor shaft must be rotated a minimum of 15 times after greasing.
5. Motor Shafts are to be rotated at least 15 revolutions manually every 3 months and additional grease added every nine months (see Section 3) to each bearing.
6. Bearings are to be greased at the time of removal from storage.

#### **Removal From Storage**

1. Remove all packing material.
2. Measure and record the electrical resistance of the winding insulation resistance meter at the time of removal from storage. The insulation resistance must not be less than 50% from the initial reading recorded when the motor was placed into storage. A decrease in resistance indicates moisture in the windings and necessitates electrical or mechanical drying before the motor can be placed into service. If resistance is low, contact your Baldor District office.
3. Regrease the bearings as instructed in Section 3 of this manual.
4. Reinstall the original shipping brace if motor is to be moved. This will hold the shaft firmly against the bearing and prevent damage during movement.

## Section 2

# Installation & Operation

---

### Overview

Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

### Location

It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip-Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

**Hazardous Locations** are those where there is a risk of ignition or explosion due to the presence of combustible gases, vapors, dust, fibers, or flyings. Facilities requiring special equipment for hazardous locations are typically classified in accordance with local requirements. In the US market, guidance is provided by the National Electric Code.

### **Caution:**

**Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

### Mounting

The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

### Alignment

Accurate alignment of the motor with the driven equipment is extremely important. The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible.

It is recommended to heat the pulley, sprocket, or gear before installing on the motor shaft.

Forcibly driving a unit on the motor shaft will damage the bearings.

#### 1. **Direct Coupling**

For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.

#### 2. **End-Play Adjustment**

The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.

#### 3. **Pulley Ratio**

The pulley ratio should not exceed 8:1.

### **Caution:**

**Do not over tension belts. Excess tension may damage the motor or driven equipment.**

#### 4. **Belt Drive**

Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.

5. Sleeve bearing motors are only suitable for coupled loads.

---

**Doweling & Bolting** After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

**WARNING:** **Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.**

**Guarding** Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions. This is particularly important where the parts have surface irregularities such as keys, key ways or set screws. Some satisfactory methods of guarding are:

1. Covering the machine and associated rotating parts with structural or decorative parts of the driven equipment.
2. Providing covers for the rotating parts. Covers should be sufficiently rigid to maintain adequate guarding during normal service.

**Power Connection** Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices. Flying leads must be insulated with two full wraps of electrical grade insulating tape or heat shrink tubing.

**Conduit Box** For ease of making connections, an oversize conduit box is provided.

The box can be rotated 360° in 90° increments.

Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

**AC Power** Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

1. AC power is within  $\pm 10\%$  of rated voltage with rated frequency. (See motor name plate for ratings).  
**OR**
2. AC power is within  $\pm 5\%$  of rated frequency with rated voltage.  
**OR**
3. A combined variation in voltage and frequency of  $\pm 10\%$  (sum of absolute values) of rated values, provided the frequency variation does not exceed  $\pm 5\%$  of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

**Figure 2-1 Accessory Connections**

HEATERS

H1  H2

H1  H2

One heater is installed in each end of motor.

Leads for each heater are labeled H1 & H2.

(Like numbers should be tied together).

THERMISTORS



Three thermistors are installed in windings and tied in series.

Leads are labeled T1 & T2.

WINDING RTDS



Winding RTDs are installed in windings (2) per phase.

Each set of leads is labeled W1, W2, W3, W4, W5, & W6.

BEARING RTD

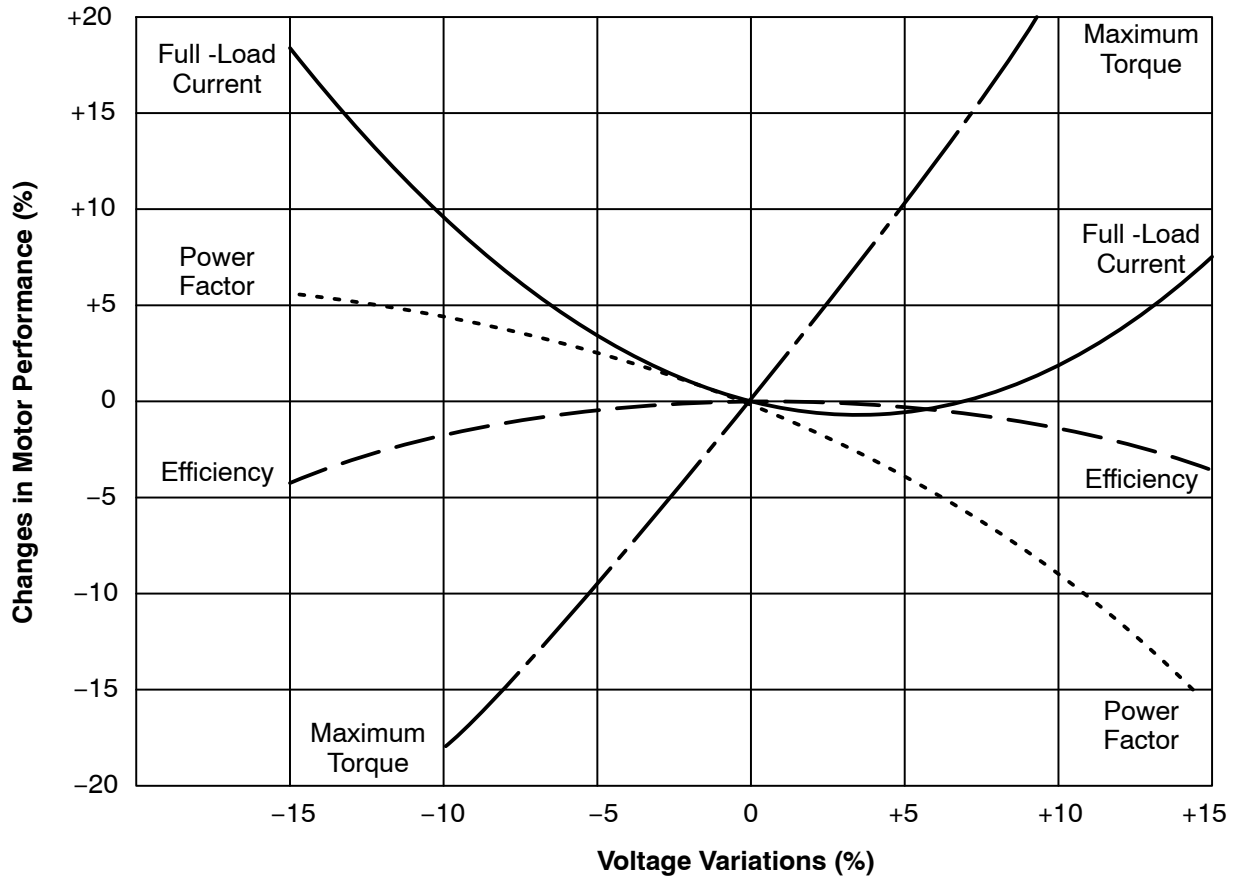


\* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE.

\* One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE.

\* Note RTD may have 2-Red/1-White leads; or 2-White/1-Red Lead.

**Figure 2-2 Typical Motor Performance VS Voltage Variations**



**Rotation** All three phase motors are reversible. To reverse the direction of rotation, disconnect and lock out power and interchange any two of the three line leads for three phase motors. For single phase motors, check the connection diagram to determine if the motor is reversible and follow the connection instructions for lead numbers to be interchanged. Not all single phase motors are reversible.

Adjustable Frequency Power Inverters used to supply adjustable frequency power to induction motors produce wave forms with lower order harmonics with voltage spikes superimposed. Turn-to-turn, phase-to-phase, and ground insulation of stator windings are subject to the resulting dielectric stresses. Suitable precautions should be taken in the design of these drive systems to minimize the magnitude of these voltage spikes. Consult the drive instructions for maximum acceptable motor lead lengths, and proper grounding.

- 
- First Time Start Up** Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.
1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
  2. If motor has been in storage or idle for some time, check winding insulation integrity.
  3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
  4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
  5. Manually rotate the motor shaft to ensure that it rotates freely.
  6. Replace all panels and covers that were removed during installation.
  7. Momentarily apply power and check the direction of rotation of the motor shaft.
  8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
  9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
  10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

**Coupled Start Up** This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor through the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

**Jogging and Repeated Starts** Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

**Heating** - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor District Office or Baldor Service Center.

## Section 3 Maintenance & Troubleshooting

**WARNING:** UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

**General Inspection** Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

**WARNING:** Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

**Relubrication & Bearings** Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

**Type of Grease** A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is **Polyrex EM (Mobil)**. Do not mix greases unless compatibility has been checked and verified.

Equivalent and compatible greases include:

Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

**Relubrication Intervals** Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

**Table 3-1 Relubrication Intervals \***

| NEMA / (IEC) Frame Size      | Rated Speed - RPM |           |             |            |            |            |
|------------------------------|-------------------|-----------|-------------|------------|------------|------------|
|                              | 10000             | 6000      | 3600        | 1800       | 1200       | 900        |
| Up to 210 incl. (132)        | **                | 2700 Hrs. | 5500 Hrs.   | 12000 Hrs. | 18000 Hrs. | 22000 Hrs. |
| Over 210 to 280 incl. (180)  |                   | **        | 3600 Hrs.   | 9500 Hrs.  | 15000 Hrs. | 18000 Hrs. |
| Over 280 to 360 incl. (225)  |                   | **        | * 2200 Hrs. | 7400 Hrs.  | 12000 Hrs. | 15000 Hrs. |
| Over 360 to 5800 incl. (300) |                   | **        | *2200 Hrs.  | 3500 Hrs.  | 7400 Hrs.  | 10500 Hrs. |

\* Relubrication intervals are for ball bearings.

For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

\*\* For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

**Table 3-2 Service Conditions**

| Severity of Service | Hours per day of Operation | Ambient Temperature Maximum   | Atmospheric Contamination                                       |
|---------------------|----------------------------|-------------------------------|---|
| Standard            | 8                          | 40° C                         | Clean, Little Corrosion   |
| Severe              | 16 Plus                    | 50° C                         | Moderate dirt, Corrosion  |
| Extreme             | 16 Plus                    | >50° C* or Class H Insulation | Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration |
| Low Temperature     |                            | <-29° C **                    |   |

\* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

\*\* Special low temperature grease is recommended (Aeroshell 7).

**Table 3-3 Relubrication Interval Multiplier**

| Severity of Service | Multiplier |
|---------------------|------------|
| Standard            | 1.0        |
| Severe              | 0.5        |
| Extreme             | 0.1        |
| Low Temperature     | 1.0        |

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

**Table 3-4 Bearings Sizes and Types**

| Frame Size<br>NEMA (IEC)  | Bearing Description<br>(These are the "Large" bearings (Shaft End) in each frame size) |   |                              |          |
|---------------------------|--|---|------------------------------|----------|
|                           | Bearing  | Weight of Grease to add *<br>oz (Grams) | Volume of grease to be added |          |
|                           |  |   | in <sup>3</sup>              | teaspoon |
| 56 to 140 (90)            | 6203   | 0.08 (2.4)                              | 0.15                         | 0.5      |
| 140 (90)                  | 6205   | 0.15 (3.9)                              | 0.2                          | 0.8      |
| 180 (100-112)             | 6206   | 0.19 (5.0)                              | 0.3                          | 1.0      |
| 210 (132)                 | 6307   | 0.30 (8.4)                              | 0.6                          | 2.0      |
| 250 (160)                 | 6309   | 0.47 (12.5)                             | 0.7                          | 2.5      |
| 280 (180)                 | 6311   | 0.61 (17)                               | 1.2                          | 3.9      |
| 320 (200)                 | 6312   | 0.76 (20.1)                             | 1.2                          | 4.0      |
| 360 (225)                 | 6313   | 0.81 (23)                               | 1.5                          | 5.2      |
| 400 (250)                 | 6316   | 1.25 (33)                               | 2.0                          | 6.6      |
| 440 (280)                 | 6319   | 2.12 (60)                               | 4.1                          | 13.4     |
| 5000 to 5800 (315-450)    | 6328   | 4.70 (130)                              | 9.2                          | 30.0     |
| 5000 to 5800 (315-450)    | NU328  | 4.70 (130)                              | 9.2                          | 30.0     |
| 360 to 449 (225-280)      | NU319  | 2.12 (60)                               | 4.1                          | 13.4     |
| <b>AC Induction Servo</b> |  |   |                              |          |
| 76 Frame 180 (112)        | 6207   | 0.22 (6.1)                              | 0.44                         | 1.4      |
| 77 Frame 210 (132)        | 6210   | 0.32 (9.0)                              | 0.64                         | 2.1      |
| 80 Frame 250(160)         | 6213   | 0.49 (14.0)                             | 0.99                         | 3.3      |

\* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

---

**Caution:** To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

**Relubrication Procedure** Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

**Caution:** Do not over-lubricate motor as this may cause premature bearing failure.

**With Grease Outlet Plug**

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

**Caution:** Over-lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed.  
This allows excess grease to purge.
5. Re-install grease outlet plug.

**Without Grease Provisions**

**Note:** Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

**Sample Relubrication Determination**

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in<sup>3</sup> or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

**Table 3-5 Troubleshooting Chart**

| Symptom                         | Possible Causes   | Possible Solutions   |
|---------------------------------|---|--|
| Motor will not start            | Usually caused by line trouble, such as, single phasing at the starter. | Check source of power. Check overloads, fuses, controls, etc.  |
| Excessive humming               | High Voltage.   | Check input line connections.  |
|                                 | Eccentric air gap.  | Have motor serviced at local Baldor service center.  |
| Motor Over Heating              | Overload. Compare actual amps (measured) with nameplate rating.         | Locate and remove source of excessive friction in motor or load.<br>Reduce load or replace with motor of greater capacity.                                   |
|                                 | Single Phasing.   | Check current at all phases (should be approximately equal) to isolate and correct the problem.  |
|                                 | Improper ventilation.   | Check external cooling fan to be sure air is moving properly across cooling fins.<br>Excessive dirt build-up on motor. Clean motor.                          |
|                                 | Unbalanced voltage.   | Check voltage at all phases (should be approximately equal) to isolate and correct the problem.  |
|                                 | Rotor rubbing on stator.  | Check air gap clearance and bearings.<br>Tighten "Thru Bolts".   |
|                                 | Over voltage or under voltage.  | Check input voltage at each phase to motor.  |
|                                 | Open stator winding.  | Check stator resistance at all three phases for balance.   |
|                                 | Grounded winding.   | Perform dielectric test and repair as required.  |
|                                 | Improper connections.   | Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram. |
|                                 | Bearing Over Heating  | Misalignment.  |
| Excessive belt tension.         |   | Reduce belt tension to proper point for load.  |
| Excessive end thrust.           |   | Reduce the end thrust from driven machine.   |
| Excessive grease in bearing.    |   | Remove grease until cavity is approximately $\frac{3}{4}$ filled.  |
| Insufficient grease in bearing. |   | Add grease until cavity is approximately $\frac{3}{4}$ filled.   |
| Dirt in bearing.                |   | Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $\frac{3}{4}$ filled.   |
| Vibration                       | Misalignment.   | Check and align motor and driven equipment.  |
|                                 | Rubbing between rotating parts and stationary parts.                    | Isolate and eliminate cause of rubbing.  |
|                                 | Rotor out of balance.   | Have rotor balance checked and repaired at your Baldor Service Center.   |
|                                 | Resonance.  | Tune system or contact your Baldor Service Center for assistance.  |
| Noise                           | Foreign material in air gap or ventilation openings.                    | Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.  |
| Growling or whining             | Bad bearing.  | Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $\frac{3}{4}$ filled.                |

**Suggested bearing and winding RTD setting guidelines**

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

**Winding RTDs – Temperature Limit In °C (40°C Maximum Ambient)**

| Motor Load              | Class B Temp Rise ≤ 80°C<br>(Typical Design) |      | Class F Temp Rise ≤ 105°C |      | Class H Temp Rise ≤ 125°C |      |
|-------------------------|--|------|---------------------------|------|---------------------------|------|
|                         | Alarm  | Trip | Alarm                     | Trip | Alarm                     | Trip |
| ≤ Rated Load            | 130  | 140  | 155                       | 165  | 175                       | 185  |
| Rated Load to 1.15 S.F. | 140  | 150  | 160                       | 165  | 180                       | 185  |

Note: • Winding RTDs are factory production installed, not from Mod-Express.  
 • When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

**Bearing RTDs – Temperature Limit In °C (40°C Maximum Ambient)**

| Bearing Type<br>Oil or Grease | Anti-Friction |      | Sleeve |      |
|-------------------------------|---------------|------|--------|------|
|                               | Alarm         | Trip | Alarm  | Trip |
| Standard*                     | 95            | 100  | 85     | 95   |
| High Temperature**            | 110           | 115  | 105    | 110  |

Note: \* Bearing temperature limits are for standard design motors operating at Class B temperature rise.  
 \*\* High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as “standard” lubricants) include the following:

- Texaco Polystar
- Mobilith SHC-100
- Darmex 707
- Rykon Premium #2
- Pennzoil Pennzlube EM-2
- Darmex 711
- Chevron SRI #2
- Chevron Black Pearl
- Petro-Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.  
 Contact Baldor application engineering for special lubricants or further clarifications.



## Baldor District Offices

### UNITED STATES

#### ARIZONA

PHOENIX  
4211 S 43RD PLACE  
PHOENIX, AZ 85040  
PHONE: 602-470-0407  
FAX: 602-470-0464

#### ARKANSAS

CLARKSVILLE  
1001 COLLEGE AVE.  
CLARKSVILLE, AR 72830  
PHONE: 479-754-9108  
FAX: 479-754-9205

#### CALIFORNIA

LOS ANGELES  
6480 FLOTILLA  
COMMERCE, CA 90040  
PHONE: 323-724-6771  
FAX: 323-721-5859  
HAYWARD  
21056 FORBES STREET  
HAYWARD, CA 94545  
PHONE: 510-785-9900  
FAX: 510-785-9910

#### COLORADO

DENVER  
3855 FOREST STREET  
DENVER, CO 80207  
PHONE: 303-623-0127  
FAX: 303-595-3772  
9980 PARK MEADOWS DRIVE  
SUITE 214  
LONE TREE, CO 80124-6739  
PHONE: 303-339-9629  
FAX: 303-339-9633

#### CONNECTICUT

WALLINGFORD  
65 SOUTH TURNPIKE ROAD  
WALLINGFORD, CT 06492  
PHONE: 203-269-1354  
FAX: 203-269-5485

#### FLORIDA

TAMPA/PUERTO RICO/  
VIRGIN ISLANDS  
3906 EAST 11TH AVENUE  
TAMPA, FL 33605  
PHONE: 813-248-5078  
FAX: 813-247-2984

#### GEORGIA

ATLANTA  
62 TECHNOLOGY DR.  
ALPHARETTA, GA 30005  
PHONE: 770-772-7000  
FAX: 770-772-7200

5490 MCGINNIS FERRY PLACE  
SUITE 133  
ALPHARETTA, GA 30005  
PHONE: 770-752-4254  
FAX: 770-752-4257

#### ILLINOIS

CHICAGO  
4 SAMMONS COURT  
BOLINGBROOK, IL 60440  
PHONE: 630-296-1400  
FAX: 630-226-9420

#### INDIANA

COLUMBUS  
3300 TENTH ST  
COLUMBUS, IN 47201  
PHONE: 812-378-2556  
FAX: 812-378-2555  
INDIANAPOLIS  
5525 W. MINNESOTA STREET  
INDIANAPOLIS, IN 46241  
PHONE: 317-246-5100  
FAX: 317-246-5110

#### IOWA

DES MOINES  
1800 DIXON STREET, SUITE C  
DES MOINES, IA 50316  
PHONE: 515-263-6929  
FAX: 515-263-6515

#### KANSAS

5030 BOB BILLINGS PKWY STE B  
LAWRENCE, KS 66049  
PHONE: 785-749-4339  
FAX: 785-749-4217

#### MARYLAND

BALTIMORE  
6660 SANTA BARBARA RD.  
SUITE 22-24  
ELK RIDGE, MD 21075  
PHONE: 410-579-2135  
FAX: 410-579-2677

#### MASSACHUSETTS

BOSTON  
6 PULLMAN STREET  
WORCESTER, MA 01606  
PHONE: 508-854-0708  
FAX: 508-854-0291

#### MICHIGAN

DETROIT  
33782 STERLING PONDS BLVD.  
STERLING HEIGHTS, MI 48312  
PHONE: 586-978-9800  
FAX: 586-978-9969  
GRAND RAPIDS  
668 THREE MILE ROAD NW  
GRAND RAPIDS, MI 49504  
PHONE: 616-785-1784  
FAX: 616-785-1788

#### MINNESOTA

MINNEAPOLIS  
21080 134TH AVE. NORTH  
ROGERS, MN 55374  
PHONE: 763-428-3633  
FAX: 763-428-4551

#### MISSOURI

ST LOUIS  
422 INDUSTRIAL DRIVE  
MARYLAND HEIGHTS, MO 63043  
PHONE: 314-298-1800  
FAX: 314-298-7660  
KANSAS CITY  
1501 BEDFORD AVENUE  
NORTH KANSAS CITY, MO 64116  
PHONE: 816-587-0272  
FAX: 816-587-3735

#### NEW YORK

AUBURN  
ONE ELLIS DRIVE  
AUBURN, NY 13021  
PHONE: 315-255-3403  
FAX: 315-253-9923

#### NORTH CAROLINA

GREENSBORO  
1220 ROTHERWOOD ROAD  
GREENSBORO, NC 27406  
PHONE: 336-272-6104  
FAX: 336-273-6628

#### OHIO

CINCINNATI  
2929 CRESCENTVILLE ROAD  
WEST CHESTER, OH 45069  
PHONE: 513-771-2600  
FAX: 513-772-2219

CLEVELAND  
8929 FREEWAY DRIVE  
MACEDONIA, OH 44056  
PHONE: 330-468-4777  
FAX: 330-468-4778

29525 CHAGRIN BLVD SUITE 208  
CLEVELAND, OH 44122  
PHONE: 216-360-8296  
FAX: 216-360-4172

#### OKLAHOMA

TULSA  
2 EAST DAWES  
BIXBY, OK 74008  
PHONE: 918-366-9320  
FAX: 918-366-9338

#### OREGON

PORTLAND  
20393 SW AVERY COURT  
TUALATIN, OR 97062  
PHONE: 503-691-9010  
FAX: 503-691-9012

#### PENNSYLVANIA

KING OF PRUSSIA  
1060 FIRST AVE STE 400  
KING OF PRUSSIA, PA 19406  
PHONE: 610-768-8018  
FAX: 215-672-5759

PHILADELPHIA  
1035 THOMAS BUSCH  
MEMORIAL HIGHWAY  
PENNSAUKEN, NJ 08110  
PHONE: 856-661-1442  
FAX: 856-663-6363

PITTSBURGH  
159 PROMINENCE DRIVE  
NEW KENSINGTON, PA 15068  
PHONE: 724-889-0092  
FAX: 724-889-0094

#### TENNESSEE

MEMPHIS  
4000 WINCHESTER ROAD  
MEMPHIS, TN 38118  
PHONE: 901-365-2020  
FAX: 901-365-3914

#### TEXAS

ADDISON  
3939 BELT LINE ROAD #250  
ADDISON, TX 75001  
PHONE: 972-499-7746, 499-7747  
FAX: 972-242-1505

DALLAS  
3040 QUEBEC  
DALLAS, TX 75247  
PHONE: 214-634-7271  
FAX: 214-634-8874

HOUSTON  
4647 PINE TIMBERS  
SUITE # 135  
HOUSTON, TX 77041  
PHONE: 713-895-7062  
FAX: 713-690-4540

#### UTAH

SALT LAKE CITY  
2230 SOUTH MAIN STREET  
SALT LAKE CITY, UT 84115  
PHONE: 801-832-0127  
FAX: 801-832-8911

#### VIRGINIA

RICHMOND  
6767 FOREST HILL AVE STE 305  
RICHMOND, VA 23225  
PHONE: 804-545-6848  
FAX: 804-545-6840

#### WASHINGTON

KIRKLAND, WA  
550 KIRKLAND WAY STE 205  
KIRKLAND, WA 98033  
PHONE: 425-952-5000  
FAX: 775-255-8019

#### WISCONSIN

MILWAUKEE  
2725 SOUTH 163RD STREET  
NEW BERLIN, WI 53151  
PHONE: 262-784-5940  
FAX: 262-784-1215  
WAUKESHA  
N14 W23777 STONE RIDGE DRIVE  
SUITE 170  
WAUKESHA, WI 53188  
PHONE: 262-347-2000  
FAX: 262-437-0258

#### INTERNATIONAL SALES

FORT SMITH, AR  
P.O. BOX 2400  
FORT SMITH, AR 72902  
PHONE: 479-646-4711  
FAX: 479-648-5895

#### CANADA

EDMONTON, ALBERTA  
4053-92 STREET  
EDMONTON, ALBERTA T6E 6R8  
PHONE: 780-434-4900  
FAX: 780-438-2600

11428-168 STREET  
EDMONTON, ALBERTA T5M 3T9  
PHONE: 780-822-7865  
FAX: 780-822-7878

MISSISSAUGA, ONTARIO  
244 BRITANNIA ROAD EAST  
MISSISSAUGA, ONTARIO L4Z 1S6  
PHONE: 905-890-5110  
FAX: 905-890-5540

OAKVILLE, ONTARIO  
2750 COVENTRY ROAD  
OAKVILLE, ONTARIO L6H 6R1  
PHONE: 905-829-3301  
FAX: 905-829-3302

DORVAL, QUEBEC  
95 RUE LINDSAY  
DORVAL QUEBEC H9P 2S6  
PHONE: 514-422-8818  
FAX: 514-422-8982

MONTREAL, QUEBEC  
1844 WILLIAM STREET  
MONTREAL, QUEBEC H3J 1R5  
PHONE: 514-933-2711  
FAX: 514-933-8639

VANCOUVER,  
BRITISH COLUMBIA  
1538 KEBET WAY  
PORT COQUITLAM,  
BRITISH COLUMBIA V3C 5M5  
PHONE 604-421-2822  
FAX: 604-421-3113

WINNIPEG, MANITOBA  
54 PRINCESS STREET  
WINNIPEG, MANITOBA R3B 1K2  
PHONE: 204-942-5205  
FAX: 204-956-4251

#### AUSTRALIA

UNIT 3, 6 STANTON ROAD  
SEVEN HILLS, NSW 2147, AUSTRALIA  
PHONE: (61) (2) 9674 5455  
FAX: (61) (2) 9674 2495

UNIT 8, 5 KELLETTS ROAD  
ROWVILLE, VICTORIA, 3178  
AUSTRALIA

PHONE: (61) (3) 9753 4355

FAX: (61) (3) 9753 4366

#### EL SALVADOR

RESIDENCIAL PINARES DE SUIZA  
POL. 15 #44,  
NVA. SAN SALVADOR, EL SALVADOR  
PHONE: +503 2288-1519  
FAX: +503 2288-1518

#### CHILE

LUIS THAYER OJEDA 166,  
OF 402 - PROVIDENCIA  
SANTIAGO, CHILE  
PHONE: 56-2-290-0762  
FAX: 56-2-290-0762

#### CHINA

5299 BEI SONG ROAD  
SONGJIANG  
201611 SHANGHAI, CHINA  
PHONE: +86 21 5760 5335  
FAX: +86 21 5760 5336

UNIT 905, 9TH FLOOR,  
TOWER B WANDA PLAZA  
NO. 93 JIANGUO ROAD,  
CHAOYANG DISTRICT  
BEIJING, 100022, CHINA  
PHONE +86 (010) 58205516  
FAX +86 (010) 58204231

#### GERMANY

DIESELSTRASSE 22  
D-85551 KIRCHHEIM  
MUNICH, GERMANY  
PHONE: +49 89 90 5080  
FAX: +49 89 90 50 8492

HERMANN-HEINRICH-GOSSEN-  
STRASSE 3  
D-50858 KÖLN, GERMANY  
PHONE: 49 2234 37941 0  
FAX: 49 2234 37941 64

#### INDIA

14, COMMERCE AVENUE  
MAHAGANESH COLONY  
PAUD ROAD  
PUNE - 411038  
MAHARASHTRA, INDIA  
PHONE: 91 20 25452717, 25452718  
FAX: 91 20 25452719

#### ITALY

BALDOR ASR AG  
SUCCURSALE DI MENDRISIO  
VIA BORROMINI, 20A  
CH-6850 MENDRISIO  
SWITZERLAND  
PHONE: 0041 91 640 99 50  
FAX: 0041 91 630 26 33

#### JAPAN

DIA BLDG 802,  
2-21-1 TSURUYA-CHO,  
KANAGAWA-KU  
YOKOHAMA, 221-0835, JAPAN  
PHONE: 81-45-412-4506  
FAX: 81-45-412-4507

#### KOREA

RM 1715, SUSEO TOWER, 725,  
SUSEO-DONG, GANGNAM-GU,  
SEOUL 135-757 KOREA  
TEL : (82) 2 2226 9369  
FAX : (82) 2 2226 9368

#### MEXICO

LEON, GUANAJUATO  
KM. 2.0 BLVD. AEROPUERTO  
LEON 37545, GUANAJUATO, MEXICO  
PHONE: 52 477 761 2030  
FAX: 52 477 761 2010

#### MIDDLE EAST & NORTH AFRICA

VSE INTERNATIONAL CORP.  
P. O. BOX 5618  
BUFFALO GROVE, IL 60089-5618  
PHONE: 847 590 5547  
FAX: 847 590 5587

#### SINGAPORE

18, KAKI BUKIT ROAD 3  
#03-09 ENTREPRENEUR  
BUSINESS CENTRE  
SINGAPORE 415978  
PHONE: (65) 6744 2572  
FAX: (65) 6747 1708

#### PANAMA

AVE. RICARDO J. ALFARO  
EDIFICIO SUN TOWERS MALL  
PISO 2, LOCAL 55  
CIUDAD DE PANAMÁ, PANAMÁ  
PHONE: +507 236-5155  
FAX: +507 261-5355

#### SWITZERLAND

POSTFACH 73  
SCHUTZENSTRASSE 59  
CH-8245 FEUERTHALEN  
SWITZERLAND  
PHONE: +41 52 647 4700  
FAX: +41 52 659 2394

#### TAIWAN

1F, NO 126 WENSHAN 3RD STREET,  
NANTUN DISTRICT,  
TAICHUNG CITY 408  
TAIWAN R.O.C  
PHONE: (886) 4 238 04235  
FAX: (886) 4 238 04463

#### UNITED KINGDOM

6 BRISTOL DISTRIBUTION PARK  
HAWKLEY DRIVE  
BRISTOL BS32 0BF U.K.  
PHONE: +44 1454 850000  
FAX: +44 1454 859001

#### VENEZUELA

AV. ROMA, QTA EL MILAGRO. URB.  
CALIFORNIA NORTE  
CARACAS, 1070 VENEZUELA  
PHONE: 58-414-114-8623  
FAX: 58-412-322-5790



\* 4 0 0 - 0 2 0 9 \*



**BALDOR ELECTRIC COMPANY**  
**World Headquarters**  
**P.O. Box 2400 Fort Smith, AR 72901-2400**  
**(479) 646-4711 Fax (479) 648-5792**  
**[www.baldor.com](http://www.baldor.com)**

# PART 6: VARIABLE FREQUENCY DRIVE

# ABB component drives

## ACS150, 0.37 to 4 kW / 0.5 to 5 hp



### ABB component drives

ABB component drives are designed for machine building. These drives are components that are bought together with other components from a logistical distributor. The drive are stocked, and the number of options and variants is optimized for logistical distribution.

### Highlights

- FlashDrop
- Integrated interface
- Integrated potentiometer
- Inbuilt C3 EMC filter
- Inbuilt brake chopper
- Side-by-side mounting
- Coated boards

### Voltage and power range

- 1-phase, 200 to 240 V  $\pm 10\%$   
0.37 to 2.2 kW (0.5 to 3 hp)
- 3-phase, 200 to 240 V  $\pm 10\%$   
0.37 to 2.2 kW (0.5 to 3 hp)
- 3-phase, 380 to 480 V  $\pm 10\%$   
0.37 to 4 kW (0.5 to 5 hp)

### Applications

- Fans
- Pumps
- Gate control
- Material handling
- Conveyors

### Options

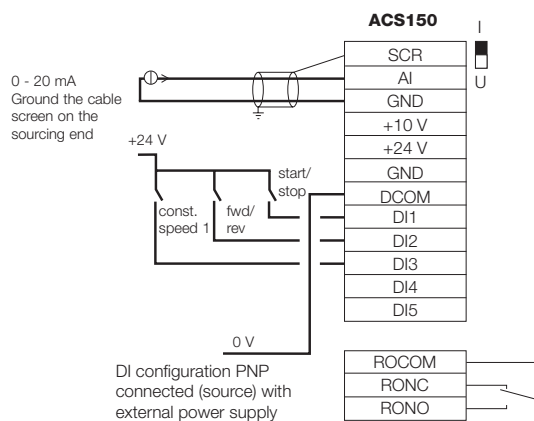
- FlashDrop
- Input/Output chokes
- C2 EMC filters
- NEMA 1 kit

# Ratings, types, voltages and dimensions



| Ratings   |             |               | Type code         | Frame size | IP20 UL open |         |         |              | NEMA 1   |         |         |              |
|---|-------------|---------------|-------------------|------------|--------------|---------|---------|--------------|----------|---------|---------|--------------|
| $P_N$<br>kW                                     | $P_N$<br>hp | $I_{2N}$<br>A |                   |            | H2<br>mm     | W<br>mm | D<br>mm | Weight<br>kg | H5<br>mm | W<br>mm | D<br>mm | Weight<br>kg |
| <b>3-phase supply voltage 200 - 240 V units</b> |             |               |                   |            |              |         |         |              |          |         |         |              |
| 0.75  | 1           | 4.7           | ACS150-03X-04A7-2 | R1         | 202          | 70      | 142     | 1.3          | 280      | 70      | 142     | 1.7          |

X within the type code stands for E or U.  
 E = EMC filter connected. U = EMC filter disconnected.  
 H2 = Height with fastenings but without clamping plate.  
 H5 = Height with fastenings, NEMA 1 connection box and hood.  
 W = Width, D = Depth



## Motor connection

|   |   |
|---|---|
| <b>Voltage</b>  | 3-phase, from 0 to $U_{supply}$   |
| <b>Frequency</b>  | 0 to 500 Hz   |
| <b>Overload capability</b><br>(at a max. ambient temperature of 40°C) | At heavy duty use $1.5 \times I_{2N}$ for 1 minute every 10 minutes<br>At start $1.8 \times I_{2N}$ for 2 s |
| <b>Switching frequency</b>  |   |
| Default   | 4 kHz   |
| Selectable  | 4 to 16 kHz with 4 kHz steps  |
| <b>Acceleration time</b>  | 0.1 to 1800 s   |
| <b>Deceleration time</b>  | 0.1 to 1800 s   |
| <b>Braking</b>  | Inbuilt brake chopper as standard   |

## Programmable control connections

|                               |   |
|-------------------------------|---|
| <b>One analog input</b>       |   |
| Voltage signal                | 0 (2) to 10 V, $R_{in} > 312 \text{ k}\Omega$   |
| Current signal                | 0 (4) to 20 mA, $R_{in} = 100 \Omega$   |
| Potentiometer reference value | 10 V $\pm 1\%$ max. 10 mA, $R < 10 \text{ k}\Omega$                                   |
| Resolution                    | 0.1 %   |
| Accuracy                      | $\pm 2\%$   |
| <b>Auxiliary voltage</b>      | 24 V DC $\pm 10\%$ , max. 200 mA  |
| <b>Five digital inputs</b>    | 12 to 24 V DC with internal or external supply, PNP and NPN, pulse train 0 to 10 kHz. |
| Input impedance               | 2.4 k $\Omega$  |
| <b>One relay output</b>       |   |
| Type                          | NO + NC   |
| Maximum switching voltage     | 250 V AC/30 V DC  |
| Maximum switching current     | 0.5 A/30 V DC; 5 A/230 V AC   |
| Maximum continuous current    | 2 A rms   |

## Product compliance

UL, cUL, CE, C-Tick and GOST R approvals

## Environmental limits

|                             |   |
|-----------------------------|---|
| <b>Degree of protection</b> | IP20 / Optional NEMA 1 enclosure  |
| <b>Ambient temperature</b>  | -10 to 40 °C (14 to 104 °F), no frost allowed, 50 °C (122 °F) with 10% derating |
| <b>Relative humidity</b>    | Lower than 95% (without condensation)   |



**ABB Oy**  
 Drives  
 P. O. Box 184  
 FI - 00381 Helsinki  
 Finland  
 Telephone +358 10 22 11  
 Fax +358 10 22 23764  
 Internet [www.abb.com/motors&drives](http://www.abb.com/motors&drives)

For more information see technical catalogue  
 ABB component drives, ACS150 (3AFE68596114).

Find your nearest contact at



[www.abb.com/drivespartners](http://www.abb.com/drivespartners)

ABB component drives

# User's manual

## ACS150 drives (0.37...4 kW, 0.5...5 hp)



## List of related manuals

### Drive manuals

*ACS310 User's Manual* 1), 2) [3AFE68576032](#)

### Code (English)

### Option manuals and guides

*MUL1-R1 Installation instructions for ACS150, ACS310, ACS320, ACS350 and ACS355* 1), 2) [3AFE68642868](#)

*MFDT-01 FlashDrop user's manual* 1), 2) [3AFE68591074](#)

### Maintenance manuals

*Guide for capacitor reforming in ACS50, ACS55, ACS150, ACS310, ACS350, ACS355, ACS550, ACH550 and R1-R4 OINT-/SINT-boards* 2) [3AFE68735190](#)

1) Delivered as a printed copy with the drive or optional equipment.

2) Available in the Internet.

All manuals are available in PDF format on the Internet. See section [Further information](#) on the inside of the back cover.

ACS150 drives  
0.37...4 kW  
0.5...5 hp

## **User's manual**

3AFE68576032 Rev C  
EN  
EFFECTIVE: 2011-01-01



# Table of contents

---

|                               |   |
|-------------------------------|---|
| List of related manuals ..... | 2 |
|-------------------------------|---|

## ***Table of contents***

### **Safety**

|  |    |
|--|----|
| What this chapter contains .....             | 11 |
| Use of warnings .....                        | 11 |
| Safety in installation and maintenance ..... | 11 |
| Electrical safety .....                      | 11 |
| General safety .....                         | 12 |
| Safety in start-up and operation .....       | 13 |

### ***Introduction to the manual***

|  |    |
|--|----|
| What this chapter contains .....                     | 15 |
| Applicability .....                                  | 15 |
| Target audience .....                                | 15 |
| Purpose of the manual .....                          | 15 |
| Contents of this manual .....                        | 15 |
| Related documents .....                              | 16 |
| Categorization according to the frame size .....     | 16 |
| Quick installation and commissioning flowchart ..... | 17 |

### ***Operation principle and hardware description***

|  |    |
|--|----|
| What this chapter contains .....               | 19 |
| Operation principle .....                      | 19 |
| Product overview .....                         | 20 |
| Layout .....                                   | 20 |
| Power connections and control interfaces ..... | 21 |
| Type designation label .....                   | 22 |
| Type designation key .....                     | 22 |

### ***Mechanical installation***

|  |    |
|--|----|
| What this chapter contains .....             | 23 |
| Checking the installation site .....         | 23 |
| Requirements for the installation site ..... | 23 |
| Operation conditions .....                   | 23 |
| Wall .....                                   | 23 |
| Floor .....                                  | 23 |
| Free space around the drive .....            | 23 |
| Required tools .....                         | 24 |
| Unpacking .....                              | 24 |

|                        |    |
|------------------------|----|
| Checking the delivery  | 25 |
| Installing             | 25 |
| Install the drive      | 25 |
| With screws            | 25 |
| On DIN rail            | 26 |
| Horizontally           | 27 |
| Fasten clamping plates | 28 |

### ***Planning the electrical installation***

|   |    |
|---|----|
| What this chapter contains  | 29 |
| Implementing the AC power line connection   | 29 |
| Selecting the supply disconnecting device (disconnecting means)   | 29 |
| European union  | 29 |
| Other regions   | 29 |
| Checking the compatibility of the motor and drive   | 30 |
| Selecting the power cables  | 30 |
| General rules   | 30 |
| Alternative power cable types   | 31 |
| Motor cable shield  | 31 |
| Additional US requirements  | 32 |
| Conduit   | 32 |
| Armored cable / shielded power cable  | 32 |
| Selecting the control cables  | 33 |
| General rules   | 33 |
| Relay cable   | 33 |
| Routing the cables  | 34 |
| Control cable ducts   | 34 |
| Protecting the drive, input power cable, motor and motor cable in short-circuit situations and against thermal overload | 35 |
| Protecting the drive and input power cable in short-circuit situations  | 35 |
| Protecting the motor and motor cable in short-circuit situations  | 35 |
| Protecting the drive, motor cable and input power cable against thermal overload  | 36 |
| Protecting the motor against thermal overload   | 36 |
| Residual current device (RCD) compatibility   | 36 |
| Implementing a bypass connection  | 36 |
| Protecting the contacts of relay outputs  | 37 |

### ***Electrical installation***

|  |    |
|--|----|
| What this chapter contains   | 39 |
| Checking the insulation of the assembly  | 39 |
| Drive  | 39 |
| Input power cable  | 39 |
| Motor and motor cable  | 39 |
| Checking the compatibility with IT (ungrounded) and corner-grounded TN systems | 40 |
| Connecting the power cables  | 41 |
| Connection diagram   | 41 |
| Connection procedure   | 42 |
| Connecting the control cables  | 44 |

|  |    |
|--|----|
| I/O terminals  | 44 |
| PNP and NPN configuration for digital inputs                   | 45 |
| External power supply for digital inputs                       | 45 |
| Default I/O connection diagram                                 | 46 |
| Connection procedure   | 47 |
| <br>   |    |
| <b>Installation checklist</b>                                  |    |
| Checking the installation                                      | 49 |
| <br>   |    |
| <b>Start-up and control with I/O</b>                           |    |
| What this chapter contains                                     | 51 |
| How to start up the drive                                      | 51 |
| How to control the drive through the I/O interface             | 55 |
| <br>   |    |
| <b>Control panel</b>   |    |
| What this chapter contains                                     | 57 |
| Integrated control panel                                       | 57 |
| Overview   | 58 |
| Operation  | 59 |
| How to perform common tasks                                    | 60 |
| How to start, stop and switch between local and remote control | 61 |
| How to change the direction of the motor rotation              | 61 |
| How to set the frequency reference                             | 62 |
| Output mode  | 63 |
| How to browse the monitored signals                            | 63 |
| Reference mode   | 64 |
| How to view and set the frequency reference                    | 64 |
| Parameter modes  | 65 |
| How to select a parameter and change its value                 | 65 |
| How to select the monitored signals                            | 66 |
| Changed parameters mode  | 67 |
| How to view and edit changed parameters                        | 67 |
| <br>   |    |
| <b>Application macros</b>                                      |    |
| What this chapter contains                                     | 69 |
| Overview of macros   | 69 |
| Summary of I/O connections of application macros               | 70 |
| ABB standard macro   | 71 |
| Default I/O connections  | 71 |
| 3-wire macro   | 72 |
| Default I/O connections  | 72 |
| Alternate macro  | 73 |
| Default I/O connections  | 73 |
| Motor potentiometer macro                                      | 74 |
| Default I/O connections  | 74 |

|                               |    |
|-------------------------------|----|
| Hand/Auto macro .....         | 75 |
| Default I/O connections ..... | 75 |
| PID control macro .....       | 76 |
| Default I/O connections ..... | 76 |
| User macros .....             | 77 |

### ***Actual signals and parameters***

|  |     |
|--|-----|
| What this chapter contains .....                     | 79  |
| Terms and abbreviations .....                        | 79  |
| Default parameter values with different macros ..... | 79  |
| Parameters in the Short parameter mode .....         | 80  |
| 99 START-UP DATA .....                               | 80  |
| 04 FAULT HISTORY .....                               | 81  |
| 11 REFERENCE SELECT .....                            | 81  |
| 12 CONSTANT SPEEDS .....                             | 82  |
| 13 ANALOG INPUTS .....                               | 82  |
| 20 LIMITS .....                                      | 82  |
| 21 START/STOP .....                                  | 82  |
| 22 ACCEL/DECEL .....                                 | 83  |
| Actual signals .....                                 | 84  |
| 01 OPERATING DATA .....                              | 84  |
| 04 FAULT HISTORY .....                               | 85  |
| Parameters in the Long parameter mode .....          | 86  |
| 10 START/STOP/DIR .....                              | 86  |
| 11 REFERENCE SELECT .....                            | 89  |
| 12 CONSTANT SPEEDS .....                             | 92  |
| 13 ANALOG INPUTS .....                               | 94  |
| 14 RELAY OUTPUTS .....                               | 94  |
| 16 SYSTEM CONTROLS .....                             | 96  |
| 18 FREQ INPUT .....                                  | 98  |
| 20 LIMITS .....                                      | 98  |
| 21 START/STOP .....                                  | 99  |
| 22 ACCEL/DECEL .....                                 | 101 |
| 25 CRITICAL SPEEDS .....                             | 104 |
| 26 MOTOR CONTROL .....                               | 105 |
| 30 FAULT FUNCTIONS .....                             | 107 |
| 31 AUTOMATIC RESET .....                             | 112 |
| 32 SUPERVISION .....                                 | 114 |
| 33 INFORMATION .....                                 | 115 |
| 34 PANEL DISPLAY .....                               | 116 |
| 40 PROCESS PID SET 1 .....                           | 119 |
| 99 START-UP DATA .....                               | 124 |

### ***Fault tracing***

|                                   |     |
|-----------------------------------|-----|
| What this chapter contains .....  | 127 |
| Safety .....                      | 127 |
| Alarm and fault indications ..... | 127 |
| How to reset .....                | 127 |

|   |     |
|---|-----|
| Fault history .....                         | 127 |
| Alarm messages generated by the drive ..... | 128 |
| Fault messages generated by the drive ..... | 130 |

### **Maintenance**

|                                   |     |
|-----------------------------------|-----|
| What this chapter contains .....  | 133 |
| Maintenance intervals .....       | 133 |
| Cooling fan .....                 | 134 |
| Fan replacement (R1 and R2) ..... | 134 |
| Capacitors .....                  | 135 |
| Reforming the capacitors .....    | 135 |
| Power connections .....           | 136 |
| Control panel .....               | 136 |
| Cleaning .....                    | 136 |

### **Technical data**

|   |     |
|---|-----|
| What this chapter contains .....                          | 137 |
| Ratings .....   | 137 |
| Current and power .....                                   | 137 |
| Symbols .....   | 138 |
| Sizing .....  | 138 |
| Derating .....  | 138 |
| Temperature derating, I2N .....                           | 138 |
| Altitude derating, I2N .....                              | 138 |
| Switching frequency derating, I2N .....                   | 139 |
| Power cable sizes and fuses .....                         | 140 |
| Dimensions, weights and free space requirements .....     | 141 |
| Dimensions and weights .....                              | 141 |
| Symbols .....   | 141 |
| Free space requirements .....                             | 141 |
| Losses, cooling data and noise .....                      | 142 |
| Losses and cooling data .....                             | 142 |
| Noise .....   | 142 |
| Terminal and lead-through data for the power cables ..... | 143 |
| Terminal data for the control cables .....                | 143 |
| Electric power network specification .....                | 144 |
| Motor connection data .....                               | 144 |
| Control connection data .....                             | 146 |
| Brake resistor connection .....                           | 146 |
| Efficiency .....  | 146 |
| Degrees of protection .....                               | 146 |
| Ambient conditions .....                                  | 147 |
| Materials .....   | 147 |
| Applicable standards .....                                | 148 |
| CE marking .....  | 148 |
| Compliance with the European EMC Directive .....          | 148 |
| Compliance with the EN 61800-3:2004 .....                 | 148 |
| Definitions .....   | 148 |

|   |     |
|---|-----|
| Compliance  | 149 |
| Category C1   | 149 |
| Category C2   | 149 |
| Category C3   | 149 |
| UL marking  | 150 |
| UL checklist  | 150 |
| C-Tick marking  | 150 |
| RoHS marking  | 150 |
| Brake resistors   | 151 |
| Selecting the brake resistor  | 151 |
| Selecting the brake resistor cables   | 153 |
| Placing the brake resistor  | 153 |
| Protecting the system in brake circuit fault situations                       | 153 |
| Protection of the system in cable and brake resistor short-circuit situations | 153 |
| Protection of the system in brake resistor overheating situations             | 153 |
| Electrical installation   | 153 |
| Start-up  | 154 |

### ***Dimension drawings***

|  |     |
|--|-----|
| Frame sizes R0 and R1, IP20 (cabinet installation) / UL open | 156 |
| Frame sizes R0 and R1, IP20 / NEMA 1                         | 157 |
| Frame size R2, IP20 (cabinet installation) / UL open         | 158 |
| Frame size R2, IP20 / NEMA 1                                 | 159 |

### ***Appendix: Process PID control***

|  |     |
|--|-----|
| What this chapter contains   | 161 |
| Process PID control  | 161 |
| Quick configuration of process PID control                           | 161 |
| Pressure boost pump  | 162 |
| How to scale the PID actual (feedback) signal 0...10 bar / 4...20 mA | 163 |
| How to scale the PID setpoint signal                                 | 163 |
| PID sleep functionality  | 164 |

### ***Further information***

|  |     |
|--|-----|
| Product and service inquiries            | 169 |
| Product training                         | 169 |
| Providing feedback on ABB Drives manuals | 169 |
| Document library on the Internet         | 169 |

# Safety

---

## What this chapter contains

The chapter contains safety instructions that you must follow when installing, operating and servicing the drive. If ignored, physical injury or death may follow, or damage may occur to the drive, motor or driven equipment. Read the safety instructions before you work on the drive.

## Use of warnings

Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment, and advise on how to avoid the danger. The warning symbols are used as follows:



**Electricity warning** warns of hazards from electricity which can cause physical injury and/or damage to the equipment.



**General warning** warns about conditions, other than those caused by electricity, which can result in physical injury and/or damage to the equipment.

## Safety in installation and maintenance

These warnings are intended for all who work on the drive, motor cable or motor.

### Electrical safety



**WARNING!** Ignoring the instructions can cause physical injury or death, or damage to the equipment.

#### **Only qualified electricians are allowed to install and maintain the drive!**

- Never work on the drive, motor cable or motor when input power is applied. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.

Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that:

1. There is no voltage between the drive input phases U1, V1 and W1 and the ground.
  2. There is no voltage between terminals BRK+ and BRK- and the ground.
- Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may carry dangerous voltage even when the input power of the drive is switched off.
  - Do not make any insulation or voltage withstand tests on the drive.

- Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors. This may cause danger or damage the drive. See page 40. **Note:** When the internal EMC filter is disconnected, the drive is not EMC compatible.
- Disconnect the internal EMC filter when installing the drive on a corner-grounded TN system, otherwise the drive will be damaged. See page 40. **Note:** When the internal EMC filter is disconnected, the drive is not EMC compatible.
- All ELV (extra low voltage) circuits connected to the drive must be used within a zone of equipotential bonding, ie within a zone where all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. This is accomplished by a proper factory grounding.

**Note:**

Even when the motor is stopped, dangerous voltage is present at the power circuit terminals U1, V1, W1 and U2, V2, W2 and BRK+ and BRK-.

---

**General safety**

---



**WARNING!** Ignoring the following instructions can cause physical injury or death, or damage to the equipment.



- The drive is not field repairable. Never attempt to repair a malfunctioning drive; contact your local ABB representative or Authorized Service Center for replacement.
  - Make sure that dust from drilling does not enter the drive during the installation. Electrically conductive dust inside the drive may cause damage or lead to malfunction.
  - Ensure sufficient cooling.
-

## Safety in start-up and operation



These warnings are intended for all who plan the operation, start up or operate the drive.



**WARNING!** Ignoring the following instructions can cause physical injury or death, or damage to the equipment.

- Before adjusting the drive and putting it into service, make sure that the motor and all driven equipment are suitable for operation throughout the speed range provided by the drive. The drive can be adjusted to operate the motor at speeds above and below the speed provided by connecting the motor directly to the power line.
- Do not activate automatic fault reset functions if dangerous situations can occur. When activated, these functions reset the drive and resume operation after a fault.
- Do not control the motor with an AC contactor or disconnecting device (disconnecting means); use instead the control panel start and stop keys  and  or external commands (I/O). The maximum allowed number of charging cycles of the DC capacitors (that is, power-ups by applying power) is two per minute and the maximum total number of chargings is 15 000.

**Note:**

- If an external source for start command is selected and it is ON, the drive starts immediately after an input voltage break or fault reset unless the drive is configured for 3-wire (a pulse) start/stop.
- When the control location is not set to local (LOC not shown on the display), the stop key on the control panel does not stop the drive. To stop the drive using the control panel, press the LOC/REM key  and then the stop key .



# Introduction to the manual

---

## What this chapter contains

The chapter describes applicability, the target audience and purpose of this manual. It describes the contents of this manual and refers to a list of related manuals for more information. It also contains a flowchart of steps for checking the delivery, installing and commissioning the drive. The flowchart refers to chapters/sections in this manual.

## Applicability

The manual is applicable to the ACS150 drive firmware version 1.35b or later. See parameter [3301 FIRMWARE](#) on page [115](#).

## Target audience

The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

This manual is written for readers worldwide. Both SI and imperial units are shown. Special US instructions for installations in the United States are given.

## Purpose of the manual

This manual provides information needed for planning the installation, installing, commissioning, using and servicing the drive.

## Contents of this manual

The manual consists of the following chapters:

- [Safety](#) (page [11](#)) gives safety instructions you must follow when installing, commissioning, operating and servicing the drive.
- [Introduction to the manual](#) (this chapter, page [15](#)) describes applicability, target audience, purpose and contents of this manual. It also contains a quick installation and commissioning flowchart.
- [Operation principle and hardware description](#) (page [19](#)) describes the operation principle, layout, type designation label and type designation information. It also shows a general diagram of power connections and control interfaces.
- [Mechanical installation](#) (page [23](#)) tells how to check the installation site, unpack, check the delivery and install the drive mechanically.
- [Planning the electrical installation](#) (page [29](#)) tells how to check the compatibility of the motor and the drive and select cables, protections and cable routing.

- [Electrical installation](#) (page 39) tells how to check the insulation of the assembly and the compatibility with IT (ungrounded) and corner-grounded TN systems as well as connect power cables and control cables.
- [Installation checklist](#) (page 49) contains a checklist for checking the mechanical and electrical installation of the drive.
- [Start-up and control with I/O](#) (page 51) tells how to start, stop, change the direction of the motor rotation and adjust the motor speed through the I/O interface.
- [Control panel](#) (page 57) describes the control panel keys, LED indicators and display fields and tells how to use the panel for control, monitoring and changing the settings.
- [Application macros](#) (page 69) gives a brief description of each application macro together with a wiring diagram showing the default control connections. It also explains how to save a user macro and how to recall it.
- [Actual signals and parameters](#) (page 79) describes actual signals and parameters. It also lists the default values for the different macros.
- [Fault tracing](#) (page 127) tells how to reset faults and view fault history. It lists all alarm and fault messages including the possible cause and corrective actions.
- [Maintenance](#) (page 133) contains preventive maintenance instructions.
- [Technical data](#) (page 137) contains technical specifications of the drive, such as ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE and other marks.
- [Dimension drawings](#) (page 155) shows dimension drawings of the drive.
- [Appendix: Process PID control](#) (page 161) contains instructions on quick configuration of the process control, gives an application example and describes the PID sleep functionality.
- [Further information](#) (page 169) (inside of the back cover, page 169) tells how to make product and service inquiries, get information on product training, provide feedback on ABB Drives manuals and find documents on the Internet.

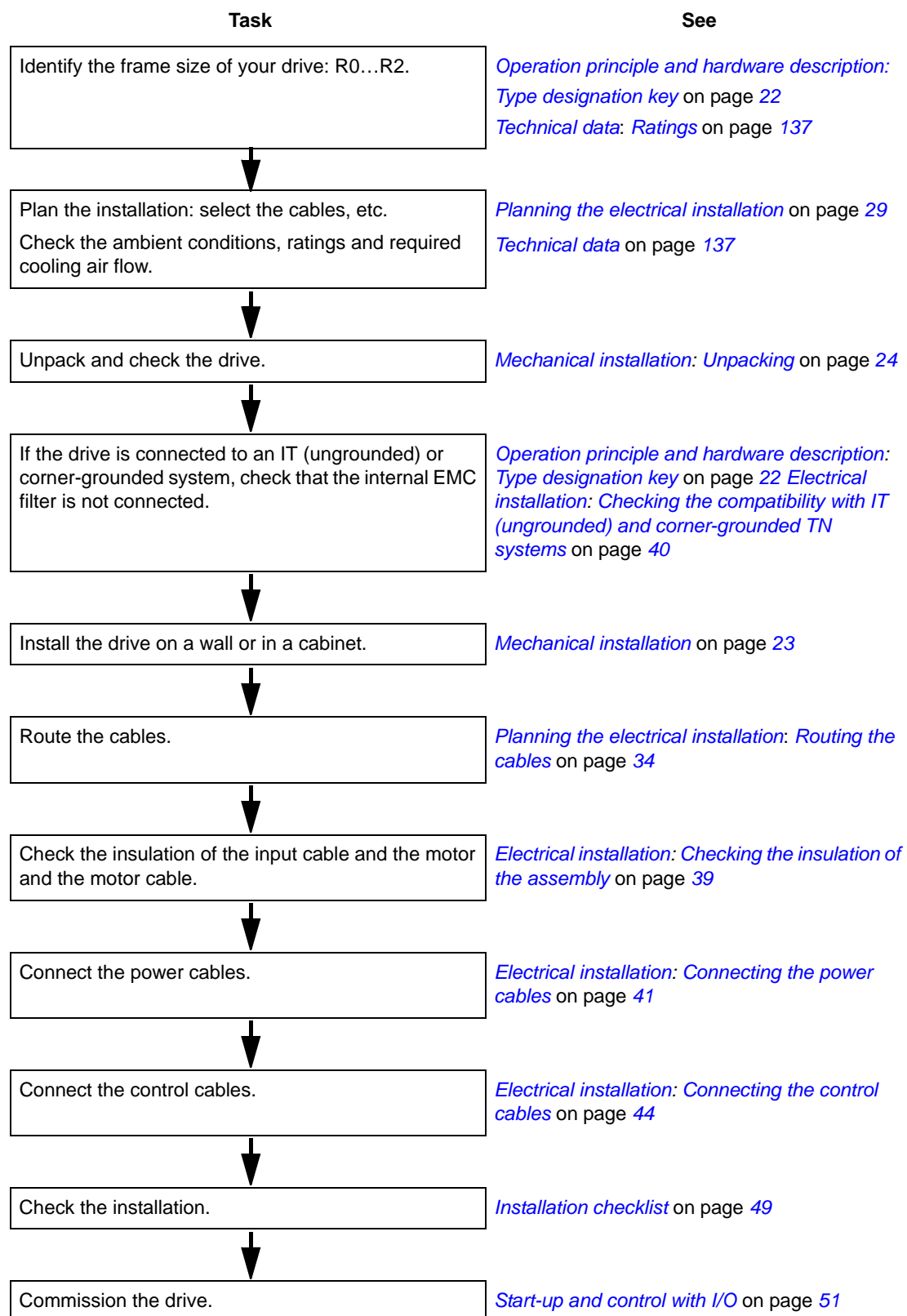
## Related documents

See [List of related manuals](#) on page 2 (inside of the front cover).

## Categorization according to the frame size

The ACS150 is manufactured in frame sizes R0...R2. Some instructions and other information which only concern certain frame sizes are marked with the symbol of the frame size (R0...R2). To identify the frame size of your drive, see the table in section [Ratings](#) on page 137.

## Quick installation and commissioning flowchart





# Operation principle and hardware description

---

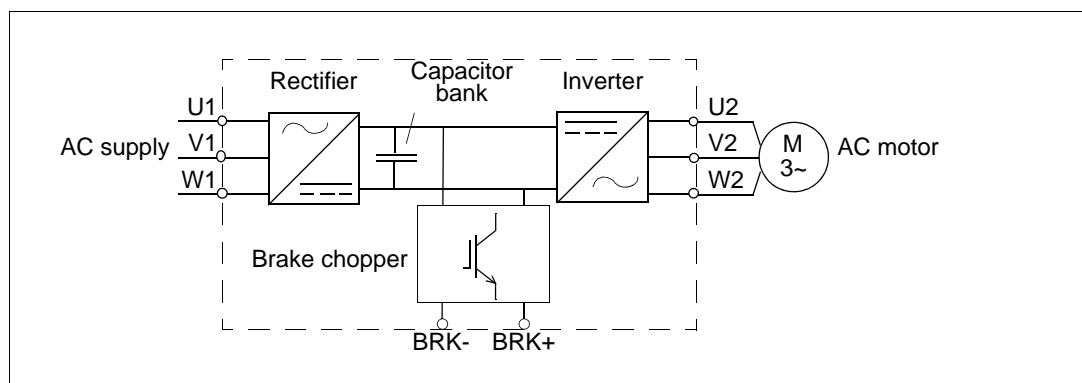
## What this chapter contains

The chapter briefly describes the operation principle, layout, type designation label and type designation information. It also shows a general diagram of power connections and control interfaces.

## Operation principle

The ACS150 is a wall or cabinet mountable drive for controlling AC induction motors.

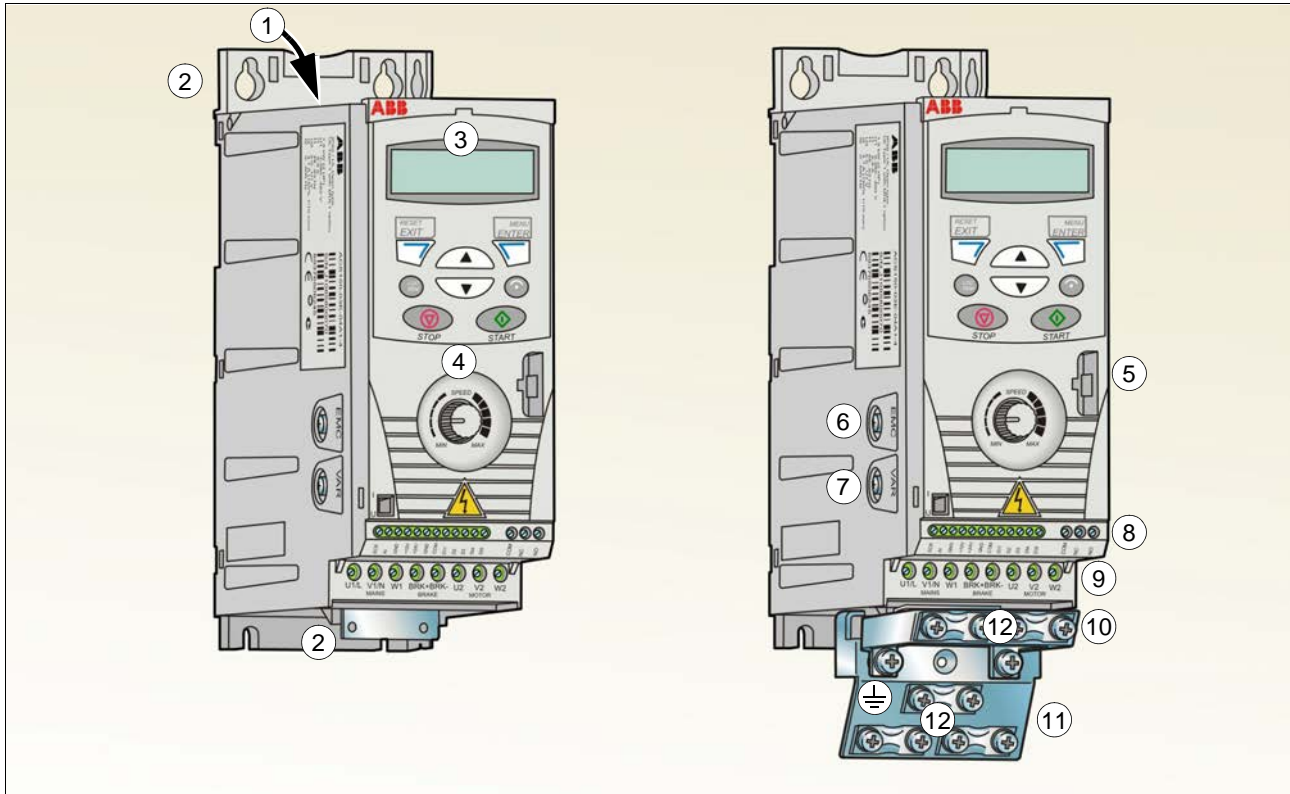
The figure below shows the simplified main circuit diagram of the drive. The rectifier converts three-phase AC voltage to DC voltage. The capacitor bank of the intermediate circuit stabilizes the DC voltage. The inverter converts the DC voltage back to AC voltage for the AC motor. The brake chopper connects the external brake resistor to the intermediate DC circuit when the voltage in the circuit exceeds its maximum limit.



## Product overview

### Layout

The layout of the drive is presented below. The construction of frame sizes R0...R2 varies to some extent.



*Without plates (R0 and R1)*

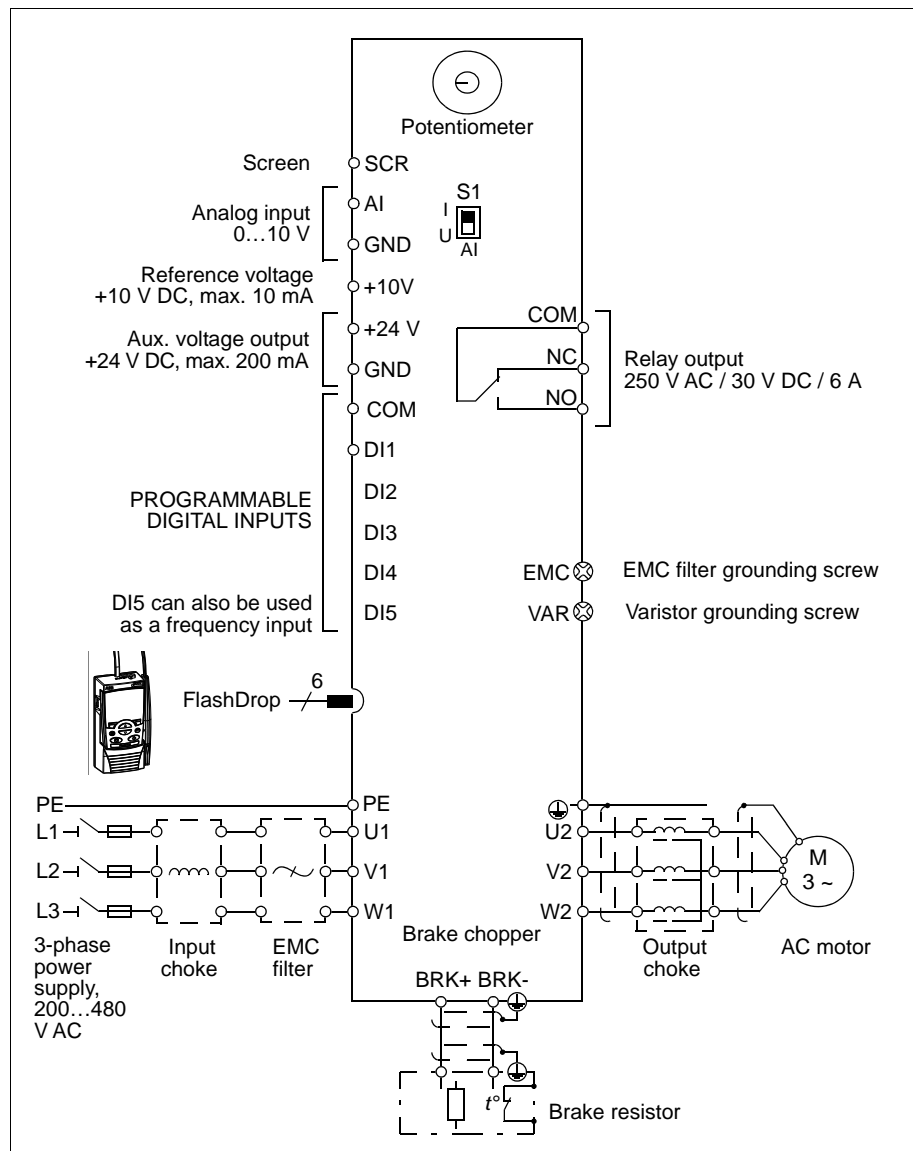
|   |                                  |
|---|----------------------------------|
| 1 | Cooling outlet through top cover |
| 2 | Mounting holes                   |
| 3 | Integrated control panel         |
| 4 | Integrated potentiometer         |

*With plates (R0 and R1)*

|    |   |
|----|---|
| 5  | FlashDrop connection  |
| 6  | EMC filter grounding screw (EMC)  |
| 7  | Varistor grounding screw (VAR)  |
| 8  | I/O connections   |
| 9  | Input power connection (U1, V1, W1), brake resistor connection (BRK+, BRK-) and motor connection (U2, V2, W2) |
| 10 | I/O clamping plate  |
| 11 | Clamping plate  |
| 12 | Clamps  |

## Power connections and control interfaces

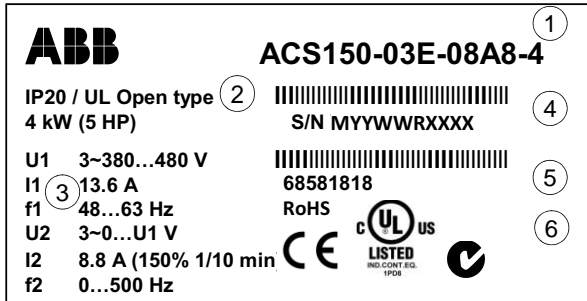
The diagram gives an overview of connections. The I/O connections are parameterable. See chapter [Application macros](#) on page 69 for the I/O connections for the different macros and chapter [Electrical installation](#) on page 39 for installation in general.



**Note:** For 1-phase power supply, connect power to U1/L and V1/N terminals. For connecting the power cables, see [Connecting the power cables](#) on page 41.

## Type designation label

The type designation label is attached to the left side of the drive. An example label and explanation of the label contents are shown below.

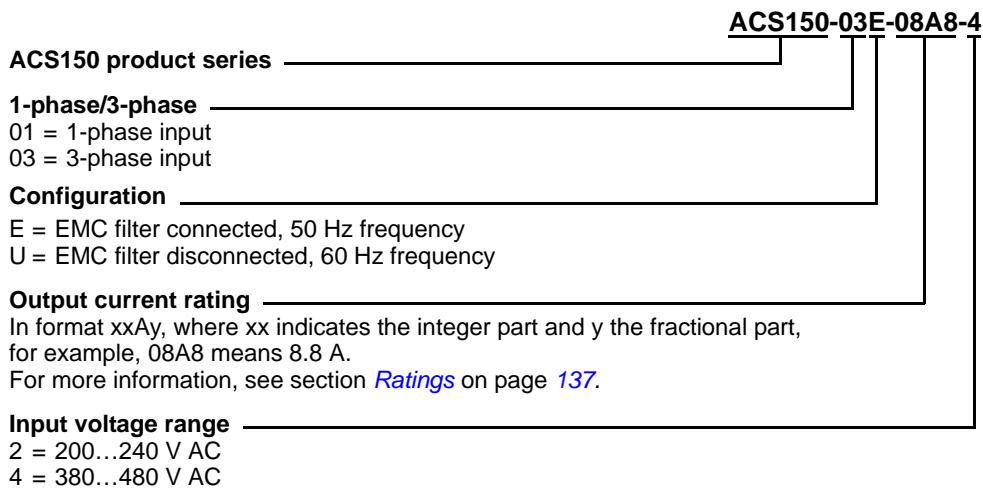


Type designation label

|   |  |
|---|--|
| 1 | Type designation, see section <a href="#">Type designation key</a> on page 22  |
| 2 | Degree of protection by enclosure (IP and UL/NEMA)   |
| 3 | Nominal ratings, see section <a href="#">Ratings</a> on page 137.  |
| 4 | Serial number of format MYYWWRXXXX, where<br>M: Manufacturer<br>YY: 09, 10, 11, ... for 2009, 2010, 2011, ...<br>WW: 01, 02, 03, ... for week 1, week 2, week 3, ...<br>R: A, B, C, ... for product revision number<br>XXXX: Integer starting every week from 0001 |
| 5 | ABB MRP code of the drive  |
| 6 | CE marking and C-Tick, C-UL US and RoHS marks (the label of your drive shows the valid markings)   |

## Type designation key

The type designation contains information on the specifications and configuration of the drive. You find the type designation label attached to the drive. The first digits from the left express the basic configuration, for example ACS150-03E-08A8-4. The explanations of the type designation label selections are described below.



# Mechanical installation

---

## What this chapter contains

The chapter describes tells how to check the installation site, unpack, check the delivery and install the drive mechanically.

## Checking the installation site

The ACS150 may be installed on the wall or in a cabinet. Check the enclosure requirements for the need to use the NEMA 1 option in wall installations (see chapter [Technical data](#) on page 137).

The drive can be mounted in four different ways:

- a) vertical back mounting (all frame sizes)
- b) horizontal back mounting (frame sizes R1...R2)
- c) vertical side mounting (all frame sizes)
- d) vertical DIN rail mounting (all frame sizes).

Check the installation site according to the requirements below. Refer to chapter [Dimension drawings](#) on page 155 for frame details.

### Requirements for the installation site

#### *Operation conditions*

See chapter [Technical data](#) on page 137 for the allowed operation conditions of the drive.

#### *Wall*

The wall should be as close to vertical and even as possible, of non-flammable material and strong enough to carry the weight of the drive.

#### *Floor*

The floor/material below the installation should be non-flammable.

#### *Free space around the drive*

In vertical mounting, the required free space for cooling above and below the drive is 75 mm (3 in). No free space is required on the sides of the drive, so the drives can be mounted immediately next to each other.

When you install the drive horizontally, you need to have free space both above and below AND on the sides of the drive. For more information, see the figure in section [Horizontally](#) on page 27.

## Required tools

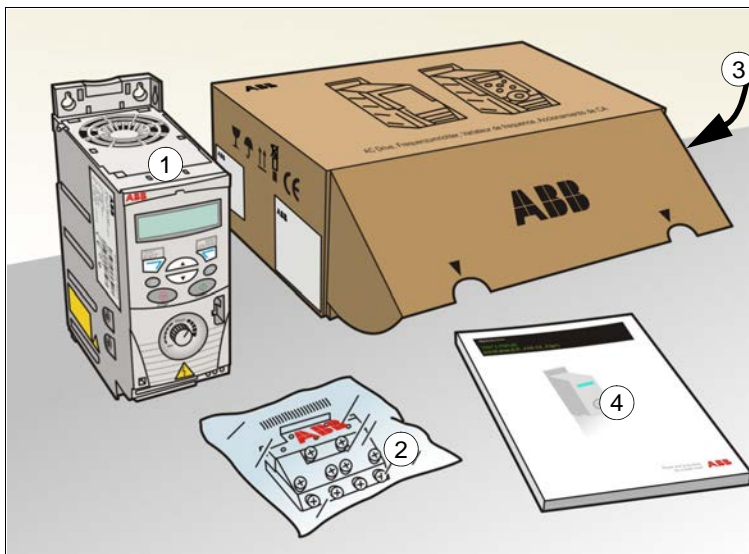
To install the drive, you need the following tools:

- screwdrivers (as appropriate for the mounting hardware used)
- wire stripper
- tape measure
- drill (if the drive is installed with screws/bolts)
- mounting hardware: screws or bolts (if the drive is installed with screws/bolts). For the number of screws/bolts, see section [With screws](#) on page 25.

## Unpacking

The drive (1) is delivered in a package that also contains the following items (frame size R0 shown in the figure):

- plastic bag (2) including clamping plate, I/O clamping plate, clamps and screws
- mounting template, integrated into the package (3)
- user's manual (4).



## Checking the delivery

Check that there are no signs of damage. Notify the shipper immediately if damaged components are found.

Before attempting installation and operation, check the information on the type designation label of the drive to verify that the drive is of the correct type. See section [Type designation label](#) on page 22.

## Installing

The instructions in this manual cover drives with the IP20 degree of protection. To comply with NEMA 1, use the MUL1-R1 option kit, which is delivered with multilingual installation instructions (3AFE68642868).

### Install the drive

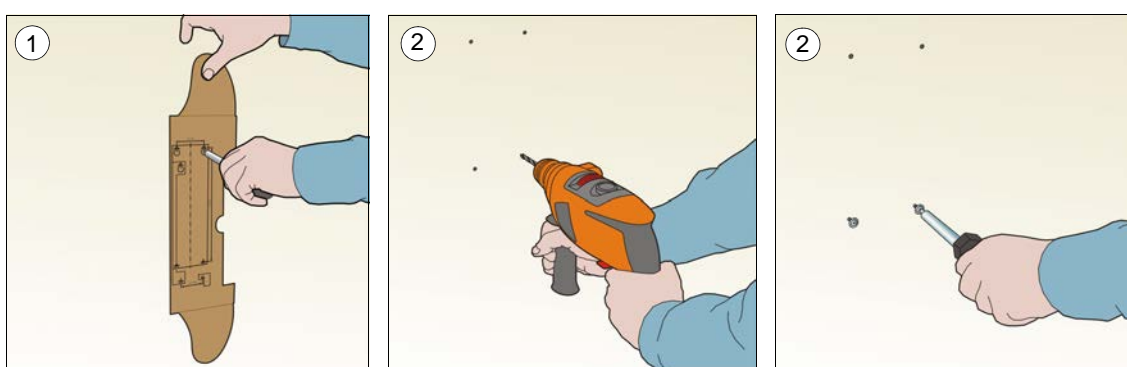
Install the drive with screws or on a DIN rail as appropriate.

**Note:** Make sure that dust from drilling does not enter the drive during the installation.

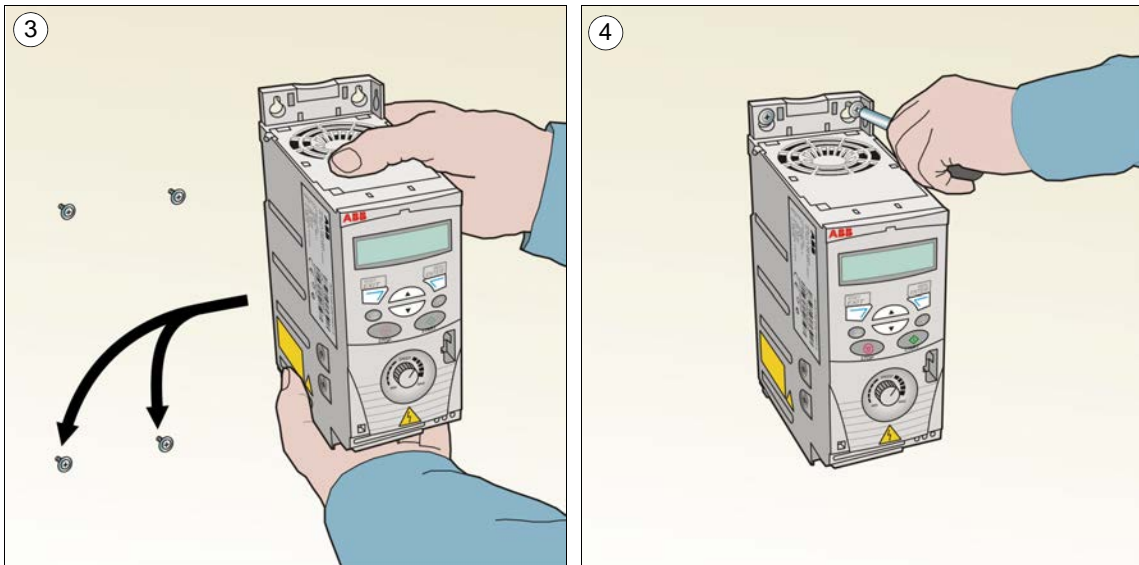
#### *With screws*

For installing the drive horizontally, see section [Horizontally](#) on page 27.

1. Mark the hole locations using for example, the mounting template cut out from the package. The locations of the holes are also shown in the drawings in chapter [Dimension drawings](#) on page 155. The number and location of the holes used depend on how the drive is installed:
  - a) back mounting: four holes
  - b) side mounting: three holes; one of the bottom holes is located in the clamping plate.
2. Fix the screws or bolts to the marked locations.

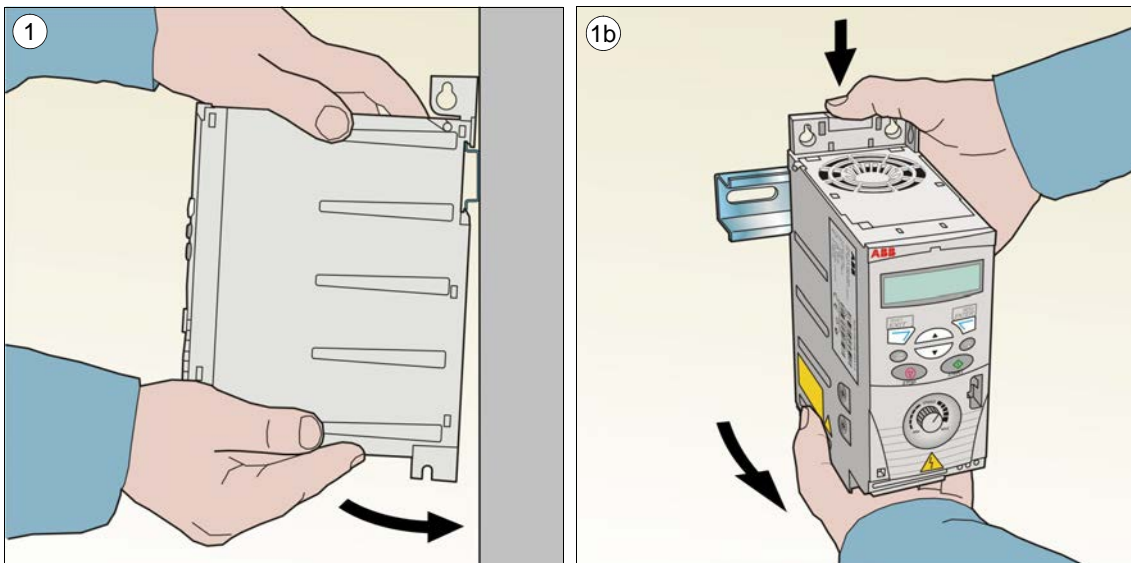


3. Position the drive onto the screws on the wall.
4. Tighten the screws in the wall securely.



*On DIN rail*

1. Click the drive to the rail. To detach the drive, press the release lever on top of the drive as shown in Figure 1b.



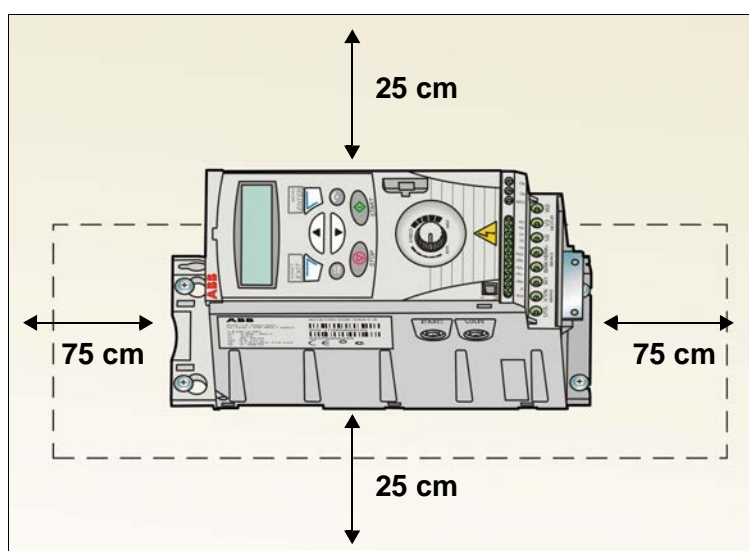
### Horizontally

You can install the drive horizontally with screws (**only** back mounting, four holes). For the installation instructions, see section [With screws](#) on page 25.

**Note:** For the required free space, see the following figure.



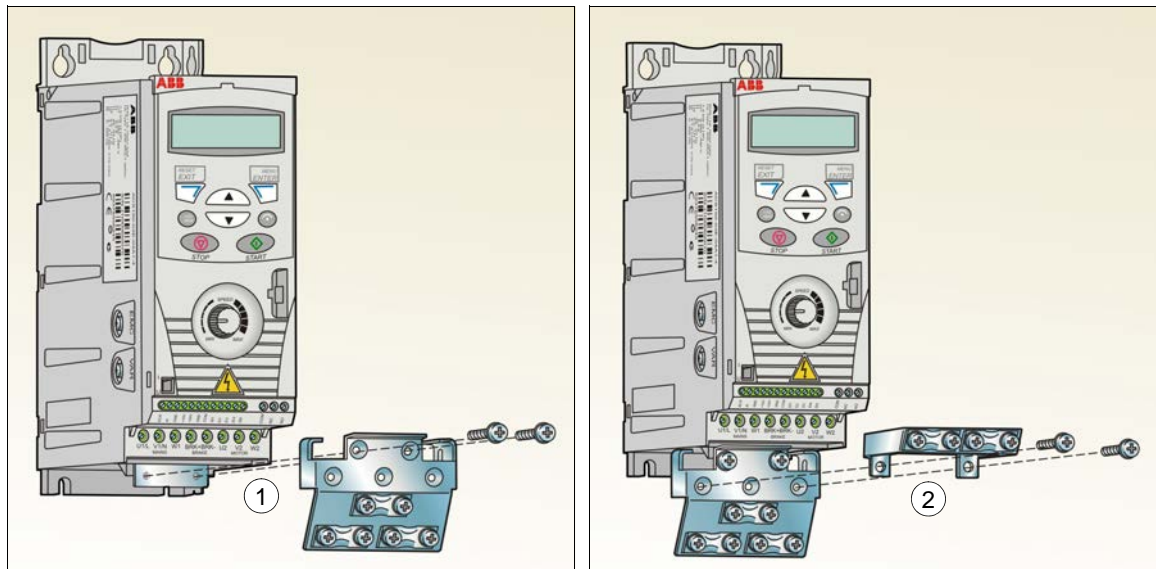
**WARNING!** Horizontal mounting is permitted only for frame sizes R1 and R2 because they include a cooling fan. Position the drive so that the connectors at the bottom of the drive are situated to the right and the fan to the left as shown in the following figure. Do not install frame size R0 horizontally!



### Fasten clamping plates

**Note:** Make sure that you do not throw the clamping plates away as they are required for proper grounding of the power and control cables.

1. Fasten the clamping plate to the plate at the bottom of the drive with the provided screws.
2. Fasten the I/O clamping plate to the clamping plate with the provided screws.



# Planning the electrical installation

---

## What this chapter contains

The chapter contains the instructions that you must follow when checking the compatibility of the motor and drive, and selecting cables, protections, cable routing and way of operation for the drive.

**Note:** The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

## Implementing the AC power line connection

See the requirements in section [Electric power network specification](#) on page 144. Use a fixed connection to the AC power line.



**WARNING!** As the leakage current of the device typically exceeds 3.5 mA, a fixed installation is required according to IEC 61800-5-1.

---

## Selecting the supply disconnecting device (disconnecting means)

Install a hand-operated supply disconnecting device (disconnecting means) between the AC power source and the drive. The disconnecting device must be of a type that can be locked to the open position for installation and maintenance work.

### European union

To meet the European Union Directives, according to standard EN 60204-1, Safety of Machinery, the disconnecting device must be one of the following types:

- a switch-disconnector of utilization category AC-23B (EN 60947-3)
- a disconnector having an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
- a circuit breaker suitable for isolation in accordance with EN 60947-2.

### Other regions

The disconnecting device must conform to the applicable safety regulations.

## Checking the compatibility of the motor and drive

Check that the 3-phase AC induction motor and the drive are compatible according to the rating table in section [Ratings](#) on page [137](#). The table lists the typical motor power for each drive type.

## Selecting the power cables

### General rules

Dimension the input power and motor cables **according to local regulations**.

- The input power and the motor cables must be able to carry the corresponding load currents. See section [Ratings](#) on page [137](#) for the rated currents.
- The cable must be rated for at least 70 °C maximum permissible temperature of the conductor in continuous use. For US, see section [Additional US requirements](#) on page [32](#).
- The conductivity of the PE conductor must be equal to that of the phase conductor (same cross-sectional area).
- 600 V AC cable is accepted for up to 500 V AC.
- Refer to chapter [Technical data](#) on page [137](#) for the EMC requirements.

A symmetrical shielded motor cable (see the following figure) must be used to meet the EMC requirements of the CE and C-Tick marks.

A four-conductor system is allowed for input cabling, but a shielded symmetrical cable is recommended.

Compared to a four-conductor system, the use of a symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as motor bearing currents and wear.

## Alternative power cable types

Power cable types that can be used with the drive are presented below.

**Allowed as motor cables**  
(recommended for input cables also)

Symmetrical shielded cable: three phase conductors, a concentric or otherwise symmetrically constructed PE conductor and a shield

**Note:** A separate PE conductor is required if the conductivity of the cable shield is not sufficient for the purpose.

**Allowed as input cables**

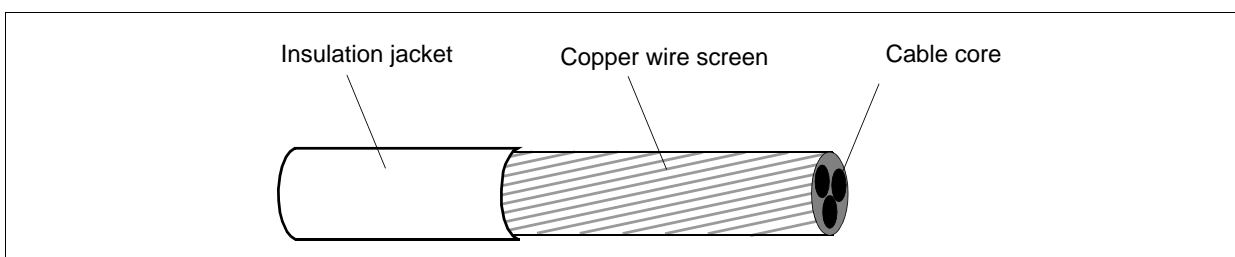
A four-conductor system: three phase conductors and a protective conductor

**Not allowed for motor cabling:** Separate cables for each phase and PE

## Motor cable shield

To function as a protective conductor, the shield must have the same cross-sectional area as the phase conductors when they are made of the same metal.

To effectively suppress radiated and conducted radio-frequency emissions, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminium shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires. The better and tighter the shield, the lower the emission level and bearing currents.



**Additional US requirements**

Type MC continuous corrugated aluminium armor cable with symmetrical grounds or shielded power cable is recommended for the motor cables if metallic conduit is not used.

The power cables must be rated for 75 °C (167 °F).

*Conduit*

Where conduits must be coupled together, bridge the joint with a ground conductor bonded to the conduit on each side of the joint. Bond the conduits also to the drive enclosure. Use separate conduits for input power, motor, brake resistors and control wiring. Do not run motor wiring from more than one drive in the same conduit.

*Armored cable / shielded power cable*

Six-conductor (three phases and three ground) type MC continuous corrugated aluminium armor cable with symmetrical grounds is available from the following suppliers (trade names in parentheses):

- Anixter Wire & Cable (Philsheath)
- BICC General Corp (Philsheath)
- Rockbestos Co. (Gardex)
- Oaknite (CLX).

Shielded power cables are available from the following suppliers:

- Belden
- LAPPKABEL (ÖLFLEX)
- Pirelli.

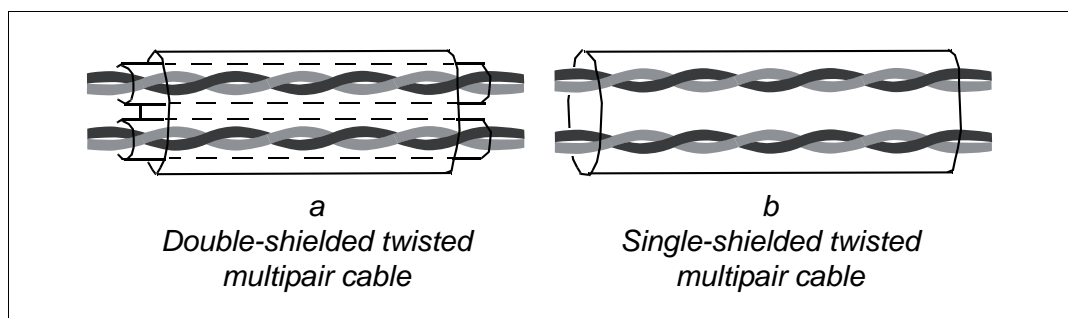
## Selecting the control cables

### General rules

The analog control cable (if analog input AI is used) and the cable used for the frequency input must be shielded.

Use a double-shielded twisted pair cable (Figure a, for example, JAMAK by Draka NK Cables) for the analog signal.

A double-shielded cable is the best alternative for low-voltage digital signals, but a single-shielded or unshielded twisted multipair cable (Figure b) is also usable. However, for frequency input, always use a shielded cable.



Run the analog signal and digital signals in separate cables.

Relay-controlled signals, providing their voltage does not exceed 48 V, can be run in the same cables as digital input signals. It is recommended that the relay-controlled signals are run as twisted pairs.

Never mix 24 V DC and 115/230 V AC signals in the same cable.

### Relay cable

The cable type with braided metallic screen (for example, ÖLFLEX by LAPPKABEL) has been tested and approved by ABB.

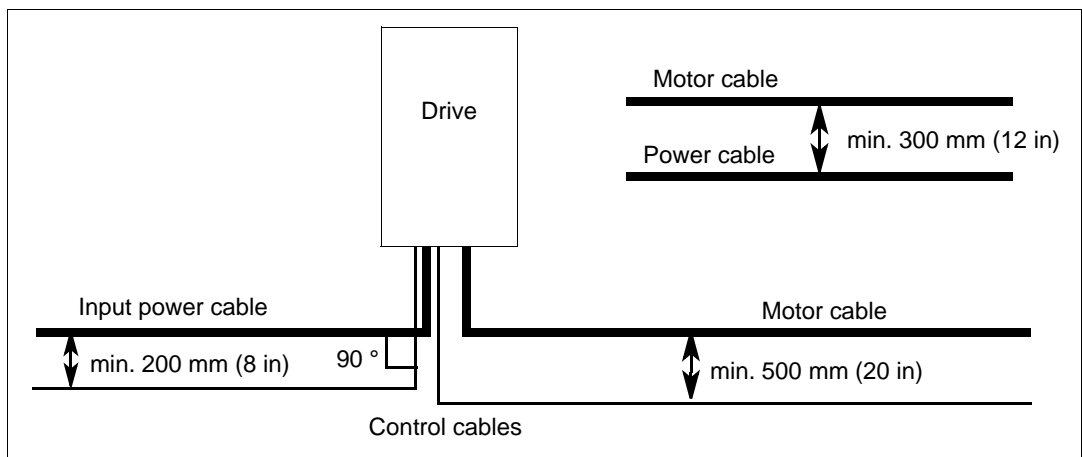
## Routing the cables

Route the motor cable away from other cable routes. Motor cables of several drives can be run in parallel installed next to each other. It is recommended that the motor cable, input power cable and control cables are installed on separate trays. Avoid long parallel runs of motor cables with other cables to decrease electromagnetic interference caused by the rapid changes in the drive output voltage.

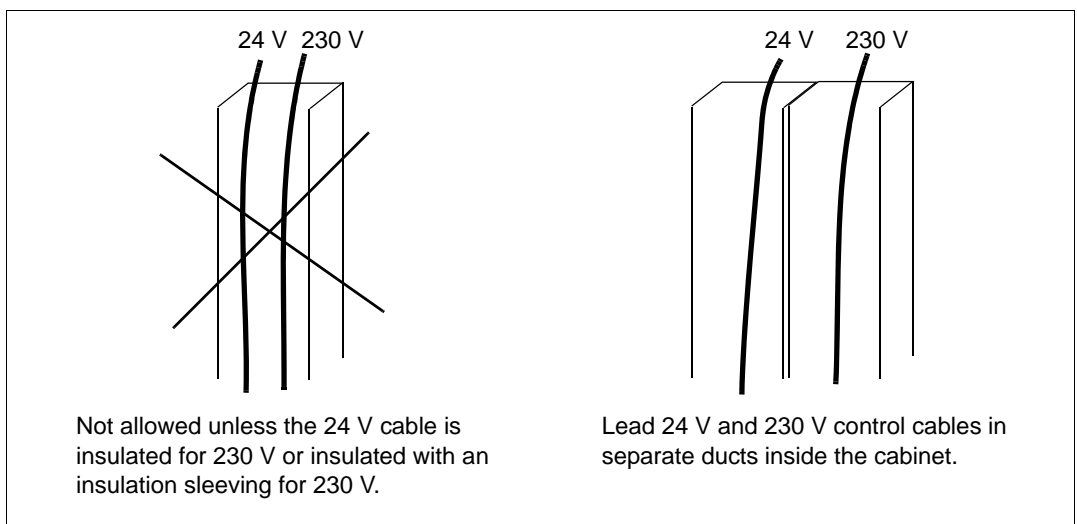
Where control cables must cross power cables make sure that they are arranged at an angle as near to 90 degrees as possible.

The cable trays must have good electrical bonding to each other and to the grounding electrodes. Aluminium tray systems can be used to improve local equalizing of potential.

A diagram of the cable routing is shown below.



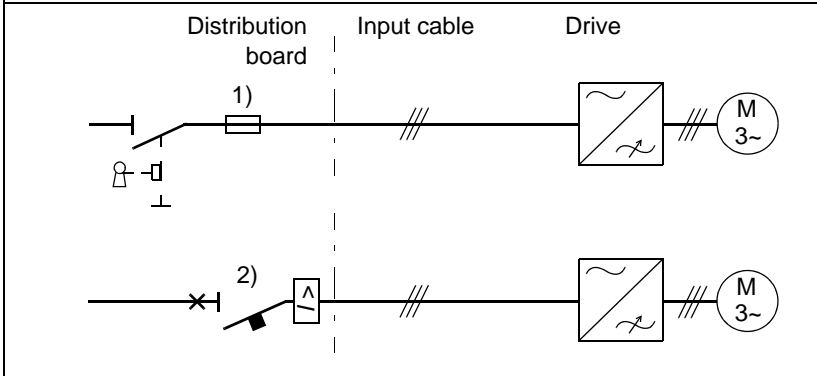
## Control cable ducts



## Protecting the drive, input power cable, motor and motor cable in short-circuit situations and against thermal overload

### Protecting the drive and input power cable in short-circuit situations

Arrange the protection according to the following guidelines.

| Circuit diagram  | Short-circuit protection   |
|--|--|
|  <p>The diagram is divided into three sections: 'Distribution board', 'Input cable', and 'Drive'.<br/>     Scenario 1 (top): A switch in the distribution board is followed by a fuse labeled '1)'. The circuit then passes through the 'Input cable' section and into the 'Drive' section, which is connected to a 3-phase motor (M 3~).<br/>     Scenario 2 (bottom): The circuit enters the 'Distribution board' section through a circuit breaker labeled '2)'. It then passes through the 'Input cable' section and into the 'Drive' section, which is connected to a 3-phase motor (M 3~).</p> | <p>Protect the drive and input cable with fuses or a circuit breaker. See footnotes 1) and 2).</p> |

- 1) Size the fuses according to instructions given in chapter [Technical data](#) on page 137. The fuses protect the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short circuit inside the drive.
- 2) Circuit breakers which have been tested by ABB with the ACS150 can be used. Fuses must be used with other circuit breakers. Contact your local ABB representative for the approved breaker types and supply network characteristics.

The protective characteristics of circuit breakers depend on the type, construction and settings of the breakers. There are also limitations pertaining to the short-circuit capacity of the supply network.



**WARNING!** Due to the inherent operating principle and construction of circuit breakers, independent of the manufacturer, hot ionized gases may escape from the breaker enclosure in case of a short circuit. To ensure safe use, special attention must be paid to the installation and placement of the breakers. Follow the manufacturer's instructions.

### Protecting the motor and motor cable in short-circuit situations

The drive protects the motor and motor cable in a short-circuit situation when the motor cable is dimensioned according to the nominal current of the drive. No additional protection devices are needed.

### Protecting the drive, motor cable and input power cable against thermal overload

The drive protects itself and the input and motor cables against thermal overload when the cables are dimensioned according to the nominal current of the drive. No additional thermal protection devices are needed.



**WARNING!** If the drive is connected to multiple motors, a separate thermal overload switch or a circuit breaker must be used for protecting each cable and motor. These devices may require a separate fuse to cut off the short-circuit current.

---

### Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. See parameter [3005](#) MOT THERM PROT for more information on the motor thermal protection.

## Residual current device (RCD) compatibility

ACS150-01x drives are suitable to be used with residual current devices of Type A, ACS150-03x drives with residual current devices of Type B. For ACS150-03x drives, other measures for protection in case of direct or indirect contact, such as separation from the environment by double or reinforced insulation or isolation from the supply system by a transformer, can also be applied.

## Implementing a bypass connection



**WARNING!** Never connect the supply power to the drive output terminals U2, V2 and W2. Power line voltage applied to the output can result in permanent damage to the drive.

---

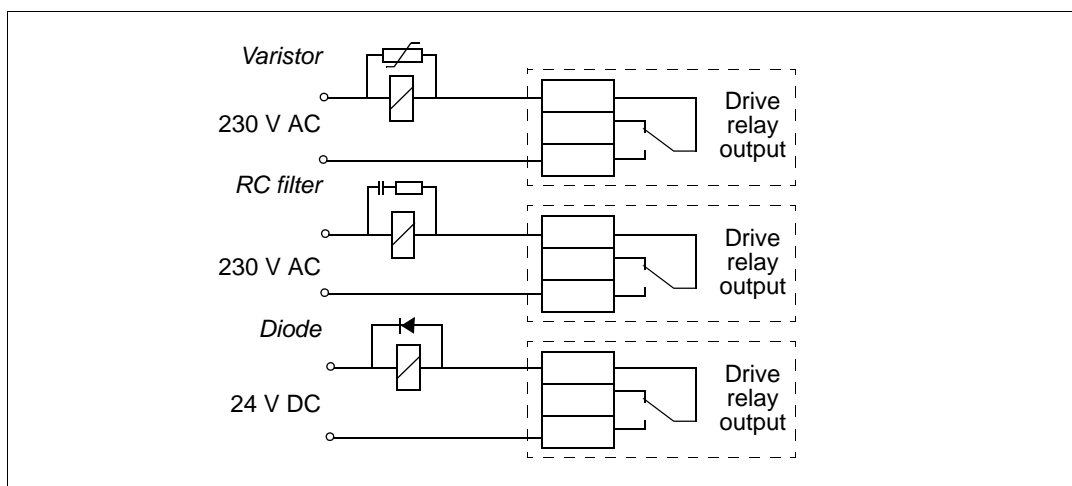
If frequent bypassing is required, employ mechanically connected switches or contactors to ensure that the motor terminals are not connected to the AC power line and drive output terminals simultaneously.

## Protecting the contacts of relay outputs

Inductive loads (relays, contactors, motors) cause voltage transients when switched off.

Equip inductive loads with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to minimize the EMC emission at switch-off. If not suppressed, the disturbances may connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

Install the protective component as close to the inductive load as possible. Do not install protective components at the I/O terminal block.





# Electrical installation

---

## What this chapter contains

The chapter tells how to check the insulation of the assembly and the compatibility with IT (ungrounded) and corner-grounded TN systems as well as connect power cables and control cables.



**WARNING!** The work described in this chapter may only be carried out by a qualified electrician. Follow the instructions in chapter [Safety](#) on page 11. Ignoring the safety instructions can cause injury or death.

**Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.**

---

## Checking the insulation of the assembly

### Drive

Do not make any voltage tolerance or insulation resistance tests (for example, hi-pot or megger) on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. Also, there are voltage-limiting circuits inside the drive which cut down the testing voltage automatically.

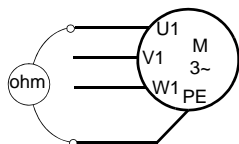
### Input power cable

Check the insulation of the input power cable according to local regulations before connecting to the drive.

### Motor and motor cable

Check the insulation of the motor and motor cable as follows:

1. Check that the motor cable is connected to the motor and disconnected from the drive output terminals U2, V2 and W2.
2. Measure the insulation resistance between each phase conductor and the Protective Earth conductor using a measuring voltage of 500 V DC. The insulation resistance of an ABB motor must exceed 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions. **Note:** Moisture inside the motor casing reduces the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.



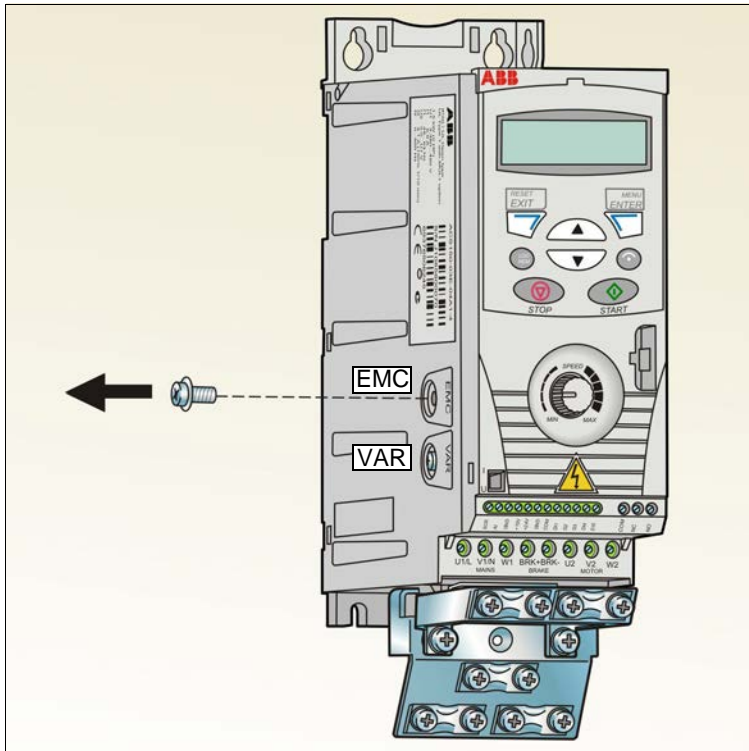
## Checking the compatibility with IT (ungrounded) and corner-grounded TN systems



**WARNING!** Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors. This may cause danger or damage the drive.

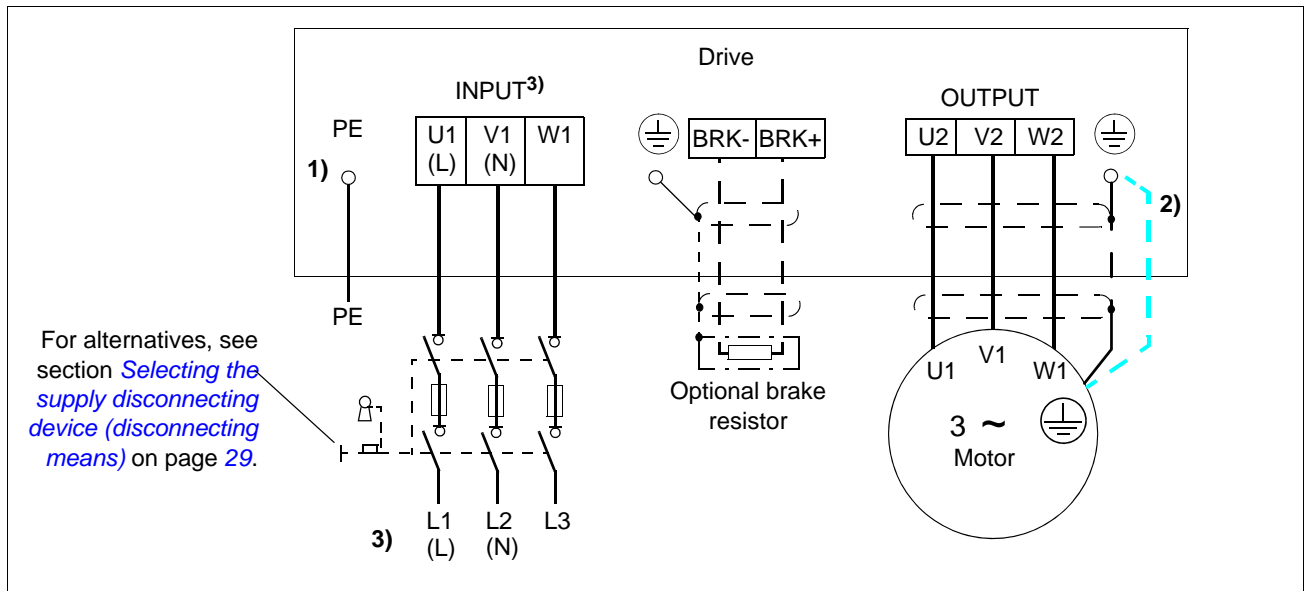
Disconnect the internal EMC filter when installing the drive on a corner-grounded TN system, otherwise the drive will be damaged.

1. If you have an IT (ungrounded) system or corner-grounded TN system, disconnect the internal EMC filter by removing the EMC screw. For 3-phase U-type drives (with type designation ACS150-03U-), the EMC screw is already removed at the factory and replaced by a plastic screw.



## Connecting the power cables

### Connection diagram



- 1) Ground the other end of the PE conductor at the distribution board.
- 2) Use a separate grounding cable if the conductivity of the cable shield is insufficient (smaller than the conductivity of the phase conductor) and there is no symmetrically constructed grounding conductor in the cable (see section [Selecting the power cables](#) on page 30).
- 3) L and N are connection markings for 1-phase supply.

#### Note:

Do not use an asymmetrically constructed motor cable.

If there is a symmetrically constructed grounding conductor in the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the drive and motor ends.

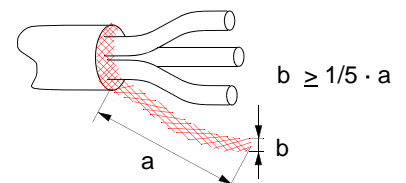
For the 1-phase power supply, connect power to U1 (L) and V1 (N) terminals.

Route the motor cable, input power cable and control cables separately. For more information, see section [Routing the cables](#) on page 34.

#### Grounding of the motor cable shield at the motor end

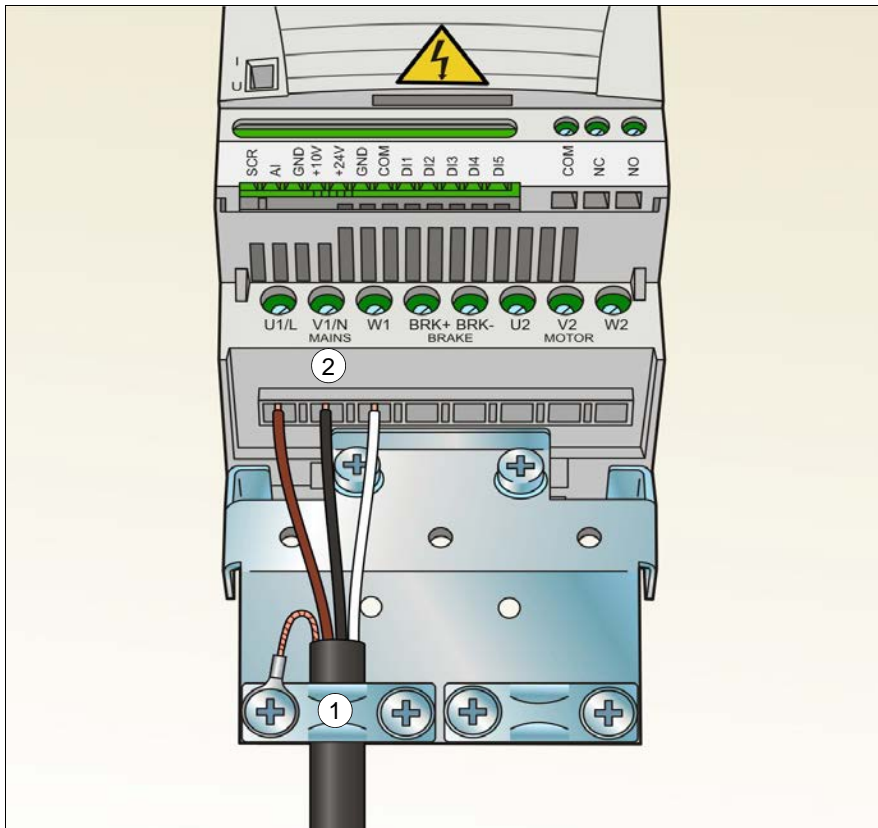
For minimum radio frequency interference:

- ground the cable by twisting the shield as follows: flattened width  $\geq 1/5 \cdot \text{length}$
- or ground the cable shield 360 degrees at the lead-through of the motor terminal box.

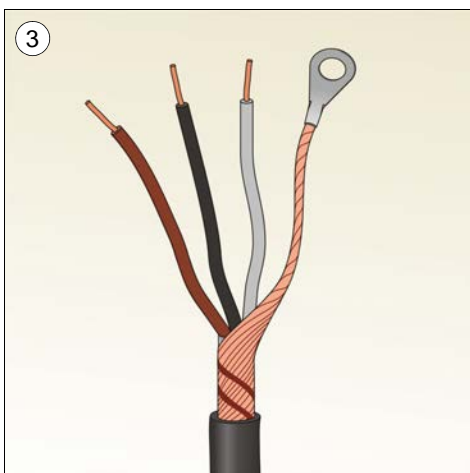


### Connection procedure

1. Fasten the input power cable under the grounding clamp. Crimp a cable lug onto the grounding conductor (PE) of the cable and fasten the lug under a grounding clamp screw.
2. Connect the phase conductors to the U1, V1 and W1 terminals. Use a tightening torque of 0.8 N·m (7 lbf·in).

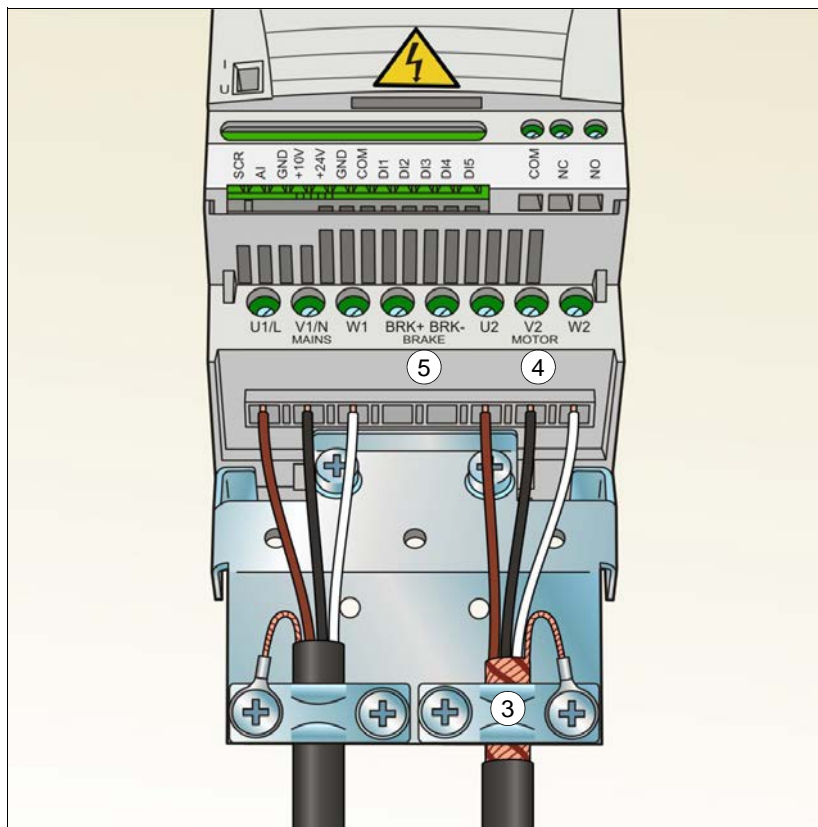


3. Strip the motor cable and twist the shield to form as short a pigtail as possible. Fasten the stripped motor cable under the grounding clamp. Crimp a cable lug onto the pigtail and fasten the lug under a grounding clamp screw.



Tightening torque:  
0.8 N·m (7 lbf·in)

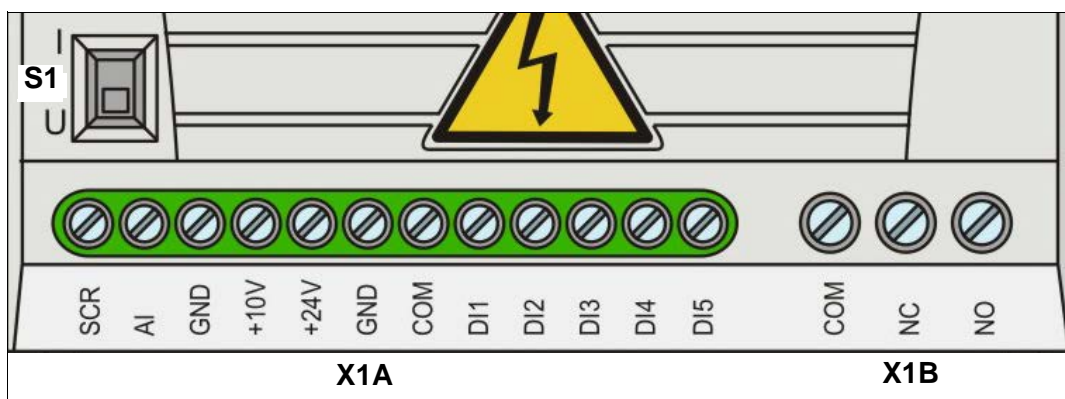
4. Connect the phase conductors to the U2, V2 and W2 terminals. Use a tightening torque of 0.8 N·m (7 lbf·in).
5. Connect the optional brake resistor to the BRK+ and BRK- terminals with a shielded cable using the same procedure as for the motor cable in the previous step.
6. Secure the cables outside the drive mechanically.



## Connecting the control cables

### I/O terminals

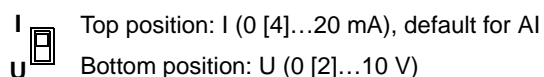
The figure below shows the I/O terminals.



|                                |              |
|--------------------------------|--------------|
| X1A: SCR                       | X1B: (RO)COM |
| AI(1)                          | (RO)NC       |
| GND                            | (RO)NO       |
| +10 V                          |              |
| +24 V                          |              |
| GND                            |              |
| COM                            |              |
| DI1                            |              |
| DI2                            |              |
| DI3                            |              |
| DI4                            |              |
| DI5 digital or frequency input |              |

The default connection of the control signals depends on the application macro in use, which is selected with parameter [9902 APPLIC MACRO](#). See chapter [Application macros](#) on page [69](#) for the connection diagrams.

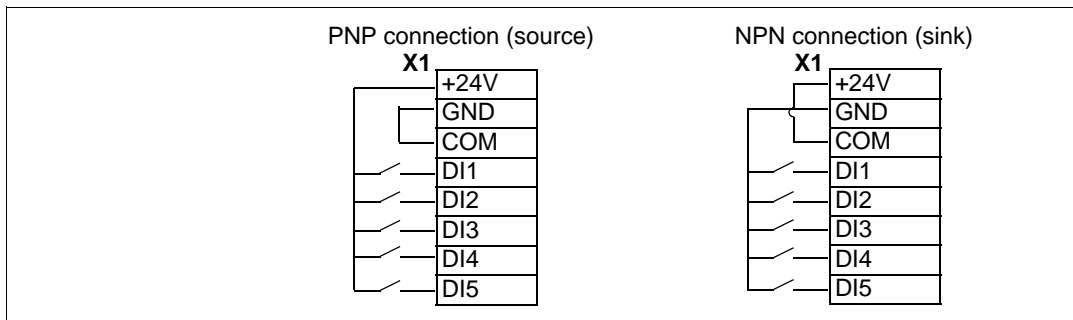
Switch S1 selects voltage (0 [2]...10 V) or current (0 [4]...20 mA) as the signal type for analog input AI. By default, switch S1 is in the current position.



If DI5 is used as a frequency input, set group [18 FREQ INPUT](#) parameters accordingly.

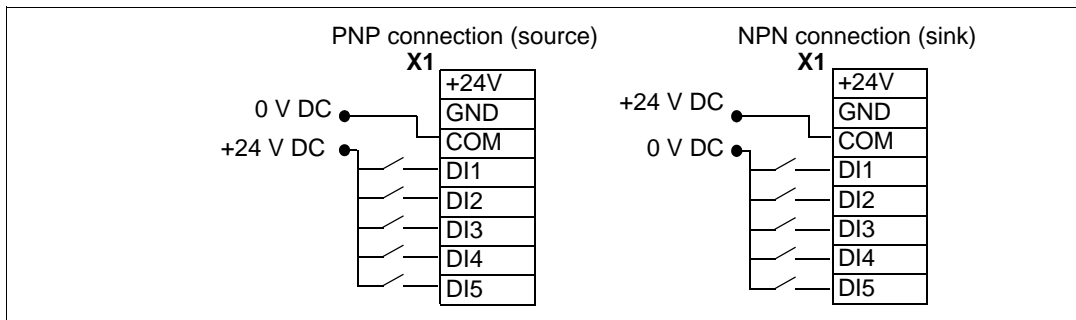
*PNP and NPN configuration for digital inputs*

You can wire the digital input terminals in either a PNP or NPN configuration.



*External power supply for digital inputs*

For using an external +24 V supply for the digital inputs, see the figure below.

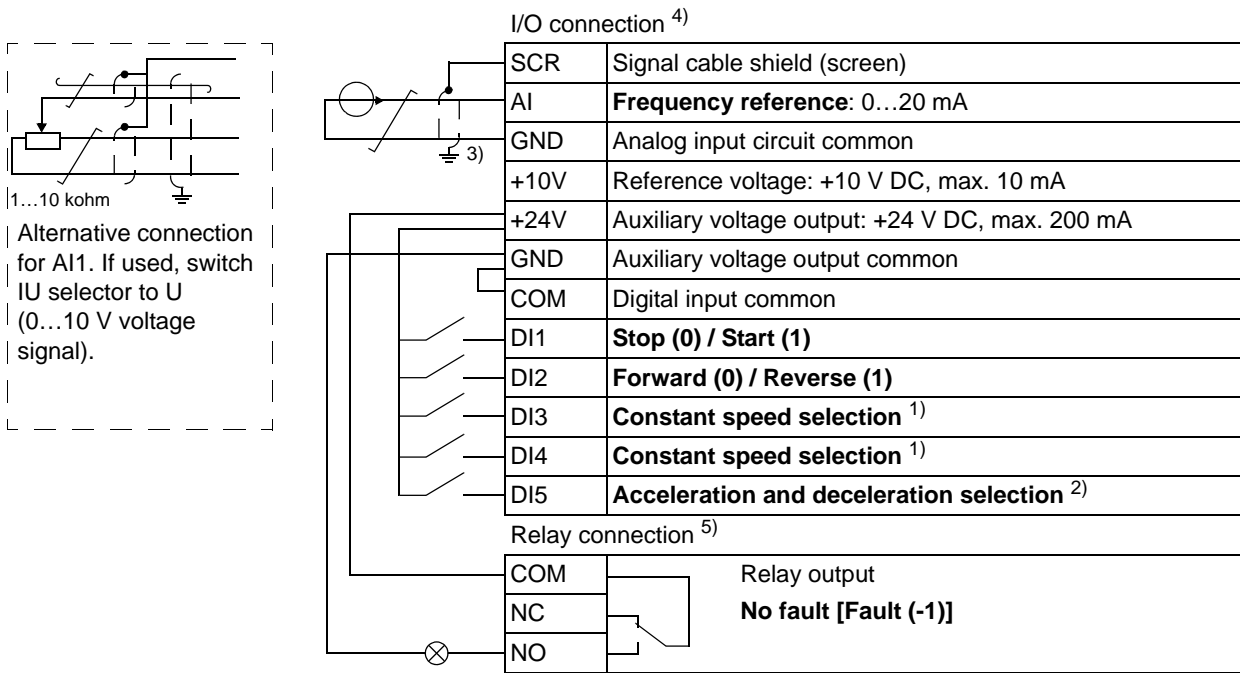


### Default I/O connection diagram

The default connection of the control signals depends on the application macro in use, which is selected with parameter [9902 APPLIC MACRO](#).

The default macro is the ABB standard macro. It provides a general purpose I/O configuration with three constant speeds. Parameter values are the default values given in section [Default parameter values with different macros](#) on page 79. For information on other macros, see chapter [Application macros](#) on page 69.

The default I/O connections for the ABB standard macro are given in the figure below.



1) See parameter group [12 CONSTANT SPEEDS](#):

| DI3 | DI4 | Operation (parameter)                          |
|-----|-----|--|
| 0   | 0   | Set speed through integrated potentiometer     |
| 1   | 0   | Speed 1 ( <a href="#">1202 CONST SPEED 1</a> ) |
| 0   | 1   | Speed 2 ( <a href="#">1203 CONST SPEED 2</a> ) |
| 1   | 1   | Speed 3 ( <a href="#">1204 CONST SPEED 3</a> ) |

2) 0 = ramp times according to parameters [2202 ACCELER TIME 1](#) and [2203 DECELER TIME 1](#).  
1 = ramp times according to parameters [2205 ACCELER TIME 2](#) and [2206 DECELER TIME 2](#).

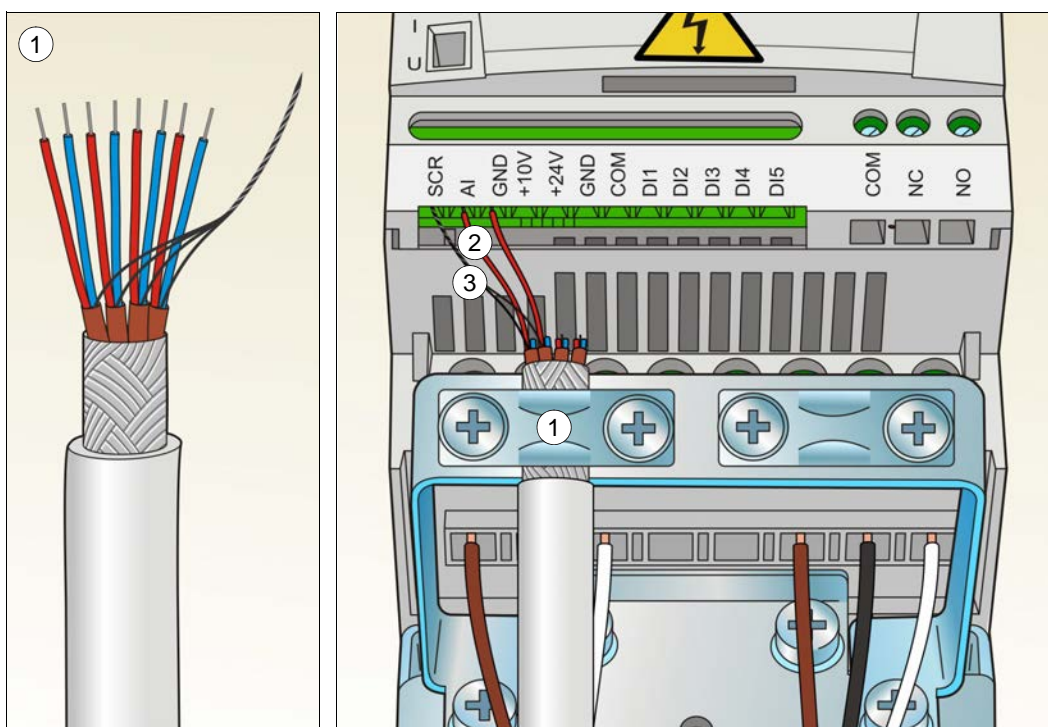
3) 360 degree grounding under a clamp.

4) Tightening torque: 0.22 N·m / 2 lbf·in

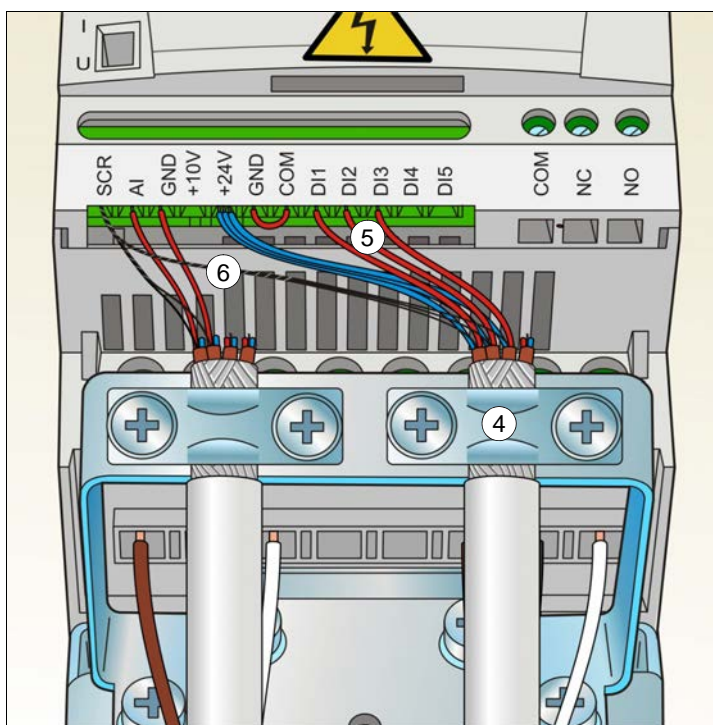
5) Tightening torque: 0.5 N·m / 4.4 lbf·in

### Connection procedure

1. *Analog signal (if connected)*: Strip the outer insulation of the analog signal cable 360 degrees and ground the bare shield under the clamp.
2. Connect the conductors to the appropriate terminals.
3. Twist the grounding conductors of the used pairs in the analog signal cable together and connect the bundle to the SCR terminal.



4. *Digital signals*: Strip the outer insulation of the digital signal cable 360 degrees and ground the bare shield under the clamp.
5. Connect the conductors of the cable to the appropriate terminals.
6. Twist the grounding conductors of the used pairs in the digital signal cable together and connect the bundle to the SCR terminal.
7. Secure all analog and digital signal cables outside the drive mechanically.



Tightening torque for:

- input signals  
0.22 N·m / 2 lbf·in
- relay outputs  
0.5 N·m / 4.4 lbf·in

# Installation checklist

---

## Checking the installation

Check the mechanical and electrical installation of the drive before start-up. Go through the checklist below together with another person. Read chapter [Safety](#) on page [11](#) of this manual before you work on the drive.

| Check  |
|--|
| <p><b>MECHANICAL INSTALLATION</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> The ambient operating conditions are within allowed limits. (See <a href="#">Mechanical installation: Checking the installation site</a> on page <a href="#">23</a> as well as <a href="#">Technical data: Losses, cooling data and noise</a> on page <a href="#">142</a> and <a href="#">Ambient conditions</a> on page <a href="#">147</a>.)</li> <li><input type="checkbox"/> The drive is fixed properly on an even vertical non-flammable wall. (See <a href="#">Mechanical installation</a> on page <a href="#">23</a>.)</li> <li><input type="checkbox"/> The cooling air flows freely. (See <a href="#">Mechanical installation: Free space around the drive</a> on page <a href="#">23</a>.)</li> <li><input type="checkbox"/> The motor and the driven equipment are ready for start. (See <a href="#">Planning the electrical installation: Checking the compatibility of the motor and drive</a> on page <a href="#">30</a> as well as <a href="#">Technical data: Motor connection data</a> on page <a href="#">144</a>.)</li> </ul> <p><b>ELECTRICAL INSTALLATION</b> (See <a href="#">Planning the electrical installation</a> on page <a href="#">29</a> and <a href="#">Electrical installation</a> on page <a href="#">39</a>.)</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> For ungrounded and corner-grounded systems: The internal EMC filter is disconnected (screw EMC removed).</li> <li><input type="checkbox"/> The capacitors are reformed if the drive has been stored over a year.</li> <li><input type="checkbox"/> The drive is grounded properly.</li> <li><input type="checkbox"/> The input power voltage matches the drive nominal input voltage.</li> <li><input type="checkbox"/> The input power connections at U1, V1 and W1 are OK and tightened with the correct torque.</li> <li><input type="checkbox"/> Appropriate input power fuses and disconnecter are installed.</li> <li><input type="checkbox"/> The motor connections at U2, V2 and W2 are OK and tightened with the correct torque.</li> <li><input type="checkbox"/> The motor cable, input power cable and control cables are routed separately.</li> <li><input type="checkbox"/> The external control (I/O) connections are OK.</li> <li><input type="checkbox"/> The input power voltage cannot be applied to the output of the drive (with a bypass connection).</li> <li><input type="checkbox"/> Terminal cover and, for NEMA 1, hood and connection box, are in place.</li> </ul> |



# Start-up and control with I/O

## What this chapter contains

The chapter instructs how to:

- perform the start-up
- start, stop, change the direction of the motor rotation and adjust the speed of the motor through the I/O interface.

Using the control panel to do these tasks is explained briefly in this chapter. For details on how to use the control panel, please refer to chapter [Control panel](#) on page 57.

## How to start up the drive



**WARNING!** The start-up may only be carried out by a qualified electrician.

The safety instructions given in chapter [Safety](#) on page 11 must be followed during the start-up procedure.

The drive starts up automatically at power-up if the external run command is on and the drive is in the remote control mode.

Check that the starting of the motor does not cause any danger. **De-couple the driven machine** if there is a risk of damage in case of incorrect direction of rotation.

Check the installation. See the checklist in chapter [Installation checklist](#) on page 49.

Before you start, ensure that you have the motor nameplate data on hand.

| POWER-UP                 |  |     |      |    |        |     |     |
|--------------------------|--|-----|------|----|--------|-----|-----|
| <input type="checkbox"/> | Apply input power.<br>The panel powers up into the Output mode.  |     |      |    |        |     |     |
|                          | <table border="1"> <tr> <td>LOC</td> <td style="font-size: 2em;">00</td> <td>Hz</td> </tr> <tr> <td>OUTPUT</td> <td></td> <td>FWD</td> </tr> </table>  | LOC | 00   | Hz | OUTPUT |     | FWD |
| LOC                      | 00   | Hz  |      |    |        |     |     |
| OUTPUT                   |  | FWD |      |    |        |     |     |
| ENTRY OF START-UP DATA   |  |     |      |    |        |     |     |
| <input type="checkbox"/> | Select the application macro (parameter <a href="#">9902</a> APPLIC MACRO) according to how the control cables are connected.<br>The default value 1 (ABB STANDARD) is suitable in most cases.<br>The general parameter setting procedure in the Short parameter mode is described below. You can find more detailed instructions on setting parameters on page <a href="#">65</a> . |     |      |    |        |     |     |
|                          | <table border="1"> <tr> <td>LOC</td> <td style="font-size: 2em;">9902</td> <td>s</td> </tr> <tr> <td></td> <td>PAR</td> <td>FWD</td> </tr> </table>  | LOC | 9902 | s  |        | PAR | FWD |
| LOC                      | 9902   | s   |      |    |        |     |     |
|                          | PAR  | FWD |      |    |        |     |     |

The general parameter setting procedure in the Short parameter mode:

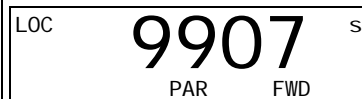
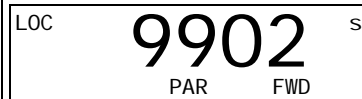
1. To go to the Main menu, press if the bottom line shows OUTPUT; otherwise press repeatedly until you see MENU at the bottom.
2. Press keys / until you see "PAR S" on the display.
3. Press . The display shows a parameter of the Short parameter mode.
4. Find the appropriate parameter with keys /.
5. Press and hold for about two seconds until the parameter value is shown with **SET** under the value.
6. Change the value with keys /. The value changes faster while you keep the key pressed down.
7. Save the parameter value by pressing .

Enter the motor data from the motor nameplate:

| ABB Motors                 |    |    |       |      |       |                                |                   |  |  |
|----------------------------|----|----|-------|------|-------|--------------------------------|-------------------|--|--|
| 3 ~ motor M2AA 200 MLA 4   |    |    |       |      |       |                                |                   |  |  |
| IEC 200 M/L 55             |    |    |       |      |       |                                |                   |  |  |
| No                         |    |    |       |      |       |                                |                   |  |  |
| Ins.cl. F IP 55            |    |    |       |      |       |                                |                   |  |  |
| V                          | Hz | kW | r/min | A    | cos φ | I <sub>A</sub> /I <sub>N</sub> | t <sub>E</sub> /s |  |  |
| 690 Y                      | 50 | 30 | 1475  | 32.5 | 0.83  |                                |                   |  |  |
| 400 D                      | 50 | 30 | 1475  | 56   | 0.83  |                                |                   |  |  |
| 660 Y                      | 50 | 30 | 1470  | 34   | 0.83  |                                |                   |  |  |
| 380 D                      | 50 | 30 | 1470  | 59   | 0.83  |                                |                   |  |  |
| 415 D                      | 50 | 30 | 1475  | 54   | 0.83  |                                |                   |  |  |
| 440 D                      | 60 | 35 | 1770  | 59   | 0.83  |                                |                   |  |  |
| Cat. no 3GAA 202 001 - ADA |    |    |       |      |       |                                |                   |  |  |
| 6312/C3 6210/C3 180 kg     |    |    |       |      |       |                                |                   |  |  |
| IEC 34-1                   |    |    |       |      |       |                                |                   |  |  |

380 V  
supply  
voltage




- motor nominal voltage (parameter **9905** MOTOR NOM VOLT) – follow steps given above, starting from step 4.
- motor nominal current (parameter **9906** MOTOR NOM CURR)  
Allowed range: 0.2...2.0 · I<sub>2N</sub> A



**Note:** Set the motor data to exactly the same value as on the motor nameplate. Wrong motor settings of parameter group 99 may result in incorrect operation of the drive.

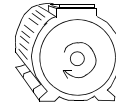
For example, if the motor nominal speed is 1440 rpm on the nameplate, setting the value of parameter **9908** MOTOR NOM SPEED to 1500 rpm results in the wrong operation of the drive.



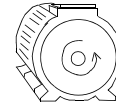
|  |  |  |     |             |   |  |              |  |
|--|--|--|-----|-------------|---|--|--------------|--|
| <input type="checkbox"/>               | <ul style="list-style-type: none"> <li>motor nominal frequency (parameter <b>9907</b> MOTOR NOM FREQ)</li> </ul>   | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>9907</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>9907</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>9907</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
| <input type="checkbox"/>               | Set the maximum value for external reference REF1 (parameter <b>1105</b> REF1 MAX).  | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>1105</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>1105</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>1105</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
| <input type="checkbox"/>               | Set constant speeds (drive output frequencies) 1, 2 and 3 (parameters <b>1202</b> CONST SPEED 1, <b>1203</b> CONST SPEED 2 and <b>1204</b> CONST SPEED 3).   | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>1202</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>1202</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>1202</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
|  |  | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>1203</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>1203</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>1203</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
|  |  | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>1204</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>1204</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>1204</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
| <input type="checkbox"/>               | Set the minimum value (%) corresponding to the minimum signal for AI(1) (parameter <b>1301</b> MINIMUM AI1).   | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>1301</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>1301</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>1301</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
| <input type="checkbox"/>               | Set the maximum limit for the drive output frequency (parameter <b>2008</b> MAXIMUM FREQ).   | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>2008</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>2008</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>2008</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
| <input type="checkbox"/>               | Select the motor stop function (parameter <b>2102</b> STOP FUNCTION).  | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>2102</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>2102</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>2102</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |
| <b>DIRECTION OF THE MOTOR ROTATION</b> |  |  |     |             |   |  |              |  |
| <input type="checkbox"/>               | Check the direction of the motor rotation. <ul style="list-style-type: none"> <li>Turn the potentiometer fully counterclockwise.</li> <li>If the drive is in remote control (REM shown on the left), switch to local control by pressing .</li> <li>Press  to start the motor.</li> <li>Turn the potentiometer slightly clockwise until the motor rotates.</li> <li>Check that the actual direction of the motor is the same as indicated on the display (FWD means forward and REV reverse).</li> <li>Press  to stop the motor.</li> </ul> | <table border="1"> <tr> <td>LOC</td> <td style="text-align: center; font-size: 2em;"><b>2102</b></td> <td>S</td> </tr> <tr> <td></td> <td style="text-align: center;">PAR      FWD</td> <td></td> </tr> </table> | LOC | <b>2102</b> | S |  | PAR      FWD |  |
| LOC                                    | <b>2102</b>  | S  |     |             |   |  |              |  |
|  | PAR      FWD   |  |     |             |   |  |              |  |

To change the direction of the motor rotation:

- Disconnect input power from the drive, and wait 5 minutes for the intermediate circuit capacitors to discharge. Measure the voltage between each input terminal (U1, V1 and W1) and earth with a multimeter to ensure that the drive is discharged.
- Exchange the position of two motor cable phase conductors at the drive output terminals or at the motor connection box.
- Verify your work by applying input power and repeating the check as described above.



forward  
direction



reverse  
direction

**ACCELERATION/DECELERATION TIMES**

- Set the acceleration time 1 (parameter **2202** ACCELER TIME 1).  
**Note:** Set also acceleration time 2 (parameter **2205**) if two acceleration times will be used in the application.



- Set the deceleration time 1 (parameter **2203** DECELER TIME 1).  
**Note:** Set also deceleration time 2 (parameter **2206**) if two deceleration times will be used in the application.



**FINAL CHECK**


- The start-up is now completed. Check that there are no faults or alarms shown on the display.

**The drive is now ready for use.**

## How to control the drive through the I/O interface

The table below instructs how to operate the drive through the digital and analog inputs when:

- the motor start-up is performed, and
- the default (standard) parameter settings are valid.

| PRELIMINARY SETTINGS   |  |     |     |    |        |  |     |     |     |    |        |  |     |
|--|--|-----|-----|----|--------|--|-----|-----|-----|----|--------|--|-----|
| <p>If you need to change the direction of rotation, check that parameter <a href="#">1003</a> DIRECTION is set to 3 (REQUEST).</p> <p>Ensure that the control connections are wired according to the connection diagram given for the ABB standard macro.</p> <p>Ensure that the drive is in remote control. Press key  to switch between remote and local control.</p> | <p>See <a href="#">Default I/O connection diagram</a> on page 46.</p> <p>In remote control, the panel display shows text REM.</p>  |     |     |    |        |  |     |     |     |    |        |  |     |
| STARTING AND CONTROLLING THE SPEED OF THE MOTOR  |  |     |     |    |        |  |     |     |     |    |        |  |     |
| <p>Start by switching digital input DI1 on.<br/>Text FWD starts flashing fast and stops after the setpoint is reached.</p> <p>Regulate the drive output frequency (motor speed) by adjusting the voltage or current of the analog input AI(1).</p>   | <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="padding: 2px;">REM</td> <td style="font-size: 2em; font-weight: bold;">00</td> <td style="padding: 2px;">Hz</td> </tr> <tr> <td style="padding: 2px;">OUTPUT</td> <td></td> <td style="padding: 2px;">FWD</td> </tr> </table><br><table border="1" style="width: 100%; text-align: center;"> <tr> <td style="padding: 2px;">REM</td> <td style="font-size: 2em; font-weight: bold;">500</td> <td style="padding: 2px;">Hz</td> </tr> <tr> <td style="padding: 2px;">OUTPUT</td> <td></td> <td style="padding: 2px;">FWD</td> </tr> </table>  | REM | 00  | Hz | OUTPUT |  | FWD | REM | 500 | Hz | OUTPUT |  | FWD |
| REM  | 00   | Hz  |     |    |        |  |     |     |     |    |        |  |     |
| OUTPUT   |  | FWD |     |    |        |  |     |     |     |    |        |  |     |
| REM  | 500  | Hz  |     |    |        |  |     |     |     |    |        |  |     |
| OUTPUT   |  | FWD |     |    |        |  |     |     |     |    |        |  |     |
| CHANGING THE DIRECTION OF THE MOTOR ROTATION   |  |     |     |    |        |  |     |     |     |    |        |  |     |
| <p>Reverse direction: Switch digital input DI2 on.</p> <p>Forward direction: Switch digital input DI2 off.</p>   | <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="padding: 2px;">REM</td> <td style="font-size: 2em; font-weight: bold;">500</td> <td style="padding: 2px;">Hz</td> </tr> <tr> <td style="padding: 2px;">OUTPUT</td> <td></td> <td style="padding: 2px;">REV</td> </tr> </table><br><table border="1" style="width: 100%; text-align: center;"> <tr> <td style="padding: 2px;">REM</td> <td style="font-size: 2em; font-weight: bold;">500</td> <td style="padding: 2px;">Hz</td> </tr> <tr> <td style="padding: 2px;">OUTPUT</td> <td></td> <td style="padding: 2px;">FWD</td> </tr> </table> | REM | 500 | Hz | OUTPUT |  | REV | REM | 500 | Hz | OUTPUT |  | FWD |
| REM  | 500  | Hz  |     |    |        |  |     |     |     |    |        |  |     |
| OUTPUT   |  | REV |     |    |        |  |     |     |     |    |        |  |     |
| REM  | 500  | Hz  |     |    |        |  |     |     |     |    |        |  |     |
| OUTPUT   |  | FWD |     |    |        |  |     |     |     |    |        |  |     |
| STOPPING THE MOTOR   |  |     |     |    |        |  |     |     |     |    |        |  |     |
| <p>Switch digital input DI1 off.<br/>The motor stops and text FWD starts flashing slowly.</p>  | <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="padding: 2px;">REM</td> <td style="font-size: 2em; font-weight: bold;">00</td> <td style="padding: 2px;">Hz</td> </tr> <tr> <td style="padding: 2px;">OUTPUT</td> <td></td> <td style="padding: 2px;">FWD</td> </tr> </table>  | REM | 00  | Hz | OUTPUT |  | FWD |     |     |    |        |  |     |
| REM  | 00   | Hz  |     |    |        |  |     |     |     |    |        |  |     |
| OUTPUT   |  | FWD |     |    |        |  |     |     |     |    |        |  |     |



# Control panel

---

## What this chapter contains

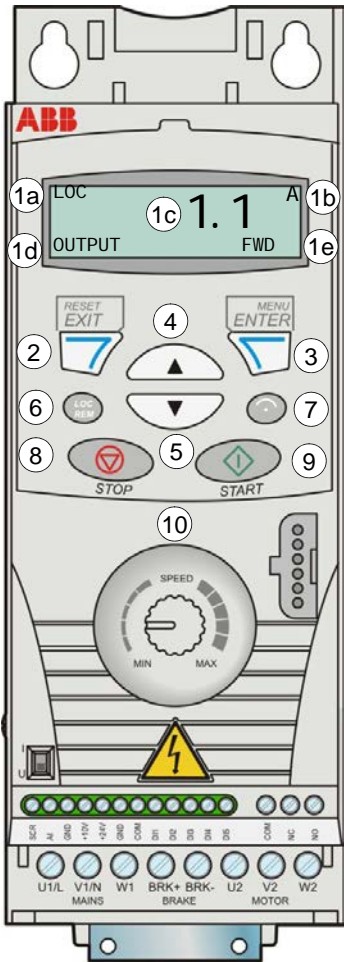
The chapter describes the control panel keys and display fields. It also instructs in using the panel in control, monitoring and changing the settings.

## Integrated control panel

The ACS150 works with an integrated control panel, which provides basic tools for manual entry of parameter values.

### Overview

The following table summarizes the key functions and displays on the integrated control panel.



| No. | Use   |
|-----|---|
| 1   | <p>LCD display – Divided into five areas:</p> <p>a. Upper left – Control location:<br/>                     LOC: drive control is local, that is, from the control panel<br/>                     REM: drive control is remote, such as the drive I/O.</p> <p>b. Upper right – Unit of the displayed value.<br/>                     s: Short parameter mode, browsing the list of parameters.</p> <p>c. Center – Variable; in general, shows parameter and signal values, menus or lists. Also displays alarm and fault codes.</p> <p>d. Lower left and center – Panel operation state:<br/>                     OUTPUT: Output mode<br/>                     PAR:<br/>                         Steady: Parameter modes<br/>                         Flashing: Changed parameters mode<br/>                     MENU: Main menu.<br/> <b>FAULT</b>: Fault mode.</p> <p>e. Lower right – Indicators:<br/>                     FWD (forward) / REV (reverse): direction of the motor rotation<br/>                         Flashing slowly: stopped<br/>                         Flashing quickly: running, not at setpoint<br/>                         Steady: running, at setpoint<br/> <b>SET</b>: Displayed value can be modified (in the Parameter or Reference mode).</p> |
| 2   | RESET/EXIT – Exits to the next higher menu level without saving changed values. Resets faults in the Output and Fault modes.  |
| 3   | MENU/ENTER – Enters deeper into menu level. In the Parameter mode, saves the displayed value as the new setting.  |
| 4   | Up – <ul style="list-style-type: none"> <li>• Scrolls up through a menu or list.</li> <li>• Increases a value if a parameter is selected.</li> </ul> Holding the key down changes the value faster.   |
| 5   | Down – <ul style="list-style-type: none"> <li>• Scrolls down through a menu or list.</li> <li>• Decreases a value if a parameter is selected.</li> </ul> Holding the key down changes the value faster.   |
| 6   | LOC/REM – Changes between local and remote control of the drive.  |
| 7   | DIR – Changes the direction of the motor rotation.  |
| 8   | STOP – Stops the drive in local control.  |
| 9   | START – Starts the drive in local control.  |
| 10  | Potentiometer – Changes the frequency reference.  |

## Operation

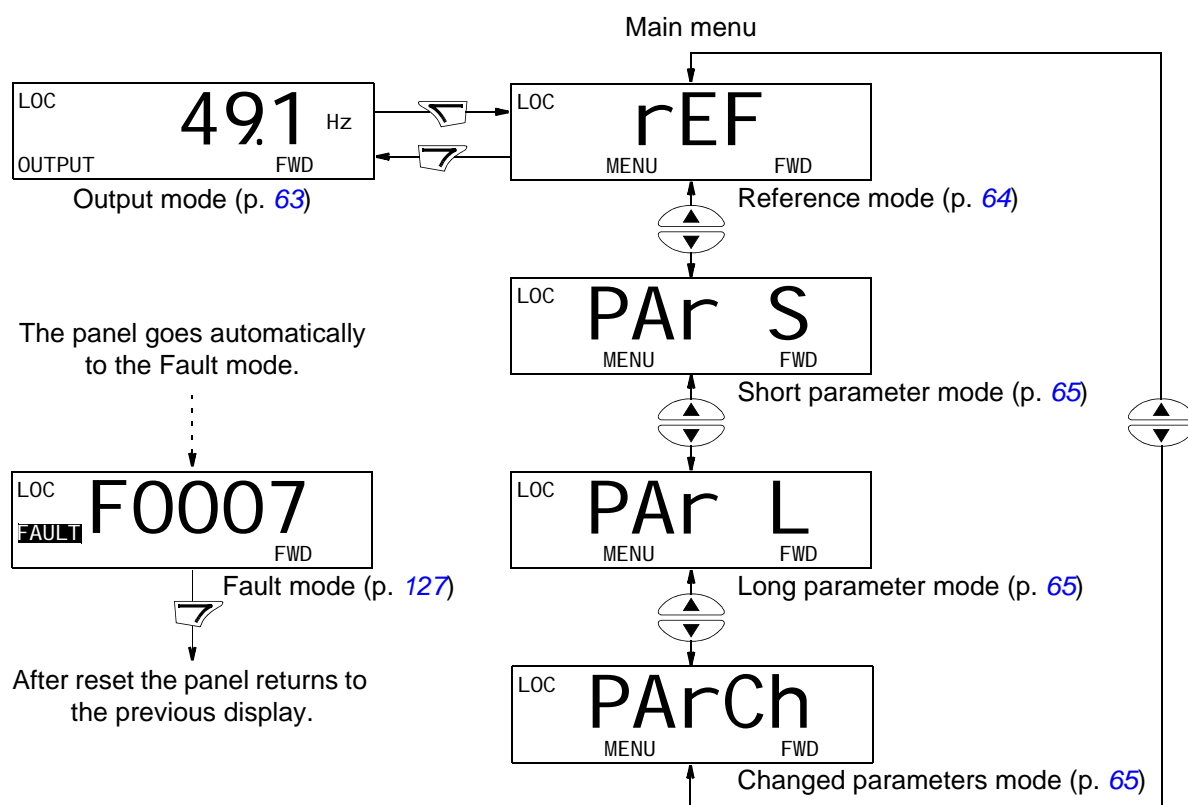
You can operate the control panel with the help of menus and keys. You can select an option, for example, an operation mode or a parameter, by scrolling the ▲ and ▼ arrow keys until the option is visible on the display and then pressing the ▢ key.

With the ▢ key, you can return to the previous operation level without saving the made changes.

The ACS150 includes an integrated potentiometer located at the front of the drive. It is used for setting the frequency reference.

The integrated control panel has six panel modes: *Output mode*, *Reference mode*, *Parameter modes* (Short parameter and Long parameter modes), *Changed parameters mode* and *Fault mode*. The operation in the first five modes is described in this chapter. When a fault or alarm occurs, the panel goes automatically to the Fault mode showing the fault or alarm code. You can reset the fault or alarm in the Output or Fault mode (see chapter *Fault tracing* on page 127).

When the power is switched on, the panel is in the Output mode, where you can start, stop, change the direction, switch between local and remote control, monitor up to three actual values (one at a time) and set the frequency reference. To perform other tasks, go first to the Main menu and select the appropriate mode. The figure below shows how to move between the modes.







### *How to perform common tasks*

The table below lists common tasks, the mode in which you can perform them and the page number where the steps of the task are described in detail.

| <b>Task</b>                                       | <b>Mode</b>          | <b>Page</b>         |
|---|----------------------|---------------------|
| How to switch between local and remote control    | Any                  | <a href="#">61</a>  |
| How to start and stop the drive                   | Any                  | <a href="#">61</a>  |
| How to change the direction of the motor rotation | Any                  | <a href="#">61</a>  |
| How to set the frequency reference                | Any                  | <a href="#">62</a>  |
| How to view and set the frequency reference       | Reference            | <a href="#">64</a>  |
| How to browse the monitored signals               | Output               | <a href="#">63</a>  |
| How to change the value of a parameter            | Short/Long Parameter | <a href="#">65</a>  |
| How to select the monitored signals               | Short/Long Parameter | <a href="#">66</a>  |
| How to view and edit changed parameters           | Changed Parameters   | <a href="#">67</a>  |
| How to reset faults and alarms                    | Output, Fault        | <a href="#">127</a> |



### How to start, stop and switch between local and remote control

You can start, stop and switch between local and remote control in any mode. To be able to start or stop the drive, the drive must be in local control.

| Step | Action  | Display  |
|------|---|--|
| 1.   | <ul style="list-style-type: none"> <li>To switch between remote control (REM shown on the left) and local control (LOC shown on the left), press .</li> </ul> <p><b>Note:</b> Switching to local control can be disabled with parameter <b>1606 LOCAL LOCK</b>.</p> <p>After pressing the key, the display briefly shows message “LoC” or “rE”, as appropriate, before returning to the previous display.</p> <p>The very first time the drive is powered up, it is in remote control (REM) and controlled through the drive I/O terminals. To switch to local control (LOC) and control the drive using the control panel and the integrated potentiometer, press . The result depends on how long you press the key:</p> <ul style="list-style-type: none"> <li>If you release the key immediately (the display flashes “LoC”), the drive stops. Set the local control reference with the potentiometer.</li> <li>If you press the key for about two seconds (release when the display changes from “LoC” to “LoC r”), the drive continues as before, except that the current position of the potentiometer determines the local reference (if there is a great difference between the remote and local references, the transfer from remote to local control is not smooth). The drive copies the current remote value for run/stop status and uses it as the initial local run/stop setting.</li> </ul> <ul style="list-style-type: none"> <li>To stop the drive in local control, press .</li> <li>To start the drive in local control, press .</li> </ul> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">           LOC <span style="float: right; font-size: 2em;">49.1</span> Hz<br/>           OUTPUT <span style="float: right;">FWD</span> </div> <div style="border: 1px solid black; padding: 5px;">           LOC <span style="float: right; font-size: 3em;">LoC</span><br/> <span style="float: right;">FWD</span> </div> <p style="font-size: 0.8em; margin-top: 10px;">Text FWD or REV on the bottom line starts flashing slowly.</p> <p style="font-size: 0.8em;">Text FWD or REV on the bottom line starts flashing quickly. It stops flashing when the drive reaches the setpoint.</p> |



### How to change the direction of the motor rotation

You can change the direction of the motor rotation in any mode.





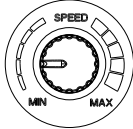
| Step | Action  | Display   |
|------|---|---|
| 1.   | <p>If the drive is in remote control (REM shown on the left), switch to local control by pressing . The display briefly shows message “LoC” or “rE”, as appropriate, before returning to the previous display.</p> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">           LOC <span style="float: right; font-size: 2em;">49.1</span> Hz<br/>           OUTPUT <span style="float: right;">FWD</span> </div> |
| 2.   | <p>To change the direction from forward (FWD shown at the bottom) to reverse (REV shown at the bottom), or vice versa, press .</p> <p><b>Note:</b> Parameter <b>1003 DIRECTION</b> must be set to 3 (REQUEST).</p> | <div style="border: 1px solid black; padding: 5px;">           LOC <span style="float: right; font-size: 2em;">49.1</span> Hz<br/>           OUTPUT <span style="float: right;">REV</span> </div>                     |

### How to set the frequency reference

You can set the local frequency reference with the integrated potentiometer in any mode when the drive is in local control if parameter **1109** LOC REF SOURCE has the default value 0 (POT).

If parameter **1109** LOC REF SOURCE has been changed to 1 (KEYPAD), so that you can use keys  and  for setting the local reference, you have to do it in the Reference mode (see page **64**).


To view the current local reference, you have to go to the Reference mode.

| Step | Action  | Display   |
|------|---|---|
| 1.   | <p>If the drive is in remote control (REM shown on the left), switch to local control by pressing . The display briefly shows "LoC" before switching to local control.</p> <p><b>Note:</b> With group <b>11 REFERENCE SELECT</b>, you can allow changing of the remote (external) reference in remote control (REM) for example, using the integrated potentiometer or keys  and .</p> |  |
| 2.   | <ul style="list-style-type: none"> <li>To increase the reference value, rotate the integrated potentiometer clockwise.</li> <li>To decrease the reference value, rotate the integrated potentiometer counterclockwise.</li> </ul>   |  |

## Output mode

In the Output mode, you can:



- monitor actual values of up to three group **01 OPERATING DATA** signals, one signal at a time
- start, stop, change direction, switch between local and remote control and set the frequency reference.

You can transfer to the Output mode by pressing the  key until the display shows text OUTPUT at the bottom.

The display shows the value of one group **01 OPERATING DATA** signal. The unit is shown on the right. Page 66 tells how to select up to three signals to be monitored in the Output mode. The table below shows how to view them one at a time.

|        |                |
|--------|----------------|
| REM    | <b>49.1</b> Hz |
| OUTPUT | FWD            |

### How to browse the monitored signals

| Step   | Action  | Display  |     |                |        |     |     |             |        |     |     |              |        |     |
|--------|---|--|-----|----------------|--------|-----|-----|-------------|--------|-----|-----|--------------|--------|-----|
| 1.     | <p>If more than one signals have been selected to be monitored (see page 66), you can browse them in the Output mode.</p> <p>To browse the signals forward, press key  repeatedly. To browse them backward, press key  repeatedly.</p> | <table border="1"> <tr> <td>REM</td> <td style="text-align: center;"><b>49.1</b> Hz</td> </tr> <tr> <td>OUTPUT</td> <td style="text-align: center;">FWD</td> </tr> </table><br><table border="1"> <tr> <td>REM</td> <td style="text-align: center;"><b>05</b> A</td> </tr> <tr> <td>OUTPUT</td> <td style="text-align: center;">FWD</td> </tr> </table><br><table border="1"> <tr> <td>REM</td> <td style="text-align: center;"><b>107</b> %</td> </tr> <tr> <td>OUTPUT</td> <td style="text-align: center;">FWD</td> </tr> </table> | REM | <b>49.1</b> Hz | OUTPUT | FWD | REM | <b>05</b> A | OUTPUT | FWD | REM | <b>107</b> % | OUTPUT | FWD |
| REM    | <b>49.1</b> Hz  |  |     |                |        |     |     |             |        |     |     |              |        |     |
| OUTPUT | FWD   |  |     |                |        |     |     |             |        |     |     |              |        |     |
| REM    | <b>05</b> A   |  |     |                |        |     |     |             |        |     |     |              |        |     |
| OUTPUT | FWD   |  |     |                |        |     |     |             |        |     |     |              |        |     |
| REM    | <b>107</b> %  |  |     |                |        |     |     |             |        |     |     |              |        |     |
| OUTPUT | FWD   |  |     |                |        |     |     |             |        |     |     |              |        |     |

## Reference mode












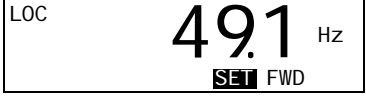


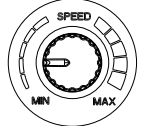


In the Reference mode, you can:

- view and set the frequency reference
- start, stop, change direction and switch between local and remote control.

### How to view and set the frequency reference

You can set the local frequency reference with the integrated potentiometer in any mode when the drive is in local control if parameter **1109** LOC REF SOURCE has the default value 0 (POT). If parameter **1109** LOC REF SOURCE has been changed to 1 (KEYPAD), you have to set the local frequency reference in the Reference mode.

You can view the current local reference in the Reference mode only.

| Step | Action  | Display   |
|------|---|---|
| 1.   | Go to the Main menu by pressing  if you are in the Output mode, otherwise by pressing  repeatedly until you see MENU at the bottom.   |    |
| 2.   | If the drive is in remote control (REM shown on the left), switch to local control by pressing  . The display briefly shows "LoC" before switching to local control.<br><b>Note:</b> With group <b>11 REFERENCE SELECT</b> , you can allow changing of the remote (external) reference in remote control (REM) for example, using the integrated potentiometer or keys  and  .   |    |
| 3.   | If the panel is not in the Reference mode ("rEF" not visible), press key  or  until you see "rEF" and then press  . Now the display shows the current reference value with <b>SET</b> under the value.   | <br>  |
| 4.   | If parameter <b>1109</b> LOC REF SOURCE = 0 (POT, default): <ul style="list-style-type: none"> <li>• To increase the reference value, rotate the integrated potentiometer clockwise.</li> <li>• To decrease the reference value, rotate the integrated potentiometer counterclockwise.</li> </ul> The new value (potentiometer setting) is shown on the display.<br><br>If parameter <b>1109</b> LOC REF SOURCE = 1 (KEYPAD): <ul style="list-style-type: none"> <li>• To increase the reference value, press .</li> <li>• To decrease the reference value, press .</li> </ul> The new value is shown on the display. | <br><br> |















## Parameter modes





There are two parameter modes: Short parameter mode and Long parameter mode. Both function identically, except that the Short parameter mode shows only the minimum number of parameters typically required to set up the drive (see section [Parameters in the Short parameter mode](#) on page 80). The Long parameter mode shows all user parameters including those shown in the Short parameter mode.

In the Parameter modes, you can:

- view and change parameter values
- start, stop, change direction, switch between local and remote control and set the frequency reference.

### How to select a parameter and change its value

| Step | Action   | Display   |
|------|--|---|
| 1.   | Go to the Main menu by pressing  if you are in the Output mode, otherwise by pressing  repeatedly until you see MENU at the bottom.  | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>rEF</b><br/>           MENU FWD         </div>   |
| 2.   | If the panel is not in the desired Parameter mode (“PAr S”/“PAr L” not visible), press key  or  until you see “PAr S” (Short parameter mode) or “PAr L” (Long parameter mode), as appropriate.   | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>PAr S</b><br/>           MENU FWD         </div> <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>PAr L</b><br/>           MENU FWD         </div>   |
| 3.   | <p>Short parameter mode (PAr S):</p> <ul style="list-style-type: none"> <li>• Press . The display shows one of the parameters of the Short parameter mode. Letter s in the top right corner indicates that you are browsing parameters in the Short parameter mode.</li> </ul> <p>Long parameter mode (PAr L):</p> <ul style="list-style-type: none"> <li>• Press . The display shows the number of one of the parameter groups in the Long parameter mode.</li> <li>• Use keys  and  to find the desired parameter group.</li> <li>• Press . The display shows one of the parameters in the selected group.</li> </ul> | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>1202</b> s<br/>           PAR FWD         </div> <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>-01-</b><br/>           PAR FWD         </div> <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>-12-</b><br/>           PAR FWD         </div> <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>1202</b><br/>           PAR FWD         </div> |
| 4.   | Use keys  and  to find the desired parameter.  | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>1203</b><br/>           PAR FWD         </div>   |
| 5.   | <p>Press and hold  for about two seconds until the display shows the value of the parameter with <b>SET</b> underneath indicating that changing of the value is now possible.</p> <p><b>Note:</b> When <b>SET</b> is visible, pressing keys  and  simultaneously changes the displayed value to the default value of the parameter.</p>   | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC<br/> <b>100</b> Hz<br/>           PAR <b>SET</b> FWD         </div>  |

| Step | Action   | Display  |
|------|--|--|
| 6.   | Use keys  and  to select the parameter value. When you have changed the parameter value, <b>SET</b> starts flashing.<br><br><ul style="list-style-type: none"> <li>To save the displayed parameter value, press .</li> <li>To cancel the new value and keep the original, press .</li> </ul> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">120</span> Hz<br/>           PAR <b>SET</b> FWD         </div> <div style="border: 1px solid black; padding: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">1203</span><br/>           PAR FWD         </div> |

### How to select the monitored signals















| Step | Action  | Display   |
|------|---|---|
| 1.   | <p>You can select which signals are monitored in the Output mode and how they are displayed with group <b>34 PANEL DISPLAY</b> parameters. See page <a href="#">65</a> for detailed instructions on changing parameter values.</p> <p>By default, the display shows: <b>0103</b> OUTPUT FREQ, <b>0104</b> CURRENT and <b>0105</b> TORQUE.</p> <p>To change the default signals, select from group <b>01 OPERATING DATA</b> up to three signals to be browsed.</p> <p>Signal 1: Change the value of parameter <b>3401</b> SIGNAL1 PARAM to the index of the signal parameter in group <b>01 OPERATING DATA</b> (= number of the parameter without the leading zero), for example, 105 means parameter <b>0105</b> TORQUE. Value 0 means that no signal is displayed.</p> <p>Repeat for signals 2 (<b>3408</b> SIGNAL2 PARAM) and 3 (<b>3415</b> SIGNAL3 PARAM). For example, if <b>3401</b> SIGNAL1 PARAM = 0 and <b>3415</b> SIGNAL3 PARAM = 0, browsing is disabled and only the signal specified by <b>3408</b> SIGNAL2 PARAM appears on the display. If all three parameters are set to 0, that is no signals are selected for monitoring, the panel displays text "n.A.".</p> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">103</span><br/>           PAR <b>SET</b> FWD         </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">104</span><br/>           PAR <b>SET</b> FWD         </div> <div style="border: 1px solid black; padding: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">105</span><br/>           PAR <b>SET</b> FWD         </div> |
| 2.   | <p>Specify the decimal point location, or use the decimal point location and unit of the source signal (setting 9 [DIRECT]). For details, see parameter <b>3404</b> OUTPUT1 DSP FORM.</p> <p>Signal 1: parameter <b>3404</b> OUTPUT1 DSP FORM<br/>           Signal 2: parameter <b>3411</b> OUTPUT2 DSP FORM<br/>           Signal 3: parameter <b>3418</b> OUTPUT3 DSP FORM.</p>  | <div style="border: 1px solid black; padding: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">9</span><br/>           PAR <b>SET</b> FWD         </div>   |
| 3.   | <p>Select the units to be displayed for the signals. This has no effect if parameter <b>3404/3411/3418</b> is set to 9 (DIRECT). For details, see parameter <b>3405</b> OUTPUT1 UNIT.</p> <p>Signal 1: parameter <b>3405</b> OUTPUT1 UNIT<br/>           Signal 2: parameter <b>3412</b> OUTPUT2 UNIT<br/>           Signal 3: parameter <b>3419</b> OUTPUT3 UNIT.</p>  | <div style="border: 1px solid black; padding: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">3</span><br/>           PAR <b>SET</b> FWD         </div>   |
| 4.   | <p>Select the scalings for the signals by specifying the minimum and maximum display values. This has no effect if parameter <b>3404/3411/3418</b> is set to 9 (DIRECT). For details, see parameters <b>3406</b> OUTPUT1 MIN and <b>3407</b> OUTPUT1 MAX.</p> <p>Signal 1: parameters <b>3406</b> OUTPUT1 MIN and <b>3407</b> OUTPUT1 MAX<br/>           Signal 2: parameters <b>3413</b> OUTPUT2 MIN and <b>3414</b> OUTPUT2 MAX<br/>           Signal 3: parameters <b>3420</b> OUTPUT3 MIN and <b>3421</b> OUTPUT3 MAX.</p>  | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">00</span> Hz<br/>           PAR <b>SET</b> FWD         </div> <div style="border: 1px solid black; padding: 5px;">           LOC <span style="font-size: 2em; font-weight: bold;">5000</span> Hz<br/>           PAR <b>SET</b> FWD         </div>   |

## Changed parameters mode

In the Changed parameters mode, you can:

- view a list of all parameters that have been changed from the macro default values
- change these parameters
- start, stop, change direction, switch between local and remote control and set the frequency reference.

### How to view and edit changed parameters

| Step | Action   | Display   |
|------|--|---|
| 1.   | Go to the Main menu by pressing  if you are in the Output mode, otherwise by pressing  repeatedly until you see MENU at the bottom.  | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>rEF</b><br/>           MENU FWD         </div>  |
| 2.   | If the panel is not in the Changed parameters mode ("PARCh" not visible), press key  or  until you see "PARCh" and then press  . The display shows the number of the first changed parameter and PAR is flashing.   | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>PARCh</b><br/>           MENU FWD         </div> <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>1103</b><br/>           PAR FWD         </div>       |
| 3.   | Use keys  and  to find the desired changed parameter on the list.  | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>1003</b><br/>           PAR FWD         </div>  |
| 4.   | Press and hold  for about two seconds until the display shows the value of the parameter with <b>SET</b> underneath indicating that changing of the value is now possible.<br><b>Note:</b> When <b>SET</b> is visible, pressing keys  and  simultaneously changes the displayed value to the default value of the parameter.  | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>1</b><br/>           PAR <b>SET</b> FWD         </div>  |
| 5.   | Use keys  and  to select the parameter value. When you have changed the parameter value, <b>SET</b> starts flashing.<br><br><ul style="list-style-type: none"> <li>• To save the displayed parameter value, press .</li> <li>• To cancel the new value and keep the original, press .</li> </ul> | <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>2</b><br/>           PAR <b>SET</b> FWD         </div> <div style="border: 1px solid black; padding: 5px; text-align: center;">           LOC <b>1003</b><br/>           PAR FWD         </div> |



# Application macros

---

## What this chapter contains

The chapter describes the application macros. For each macro, there is a wiring diagram showing the default control connections (digital and analog I/O). The chapter also explains how to save a user macro and how to recall it.

## Overview of macros

Application macros are pre-programmed parameter sets. While starting up the drive, the user selects the macro best suited for the purpose with parameter [9902 APPLIC MACRO](#), makes the essential changes and saves the result as a user macro.

The ACS150 has six standard macros and three user macros. The table below contains a summary of the macros and describes suitable applications.

| Macro               | Suitable applications   |
|---------------------|---|
| ABB standard        | Ordinary speed control applications where no, one, two or three constant speeds are used. Start/stop is controlled with one digital input (level start and stop). It is possible to switch between two acceleration and deceleration times.   |
| 3-wire              | Ordinary speed control applications where no, one, two or three constant speeds are used. The drive is started and stopped with push buttons.   |
| Alternate           | Speed control applications where no, one, two or three constant speeds are used. Start, stop and direction are controlled by two digital inputs (combination of the input states determines the operation).   |
| Motor potentiometer | Speed control applications where no or one constant speed is used. The speed is controlled by two digital inputs (increase / decrease / keep unchanged).  |
| Hand/Auto           | Speed control applications where switching between two control devices is needed. Some control signal terminals are reserved for one device, the rest for the other. One digital input selects between the terminals (devices) in use.  |
| PID control         | Process control applications, for example, different closed loop control systems such as pressure control, level control and flow control. It is possible to switch between process and speed control: Some control signal terminals are reserved for process control, others for speed control. One digital input selects between process and speed control. |
| User                | The user can save the customised standard macro, that is the parameter settings, including group <a href="#">99 START-UP DATA</a> , into the permanent memory, and recall the data at a later time.<br><br>For example, three user macros can be used when switching between three different motors is required.  |

## Summary of I/O connections of application macros

The following table gives the summary of the default I/O connections of all application macros.

| Input/output            | Macro                  |                        |                        |                          |                                     |                                      |
|-------------------------|------------------------|------------------------|------------------------|--------------------------|-------------------------------------|--------------------------------------|
|                         | ABB standard           | 3-wire                 | Alternate              | Motor potentiometer      | Hand/Auto                           | PID control                          |
| <b>AI</b>               | Frequency reference    | Frequency reference    | Frequency reference    | -                        | Frequency ref. (Auto) <sup>1)</sup> | Freq. ref. (Hand) / Proc. ref. (PID) |
| <b>DI1</b>              | Stop/Start             | Start (pulse)          | Start (forward)        | Stop/Start               | Stop/Start (Hand)                   | Stop/Start (Hand)                    |
| <b>DI2</b>              | Forward/Reverse        | Stop (pulse)           | Start (reverse)        | Forward/Reverse          | Forward/Reverse (Hand)              | Hand/PID                             |
| <b>DI3</b>              | Constant speed input 1 | Forward/Reverse        | Constant speed input 1 | Frequency reference up   | Hand/Auto                           | Constant speed 1                     |
| <b>DI4</b>              | Constant speed input 2 | Constant speed input 1 | Constant speed input 2 | Frequency reference down | Forward/Reverse (Auto)              | Run enable                           |
| <b>DI5</b>              | Ramp pair selection    | Constant speed input 2 | Ramp pair selection    | Constant speed 1         | Stop/Start (Auto)                   | Stop/Start (PID)                     |
| <b>RO (COM, NC, NO)</b> | Fault (-1)             | Fault (-1)             | Fault (-1)             | Fault (-1)               | Fault (-1)                          | Fault (-1)                           |

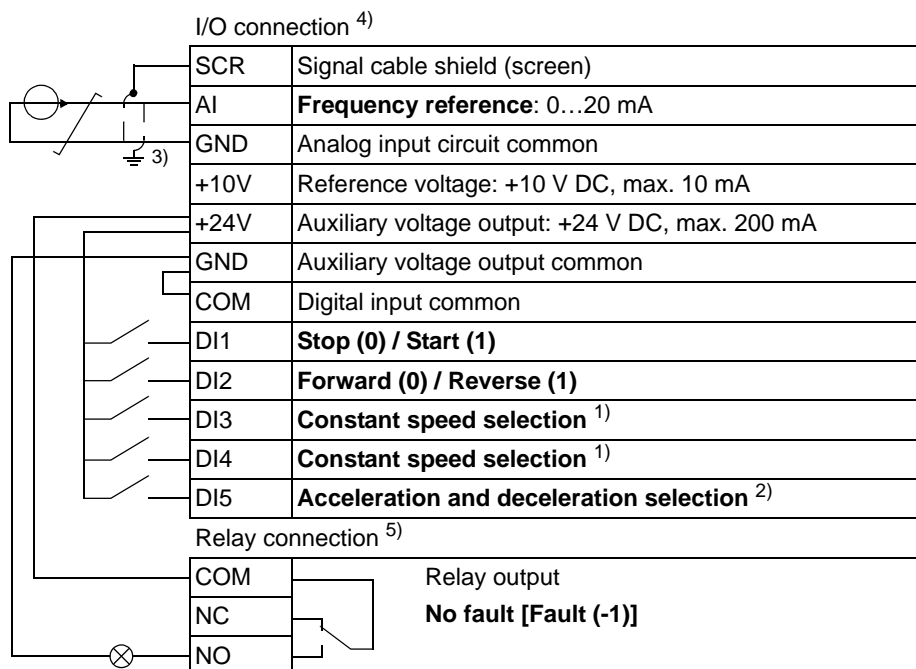
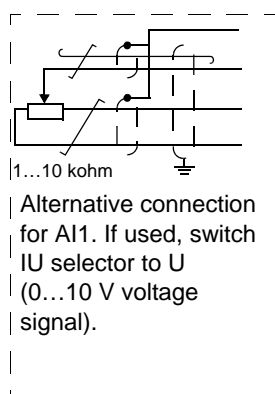
<sup>1)</sup> The frequency reference comes from the integrated potentiometer when Hand is selected.

## ABB standard macro

This is the default macro. It provides a general purpose I/O configuration with three constant speeds. Parameter values are the default values given in chapter [Actual signals and parameters](#), starting from page 79.

If you use other than the default connections presented below, see section [I/O terminals](#) on page 44.

### Default I/O connections



<sup>1)</sup> See parameter group [12 CONSTANT SPEEDS](#):

| DI3 | DI4 | Operation (parameter)                          |
|-----|-----|--|
| 0   | 0   | Set speed through integrated potentiometer     |
| 1   | 0   | Speed 1 ( <a href="#">1202 CONST SPEED 1</a> ) |
| 0   | 1   | Speed 2 ( <a href="#">1203 CONST SPEED 2</a> ) |
| 1   | 1   | Speed 3 ( <a href="#">1204 CONST SPEED 3</a> ) |

<sup>2)</sup> 0 = ramp times according to parameters [2202 ACCELER TIME 1](#) and [2203 DECELER TIME 1](#).  
1 = ramp times according to parameters [2205 ACCELER TIME 2](#) and [2206 DECELER TIME 2](#).

<sup>3)</sup> 360 degree grounding under a clamp.

<sup>4)</sup> Tightening torque: 0.22 N·m / 2 lbf·in

<sup>5)</sup> Tightening torque: 0.5 N·m / 4.4 lbf·in

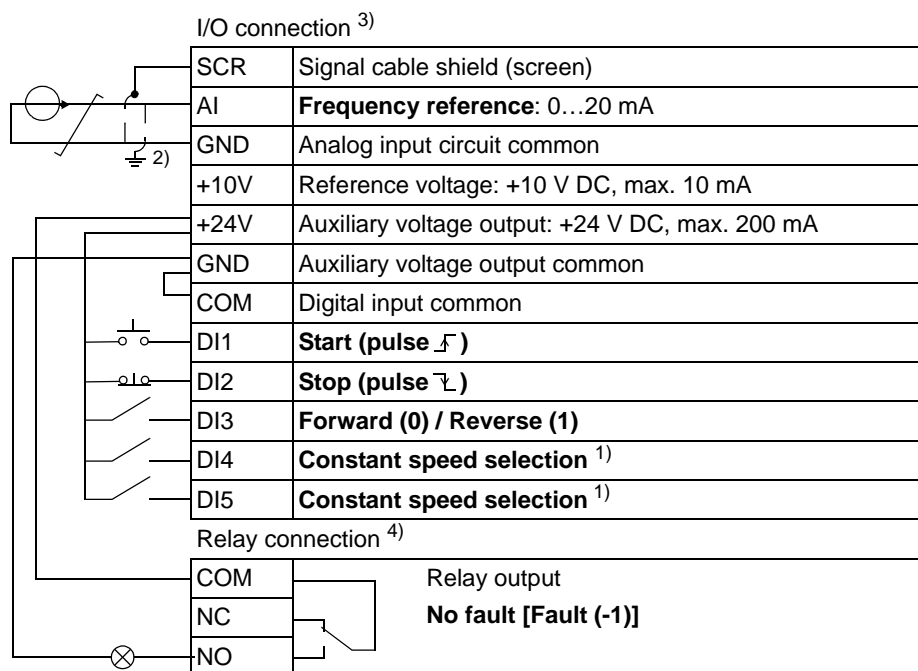
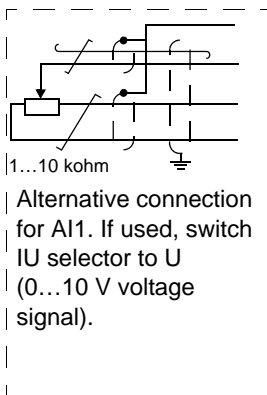
### 3-wire macro

This macro is used when the drive is controlled using momentary push-buttons. It provides three constant speeds. To enable the macro, set the value of parameter [9902 APPLIC MACRO](#) to 2 (3-WIRE).

For the parameter default values, see section [Default parameter values with different macros](#) on page 79. If you use other than the default connections presented below, see section [I/O terminals](#) on page 44.

**Note:** When the stop input (DI2) is deactivated (no input), the control panel start and stop buttons are disabled.

#### Default I/O connections



<sup>1)</sup> See parameter group [12 CONSTANT SPEEDS](#):

| DI3 | DI4 | Operation (parameter)                          |
|-----|-----|--|
| 0   | 0   | Set speed through integrated potentiometer     |
| 1   | 0   | Speed 1 ( <a href="#">1202 CONST SPEED 1</a> ) |
| 0   | 1   | Speed 2 ( <a href="#">1203 CONST SPEED 2</a> ) |
| 1   | 1   | Speed 3 ( <a href="#">1204 CONST SPEED 3</a> ) |

<sup>2)</sup> 360 degree grounding under a clamp.

<sup>3)</sup> Tightening torque: 0.22 N·m / 2 lbf·in

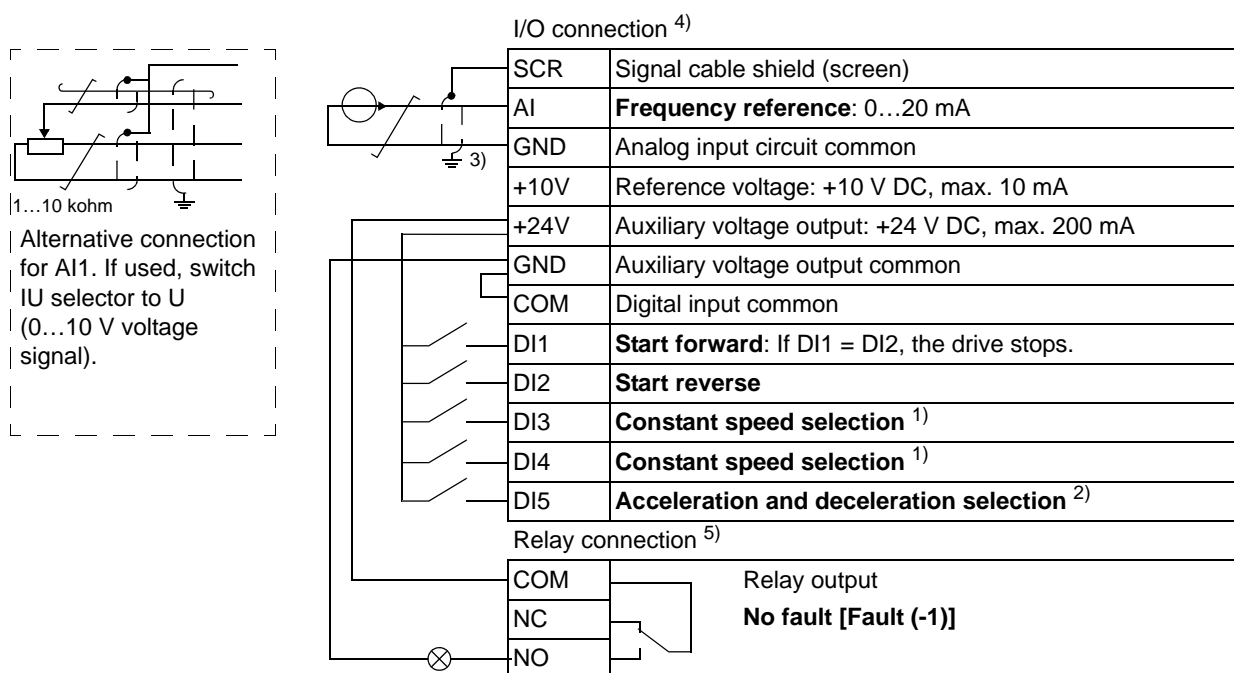
<sup>4)</sup> Tightening torque: 0.5 N·m / 4.4 lbf·in

## Alternate macro

This macro provides an I/O configuration adapted to a sequence of DI control signals used when alternating the rotation direction of the drive. To enable the macro, set the value of parameter [9902 APPLIC MACRO](#) to 3 (ALTERNATE).

For the parameter default values, see section [Default parameter values with different macros](#) on page 79. If you use other than the default connections presented below, see section [I/O terminals](#) on page 44.

### Default I/O connections



<sup>1)</sup> See parameter group [12 CONSTANT SPEEDS](#):

| DI3 | DI4 | Operation (parameter)                          |
|-----|-----|--|
| 0   | 0   | Set speed through integrated potentiometer     |
| 1   | 0   | Speed 1 ( <a href="#">1202 CONST SPEED 1</a> ) |
| 0   | 1   | Speed 2 ( <a href="#">1203 CONST SPEED 2</a> ) |
| 1   | 1   | Speed 3 ( <a href="#">1204 CONST SPEED 3</a> ) |

<sup>2)</sup> 0 = ramp times according to parameters [2202 ACCELER TIME 1](#) and [2203 DECELER TIME 1](#).

1 = ramp times according to parameters [2205 ACCELER TIME 2](#) and [2206 DECELER TIME 2](#).

<sup>3)</sup> 360 degree grounding under a clamp.

<sup>4)</sup> Tightening torque: 0.22 N·m / 2 lbf·in

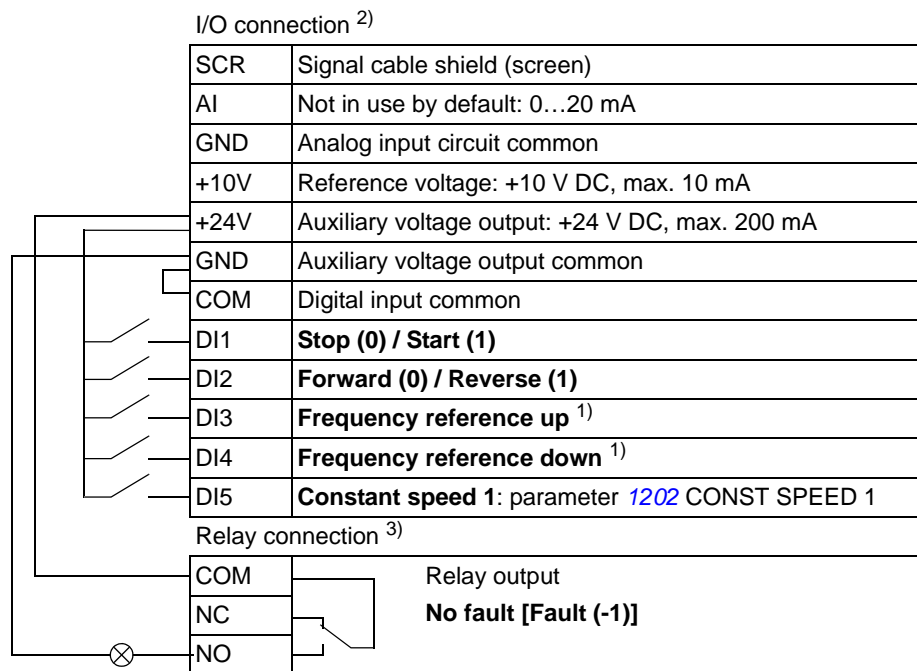
<sup>5)</sup> Tightening torque: 0.5 N·m / 4.4 lbf·in

## Motor potentiometer macro

This macro provides a cost-effective interface for PLCs that vary the speed of the drive using only digital signals. To enable the macro, set the value of parameter [9902 APPLIC MACRO](#) to 4 (MOTOR POT).

For the parameter default values, see section [Default parameter values with different macros](#) on page 79. If you use other than the default connections presented below, see section [I/O terminals](#) on page 44.

### Default I/O connections



<sup>1)</sup> If DI3 and DI4 are both active or inactive, the frequency reference is unchanged.

The existing frequency reference is stored during stop and power down.

<sup>2)</sup> Tightening torque: 0.22 N·m / 2 lbf·in

<sup>3)</sup> Tightening torque: 0.5 N·m / 4.4 lbf·in

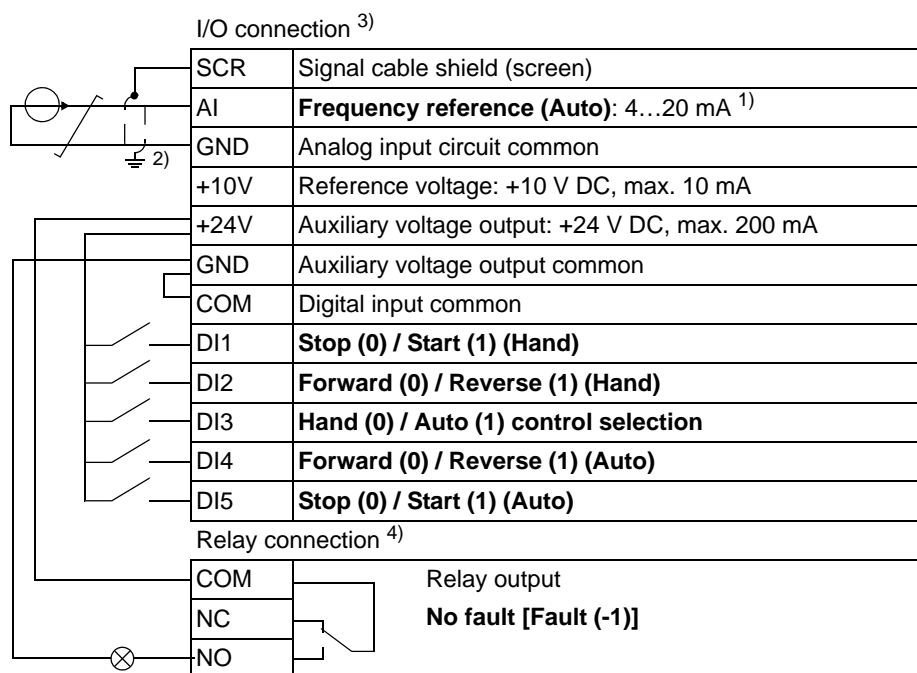
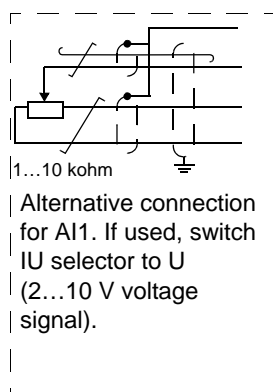
## Hand/Auto macro

This macro can be used when switching between two external control devices is needed. To enable the macro, set the value of parameter **9902 APPLIC MACRO** to 5 (HAND/AUTO).

For the parameter default values, see section [Default parameter values with different macros](#) on page 79. If you use other than the default connections presented below, see section [I/O terminals](#) on page 44.

**Note:** Parameter **2108 START INHIBIT** must remain in the default setting 0 (OFF).

### Default I/O connections



1) In the Hand mode, the frequency reference comes from the integrated potentiometer.

2) 360 degree grounding under a clamp.

3) Tightening torque: 0.22 N·m / 2 lbf·in

4) Tightening torque: 0.5 N·m / 4.4 lbf·in

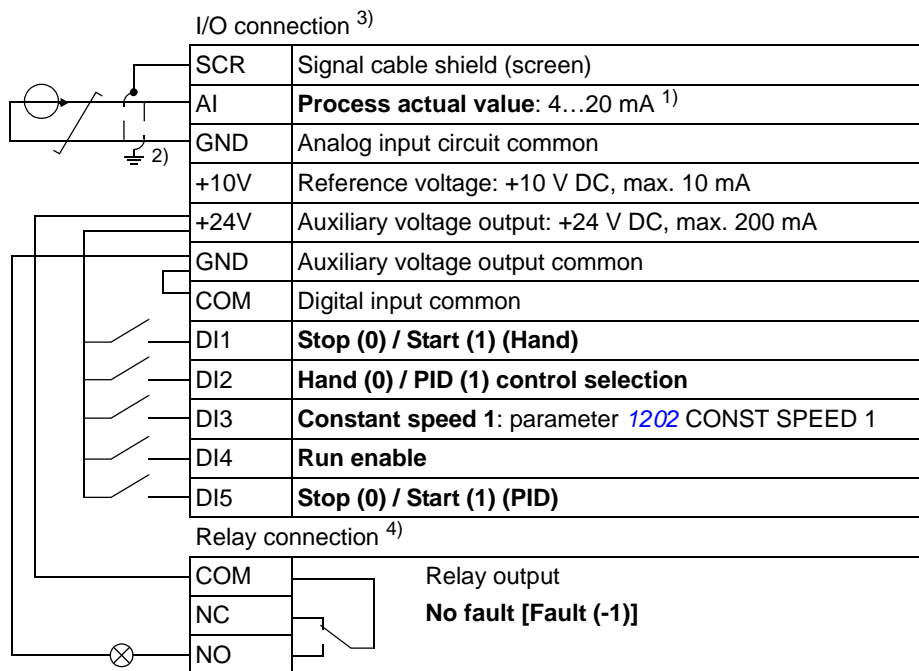
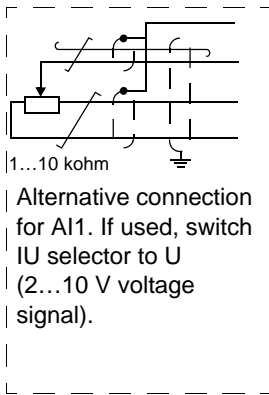
## PID control macro

This macro provides parameter settings for closed-loop control systems such as pressure control, flow control, and so on. Control can also be switched to speed control using a digital input. To enable the macro, set the value of parameter **9902** APPLIC MACRO to 6 (PID CONTROL).

For the parameter default values, see section [Default parameter values with different macros](#) on page 79. If you use other than the default connections presented below, see chapter [Electrical installation](#), section [I/O terminals](#) on page 44.

**Note:** Parameter **2108** START INHIBIT must remain in the default setting 0 (OFF).

### Default I/O connections



<sup>1)</sup> Hand: frequency reference comes from the integrated potentiometer  
 PID: Process reference comes from the integrated potentiometer.

<sup>2)</sup> 360 degree grounding under a clamp.

<sup>3)</sup> Tightening torque: 0.22 N·m / 2 lbf·in


<sup>4)</sup> Tightening torque: 0.5 N·m / 4.4 lbf·in

## User macros


In addition to the standard application macros, it is possible to create three user macros. The user macro allows the user to save the parameter settings, including group [99 START-UP DATA](#), into the permanent memory and recall the data at a later time. The panel reference is also saved if the macro is saved and loaded in local control. The remote control setting is saved into the user macro, but the local control setting is not.

The steps below show how to create and recall User macro 1. The procedure for the other two user macros is identical, only the parameter [9902 APPLIC MACRO](#) values are different.

To create User macro 1:

- Adjust the parameters.
- Save the parameter settings to the permanent memory by changing parameter [9902 APPLIC MACRO](#) to -1 (USER S1 SAVE).
- Press  to save.

To recall User macro 1:

- Change parameter [9902 APPLIC MACRO](#) to 0 (USER S1 LOAD).
- Press  to load.

**Note:** User macro load restores the parameter settings including group [99 START-UP DATA](#). Check that the settings correspond to the motor used.

**Hint:** The user can for example switch the drive between three motors without having to adjust the motor parameters every time the motor is changed. The user needs only to adjust the settings once for each motor and then to save the data as three user macros. When the motor is changed, only the corresponding user macro needs to be loaded, and the drive is ready to operate.



# Actual signals and parameters

---

## What this chapter contains

The chapter describes the actual signals and parameters. It also contains a table of the default values for the different macros.

## Terms and abbreviations

| Term          | Definition   |
|---------------|--|
| Actual signal | Signal measured or calculated by the drive. Can be monitored by the user. No user setting possible. Groups 01...04 contain actual signals. |
| Def           | Parameter default value  |
| Parameter     | A user-adjustable operation instruction of the drive. Groups 10...99 contain parameters.   |
| E             | Refers to types 01E- and 03E- with European parametrization  |
| U             | Refers to types 01U- and 03U- with US parametrization  |

## Default parameter values with different macros

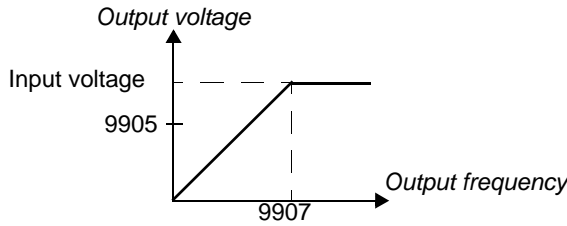
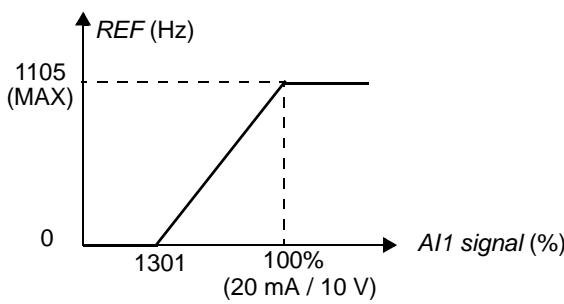
When application macro is changed ([9902 APPLIC MACRO](#)), the software updates the parameter values to their default values. The following table includes the parameter default values for different macros. For other parameters, the default values are the same for all macros (see section [Actual signals](#) on page [84](#)).

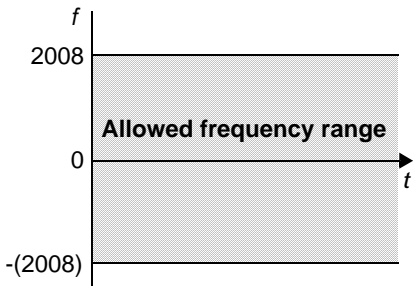
| Index | Name/<br>Selection | ABB<br>STANDARD     | 3-WIRE        | ALTERNATE        | MOTOR POT           | HAND/AUTO         | PID CONTROL        |
|-------|--------------------|---------------------|---------------|------------------|---------------------|-------------------|--------------------|
| 1001  | EXT1<br>COMMANDS   | 2 = DI1,2           | 4 = DI1P,2P,3 | 9 = DI1F,2R      | 2 = DI1,2           | 2 = DI1,2         | 1 = DI1            |
| 1002  | EXT2<br>COMMANDS   | 0 = NOT SEL         | 0 = NOT SEL   | 0 = NOT SEL      | 0 = NOT SEL         | 21 = DI5,4        | 20 = DI5           |
| 1003  | DIRECTION          | 3 = REQUEST         | 3 = REQUEST   | 3 = REQUEST      | 3 = REQUEST         | 3 = REQUEST       | 1 = FORWARD        |
| 1102  | EXT1/EXT2<br>SEL   | 0 = EXT1            | 0 = EXT1      | 0 = EXT1         | 0 = EXT1            | 3 = DI3           | 2 = DI2            |
| 1103  | REF1 SELECT        | 1 = AI1             | 1 = AI1       | 1 = AI1          | 12 =<br>DI3U,4D(NC) | 1 = AI1           | 2 = POT            |
| 1106  | REF2 SELECT        | 2 = POT             | 2 = POT       | 2 = POT          | 1 = AI1             | 2 = POT           | 19 = PID1OUT       |
| 1201  | CONST<br>SPEED SEL | 9 = DI3,4           | 10 = DI4,5    | 9 = DI3,4        | 5 = DI5             | 0 = NOT SEL       | 3 = DI3            |
| 1301  | MINIMUM AI1        | 0.0%                | 0.0%          | 0.0%             | 0.0%                | 20.0%             | 20.0%              |
| 1601  | RUN ENABLE         | 0 = NOT SEL         | 0 = NOT SEL   | 0 = NOT SEL      | 0 = NOT SEL         | 0 = NOT SEL       | 4 = DI4            |
| 2201  | ACC/DEC 1/2<br>SEL | 5 = DI5             | 0 = NOT SEL   | 5 = DI5          | 0 = NOT SEL         | 0 = NOT SEL       | 0 = NOT SEL        |
| 9902  | APPLIC<br>MACRO    | 1 = ABB<br>STANDARD | 2 = 3-WIRE    | 3 =<br>ALTERNATE | 4 = MOTOR<br>POT    | 5 = HAND/<br>AUTO | 6 = PID<br>CONTROL |

## Parameters in the Short parameter mode

The following table describes the parameters that are visible in the Short parameter mode. See section [Parameter modes](#) on page 65 for how to select the parameter mode. All parameters are presented in detail in section [Parameters in the Long parameter mode](#), starting on page 86.

| Parameters in the Short parameter mode |                   |  |                  |
|--|-------------------|--|------------------|
| No.                                    | Name/Value        | Description  | Def              |
| <b>99 START-UP DATA</b>                |                   | Application macro. Definition of motor set-up data.  |                  |
| 9902                                   | APPLIC MACRO      | Selects the application macro or activates FlashDrop parameter values. See chapter <a href="#">Application macros</a> on page 69.  | 1 = ABB STANDARD |
|  | 1 = ABB STANDARD  | Standard macro for constant speed applications   |                  |
|  | 2 = 3-WIRE        | 3-wire macro for constant speed applications   |                  |
|  | 3 = ALTERNATE     | Alternate macro for start forward and start reverse applications   |                  |
|  | 4 = MOTOR POT     | Motor potentiometer macro for digital signal speed control applications  |                  |
|  | 5 = HAND/AUTO     | Hand/Auto macro to be used when two control devices are connected to the drive:<br>- Device 1 communicates through the interface defined by external control location EXT1.<br>- Device 2 communicates through the interface defined by external control location EXT2.<br>EXT1 or EXT2 is active at a time. Switching between EXT1/2 through digital input. |                  |
|  | 6 = PID CONTROL   | PID control. For applications in which the drive controls a process value. For example, pressure control by the drive running the pressure boost pump. Measured pressure and the pressure reference are connected to the drive.  |                  |
|  | 31 = LOAD FD SET  | FlashDrop parameter values as defined by the FlashDrop file.<br>FlashDrop is an optional device for fast copying of parameters to unpowered drives. FlashDrop allows easy customisation of the parameter list, for example, selected parameters can be hidden. For more information, see <i>MFDT-01 FlashDrop user's manual</i> (3AFE68591074 [English]).    |                  |
|  | 0 = USER S1 LOAD  | User 1 macro loaded into use. Before loading, check that the saved parameter settings and the motor model are suitable for the application.  |                  |
|  | -1 = USER S1 SAVE | Save User 1 macro. Stores the current parameter settings and the motor model.  |                  |
|  | -2 = USER S2 LOAD | User 2 macro loaded into use. Before loading, check that the saved parameter settings and the motor model are suitable for the application.  |                  |
|  | -3 = USER S2 SAVE | Save User 2 macro. Stores the current parameter settings and the motor model.  |                  |
|  | -4 = USER S3 LOAD | User 3 macro loaded into use. Before loading, check that the saved parameter settings and the motor model are suitable for the application.  |                  |
|  | -5 = USER S3 SAVE | Save User 3 macro. Stores the current parameter settings and the motor model.  |                  |

| Parameters in the Short parameter mode |   |  |  |
|--|---|--|--|
| No.                                    | Name/Value  | Description  | Def  |
| 9905                                   | MOTOR NOM VOLT  | <p>Defines the nominal motor voltage. Must be equal to the value on the motor rating plate. The drive cannot supply the motor with a voltage greater than the input power voltage.</p> <p>Note that the output voltage is not limited by the nominal motor voltage but increased linearly up to the value of the input voltage</p>  <p><b>WARNING!</b> Never connect a motor to a drive which is connected to power line with voltage level higher than the rated motor voltage.</p> | 200 V<br>E units:<br>200 V<br><br>230 V<br>U units:<br>230 V<br><br>400 V<br>E units:<br>400 V<br><br>460 V<br>U units:<br>460 V |
|  | 200 V E units/<br>230 U units:<br>100...300 V<br><br>400 V E units /<br>460 V U units:<br>230...690 V | Voltage.<br><br><b>Note:</b> The stress on the motor insulations is always dependent on the drive supply voltage. This also applies to the case where the motor voltage rating is lower than the rating of the drive and the supply of the drive.  |  |
| 9906                                   | MOTOR NOM CURR  | Defines the nominal motor current. Must be equal to the value on the motor rating plate.   | $I_{2N}$   |
|  | 0.2...2.0 · $I_{2N}$  | Current  |  |
| 9907                                   | MOTOR NOM FREQ  | Defines the nominal motor frequency, that is the frequency at which the output voltage equals the motor nominal voltage:<br>Field weakening point = Nom. frequency · Supply voltage / Mot nom. voltage   | E: 50 / U: 60  |
|  | 10.0...500.0 Hz   | Frequency  |  |
| <b>04 FAULT HISTORY</b>                |   | Fault history (read-only)  |  |
| 0401                                   | LAST FAULT  | Fault code of the latest fault. See chapter <a href="#">Fault tracing</a> on page 127 for the codes. 0 = fault history is clear (on panel display = NO RECORD).  | -  |
| <b>11 REFERENCE SELECT</b>             |   | Maximum reference  |  |
| 1105                                   | REF1 MAX  | Defines the maximum value for external reference REF1. Corresponds to maximum mA(V) signal for analog input AI1.   | E: 50.0 Hz / U: 60.0 Hz  |
|  |   |    |  |
|  | 0.0...500.0 Hz  | Maximum value  |  |

| Parameters in the Short parameter mode |                |   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|--|----------------|---|----------------------------|-----|-----------|---|---|-------------------|---|---|---|---|---|---|---|---|---|--|
| No.                                    | Name/Value     | Description   | Def                        |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| <b>12 CONSTANT SPEEDS</b>              |                | <p>Constant speeds. Constant speed activation overrides the external speed reference. Constant speed selections are ignored if drive is in the local control mode.</p> <p>As default constant speed selection is made through digital inputs DI3 and DI4. 1 = DI active, 0 = DI inactive.</p> <table border="1"> <thead> <tr> <th>DI3</th> <th>DI4</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>No constant speed</td> </tr> <tr> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1202</a> CONST SPEED 1</td> </tr> <tr> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1203</a> CONST SPEED 2</td> </tr> <tr> <td>1</td> <td>1</td> <td>Speed defined by parameter <a href="#">1204</a> CONST SPEED 3</td> </tr> </tbody> </table> | DI3                        | DI4 | Operation | 0 | 0 | No constant speed | 1 | 0 | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 | 0 | 1 | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 | 1 | 1 | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 |  |
| DI3                                    | DI4            | Operation   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 0                                      | 0              | No constant speed   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 1                                      | 0              | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 0                                      | 1              | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 1                                      | 1              | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 1202                                   | CONST SPEED 1  | Defines constant speed 1 (that is drive output frequency).  | E: 5.0 Hz /<br>U: 6.0 Hz   |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 0.0...500.0 Hz | Output frequency  |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 1203                                   | CONST SPEED 2  | Defines constant speed 2 (that is drive output frequency).  | E: 10.0 Hz /<br>U: 12.0 Hz |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 0.0...500.0 Hz | Output frequency  |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 1204                                   | CONST SPEED 3  | Defines constant speed 3 (that is drive output frequency).  | E: 15.0 Hz /<br>U: 18.0 Hz |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 0.0...500.0 Hz | Output frequency  |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| <b>13 ANALOG INPUTS</b>                |                | Analog input signal minimum   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 1301                                   | MINIMUM AI1    | <p>Defines the minimum % value that corresponds to minimum mA/(V) signal for analog input AI1.</p> <p>0...20 mA <math>\hat{=}</math> 0...100%<br/>4...20 mA <math>\hat{=}</math> 20...100%</p> <p>When analog input AI1 is selected as the source for external reference REF1, the value corresponds to the minimum reference value, that is 0 Hz. See the figure for parameter <a href="#">1105</a> REF1 MAX.</p>  | 0%                         |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 0...100.0%     | Value in percent of the full signal range. Example: If the minimum value for analog input is 4 mA, the percent value for 0...20 mA range is:<br>$(4 \text{ mA} / 20 \text{ mA}) \cdot 100\% = 20\%$   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| <b>20 LIMITS</b>                       |                | Maximum frequency   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 2008                                   | MAXIMUM FREQ   | <p>Defines the maximum limit for the drive output frequency.</p>    | E: 50.0 Hz /<br>U: 60.0 Hz |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 0.0...500.0 Hz | Maximum frequency   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| <b>21 START/STOP</b>                   |                | Stop mode of the motor  |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
| 2102                                   | STOP FUNCTION  | Selects the motor stop function.  | 1 = COAST                  |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 1 = COAST      | Stop by cutting off the motor power supply. The motor coasts to stop.   |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |
|  | 2 = RAMP       | Stop along a linear ramp. See parameter group <a href="#">22 ACCEL/DECEL</a> .  |                            |     |           |   |   |                   |   |   |   |   |   |   |   |   |   |  |

| Parameters in the Short parameter mode |                |  |       |
|--|----------------|--|-------|
| No.                                    | Name/Value     | Description  | Def   |
| <b>22 ACCEL/DECEL</b>                  |                | Acceleration and deceleration times  |       |
| 2202                                   | ACCELER TIME 1 | <p>Defines the acceleration time 1, that is the time required for the speed to change from zero to the speed defined by parameter <a href="#">2008</a> MAXIMUM FREQ.</p> <ul style="list-style-type: none"> <li>- If the speed reference increases faster than the set acceleration rate, the motor speed follows the acceleration rate.</li> <li>- If the speed reference increases slower than the set acceleration rate, the motor speed follows the reference signal.</li> <li>- If the acceleration time is set too short, the drive automatically prolongs the acceleration in order not to exceed the drive operating limits.</li> </ul>  | 5.0 s |
|  | 0.0...1800.0 s | Time   |       |
| 2203                                   | DECELER TIME 1 | <p>Defines the deceleration time 1, that is the time required for the speed to change from the value defined by parameter <a href="#">2008</a> MAXIMUM FREQ to zero.</p> <ul style="list-style-type: none"> <li>- If the speed reference decreases slower than the set deceleration rate, the motor speed follows the reference signal.</li> <li>- If the reference changes faster than the set deceleration rate, the motor speed follows the deceleration rate.</li> <li>- If the deceleration time is set too short, the drive automatically prolongs the deceleration in order not to exceed drive operating limits.</li> </ul> <p>If a short deceleration time is needed for a high inertia application, the drive should be equipped a brake resistor.</p> | 5.0 s |
|  | 0.0...1800.0 s | Time   |       |

## Actual signals

The following table includes the descriptions of all actual signal.

| Actual signals |                       |  |
|----------------|-----------------------|--|
| No.            | Name/Value            | Description  |
| <b>01</b>      | <b>OPERATING DATA</b> | Basic signals for monitoring the drive (read-only).<br>For actual signal supervision, see parameter group <a href="#">32 SUPERVISION</a> .<br>For selection of an actual signal to be displayed on the control panel, see parameter group <a href="#">34 PANEL DISPLAY</a> . |
| 0101           | SPEED & DIR           | Calculated motor speed in rpm. A negative value indicates reverse direction.   |
| 0102           | SPEED                 | Calculated motor speed in rpm.   |
| 0103           | OUTPUT FREQ           | Calculated drive output frequency in Hz. (Shown by default on the panel Output mode display.)  |
| 0104           | CURRENT               | Measured motor current in A  |
| 0105           | TORQUE                | Calculated motor torque in percent of the motor nominal torque   |
| 0106           | POWER                 | Measured motor power in kW   |
| 0107           | DC BUS VOLTAGE        | Measured intermediate circuit voltage in V DC  |
| 0109           | OUTPUT VOLTAGE        | Calculated motor voltage in V AC   |
| 0110           | DRIVE TEMP            | Measured IGBT temperature in °C  |
| 0111           | EXTERNAL REF 1        | External reference REF1 in Hz  |
| 0112           | EXTERNAL REF 2        | External reference REF2 in percent. 100% equals the maximum motor speed.   |
| 0113           | CTRL LOCATION         | Active control location. (0) LOCAL; (1) EXT1; (2) EXT2.  |
| 0114           | RUN TIME (R)          | Elapsed drive running time counter (hours). Runs when the drive is modulating. The counter can be reset by pressing the UP and DOWN keys simultaneously when the control panel is in the Parameter mode.   |
| 0115           | KWH COUNTER (R)       | kWh counter. The counter value is accumulated till it reaches 65535 after which the counter rolls over and starts again from 0. The counter can be reset by pressing UP and DOWN keys simultaneously when the control panel is in the Parameter mode.                        |
| 0120           | AI 1                  | Relative value of analog input AI1 in percent  |
| 0121           | POT                   | Potentiometer value in percent   |
| 0126           | PID 1 OUTPUT          | Output value of the process PID1 controller in percent   |
| 0128           | PID 1 SETPNT          | Setpoint signal (reference) for the process PID1 controller. Unit depends on parameter <a href="#">4006 UNITS</a> and <a href="#">4007 UNIT SCALE</a> settings.  |
| 0130           | PID 1 FBK             | Feedback signal for the process PID1 controller. Unit depends on parameter <a href="#">4006 UNITS</a> and <a href="#">4007 UNIT SCALE</a> settings.  |
| 0132           | PID 1 DEVIATION       | Deviation of the process PID1 controller, that is the difference between the reference value and the actual value. Unit depends on parameter <a href="#">4006 UNITS</a> and <a href="#">4007 UNIT SCALE</a> .  |
| 0137           | PROCESS VAR 1         | Process variable 1 defined by parameter group <a href="#">34 PANEL DISPLAY</a>   |
| 0138           | PROCESS VAR 2         | Process variable 2 defined by parameter group <a href="#">34 PANEL DISPLAY</a>   |
| 0139           | PROCESS VAR 3         | Process variable 3 defined by parameter group <a href="#">34 PANEL DISPLAY</a>   |
| 0140           | RUN TIME              | Elapsed drive running time counter (thousands of hours). Runs when the drive is modulating. Counter cannot be reset.   |
| 0141           | MWH COUNTER           | MWh counter. The counter value is accumulated till it reaches 65535 after which the counter rolls over and starts again from 0. Cannot be reset.   |

| Actual signals                      |                  |   |
|-------------------------------------|------------------|---|
| No.                                 | Name/Value       | Description   |
| 0142                                | REVOLUTION CNTR  | Motor revolution counter (millions of revolutions). The counter can be reset by pressing the UP and DOWN keys simultaneously when the control panel is in the Parameter mode.   |
| 0143                                | DRIVE ON TIME HI | Drive control board power-on time in days. Counter cannot be reset.   |
| 0144                                | DRIVE ON TIME LO | Drive control board power-on time in 2 second ticks (30 ticks = 60 seconds). Counter cannot be reset.   |
| 0160                                | DI 1-5 STATUS    | Status of digital inputs. Example: 10000 = DI1 is on, DI2...DI5 are off.  |
| 0161                                | PULSE INPUT FREQ | Value of frequency input in Hz  |
| 0162                                | RO STATUS        | Status of relay output. 1 = RO is energized, 0 = RO is de-energized.  |
| <b>04 FAULT HISTORY</b> (read-only) |                  |   |
| 0401                                | LAST FAULT       | Fault code of the latest fault. See chapter <a href="#">Fault tracing</a> on page 127 for the codes. 0 = fault history is clear (on panel display = NO RECORD).   |
| 0402                                | FAULT TIME 1     | Day on which the latest fault occurred.<br>Format: The number of days elapsed after power-on.   |
| 0403                                | FAULT TIME 2     | Time at which the latest fault occurred.<br>Format: Time elapsed after power-on in 2 second ticks (minus the whole days stated by signal <a href="#">0402</a> FAULT TIME 1). 30 ticks = 60 seconds.<br>For example, value 514 equals 17 minutes and 8 seconds (= 514/30). |
| 0404                                | SPEED AT FLT     | Motor speed in rpm at the time the latest fault occurred  |
| 0405                                | FREQ AT FLT      | Frequency in Hz at the time the latest fault occurred   |
| 0406                                | VOLTAGE AT FLT   | Intermediate circuit voltage in V DC at the time the latest fault occurred  |
| 0407                                | CURRENT AT FLT   | Motor current in A at the time the latest fault occurred  |
| 0408                                | TORQUE AT FLT    | Motor torque in percent of the motor nominal torque at the time the latest fault occurred   |
| 0409                                | STATUS AT FLT    | Drive status in hexadecimal format at the time the latest fault occurred  |
| 0412                                | PREVIOUS FAULT 1 | Fault code of the 2nd latest fault. See chapter <a href="#">Fault tracing</a> on page 127 for the codes.  |
| 0413                                | PREVIOUS FAULT 2 | Fault code of the 3rd latest fault. See chapter <a href="#">Fault tracing</a> on page 127 for the codes.  |
| 0414                                | DI 1-5 AT FLT    | Status of digital inputs DI1...5 at the time the latest fault occurred. Example: 10000 = DI1 is on, DI2...DI5 are off.  |

## Parameters in the Long parameter mode

The following table includes the complete descriptions of all parameters that are visible only in the Long parameter mode. See section [Parameter modes](#) on page 65 for how to select the parameter mode.

| Parameters in the Long parameter mode |                |   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|---------------------------------------|----------------|---|-----------|-----|-----------|---|---|------|---|---|---------------|---|---|---------------|---|---|------|--|
| Index                                 | Name/Selection | Description   | Def       |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
| <b>10 START/STOP/DIR</b>              |                | The sources for external start, stop and direction control  |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
| 1001                                  | EXT1 COMMANDS  | Defines the connections and the source for the start, stop and direction commands for external control location 1 (EXT1).   | 2 = DI1,2 |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 0 = NOT SEL    | No start, stop and direction command source   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 1 = DI1        | Start and stop through digital input DI1. 0 = stop, 1 = start. Direction is fixed according to parameter <a href="#">1003</a> DIRECTION (setting REQUEST = FORWARD).  |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 2 = DI1,2      | Start and stop through digital input DI1. 0 = stop, 1 = start. Direction through digital input DI2. 0 = forward, 1 = reverse. To control direction, parameter <a href="#">1003</a> DIRECTION setting must be 3 (REQUEST).   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 3 = DI1P,2P    | Pulse start through digital input DI1. 0 -> 1: Start. (In order to start the drive, digital input DI2 must be activated prior to the pulse fed to DI1.)<br>Pulse stop through digital input DI2. 1 -> 0: Stop. Direction of rotation is fixed according to parameter <a href="#">1003</a> DIRECTION (setting REQUEST = FORWARD).<br><b>Note:</b> When the stop input (DI2) is deactivated (no input), the control panel start and stop keys are disabled.   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 4 = DI1P,2P,3  | Pulse start through digital input DI1. 0 -> 1: Start. (In order to start the drive, digital input DI2 must be activated prior to the pulse fed to DI1.)<br>Pulse stop through digital input DI2. 1 -> 0: Stop. Direction through digital input DI3. 0 = forward, 1 = reverse. To control direction, parameter <a href="#">1003</a> DIRECTION setting must be 3 (REQUEST).<br><b>Note:</b> When the stop input (DI2) is deactivated (no input), the control panel start and stop keys are disabled.                                |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 5 = DI1P,2P,3P | Pulse start forward through digital input DI1. 0 -> 1: Start forward. Pulse start reverse through digital input DI2. 0 -> 1: Start reverse. (In order to start the drive, digital input DI3 must be activated prior to the pulse fed to DI1/DI2).<br>Pulse stop through digital input DI3. 1 -> 0: Stop. To control the direction, parameter <a href="#">1003</a> DIRECTION setting must be 3 (REQUEST).<br><b>Note:</b> When the stop input (DI3) is deactivated (no input), the control panel start and stop keys are disabled. |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 8 = KEYPAD     | Start, stop and direction commands through control panel when EXT1 is active. To control the direction, parameter <a href="#">1003</a> DIRECTION setting must be 3 (REQUEST).   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 9 = DI1F,2R    | Start, stop and direction commands through digital inputs DI1 and DI2.<br><table border="1"> <thead> <tr> <th>DI1</th> <th>DI2</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Stop</td> </tr> <tr> <td>1</td> <td>0</td> <td>Start forward</td> </tr> <tr> <td>0</td> <td>1</td> <td>Start reverse</td> </tr> <tr> <td>1</td> <td>1</td> <td>Stop</td> </tr> </tbody> </table> Parameter <a href="#">1003</a> DIRECTION setting must be 3 (REQUEST).                | DI1       | DI2 | Operation | 0 | 0 | Stop | 1 | 0 | Start forward | 0 | 1 | Start reverse | 1 | 1 | Stop |  |
| DI1                                   | DI2            | Operation   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
| 0                                     | 0              | Stop  |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
| 1                                     | 0              | Start forward   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
| 0                                     | 1              | Start reverse   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
| 1                                     | 1              | Stop  |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 20 = DI5       | Start and stop through digital input DI5. 0 = stop, 1 = start. Direction is fixed according to parameter <a href="#">1003</a> DIRECTION (setting REQUEST = FORWARD).  |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |
|                                       | 21 = DI5,4     | Start and stop through digital input DI5. 0 = stop, 1 = start. Direction through digital input DI4. 0 = forward, 1 = reverse. To control direction, parameter <a href="#">1003</a> DIRECTION setting must be 3 (REQUEST).   |           |     |           |   |   |      |   |   |               |   |   |               |   |   |      |  |

| Parameters in the Long parameter mode |                |   |             |
|---------------------------------------|----------------|---|-------------|
| Index                                 | Name/Selection | Description   | Def         |
| 1002                                  | EXT2 COMMANDS  | Defines the connections and the source for the start, stop and direction commands for external control location 2 (EXT2). | 0 = NOT SEL |
|                                       |                | See parameter <a href="#">1001</a> EXT1 COMMANDS.   |             |
| 1003                                  | DIRECTION      | Enables the control of rotation direction of the motor, or fixes the direction.   | 3 = REQUEST |
|                                       | 1 = FORWARD    | Fixed to forward  |             |
|                                       | 2 = REVERSE    | Fixed to reverse  |             |
|                                       | 3 = REQUEST    | Control of rotation direction allowed   |             |

| Parameters in the Long parameter mode |                |   |  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
|---------------------------------------|----------------|---|--|---------|-----------|-------------|-----|---|---|---|-----|---|---|----------------------------------|-----|---|---|--|-----|---|---|-------------------|-----|---|---|---|-----|---|---|----------------------------------|-----|---|---|--|-----|---|---|--|------|---|---|---|-----|---|---|-------------------|-------------|
| Index                                 | Name/Selection | Description   | Def  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 1010                                  | JOGGING SEL    | <p>Defines the signal that activates the jogging function. The jogging function is typically used to control a cyclical movement of a machine section. One push button controls the drive through the whole cycle: When it is on, the drive starts, accelerates to a preset speed at a preset rate. When it is off, the drive decelerates to zero speed at a preset rate.</p> <p>The figure below describes the operation of the drive. It also represent how the drive shifts to normal operation (= jogging inactive) when the drive start command is switched on. Jog cmd = state of the jogging input, Start cmd = state of the drive start command.</p> <table border="1"> <thead> <tr> <th>Phase</th> <th>Jog cmd</th> <th>Start cmd</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1-2</td> <td>1</td> <td>0</td> <td>Drive accelerates to the jogging speed along the acceleration ramp of the jogging function.</td> </tr> <tr> <td>2-3</td> <td>1</td> <td>0</td> <td>Drive runs at the jogging speed.</td> </tr> <tr> <td>3-4</td> <td>0</td> <td>0</td> <td>Drive decelerates to zero speed along the deceleration ramp of the jogging function.</td> </tr> <tr> <td>4-5</td> <td>0</td> <td>0</td> <td>Drive is stopped.</td> </tr> <tr> <td>5-6</td> <td>1</td> <td>0</td> <td>Drive accelerates to the jogging speed along the acceleration ramp of the jogging function.</td> </tr> <tr> <td>6-7</td> <td>1</td> <td>0</td> <td>Drive runs at the jogging speed.</td> </tr> <tr> <td>7-8</td> <td>x</td> <td>1</td> <td>Normal operation overrides the jogging. Drive accelerates to the speed reference along the active acceleration ramp.</td> </tr> <tr> <td>8-9</td> <td>x</td> <td>1</td> <td>Normal operation overrides the jogging. Drive follows the speed reference.</td> </tr> <tr> <td>9-10</td> <td>0</td> <td>0</td> <td>Drive decelerates to zero speed along the active deceleration ramp.</td> </tr> <tr> <td>10-</td> <td>0</td> <td>0</td> <td>Drive is stopped.</td> </tr> </tbody> </table> <p>x = State can be either 1 or 0.</p> <p><b>Note:</b> The jogging is not operational when the drive start command is on.<br/> <b>Note:</b> The jogging speed overrides the constant speeds (<a href="#">12 CONSTANT SPEEDS</a>).<br/> <b>Note:</b> The ramp shape time (<a href="#">2207 RAMP SHAPE 2</a>) must be set to zero during jogging (that is, linear ramp).<br/>                     Jogging speed is defined by parameter <a href="#">1208 CONST SPEED 7</a>, acceleration and deceleration times are defined by parameters <a href="#">2205 ACCELER TIME 2</a> and <a href="#">2206 DECERLER TIME 2</a>. See also parameter <a href="#">2112 ZERO SPEED DELAY</a>.</p> | Phase  | Jog cmd | Start cmd | Description | 1-2 | 1 | 0 | Drive accelerates to the jogging speed along the acceleration ramp of the jogging function. | 2-3 | 1 | 0 | Drive runs at the jogging speed. | 3-4 | 0 | 0 | Drive decelerates to zero speed along the deceleration ramp of the jogging function. | 4-5 | 0 | 0 | Drive is stopped. | 5-6 | 1 | 0 | Drive accelerates to the jogging speed along the acceleration ramp of the jogging function. | 6-7 | 1 | 0 | Drive runs at the jogging speed. | 7-8 | x | 1 | Normal operation overrides the jogging. Drive accelerates to the speed reference along the active acceleration ramp. | 8-9 | x | 1 | Normal operation overrides the jogging. Drive follows the speed reference. | 9-10 | 0 | 0 | Drive decelerates to zero speed along the active deceleration ramp. | 10- | 0 | 0 | Drive is stopped. | 0 = NOT SEL |
| Phase                                 | Jog cmd        | Start cmd   | Description  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 1-2                                   | 1              | 0   | Drive accelerates to the jogging speed along the acceleration ramp of the jogging function.                          |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 2-3                                   | 1              | 0   | Drive runs at the jogging speed.   |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 3-4                                   | 0              | 0   | Drive decelerates to zero speed along the deceleration ramp of the jogging function.                                 |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 4-5                                   | 0              | 0   | Drive is stopped.  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 5-6                                   | 1              | 0   | Drive accelerates to the jogging speed along the acceleration ramp of the jogging function.                          |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 6-7                                   | 1              | 0   | Drive runs at the jogging speed.   |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 7-8                                   | x              | 1   | Normal operation overrides the jogging. Drive accelerates to the speed reference along the active acceleration ramp. |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 8-9                                   | x              | 1   | Normal operation overrides the jogging. Drive follows the speed reference.   |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 9-10                                  | 0              | 0   | Drive decelerates to zero speed along the active deceleration ramp.  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
| 10-                                   | 0              | 0   | Drive is stopped.  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
|                                       | 1 = DI1        | Digital input DI1. 0 = jogging inactive, 1 = jogging active.  |  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
|                                       | 2 = DI2        | See selection DI1.  |  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
|                                       | 3 = DI3        | See selection DI1.  |  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
|                                       | 4 = DI4        | See selection DI1.  |  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |
|                                       | 5 = DI5        | See selection DI1.  |  |         |           |             |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |                   |     |   |   |   |     |   |   |                                  |     |   |   |  |     |   |   |  |      |   |   |   |     |   |   |                   |             |

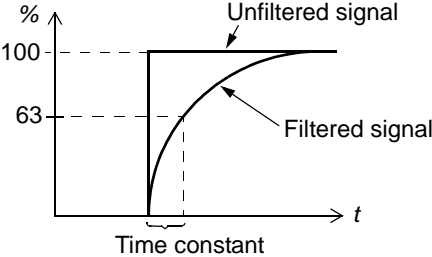
| Parameters in the Long parameter mode |                |   |          |
|---------------------------------------|----------------|---|----------|
| Index                                 | Name/Selection | Description   | Def      |
|                                       | 0 = NOT SEL    | Not selected  |          |
|                                       | -1 = DI1(INV)  | Inverted digital input DI1. 1 = jogging inactive, 0 = jogging active.   |          |
|                                       | -2 = DI2(INV)  | See selection DI1(INV).   |          |
|                                       | -3 = DI3(INV)  | See selection DI1(INV).   |          |
|                                       | -4 = DI4(INV)  | See selection DI1(INV).   |          |
|                                       | -5 = DI5(INV)  | See selection DI1(INV).   |          |
| <b>11 REFERENCE SELECT</b>            |                | <p>Panel reference type, local reference source, external control location selection and external reference sources and limits</p> <p>The drive can accept a variety of references in addition to the conventional analog input, potentiometer and control panel signals:</p> <ul style="list-style-type: none"> <li>- The drive reference can be given with two digital inputs: One digital input increases the speed, the other decreases it.</li> <li>- The drive can form a reference out of analog input and potentiometer signals by using mathematical functions: Addition, subtraction.</li> <li>- The drive reference can be given with a frequency input.</li> </ul> <p>It is possible to scale the external reference so that the signal minimum and maximum values correspond to a speed other than the minimum and maximum speed limits.</p> |          |
| 1101                                  | KEYPAD REF SEL | Selects the type of the reference in the local control mode.  | 1 = REF1 |
|                                       | 1 = REF1(Hz)   | Frequency reference   |          |
|                                       | 2 = REF2(%)    | %-reference   |          |
| 1102                                  | EXT1/EXT2 SEL  | Defines the source from which the drive reads the signal that selects between two external control locations, EXT1 or EXT2.   | 0 = EXT1 |
|                                       | 0 = EXT1       | EXT1 active. The control signal sources are defined by parameters <a href="#">1001</a> EXT1 COMMANDS and <a href="#">1103</a> REF1 SELECT.  |          |
|                                       | 1 = DI1        | Digital input DI1. 0 = EXT1, 1 = EXT2.  |          |
|                                       | 2 = DI2        | See selection DI1.  |          |
|                                       | 3 = DI3        | See selection DI1.  |          |
|                                       | 4 = DI4        | See selection DI1.  |          |
|                                       | 5 = DI5        | See selection DI1.  |          |
|                                       | 7 = EXT2       | EXT2 active. The control signal sources are defined by parameters <a href="#">1002</a> EXT2 COMMANDS and <a href="#">1106</a> REF2 SELECT.  |          |
|                                       | -1 = DI1(INV)  | Inverted digital input DI1. 1 = EXT1, 0 = EXT2.   |          |
|                                       | -2 = DI2(INV)  | See selection DI1(INV).   |          |
|                                       | -3 = DI3(INV)  | See selection DI1(INV).   |          |
|                                       | -4 = DI4(INV)  | See selection DI1(INV).   |          |
|                                       | -5 = DI5(INV)  | See selection DI1(INV).   |          |
| 1103                                  | REF1 SELECT    | Selects the signal source for external reference REF1.  | 1 = AI1  |
|                                       | 0 = KEYPAD     | Control panel   |          |
|                                       | 1 = AI1        | Analog input AI1  |          |
|                                       | 2 = POT        | Potentiometer   |          |

| Parameters in the Long parameter mode |                |   |     |
|---------------------------------------|----------------|---|-----|
| Index                                 | Name/Selection | Description   | Def |
| 3 = AI1/JOYST                         |                | <p>Analog input AI1 as joystick. The minimum input signal runs the motor at the maximum reference in the reverse direction, the maximum input at the maximum reference in the forward direction. Minimum and maximum references are defined by parameters <b>1104</b> REF1 MIN and <b>1105</b> REF1 MAX.</p> <p><b>Note:</b> Parameter <b>1003</b> DIRECTION must be set to 3 (REQUEST).</p> <p><b>WARNING!</b> If parameter <b>1301</b> MINIMUM AI1 is set to 0 V and analog input signal is lost (that is 0 V), the rotation of the motor is reversed to the maximum reference. Set the following parameters to activate a fault when analog input signal is lost:<br/>           Set parameter <b>1301</b> MINIMUM AI1 to 20% (2 V or 4 mA).<br/>           Set parameter <b>3021</b> AI1 FAULT LIMIT to 5% or higher.<br/>           Set parameter <b>3001</b> AI&lt;MIN FUNCTION to 1 (FAULT).</p> |     |
| 5 = DI3U,4D(R)                        |                | Digital input DI3: Reference increase. Digital input DI4: Reference decrease. Stop command resets the reference to zero. Parameter <b>2205</b> ACCELER TIME 2 defines the rate of the reference change.   |     |
| 6 = DI3U,4D                           |                | Digital input DI3: Reference increase. Digital input DI4: Reference decrease. The program stores the active speed reference (not reset by a stop command). When the drive is restarted, the motor ramps up with the selected acceleration rate to the stored reference. Parameter <b>2205</b> ACCELER TIME2 defines the rate of the reference change.   |     |
| 11 = DI3U,4D(RNC)                     |                | Digital input DI3: Reference increase. Digital input DI4: Reference decrease. Stop command resets the reference to zero. The reference is not saved if the control source is changed (from EXT1 to EXT2, from EXT2 to EXT1 or from LOC to REM). Parameter <b>2205</b> ACCELER TIME 2 defines the rate of the reference change.  |     |
| 12 = DI3U,4D(NC)                      |                | Digital input DI3: Reference increase. Digital input DI4: Reference decrease. The program stores the active speed reference (not reset by a stop command). The reference is not saved if the control source is changed (from EXT1 to EXT2, from EXT2 to EXT1 or from LOC to REM). When the drive is restarted, the motor ramps up with the selected acceleration rate to the stored reference. Parameter <b>2205</b> ACCELER TIME 2 defines the rate of the reference change.   |     |
| 14 = AI1+POT                          |                | Reference is calculated with the following equation:<br>$REF = AI1(\%) + POT(\%) - 50\%$  |     |
| 16 = AI1-POT                          |                | Reference is calculated with the following equation:<br>$REF = AI1(\%) + 50\% - POT(\%)$  |     |
| 30 = DI4U,5D                          |                | See selection DI3U,4D.  |     |
| 31 = DI4U,5D(NC)                      |                | See selection DI3U,4D(NC).  |     |
| 32 = FREQ INPUT                       |                | Frequency input   |     |

| Parameters in the Long parameter mode |                   |   |                            |
|---------------------------------------|-------------------|---|----------------------------|
| Index                                 | Name/Selection    | Description   | Def                        |
| 1104                                  | REF1 MIN          | Defines the minimum value for external reference REF1. Corresponds to the minimum setting of the used source signal.  | 0.0 Hz                     |
|                                       | 0.0...500.0 Hz    | <p>Minimum value.</p> <p>Example: Analog input AI1 is selected as the reference source (value of parameter <a href="#">1103</a> REF1 SELECT is AI1). The reference minimum and maximum correspond to the <a href="#">1301</a> MINIMUM AI1 and <a href="#">1302</a> MAXIMUM AI1 settings as follows:</p> |                            |
| 1105                                  | REF1 MAX          | Defines the maximum value for external reference REF1. Corresponds to the maximum setting of the used source signal.  | E: 50.0 Hz /<br>U: 60.0 Hz |
|                                       | 0.0...500.0 Hz    | Maximum value. See the example for parameter <a href="#">1104</a> REF1 MIN.   |                            |
| 1106                                  | REF2 SELECT       | Selects the signal source for external reference REF2.  | 2 = POT                    |
|                                       | 0 = KEYPAD        | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 1 = AI1           | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 2 = POT           | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 3 = AI1/JOYST     | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 5 = DI3U,4D(R)    | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 6 = DI3U,4D       | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 11 = DI3U,4D(RNC) | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 12 = DI3U,4D(NC)  | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 14 = AI1+POT      | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 16 = AI1-POT      | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 19 = PID1OUT      | PID controller 1 output. See parameter group <a href="#">40</a> PROCESS PID SET 1.  |                            |
|                                       | 30 = DI4U,5D      | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 31 = DI4U,5D(NC)  | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
|                                       | 32 = FREQ INPUT   | See parameter <a href="#">1103</a> REF1 SELECT.   |                            |
| 1107                                  | REF2 MIN          | Defines the minimum value for external reference REF2. Corresponds to the minimum setting of the used source signal.  | 0.0%                       |
|                                       | 0.0...100.0%      | Value in percent of the maximum frequency. See the example for parameter <a href="#">1104</a> REF1 MIN for correspondence to the source signal limits.  |                            |
| 1108                                  | REF2 MAX          | Defines the maximum value for external reference REF2. Corresponds to the maximum setting of the used source signal.  | 100.0%                     |
|                                       | 0.0...100.0%      | Value in percent of the maximum frequency. See the example for parameter <a href="#">1104</a> REF1 MIN for correspondence to the source signal limits.  |                            |
| 1109                                  | LOC REF SOURCE    | Selects the source for the local reference.   | 0 = POT                    |
|                                       | 0 = POT           | Potentiometer   |                            |
|                                       | 1 = KEYPAD        | Control panel   |                            |

| Parameters in the Long parameter mode |                        |   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|---------------------------------------|------------------------|---|---|-----|-----------|-----------|---|-------------------|---|-------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|
| Index                                 | Name/Selection         | Description   | Def   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| <b>12</b>                             | <b>CONSTANT SPEEDS</b> | Constant speed selection and values.<br>It is possible to define seven positive constant speeds. Constant speeds are selected with digital inputs. Constant speed activation overrides the external speed reference. Constant speed selections are ignored if drive is in the local control mode.   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1201                                  | CONST SPEED SEL        | Selects the constant speed activation signal.   | 9 = DI3,4   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0 = NOT SEL            | No constant speed in use  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 1 = DI1                | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through digital input DI1. 1 = active, 0 = inactive.   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 2 = DI2                | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through digital input DI2. 1 = active, 0 = inactive.   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 3 = DI3                | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through digital input DI3. 1 = active, 0 = inactive.   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 4 = DI4                | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through digital input DI4. 1 = active, 0 = inactive.   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 5 = DI5                | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through digital input DI5. 1 = active, 0 = inactive.   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 7 = DI1,2              | Constant speed selection through digital inputs DI1 and DI2. 1 = DI active, 0 = DI inactive.<br><table border="1"> <thead> <tr> <th>DI1</th> <th>DI2</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>No constant speed</td> </tr> <tr> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1202</a> CONST SPEED 1</td> </tr> <tr> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1203</a> CONST SPEED 2</td> </tr> <tr> <td>1</td> <td>1</td> <td>Speed defined by parameter <a href="#">1204</a> CONST SPEED 3</td> </tr> </tbody> </table>   | DI1   | DI2 | Operation | 0         | 0 | No constant speed | 1 | 0                 | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 | 0 | 1 | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 | 1 | 1 | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| DI1                                   | DI2                    | Operation   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 0                      | No constant speed   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 0                      | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 1                      | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 1                      | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 8 = DI2,3              | See selection DI1,2.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 9 = DI3,4              | See selection DI1,2.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 10 = DI4,5             | See selection DI1,2.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 12 = DI1,2,3           | Constant speed selection through digital inputs DI1, DI2 and DI3. 1 = DI active, 0 = DI inactive.<br><table border="1"> <thead> <tr> <th>DI1</th> <th>DI2</th> <th>DI3</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>No constant speed</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>Speed defined by parameter <a href="#">1202</a> CONST SPEED 1</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1203</a> CONST SPEED 2</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1204</a> CONST SPEED 3</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1205</a> CONST SPEED 4</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1206</a> CONST SPEED 5</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>Speed defined by parameter <a href="#">1207</a> CONST SPEED 6</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>Speed defined by parameter <a href="#">1208</a> CONST SPEED 7</td> </tr> </tbody> </table> | DI1   | DI2 | DI3       | Operation | 0 | 0                 | 0 | No constant speed | 1   | 0 | 0 | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 | 0 | 1 | 0   | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 | 1 | 1 | 0 | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 | 0 | 0 | 1 | Speed defined by parameter <a href="#">1205</a> CONST SPEED 4 | 1 | 0 | 1 | Speed defined by parameter <a href="#">1206</a> CONST SPEED 5 | 0 | 1 | 1 | Speed defined by parameter <a href="#">1207</a> CONST SPEED 6 | 1 | 1 | 1 | Speed defined by parameter <a href="#">1208</a> CONST SPEED 7 |  |
| DI1                                   | DI2                    | DI3   | Operation   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 0                      | 0   | No constant speed   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 0                      | 0   | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 1                      | 0   | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 1                      | 0   | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 0                      | 1   | Speed defined by parameter <a href="#">1205</a> CONST SPEED 4 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 0                      | 1   | Speed defined by parameter <a href="#">1206</a> CONST SPEED 5 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 1                      | 1   | Speed defined by parameter <a href="#">1207</a> CONST SPEED 6 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 1                      | 1   | Speed defined by parameter <a href="#">1208</a> CONST SPEED 7 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 13 = DI3,4,5           | See selection DI1,2,3.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -1 = DI1(INV)          | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through inverted digital input DI1. 0 = active, 1 = inactive.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -2 = DI2(INV)          | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through inverted digital input DI2. 0 = active, 1 = inactive.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -3 = DI3(INV)          | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through inverted digital input DI3. 0 = active, 1 = inactive.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -4 = DI4(INV)          | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through inverted digital input DI4. 0 = active, 1 = inactive.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |

| Parameters in the Long parameter mode |                     |   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|---------------------------------------|---------------------|---|---|-----|-----------|-----------|---|-------------------|---|-------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|
| Index                                 | Name/Selection      | Description   | Def   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -5 = DI5(INV)       | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 is activated through inverted digital input DI5. 0 = active, 1 = inactive.  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -7 = DI1,2 (INV)    | Constant speed selection through inverted digital inputs DI1 and DI2.<br>1 = DI active, 0 = DI inactive.<br><table border="1"> <thead> <tr> <th>DI1</th> <th>DI2</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>No constant speed</td> </tr> <tr> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1202</a> CONST SPEED 1</td> </tr> <tr> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1203</a> CONST SPEED 2</td> </tr> <tr> <td>0</td> <td>0</td> <td>Speed defined by parameter <a href="#">1204</a> CONST SPEED 3</td> </tr> </tbody> </table>   | DI1   | DI2 | Operation | 1         | 1 | No constant speed | 0 | 1                 | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 | 1 | 0 | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 | 0 | 0 | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| DI1                                   | DI2                 | Operation   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 1                   | No constant speed   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 1                   | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 0                   | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 0                   | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -8 = DI2,3 (INV)    | See selection DI1,2 (INV).  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -9 = DI3,4 (INV)    | See selection DI1,2 (INV).  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -10 = DI4,5 (INV)   | See selection DI1,2 (INV).  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -12 = DI1,2,3 (INV) | Constant speed selection through inverted digital inputs DI1, DI2 and DI3.<br>1 = DI active, 0 = DI inactive.<br><table border="1"> <thead> <tr> <th>DI1</th> <th>DI2</th> <th>DI3</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>1</td> <td>No constant speed</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>Speed defined by parameter <a href="#">1202</a> CONST SPEED 1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1203</a> CONST SPEED 2</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>Speed defined by parameter <a href="#">1204</a> CONST SPEED 3</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1205</a> CONST SPEED 4</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>Speed defined by parameter <a href="#">1206</a> CONST SPEED 5</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>Speed defined by parameter <a href="#">1207</a> CONST SPEED 6</td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> <td>Speed defined by parameter <a href="#">1208</a> CONST SPEED 7</td> </tr> </tbody> </table> | DI1   | DI2 | DI3       | Operation | 1 | 1                 | 1 | No constant speed | 0   | 1 | 1 | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 | 1 | 0 | 1   | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 | 0 | 0 | 1 | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 | 1 | 1 | 0 | Speed defined by parameter <a href="#">1205</a> CONST SPEED 4 | 0 | 1 | 0 | Speed defined by parameter <a href="#">1206</a> CONST SPEED 5 | 1 | 0 | 0 | Speed defined by parameter <a href="#">1207</a> CONST SPEED 6 | 0 | 0 | 0 | Speed defined by parameter <a href="#">1208</a> CONST SPEED 7 |  |
| DI1                                   | DI2                 | DI3   | Operation   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 1                   | 1   | No constant speed   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 1                   | 1   | Speed defined by parameter <a href="#">1202</a> CONST SPEED 1 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 0                   | 1   | Speed defined by parameter <a href="#">1203</a> CONST SPEED 2 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 0                   | 1   | Speed defined by parameter <a href="#">1204</a> CONST SPEED 3 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 1                   | 0   | Speed defined by parameter <a href="#">1205</a> CONST SPEED 4 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 1                   | 0   | Speed defined by parameter <a href="#">1206</a> CONST SPEED 5 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                                     | 0                   | 0   | Speed defined by parameter <a href="#">1207</a> CONST SPEED 6 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                                     | 0                   | 0   | Speed defined by parameter <a href="#">1208</a> CONST SPEED 7 |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | -13 = DI3,4,5 (INV) | See selection DI1,2,3(INV).   |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1202                                  | CONST SPEED 1       | Defines constant speed 1 (that is drive output frequency).  | E: 5.0 Hz /<br>U: 6.0 Hz                                      |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1203                                  | CONST SPEED 2       | Defines constant speed 2 (that is drive output frequency).  | E: 10.0 Hz /<br>U: 12.0 Hz                                    |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1204                                  | CONST SPEED 3       | Defines constant speed 3 (that is drive output frequency).  | E: 15.0 Hz /<br>U: 18.0 Hz                                    |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1205                                  | CONST SPEED 4       | Defines constant speed 4 (that is drive output frequency).  | E: 20.0 Hz /<br>U: 24.0 Hz                                    |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1206                                  | CONST SPEED 5       | Defines constant speed 5 (that is drive output frequency).  | E: 25.0 Hz /<br>U: 30.0 Hz                                    |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1207                                  | CONST SPEED 6       | Defines constant speed 6 (that is drive output frequency).  | E: 40.0 Hz /<br>U: 48.0 Hz                                    |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1208                                  | CONST SPEED 7       | Defines constant speed 7 (that is drive output frequency). Note that constant speed 7 may be used also as jogging speed ( <a href="#">1010</a> JOGGING SEL) and with fault function <a href="#">3001</a> AI<MIN FUNCTION.   | E: 50.0 Hz /<br>U: 60.0 Hz                                    |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|                                       | 0.0...500.0 Hz      | Output frequency  |   |     |           |           |   |                   |   |                   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |

| Parameters in the Long parameter mode |                |   |               |
|---------------------------------------|----------------|---|---------------|
| Index                                 | Name/Selection | Description   | Def           |
| <b>13 ANALOG INPUTS</b>               |                | Analog input signal processing  |               |
| 1301                                  | MINIMUM AI1    | <p>Defines the minimum %-value that corresponds to minimum mA/(V) signal for analog input AI1. When used as a reference, the value corresponds to the reference minimum setting.</p> <p>0...20 mA <math>\hat{=}</math> 0...100%<br/>           4...20 mA <math>\hat{=}</math> 20...100%</p> <p>Example: If AI1 is selected as the source for external reference REF1, this value corresponds to the value of parameter <b>1104</b> REF1 MIN.</p> <p><b>Note:</b> MINIMUM AI value must not exceed MAXIMUM AI value.</p> | 0.0%          |
|                                       | 0.0...100.0%   | Value in percent of the full signal range. Example: If the minimum value for analog input is 4 mA, the percent value for 0...20 mA range is:<br>$(4 \text{ mA} / 20 \text{ mA}) \cdot 100\% = 20\%$   |               |
| 1302                                  | MAXIMUM AI1    | <p>Defines the maximum %-value that corresponds to maximum mA/(V) signal for analog input AI1. When used as a reference, the value corresponds to the reference maximum setting.</p> <p>0...20 mA <math>\hat{=}</math> 0...100%<br/>           4...20 mA <math>\hat{=}</math> 20...100%</p> <p>Example: If AI1 is selected as the source for external reference REF1, this value corresponds to the value of parameter <b>1105</b> REF1 MAX.</p>  | 100.0%        |
|                                       | 0.0...100.0%   | Value in percent of the full signal range. Example: If the maximum value for analog input is 10 mA, the percent value for 0...20 mA range is:<br>$(10 \text{ mA} / 20 \text{ mA}) \cdot 100\% = 50\%$   |               |
| 1303                                  | FILTER AI1     | <p>Defines the filter time constant for analog input AI1, that is the time within which 63% of a step change is reached.</p>    | 0.1 s         |
|                                       | 0.0...10.0 s   | Filter time constant  |               |
| <b>14 RELAY OUTPUTS</b>               |                | Status information indicated through relay output and relay operating delays  |               |
| 1401                                  | RELAY OUTPUT 1 | Selects a drive status indicated through relay output RO. The relay energizes when the status meets the setting.  | 3 = FAULT(-1) |
|                                       | 0 = NOT SEL    | Not used  |               |
|                                       | 1 = READY      | Ready to function: Run enable signal on, no fault, supply voltage within acceptable range and emergency stop signal off.  |               |
|                                       | 2 = RUN        | Running: Start signal on, Run enable signal on, no active fault.  |               |
|                                       | 3 = FAULT(-1)  | Inverted fault. Relay is de-energized on a fault trip.  |               |
|                                       | 4 = FAULT      | Fault   |               |
|                                       | 5 = ALARM      | Alarm   |               |
|                                       | 6 = REVERSED   | Motor rotates in reverse direction.   |               |

| Parameters in the Long parameter mode |                    |  |       |
|---------------------------------------|--------------------|--|-------|
| Index                                 | Name/Selection     | Description  | Def   |
|                                       | 7 = STARTED        | The drive has received a start command. Relay is energized even if Run enable signal is off. Relay is de-energized when drive receives a stop command or a fault occurs.                             |       |
|                                       | 8 = SUPRV 1 OVER   | Status according to supervision parameters <a href="#">3201 SUPERV 1 PARAM</a> , <a href="#">3202 SUPERV 1 LIM LO</a> and <a href="#">3203 SUPERV 1 LIM HI</a> .                                     |       |
|                                       | 9 = SUPRV 1 UNDER  | See selection SUPRV 1 OVER.  |       |
|                                       | 10 = SUPRV 2 OVER  | Status according to supervision parameters <a href="#">3204 SUPERV 2 PARAM</a> , <a href="#">3205 SUPERV 2 LIM LO</a> and <a href="#">3206 SUPERV 2 LIM HI</a> .                                     |       |
|                                       | 11 = SUPRV 2 UNDER | See selection SUPRV 2 OVER.  |       |
|                                       | 12 = SUPRV 3 OVER  | Status according to supervision parameters <a href="#">3207 SUPERV 3 PARAM</a> , <a href="#">3208 SUPERV 3 LIM LO</a> and <a href="#">3209 SUPERV 3 LIM HI</a> .                                     |       |
|                                       | 13 = SUPRV 3 UNDER | See selection SUPRV 3 OVER.  |       |
|                                       | 14 = AT SET POINT  | Output frequency is equal to the reference frequency.  |       |
|                                       | 15 = FAULT(RST)    | Fault. Automatic reset after the autoreset delay. See parameter group <a href="#">31 AUTOMATIC RESET</a> .   |       |
|                                       | 16 = FLT/ALARM     | Fault or alarm   |       |
|                                       | 17 = EXT CTRL      | Drive is under external control.   |       |
|                                       | 18 = REF 2 SEL     | External reference REF2 is in use.   |       |
|                                       | 19 = CONST FREQ    | A constant speed is in use. See parameter group <a href="#">12 CONSTANT SPEEDS</a> .   |       |
|                                       | 20 = REF LOSS      | Reference or active control location is lost.  |       |
|                                       | 21 = OVERCURRENT   | Alarm/Fault by overcurrent protection function   |       |
|                                       | 22 = OVERVOLTAGE   | Alarm/Fault by overvoltage protection function   |       |
|                                       | 23 = DRIVE TEMP    | Alarm/Fault by drive overtemperature protection function   |       |
|                                       | 24 = UNDERVOLTAGE  | Alarm/Fault by undervoltage protection function  |       |
|                                       | 25 = AI1 LOSS      | Analog input AI1 signal is lost.   |       |
|                                       | 27 = MOTOR TEMP    | Alarm/Fault by motor overtemperature protection function. See parameter <a href="#">3005 MOT THERM PROT</a> .  |       |
|                                       | 28 = STALL         | Alarm/Fault by stall protection function. See parameter <a href="#">3010 STALL FUNCTION</a> .  |       |
|                                       | 29 = UNDERLOAD     | Alarm/Fault by underload protection function. See parameter <a href="#">3013 UNDERLOAD FUNC</a> .  |       |
|                                       | 30 = PID SLEEP     | PID sleep function. See parameter group <a href="#">40 PROCESS PID SET 1</a> .   |       |
|                                       | 33 = FLUX READY    | Motor is magnetized and able to supply nominal torque.   |       |
| 1404                                  | RO 1 ON DELAY      | Defines the operation delay for relay output RO.   | 0.0 s |
|                                       | 0.0...3600.0 s     | <p>Delay time. The figure below illustrates the operation (on) and release (off) delays for relay output RO.</p> <p>Control event</p> <p>Relay status</p> <p>1404 On delay</p> <p>1405 Off delay</p> |       |
| 1405                                  | RO 1 OFF DELAY     | Defines the release delay for relay output RO.   | 0.0 s |
|                                       | 0.0...3600.0 s     | Delay time. See the figure for parameter <a href="#">1404 RO 1 ON DELAY</a> .  |       |

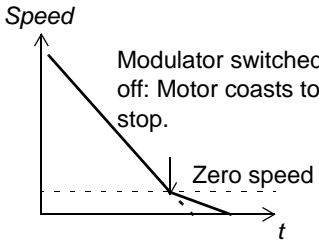
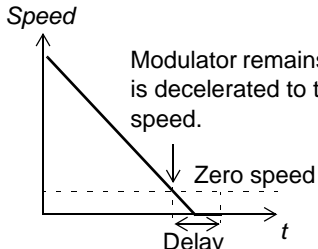
| Parameters in the Long parameter mode |                 |   |             |
|---------------------------------------|-----------------|---|-------------|
| Index                                 | Name/Selection  | Description   | Def         |
| <b>16 SYSTEM CONTROLS</b>             |                 | Run enable, parameter lock etc.   |             |
| 1601                                  | RUN ENABLE      | Selects a source for the external Run enable signal.  | 0 = NOT SEL |
|                                       | 0 = NOT SEL     | Allows the drive to start without an external Run enable signal.  |             |
|                                       | 1 = DI1         | External signal required through digital input DI1. 1 = Run enable. If Run enable signal is switched off, the drive does not start or coasts to stop if it is running.  |             |
|                                       | 2 = DI2         | See selection DI1.  |             |
|                                       | 3 = DI3         | See selection DI1.  |             |
|                                       | 4 = DI4         | See selection DI1.  |             |
|                                       | 5 = DI5         | See selection DI1.  |             |
|                                       | -1 = DI1(INV)   | External signal required through inverted digital input DI1. 0 = Run enable. If Run enable signal is switched on, the drive does not start or coasts to stop if it is running.  |             |
|                                       | -2 = DI2(INV)   | See selection DI1(INV)  |             |
|                                       | -3 = DI3(INV)   | See selection DI1(INV)  |             |
|                                       | -4 = DI4(INV)   | See selection DI1(INV)  |             |
|                                       | -5 = DI5(INV)   | See selection DI1(INV)  |             |
| 1602                                  | PARAMETER LOCK  | Selects the state of the parameter lock. The lock prevents parameter changing from the control panel.   | 1 = OPEN    |
|                                       | 0 = LOCKED      | Parameter values cannot be changed from the control panel. The lock can be opened by entering the valid code to parameter <a href="#">1603</a> PASS CODE. The lock does not prevent parameter changes made by macros. |             |
|                                       | 1 = OPEN        | The lock is open. Parameter values can be changed.  |             |
|                                       | 2 = NOT SAVED   | Parameter changes from the control panel are not stored into the permanent memory. To store changed parameter values, set parameter <a href="#">1607</a> PARAM SAVE value to 1 (SAVE).                                |             |
| 1603                                  | PASS CODE       | Selects the pass code for the parameter lock (see parameter <a href="#">1602</a> PARAMETER LOCK).   | 0           |
|                                       | 0...65535       | Pass code. Setting 358 opens the lock. The value reverts back to 0 automatically.   |             |
| 1604                                  | FAULT RESET SEL | Selects the source for the fault reset signal. The signal resets the drive after a fault trip if the cause of the fault no longer exists.   | 0 = KEYPAD  |
|                                       | 0 = KEYPAD      | Fault reset only from the control panel   |             |
|                                       | 1 = DI1         | Reset through digital input DI1 (reset on the rising edge of DI1) or from the control panel   |             |
|                                       | 2 = DI2         | See selection DI1.  |             |
|                                       | 3 = DI3         | See selection DI1.  |             |
|                                       | 4 = DI4         | See selection DI1.  |             |
|                                       | 5 = DI5         | See selection DI1.  |             |
|                                       | 7 = START/STOP  | Reset along with the stop signal received through a digital input, or from the control panel.   |             |
|                                       | -1 = DI1(INV)   | Reset through inverted digital input DI1 (reset on the falling edge of DI1) or from the control panel   |             |
|                                       | -2 = DI2(INV)   | See selection DI1(INV).   |             |

| Parameters in the Long parameter mode |                |  |             |
|---------------------------------------|----------------|--|-------------|
| Index                                 | Name/Selection | Description  | Def         |
|                                       | -3 = DI3(INV)  | See selection DI1(INV).  |             |
|                                       | -4 = DI4(INV)  | See selection DI1(INV).  |             |
|                                       | -5 = DI5(INV)  | See selection DI1(INV).  |             |
| 1606                                  | LOCAL LOCK     | Disables entering the local control mode or selects the source for the local control mode lock signal. When local lock is active, entering the local control mode is disabled (LOC/REM key of the panel).  | 0 = NOT SEL |
|                                       | 0 = NOT SEL    | Local control is allowed.  |             |
|                                       | 1 = DI1        | Local control mode lock signal through digital input DI1. Rising edge of digital input DI1: Local control disabled. Falling edge of digital input DI1: Local control allowed.  |             |
|                                       | 2 = DI2        | See selection DI1.   |             |
|                                       | 3 = DI3        | See selection DI1.   |             |
|                                       | 4 = DI4        | See selection DI1.   |             |
|                                       | 5 = DI5        | See selection DI1.   |             |
|                                       | 7 = ON         | Local control is disabled.   |             |
|                                       | -1 = DI1(INV)  | Local lock through inverted digital input DI1. Rising edge of inverted digital input DI1: Local control allowed. Falling edge of inverted digital input DI1: Local control disabled.   |             |
|                                       | -2 = DI2(INV)  | See selection DI1(INV).  |             |
|                                       | -3 = DI3(INV)  | See selection DI1(INV).  |             |
|                                       | -4 = DI4(INV)  | See selection DI1(INV).  |             |
|                                       | -5 = DI5(INV)  | See selection DI1(INV).  |             |
| 1607                                  | PARAM SAVE     | Saves the valid parameter values into the permanent memory.  | 0 = DONE    |
|                                       | 0 = DONE       | Saving completed   |             |
|                                       | 1 = SAVE       | Saving in progress   |             |
| 1610                                  | DISPLAY ALARMS | Activates/deactivates alarms <i>OVERCURRENT</i> (code: <a href="#">A2001</a> ), <i>OVERVOLTAGE</i> (code: <a href="#">A2002</a> ), <i>UNDERVOLTAGE</i> (code: <a href="#">A2003</a> ) and <i>DEVICE OVERTEMP</i> (code: <a href="#">A2006</a> ). For more information, see chapter <i>Fault tracing</i> on page <a href="#">127</a> .  | 0 = NO      |
|                                       | 0 = NO         | Alarms are inactive.   |             |
|                                       | 1 = YES        | Alarms are active.   |             |
| 1611                                  | PARAMETER VIEW | Selects the parameter view, that is which parameters are shown on the control panel.<br><b>Note:</b> This parameter is visible only when it is activated by the optional FlashDrop device. FlashDrop allows easy customisation of the parameter list, for example, selected parameters can be hidden. For more information, see <i>MFDT-01 FlashDrop user's manual</i> (3AFE68591074 [English]).<br>FlashDrop parameter values are activated by setting parameter <a href="#">9902</a> APPLIC MACRO to 31 (LOAD FD SET). | 0 = DEFAULT |
|                                       | 0 = DEFAULT    | Complete long and short parameter lists  |             |
|                                       | 1 = FLASHDROP  | FlashDrop parameter list. Does not include short parameter list. Parameters which are hidden by the FlashDrop device are not visible.  |             |

| Parameters in the Long parameter mode |                             |  |                      |
|---------------------------------------|-----------------------------|--|----------------------|
| Index                                 | Name/Selection              | Description  | Def                  |
| <b>18 FREQ INPUT</b>                  |                             |  |                      |
|                                       |                             | Frequency input signal processing. Digital input DI5 can be programmed as a frequency input. Frequency input can be used as external reference signal source. See parameter <a href="#">1103/1106</a> REF1/2 SELECT.   |                      |
| 1801                                  | FREQ INPUT MIN              | Defines the minimum input value when DI5 is used as a frequency input.   | 0 Hz                 |
|                                       | 0...16000 Hz                | Minimum frequency  |                      |
| 1802                                  | FREQ INPUT MAX              | Defines the maximum input value when DI5 is used as a frequency input.   | 1000 Hz              |
|                                       | 0...16000 Hz                | Maximum frequency  |                      |
| 1803                                  | FILTER FREQ IN              | Defines the filter time constant for frequency input, that is the time within which 63% of a step change is reached.   | 0.1 s                |
|                                       | 0.0...10.0 s                | Filter time constant   |                      |
| <b>20 LIMITS</b>                      |                             |  |                      |
| Drive operation limits                |                             |  |                      |
| 2003                                  | MAX CURRENT                 | Defines the allowed maximum motor current.   | $1.8 \cdot I_{2N}$ A |
|                                       | 0.0... $1.8 \cdot I_{2N}$ A | Current  |                      |
| 2005                                  | OVERVOLT CTRL               | Activates or deactivates the overvoltage control of the intermediate DC link. Fast braking of a high inertia load causes the voltage to rise to the overvoltage control limit. To prevent the DC voltage from exceeding the limit, the overvoltage controller automatically decreases the braking torque.<br><b>Note:</b> If a brake chopper and resistor are connected to the drive, the controller must be off (selection DISABLE) to allow chopper operation.   | 1 = ENABLE           |
|                                       | 0 = DISABLE                 | Overvoltage control deactivated  |                      |
|                                       | 1 = ENABLE                  | Overvoltage control activated  |                      |
| 2006                                  | UNDERVOLT CTRL              | Activates or deactivates the undervoltage control of the intermediate DC link. If the DC voltage drops due to input power cut off, the undervoltage controller automatically decreases the motor speed in order to keep the voltage above the lower limit. By decreasing the motor speed, the inertia of the load causes regeneration back into the drive, keeping the DC link charged and preventing an undervoltage trip until the motor coasts to stop. This acts as a power-loss ride-through functionality in systems with a high inertia, such as a centrifuge or a fan.   | 1 = ENABLE (TIME)    |
|                                       | 0 = DISABLE                 | Undervoltage control deactivated   |                      |
|                                       | 1 = ENABLE(TIME)            | Undervoltage control activated. The undervoltage control is active for 500 ms.   |                      |
|                                       | 2 = ENABLE                  | Undervoltage control activated. No operation time limit.   |                      |
| 2007                                  | MINIMUM FREQ                | Defines the minimum limit for the drive output frequency. A positive (or zero) minimum frequency value defines two ranges, one positive and one negative. A negative minimum frequency value defines one speed range.<br><b>Note:</b> MINIMUM FREQ value must not exceed MAXIMUM FREQ value.   | 0.0 Hz               |
|                                       |                             | <p>The figure contains two graphs illustrating the allowed frequency range based on the value of parameter 2007. Both graphs have frequency (f) on the vertical axis and time (t) on the horizontal axis.</p> <ul style="list-style-type: none"> <li><b>Left Graph:</b> Titled "2007 value is &lt; 0". The vertical axis has values 2008, 0, and 2007. A shaded horizontal bar labeled "Allowed frequency range" spans from 0 to 2008 Hz.</li> <li><b>Right Graph:</b> Titled "2007 value is ≥ 0". The vertical axis has values 2008, 2007, 0, -(2007), and -(2008). Two shaded horizontal bars labeled "Allowed frequency range" are shown: one from 0 to 2008 Hz, and another from -(2007) to -(2008) Hz.</li> </ul> |                      |
|                                       | -500.0...500.0 Hz           | Minimum frequency  |                      |

| Parameters in the Long parameter mode |                |  |                            |
|---------------------------------------|----------------|--|----------------------------|
| Index                                 | Name/Selection | Description  | Def                        |
| 2008                                  | MAXIMUM FREQ   | Defines the maximum limit for the drive output frequency.  | E: 50.0 Hz /<br>U: 60.0 Hz |
|                                       | 0.0...500.0 Hz | Maximum frequency. See parameter <a href="#">2007 MINIMUM FREQ.</a>  |                            |
| 2020                                  | BRAKE CHOPPER  | Selects the brake chopper control.   | 0 = INBUILT                |
|                                       | 0 = INBUILT    | Internal brake chopper control.<br><b>Note:</b> Ensure the brake resistor(s) is installed and the overvoltage control is switched off by setting parameter <a href="#">2005 OVERVOLT CTRL</a> to selection 0 (DISABLE).  |                            |
|                                       | 1 = EXTERNAL   | External brake chopper control.<br><b>Note:</b> The drive is compatible only with ABB <b>ACS-BRK-X</b> brake units.<br><b>Note:</b> Ensure the brake unit is installed and the overvoltage control is switched off by setting parameter <a href="#">2005 OVERVOLT CTRL</a> to selection 0 (DISABLE).   |                            |
| <b>21 START/STOP</b>                  |                | Start and stop modes of the motor  |                            |
| 2101                                  | START FUNCTION | Selects the motor starting method.   | 1 = AUTO                   |
|                                       | 1 = AUTO       | Frequency reference ramps immediately from 0 Hz.   |                            |
|                                       | 2 = DC MAGN    | The drive pre-magnetizes the motor with DC current before the start. The pre-magnetizing time is defined by parameter <a href="#">2103 DC MAGN TIME</a> .<br><b>Note:</b> Starting the drive connected to a rotating motor is not possible when 2 (DC MAGN) is selected.<br><b>WARNING!</b> The drive starts after the set pre-magnetizing time has passed even if the motor magnetization is not completed. In applications where a full break-away torque is essential, always ensure that the constant magnetizing time is long enough to allow generation of full magnetization and torque.  |                            |
|                                       | 4 = TORQ BOOST | Torque boost should be selected if a high break-away torque is required. The drive pre-magnetizes the motor with DC current before the start. The pre-magnetizing time is defined by parameter <a href="#">2103 DC MAGN TIME</a> .<br>Torque boost is applied at start. Torque boost is stopped when output frequency exceeds 20 Hz or when it is equal to the reference value. See parameter <a href="#">2110 TORQ BOOST CURR</a> .<br><b>Note:</b> Starting the drive connected to a rotating motor is not possible when 4 (TORQ BOOST) is selected.<br><b>WARNING!</b> The drive starts after the set pre-magnetizing time has passed although the motor magnetization is not completed. In applications where a full break-away torque is essential, always ensure that the constant magnetizing time is long enough to allow generation of full magnetization and torque. |                            |
|                                       | 6 = SCAN START | Frequency scanning flying start (starting the drive connected to a rotating motor). Based on frequency scanning (interval <a href="#">2008 MAXIMUM FREQ</a> ... <a href="#">2007 MINIMUM FREQ</a> ) to identify the frequency. If frequency identification fails, DC magnetization is used. See selection 2 (DC MAGN).   |                            |
|                                       | 7 = SCAN+BOOST | Combines frequency scanning flying start (starting the drive connected to a rotating motor) and torque boost. See selections 6 (SCAN START) and 4 (TORQ BOOST). If frequency identification fails, torque boost is used.   |                            |
| 2102                                  | STOP FUNCTION  | Selects the motor stop function.   | 1 = COAST                  |
|                                       | 1 = COAST      | Stop by cutting off the motor power supply. The motor coasts to stop.  |                            |
|                                       | 2 = RAMP       | Stop along a ramp. See parameter group <a href="#">22 ACCEL/DECEL</a> .  |                            |

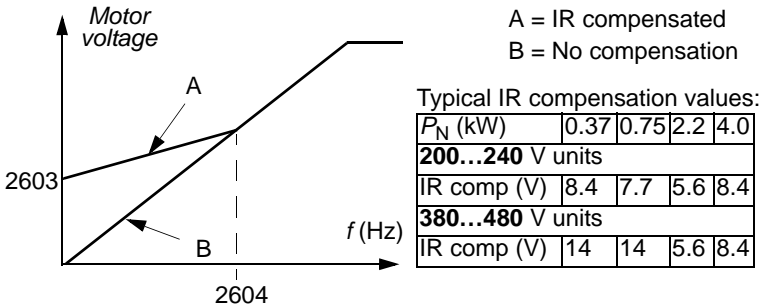
| Parameters in the Long parameter mode |                |   |             |
|---------------------------------------|----------------|---|-------------|
| Index                                 | Name/Selection | Description   | Def         |
| 2103                                  | DC MAGN TIME   | Defines the pre-magnetizing time. See parameter <a href="#">2101</a> START FUNCTION. After the start command, the drive automatically pre-magnetizes the motor for the defined time.  | 0.30 s      |
|                                       | 0.00...10.00 s | Magnetizing time. Set this value long enough to allow full motor magnetization. Too long a time heats the motor excessively.  |             |
| 2104                                  | DC HOLD CTL    | Activates the DC braking function.  | 0 = NOT SEL |
|                                       | 0 = NOT SEL    | Inactive  |             |
|                                       | 2 = DC BRAKING | DC current braking function active.<br>If parameter <a href="#">2102</a> STOP FUNCTION is set to 1(COAST), DC braking is applied after the start command is removed.<br>If parameter <a href="#">2102</a> STOP FUNCTION is set to 2 (RAMP), DC braking is applied after the ramp.   |             |
| 2106                                  | DC CURR REF    | Defines the DC braking current. See parameter <a href="#">2104</a> DC HOLD CTL.   | 30%         |
|                                       | 0...100%       | Value in percent of the motor nominal current (parameter <a href="#">9906</a> MOTOR NOM CURR)   |             |
| 2107                                  | DC BRAKE TIME  | Defines the DC braking time.  | 0.0 s       |
|                                       | 0.0...250.0 s  | Time  |             |
| 2108                                  | START INHIBIT  | Sets the Start inhibit function on or off. If the drive is not actively started and running, the Start inhibit function ignores a pending start command in any of the following situations and a new start command is required:<br>- a fault is reset.<br>- Run enable signal activates while the start command is active. See parameter <a href="#">1601</a> RUN ENABLE.<br>- the control mode changes from local to remote.<br>- the external control mode switches from EXT1 to EXT2 or from EXT2 to EXT1. | 0 = OFF     |
|                                       | 0 = OFF        | Disabled  |             |
|                                       | 1 = ON         | Enabled   |             |
| 2109                                  | EMERG STOP SEL | Selects the source for the external emergency stop command.<br>The drive cannot be restarted before the emergency stop command is reset.<br><b>Note:</b> The installation must include emergency stop devices and any other safety equipment that may be needed. Pressing the stop key on the drive's control panel does NOT<br>- generate an emergency stop of the motor.<br>- separate the drive from dangerous potential.  | 0 = NOT SEL |
|                                       | 0 = NOT SEL    | Emergency stop function is not selected.  |             |
|                                       | 1 = DI1        | Digital input DI1. 1 = stop along the emergency stop ramp. See parameter <a href="#">2208</a> EMERG DEC TIME. 0 = emergency stop command reset.   |             |
|                                       | 2 = DI2        | See selection DI1.  |             |
|                                       | 3 = DI3        | See selection DI1.  |             |
|                                       | 4 = DI4        | See selection DI1.  |             |
|                                       | 5 = DI5        | See selection DI1.  |             |
|                                       | -1 = DI1(INV)  | Inverted digital input DI. 0 = stop along the emergency stop ramp. See parameter <a href="#">2208</a> EMERG DEC TIME. 1 = emergency stop command reset  |             |
|                                       | -2 = DI2(INV)  | See selection DI1(INV).   |             |
|                                       | -3 = DI3(INV)  | See selection DI1(INV).   |             |

| Parameters in the Long parameter mode |                               |  |               |
|---------------------------------------|-------------------------------|--|---------------|
| Index                                 | Name/Selection                | Description  | Def           |
|                                       | -4 = DI4(INV)                 | See selection DI1(INV).  |               |
|                                       | -5 = DI5(INV)                 | See selection DI1(INV).  |               |
| 2110                                  | TORQ BOOST CURR               | Defines the maximum supplied current during torque boost. See parameter <a href="#">2101</a> START FUNCTION.   | 100%          |
|                                       | 15...300%                     | Value in percent   |               |
| 2112                                  | ZERO SPEED DELAY              | <p>Defines the delay for the Zero speed delay function. The function is useful in applications where a smooth and quick restarting is essential. During the delay the drive knows accurately the rotor position.</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p><b>No Zero speed delay</b></p>  </div> <div style="text-align: center;"> <p><b>With Zero speed delay</b></p>  </div> </div> <p>Zero speed delay can be used, for example, with jogging function (parameter <a href="#">1010</a> JOGGING SEL).</p> <p><b>No Zero speed delay</b></p> <p>The drive receives a stop command and decelerates along a ramp. When the motor actual speed falls below an internal limit (called Zero speed), the modulator is switched off. The inverter modulation is stopped and the motor coasts to standstill.</p> <p><b>With Zero speed delay</b></p> <p>The drive receives a stop command and decelerates along a ramp. When the actual motor speed falls below an internal limit (called Zero speed), the zero speed delay function activates. During the delay the functions keeps the modulator live: The inverter modulates, motor is magnetized and the drive is ready for a quick restart.</p> | 0.0 = NOT SEL |
|                                       | 0.0 = NOT SEL<br>0.0...60.0 s | Delay time. If parameter value is set to zero, the Zero speed delay function is disabled.  |               |
| <b>22 ACCEL/DECEL</b>                 |                               | Acceleration and deceleration times  |               |
| 2201                                  | ACC/DEC 1/2 SEL               | Defines the source from which the drive reads the signal that selects between two ramp pairs, acceleration/deceleration pair 1 and 2. Ramp pair 1 is defined by parameters <a href="#">2202</a> ACCELER TIME 1, <a href="#">2003</a> DECELER TIME 1 and <a href="#">2204</a> RAMP SHAPE 1. Ramp pair 2 is defined by parameters <a href="#">2205</a> ACCELER TIME 2, <a href="#">2206</a> DECELER TIME 2 and <a href="#">2207</a> RAMP SHAPE 1.  | 5 = DI5       |
|                                       | 0 = NOT SEL                   | Ramp pair 1 is used.   |               |
|                                       | 1 = DI1                       | Digital input DI1. 1 = ramp pair 2, 0 = ramp pair 1.   |               |
|                                       | 2 = DI2                       | See selection DI1.   |               |
|                                       | 3 = DI3                       | See selection DI1.   |               |
|                                       | 4 = DI4                       | See selection DI1.   |               |
|                                       | 5 = DI5                       | See selection DI1.   |               |
|                                       | -1 = DI1(INV)                 | Inverted digital input DI1. 0 = ramp pair 2, 1 = ramp pair 1.  |               |
|                                       | -2 = DI2(INV)                 | See selection DI1(INV).  |               |



| Parameters in the Long parameter mode |                                |   |              |
|---------------------------------------|--------------------------------|---|--------------|
| Index                                 | Name/Selection                 | Description   | Def          |
|                                       | -3 = DI3(INV)                  | See selection DI1(INV).   |              |
|                                       | -4 = DI4(INV)                  | See selection DI1(INV).   |              |
|                                       | -5 = DI5(INV)                  | See selection DI1(INV).   |              |
| 2202                                  | ACCELER TIME 1                 | <p>Defines the acceleration time 1, that is the time required for the speed to change from zero to the speed defined by parameter <b>2008</b> MAXIMUM FREQ.</p> <ul style="list-style-type: none"> <li>- If the speed reference increases faster than the set acceleration rate, the motor speed follows the acceleration rate.</li> <li>- If the speed reference increases slower than the set acceleration rate, the motor speed follows the reference signal.</li> <li>- If the acceleration time is set too short, the drive automatically prolongs the acceleration in order not to exceed the drive operating limits.</li> </ul> <p>Actual acceleration time depends on parameter <b>2204</b> RAMP SHAPE 1 setting.</p>   | 5.0 s        |
|                                       | 0.0...1800.0 s                 | Time  |              |
| 2203                                  | DECELER TIME 1                 | <p>Defines the deceleration time 1, that is the time required for the speed to change from the value defined by parameter <b>2008</b> MAXIMUM FREQ to zero.</p> <ul style="list-style-type: none"> <li>- If the speed reference decreases slower than the set deceleration rate, the motor speed follows the reference signal.</li> <li>- If the reference changes faster than the set deceleration rate, the motor speed follows the deceleration rate.</li> <li>- If the deceleration time is set too short, the drive automatically prolongs the deceleration in order not to exceed drive operating limits.</li> </ul> <p>If a short deceleration time is needed for a high inertia application, the drive should be equipped with a brake resistor.</p> <p>Actual deceleration time depends on parameter <b>2204</b> RAMP SHAPE 1 setting.</p> | 5.0 s        |
|                                       | 0.0...1800.0 s                 | Time  |              |
| 2204                                  | RAMP SHAPE 1                   | <p>Selects the shape of the acceleration/deceleration ramp 1. The function is deactivated during emergency stop (<b>2109</b> EMERG STOP SEL) and jogging (<b>1010</b> JOGGING SEL).</p>   | 0.0 = LINEAR |
|                                       | 0.0 = LINEAR<br>0.0...1000.0 s | <p>0.0 s: Linear ramp. Suitable for steady acceleration or deceleration and for slow ramps.</p> <p>0.1...1000.0 s: S-curve ramp. S-curve ramps are ideal for conveyors carrying fragile loads, or other applications where a smooth transition is required when changing from one speed to another. The S-curve consists of symmetrical curves at both ends of the ramp and a linear part in between.</p> <p>A rule of thumb<br/>A suitable relation between the ramp shape time and the acceleration ramp time is 1/5.</p>   |              |
|                                       |                                |   |              |

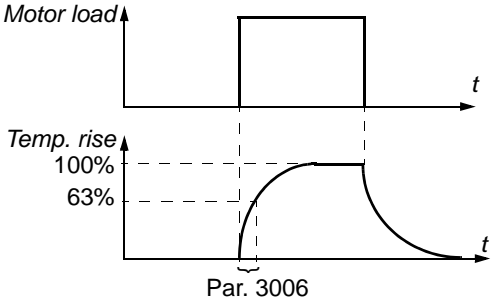
| Parameters in the Long parameter mode |                                |   |              |
|---------------------------------------|--------------------------------|---|--------------|
| Index                                 | Name/Selection                 | Description   | Def          |
| 2205                                  | ACCELER TIME 2                 | Defines the acceleration time 2, that is the time required for the speed to change from zero to the speed defined by parameter <a href="#">2008</a> MAXIMUM FREQ. See parameter <a href="#">2202</a> ACCELER TIME 1. Acceleration time 2 is used also as jogging acceleration time. See parameter <a href="#">1010</a> JOGGING SEL. | 60.0 s       |
|                                       | 0.0...1800.0 s                 | Time  |              |
| 2206                                  | DECELER TIME 2                 | Defines the deceleration time 2, that is the time required for the speed to change from the value defined by parameter <a href="#">2008</a> MAXIMUM FREQ to zero. See parameter <a href="#">2203</a> DECELER TIME 1. Deceleration time 2 is used also as jogging deceleration time. See parameter <a href="#">1010</a> JOGGING SEL. | 60.0 s       |
|                                       | 0.0...1800.0 s                 | Time  |              |
| 2207                                  | RAMP SHAPE 2                   | Selects the shape of the acceleration/deceleration ramp 2. The function is deactivated during emergency stop ( <a href="#">2109</a> EMERG STOP SEL). Ramp shape 2 is used also as jogging ramp shape time. See parameter <a href="#">1010</a> JOGGING SEL.  | 0.0 = LINEAR |
|                                       | 0.0 = LINEAR<br>0.0...1000.0 s | See parameter <a href="#">2204</a> RAMP SHAPE 1.  |              |
| 2208                                  | EMERG DEC TIME                 | Defines the time within which the drive is stopped if an emergency stop is activated. See parameter <a href="#">2109</a> EMERG STOP SEL.  | 1.0 s        |
|                                       | 0.0...1800.0 s                 | Time  |              |
| 2209                                  | RAMP INPUT 0                   | Defines the source for forcing the ramp input to zero.  | 0 = NOT SEL  |
|                                       | 0 = NOT SEL                    | Not selected  |              |
|                                       | 1 = DI1                        | Digital input DI1. 1 = ramp input is forced to zero. Ramp output ramps to zero according to the used ramp time.   |              |
|                                       | 2 = DI2                        | See selection DI1.  |              |
|                                       | 3 = DI3                        | See selection DI1.  |              |
|                                       | 4 = DI4                        | See selection DI1.  |              |
|                                       | 5 = DI5                        | See selection DI1.  |              |
|                                       | -1 = DI1(INV)                  | Inverted digital input DI1. 0 = ramp input is forced to zero. Ramp output ramps to zero according to the used ramp time.  |              |
|                                       | -2 = DI2(INV)                  | See selection DI1(INV).   |              |
|                                       | -3 = DI3(INV)                  | See selection DI1(INV).   |              |
|                                       | -4 = DI4(INV)                  | See selection DI1(INV).   |              |
|                                       | -5 = DI5(INV)                  | See selection DI1(INV).   |              |

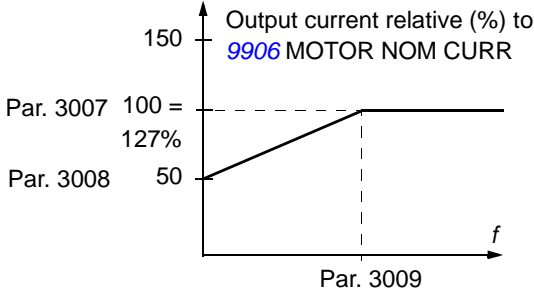
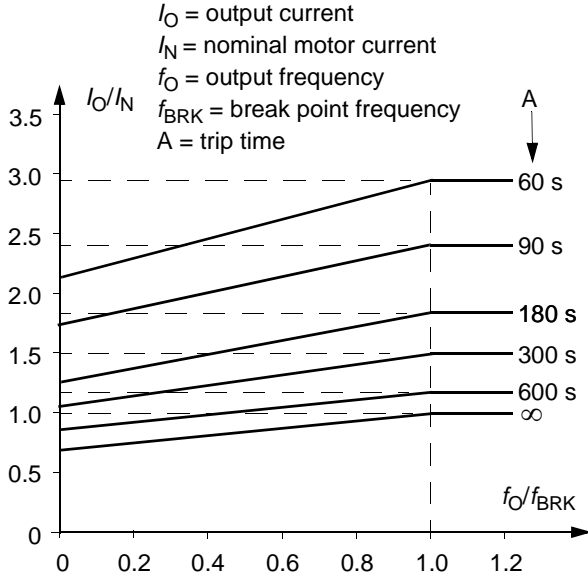
| Parameters in the Long parameter mode |                   |  |        |                   |   |                   |   |                   |   |                   |         |
|---------------------------------------|-------------------|--|--------|-------------------|---|-------------------|---|-------------------|---|-------------------|---------|
| Index                                 | Name/Selection    | Description  | Def    |                   |   |                   |   |                   |   |                   |         |
| <b>25 CRITICAL SPEEDS</b>             |                   | Speed bands within which the drive is not allowed to operate.<br>A Critical Speeds function is available for applications where it is necessary to avoid certain motor speeds or speed bands because of for example, mechanical resonance problems. The user can define three critical speeds or speed bands.  |        |                   |   |                   |   |                   |   |                   |         |
| 2501                                  | CRIT SPEED SEL    | <p>Activates/deactivates the critical speeds function. The critical speed function avoids specific speed ranges.</p> <p>Example: A fan has vibrations in the range of 18 to 23 Hz and 46 to 52 Hz. To make the drive to jump over the vibration speed ranges:</p> <ul style="list-style-type: none"> <li>- Activate the critical speeds function.</li> <li>- Set the critical speed ranges as in the figure below.</li> </ul> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>1</td> <td>Par. 2502 = 18 Hz</td> </tr> <tr> <td>2</td> <td>Par. 2503 = 23 Hz</td> </tr> <tr> <td>3</td> <td>Par. 2504 = 46 Hz</td> </tr> <tr> <td>4</td> <td>Par. 2505 = 52 Hz</td> </tr> </table> | 1      | Par. 2502 = 18 Hz | 2 | Par. 2503 = 23 Hz | 3 | Par. 2504 = 46 Hz | 4 | Par. 2505 = 52 Hz | 0 = OFF |
| 1                                     | Par. 2502 = 18 Hz |  |        |                   |   |                   |   |                   |   |                   |         |
| 2                                     | Par. 2503 = 23 Hz |  |        |                   |   |                   |   |                   |   |                   |         |
| 3                                     | Par. 2504 = 46 Hz |  |        |                   |   |                   |   |                   |   |                   |         |
| 4                                     | Par. 2505 = 52 Hz |  |        |                   |   |                   |   |                   |   |                   |         |
|                                       | 0 = OFF           | Inactive   |        |                   |   |                   |   |                   |   |                   |         |
|                                       | 1 = ON            | Active   |        |                   |   |                   |   |                   |   |                   |         |
| 2502                                  | CRIT SPEED 1 LO   | Defines the minimum limit for critical speed/frequency range 1.  | 0.0 Hz |                   |   |                   |   |                   |   |                   |         |
|                                       | 0.0...500.0 Hz    | Limit. The value cannot be above the maximum (parameter 2503 CRIT SPEED 1 HI).   |        |                   |   |                   |   |                   |   |                   |         |
| 2503                                  | CRIT SPEED 1 HI   | Defines the maximum limit for critical speed/frequency range 1.  | 0.0 Hz |                   |   |                   |   |                   |   |                   |         |
|                                       | 0.0...500.0 Hz    | Limit. The value cannot be below the minimum (parameter 2502 CRIT SPEED 1 LO).   |        |                   |   |                   |   |                   |   |                   |         |
| 2504                                  | CRIT SPEED 2 LO   | See parameter 2502 CRIT SPEED 1 LO.  | 0.0 Hz |                   |   |                   |   |                   |   |                   |         |
|                                       | 0.0...500.0 Hz    | See parameter 2502.  |        |                   |   |                   |   |                   |   |                   |         |
| 2505                                  | CRIT SPEED 2 HI   | See parameter 2503 CRIT SPEED 1 HI.  | 0.0 Hz |                   |   |                   |   |                   |   |                   |         |
|                                       | 0.0...500.0 Hz    | See parameter 2503.  |        |                   |   |                   |   |                   |   |                   |         |
| 2506                                  | CRIT SPEED 3 LO   | See parameter 2502 CRIT SPEED 1 LO.  | 0.0 Hz |                   |   |                   |   |                   |   |                   |         |
|                                       | 0.0...500.0 Hz    | See parameter 2502.  |        |                   |   |                   |   |                   |   |                   |         |
| 2507                                  | CRIT SPEED 3 HI   | See parameter 2503 CRIT SPEED 1 HI.  | 0.0 Hz |                   |   |                   |   |                   |   |                   |         |
|                                       | 0.0...500.0 Hz    | See parameter 2503.  |        |                   |   |                   |   |                   |   |                   |         |

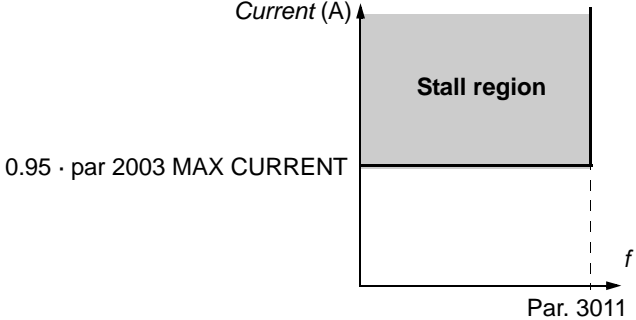
| Parameters in the Long parameter mode |                 |   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|---------------------------------------|-----------------|---|------------|------|------|-----|-----|--------------------------|--|--|--|--|-------------|-----|-----|-----|-----|--------------------------|--|--|--|--|-------------|----|----|-----|-----|----------------|
| Index                                 | Name/Selection  | Description   | Def        |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| <b>26 MOTOR CONTROL</b>               |                 | Motor control variables   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| 2601                                  | FLUX OPT ENABLE | Activates/deactivates the Flux optimisation function. Flux optimisation reduces the total energy consumption and motor noise level when the drive operates below the nominal load. The total efficiency (motor and the drive) can be improved by 1% to 10%, depending on the load torque and speed.<br><br>The disadvantage of this function is that the dynamic performance of the drive is weakened.  | 0 = OFF    |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 0 = OFF         | Inactive  |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 1 = ON          | Active  |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| 2603                                  | IR COMP VOLT    | Defines the output voltage boost at zero speed (IR compensation). The function is useful in applications with a high break-away torque. To prevent overheating, set IR compensation voltage as low as possible.<br><br>The figure below illustrates the IR compensation.<br><br> <p>A = IR compensated<br/>B = No compensation</p> <table border="1"> <thead> <tr> <th><math>P_N</math> (kW)</th> <th>0.37</th> <th>0.75</th> <th>2.2</th> <th>4.0</th> </tr> </thead> <tbody> <tr> <td colspan="5"><b>200...240 V units</b></td> </tr> <tr> <td>IR comp (V)</td> <td>8.4</td> <td>7.7</td> <td>5.6</td> <td>8.4</td> </tr> <tr> <td colspan="5"><b>380...480 V units</b></td> </tr> <tr> <td>IR comp (V)</td> <td>14</td> <td>14</td> <td>5.6</td> <td>8.4</td> </tr> </tbody> </table> | $P_N$ (kW) | 0.37 | 0.75 | 2.2 | 4.0 | <b>200...240 V units</b> |  |  |  |  | IR comp (V) | 8.4 | 7.7 | 5.6 | 8.4 | <b>380...480 V units</b> |  |  |  |  | IR comp (V) | 14 | 14 | 5.6 | 8.4 | Type dependent |
| $P_N$ (kW)                            | 0.37            | 0.75  | 2.2        | 4.0  |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| <b>200...240 V units</b>              |                 |   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| IR comp (V)                           | 8.4             | 7.7   | 5.6        | 8.4  |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| <b>380...480 V units</b>              |                 |   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| IR comp (V)                           | 14              | 14  | 5.6        | 8.4  |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 0.0...100.0 V   | Voltage boost   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| 2604                                  | IR COMP FREQ    | Defines the frequency at which the IR compensation is 0 V. See the figure for parameter <a href="#">2603</a> IR COMP VOLT.  | 80%        |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 0...100%        | Value in percent of the motor frequency   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| 2605                                  | U/F RATIO       | Selects the voltage to frequency (U/f) ratio below the field weakening point.   | 1 = LINEAR |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 1 = LINEAR      | Linear ratio for constant torque applications   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 2 = SQUARED     | Squared ratio for centrifugal pump and fan applications. With squared U/f ratio the noise level is lower for most operating frequencies.  |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
| 2606                                  | SWITCHING FREQ  | Defines the switching frequency of the drive. Higher switching frequency results in lower acoustic noise. See also parameter <a href="#">2607</a> SWITCH FREQ CTRL and section <a href="#">Switching frequency derating, I2N</a> on page <a href="#">139</a> .<br><br>In multimotor systems, do not change the switching frequency from the default value.  | 4 kHz      |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 4 kHz           | 4 kHz   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 8 kHz           | 8 kHz   |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 12 kHz          | 12 kHz  |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |
|                                       | 16 kHz          | 16 kHz  |            |      |      |     |     |                          |  |  |  |  |             |     |     |     |     |                          |  |  |  |  |             |    |    |     |     |                |

| Parameters in the Long parameter mode |                  |   |             |
|---------------------------------------|------------------|---|-------------|
| Index                                 | Name/Selection   | Description   | Def         |
| 2607                                  | SWITCH FREQ CTRL | <p>Activates the switching frequency control. When active, the selection of parameter <a href="#">2606 SWITCHING FREQ</a> is limited when the drive internal temperature increases. See the figure below. This function allows the highest possible switching frequency at a specific operation point. Higher switching frequency results in lower acoustic noise, but higher internal losses.</p> <p>The graph plots the switching frequency limit (<math>f_{sw} \text{ limit}</math>) on the y-axis against Drive temperature (<math>T</math>) on the x-axis. The y-axis has markers at 4 kHz, 8 kHz, and 12 kHz. The x-axis has markers at 100 °C, 110 °C, and 120 °C. The curve starts at 12 kHz for temperatures up to 100 °C. Between 100 °C and 120 °C, the limit decreases linearly from 12 kHz to 4 kHz. For temperatures above 120 °C, the limit remains constant at 4 kHz.</p> | 1 = ON      |
|                                       | 1 = ON           | Active  |             |
|                                       | 2 = ON (LOAD)    | Switching frequency can adapt to loading instead of limiting the output current. This allows maximum loading with all switching frequency selections. The drive automatically decreases the actual switching frequency if loading is too high for the selected switching frequency.   |             |
| 2608                                  | SLIP COMP RATIO  | <p>Defines the slip gain for the motor slip compensation control. 100% means full slip compensation, 0% means no slip compensation. Other values can be used if a static speed error is detected despite of the full slip compensation. Example: 35 Hz constant speed reference is given to the drive. Despite of the full slip compensation (SLIP COMP RATIO = 100%), a manual tachometer measurement from the motor axis gives a speed value of 34 Hz. The static speed error is 35 Hz - 34 Hz = 1 Hz. To compensate the error, the slip gain should be increased.</p>  | 0%          |
|                                       | 0...200%         | Slip gain   |             |
| 2609                                  | NOISE SMOOTHING  | <p>Enables the noise smoothing function. Noise smoothing distributes the acoustic motor noise over a range of frequencies instead of a single tonal frequency resulting in lower peak noise intensity. A random component with an average of 0 Hz is added to the switching frequency set by parameter <a href="#">2606 SWITCHING FREQ</a>.</p> <p><b>Note:</b> Parameter has no effect if parameter <a href="#">2606 SWITCHING FREQ</a> is set to 16 kHz.</p>  | 0 = DISABLE |
|                                       | 0 = DISABLE      | Disabled  |             |
|                                       | 1 = ENABLE       | Enabled   |             |
| 2619                                  | DC STABILIZER    | <p>Enables or disables the DC voltage stabilizer. The DC stabilizer is used to prevent possible voltage oscillations in the drive DC bus caused by motor load or weak supply network. In case of voltage variation, the drive tunes the frequency reference to stabilize the DC bus voltage and therefore the load torque oscillation.</p>  | 0 = DISABLE |
|                                       | 0 = DISABLE      | Disabled  |             |
|                                       | 1 = ENABLE       | Enabled   |             |

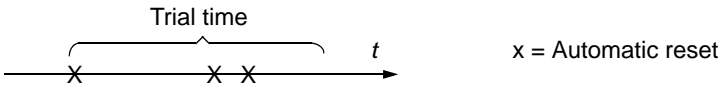
| Parameters in the Long parameter mode |                  |   |             |
|---------------------------------------|------------------|---|-------------|
| Index                                 | Name/Selection   | Description   | Def         |
| <b>30 FAULT FUNCTIONS</b>             |                  | Programmable protection functions   |             |
| 3001                                  | AI<MIN FUNCTION  | <p>Defines the drive response if the analog input (AI) signal drops below the fault limits and AI is used</p> <ul style="list-style-type: none"> <li>• as the active reference source (group <a href="#">11 REFERENCE SELECT</a>)</li> <li>• as the process or external PID controllers' feedback or setpoint source (group <a href="#">40 PROCESS PID SET 1</a>) and the corresponding PID controller is active.</li> </ul> <p><a href="#">3021 AI1 FAULT LIMIT</a> sets the fault limits</p>                      | 0 = NOT SEL |
|                                       | 0 = NOT SEL      | Protection is inactive.   |             |
|                                       | 1 = FAULT        | The drive trips on fault <a href="#">AI1 LOSS</a> (code: <a href="#">F0007</a> ) and the motor coasts to stop. Fault limit is defined by parameter <a href="#">3021 AI1 FAULT LIMIT</a> .   |             |
|                                       | 2 = CONST SP 7   | <p>The drive generates alarm <a href="#">AI1 LOSS</a> (code: <a href="#">A2006</a>) and sets the speed to the value defined by parameter <a href="#">1208 CONST SPEED 7</a>. The alarm limit is defined by parameter <a href="#">3021 AI1 FAULT LIMIT</a>.</p> <p> <b>WARNING!</b> Make sure that it is safe to continue operation in case the analog input signal is lost.</p>  |             |
|                                       | 3 = LAST SPEED   | <p>The drive generates alarm <a href="#">AI1 LOSS</a> (code: <a href="#">A2006</a>) and freezes the speed to the level the drive was operating at. The speed is determined by the average speed over the previous 10 seconds. The alarm limit is defined by parameter <a href="#">3021 AI1 FAULT LIMIT</a>.</p> <p> <b>WARNING!</b> Make sure that it is safe to continue operation in case the analog input signal is lost.</p> |             |
| 3003                                  | EXTERNAL FAULT 1 | Selects an interface for an external fault 1 signal.  | 0 = NOT SEL |
|                                       | 0 = NOT SEL      | Not selected  |             |
|                                       | 1 = DI1          | External fault indication through digital input DI1. 1: Fault trip on <a href="#">EXT FAULT 1</a> (code: <a href="#">F0014</a> ). Motor coasts to stop. 0: No external fault.   |             |
|                                       | 2 = DI2          | See selection DI1.  |             |
|                                       | 3 = DI3          | See selection DI1.  |             |
|                                       | 4 = DI4          | See selection DI1.  |             |
|                                       | 5 = DI5          | See selection DI1.  |             |
|                                       | -1 = DI1(INV)    | External fault indication through inverted digital input DI1. 0: Fault trip on <a href="#">EXT FAULT 1</a> (code: <a href="#">F0014</a> ). Motor coasts to stop. 1: No external fault.  |             |
|                                       | -2 = DI2(INV)    | See selection DI1(INV).   |             |
|                                       | -3 = DI3(INV)    | See selection DI1(INV).   |             |
|                                       | -4 = DI4(INV)    | See selection DI1(INV).   |             |
|                                       | -5 = DI5(INV)    | See selection DI1(INV).   |             |
| 3004                                  | EXTERNAL FAULT 2 | Selects an interface for an external fault 2 signal.  | 0 = NOT SEL |
|                                       |                  | See parameter <a href="#">3003 EXTERNAL FAULT 1</a> .   |             |


| Parameters in the Long parameter mode |                |   |           |
|---------------------------------------|----------------|---|-----------|
| Index                                 | Name/Selection | Description   | Def       |
| 3005                                  | MOT THERM PROT | <p>Selects how the drive reacts when motor overtemperature is detected. The drive calculates the temperature of the motor on the basis of the following assumptions:</p> <p>1) The motor is in the ambient temperature of 30 °C when power is applied to the drive.</p> <p>2) Motor temperature is calculated using either the user-adjustable (see parameters <a href="#">3006</a> MOT THERM TIME, <a href="#">3007</a> MOT LOAD CURVE, <a href="#">3008</a> ZERO SPEED LOAD and <a href="#">3009</a> BREAK POINT FREQ) or automatically calculated motor thermal time constant and motor load curve. The load curve should be adjusted in case the ambient temperature exceeds 30 °C.</p>             | 1 = FAULT |
|                                       | 0 = NOT SEL    | Protection is inactive.   |           |
|                                       | 1 = FAULT      | The drive trips on fault <i>MOT OVERTEMP</i> (code: <i>F0009</i> ) when the temperature exceeds 110 °C, and the motor coasts to stop.   |           |
|                                       | 2 = ALARM      | The drive generates alarm <i>MOTOR TEMP</i> (code: <i>A2010</i> ) when the motor temperature exceeds 90 °C.   |           |
| 3006                                  | MOT THERM TIME | <p>Defines the thermal time constant for the motor thermal model, that is the time within which the motor temperature has reached 63% of the nominal temperature with steady load.</p> <p>For thermal protection according to UL requirements for NEMA class motors, use the rule of thumb: Motor thermal time = 35 · t<sub>6</sub>. t<sub>6</sub> (in seconds) is specified by the motor manufacturer as the time the motor can safely operate at six times its rated current.</p> <p>Thermal time for a Class 10 trip curve is 350 s, for a Class 20 trip curve 700 s, and for a Class 30 trip curve 1050 s.</p>  | 500 s     |
|                                       | 256...9999 s   | Time constant   |           |

| Parameters in the Long parameter mode |                  |  |       |
|---------------------------------------|------------------|--|-------|
| Index                                 | Name/Selection   | Description  | Def   |
| 3007                                  | MOT LOAD CURVE   | <p>Defines the load curve together with parameters <a href="#">3008</a> ZERO SPEED LOAD and <a href="#">3009</a> BREAK POINT FREQ. With the default value 100%, motor overload protection is functioning when the constant current exceeds 127% of the parameter <a href="#">9906</a> MOTOR NOM CURR value.</p> <p>The default overloadability is at the same level as what motor manufacturers typically allow below 30 °C (86 °F) ambient temperature and below 1000 m (3300 ft) altitude. When the ambient temperature exceeds 30 °C (86 °F) or the installation altitude is over 1000 m (3300 ft), decrease the parameter 3007 value according to the motor manufacturer's recommendation.</p> <p><b>Example:</b> If the constant protection level needs to be 115% of the motor nominal current, set parameter 3007 value to 91% (= 115/127·100%).</p>  | 100%  |
|                                       | 50....150%       | Allowed continuous motor load relative to the nominal motor current  |       |
| 3008                                  | ZERO SPEED LOAD  | Defines the load curve together with parameters <a href="#">3007</a> MOT LOAD CURVE and <a href="#">3009</a> BREAK POINT FREQ.   | 70%   |
|                                       | 25....150%       | Allowed continuous motor load at zero speed in percent of the nominal motor current  |       |
| 3009                                  | BREAK POINT FREQ | <p>Defines the load curve together with parameters <a href="#">3007</a> MOT LOAD CURVE and <a href="#">3008</a> ZERO SPEED LOAD.</p> <p>Example: Thermal protection trip times when parameters <a href="#">3006</a> MOT THERM TIME, <a href="#">3007</a> MOT LOAD CURVE and <a href="#">3008</a> ZERO SPEED LOAD have default values.</p>  <p> <math>I_O</math> = output current<br/> <math>I_N</math> = nominal motor current<br/> <math>f_O</math> = output frequency<br/> <math>f_{BRK}</math> = break point frequency<br/> A = trip time </p>  | 35 Hz |
|                                       | 1...250 Hz       | Drive output frequency at 100% load  |       |

| Parameters in the Long parameter mode |                 |  |             |
|---------------------------------------|-----------------|--|-------------|
| Index                                 | Name/Selection  | Description  | Def         |
| 3010                                  | STALL FUNCTION  | <p>Selects how the drive reacts to a motor stall condition. The protection wakes up if the drive has operated in a stall region (see the figure below) longer than the time set by parameter <a href="#">3012</a> STALL TIME.</p>    | 0 = NOT SEL |
|                                       | 0 = NOT SEL     | Protection is inactive.  |             |
|                                       | 1 = FAULT       | The drive trips on fault <a href="#">MOTOR STALL</a> (code: <a href="#">F0012</a> ) and the motor coasts to stop.  |             |
|                                       | 2 = ALARM       | The drive generates alarm <a href="#">MOTOR STALL</a> (code: <a href="#">A2012</a> ).  |             |
| 3011                                  | STALL FREQUENCY | Defines the frequency limit for the stall function. See parameter <a href="#">3010</a> STALL FUNCTION.   | 20.0 Hz     |
|                                       | 0.5...50.0 Hz   | Frequency  |             |
| 3012                                  | STALL TIME      | Defines the time for the stall function. See parameter <a href="#">3010</a> STALL FUNCTION.  | 20 s        |
|                                       | 10...400 s      | Time   |             |
| 3013                                  | UNDERLOAD FUNC  | <p>Selects how the drive reacts to underload. The protection wakes up if</p> <ul style="list-style-type: none"> <li>- the motor torque falls below the curve selected by parameter <a href="#">3015</a> UNDERLOAD CURVE,</li> <li>- output frequency is higher than 10% of the nominal motor frequency and</li> <li>- the above conditions have been valid longer than the time set by parameter <a href="#">3014</a> UNDERLOAD TIME.</li> </ul> | 0 = NOT SEL |
|                                       | 0 = NOT SEL     | Protection is inactive.  |             |
|                                       | 1 = FAULT       | The drive trips on fault <a href="#">UNDERLOAD</a> (code: <a href="#">F0017</a> ) and the motor coasts to stop.  |             |
|                                       | 2 = ALARM       | The drive generates alarm <a href="#">UNDERLOAD</a> (code: <a href="#">A2011</a> ).  |             |
| 3014                                  | UNDERLOAD TIME  | Defines the time limit for the underload function. See parameter <a href="#">3013</a> UNDERLOAD FUNC.  | 20 s        |
|                                       | 10...400 s      | Time limit   |             |

| Parameters in the Long parameter mode |                 |  |            |
|---------------------------------------|-----------------|--|------------|
| Index                                 | Name/Selection  | Description  | Def        |
| 3015                                  | UNDERLOAD CURVE | <p>Selects the load curve for the underload function. See parameter <a href="#">3013</a> UNDERLOAD FUNC.</p> <p><math>T_M</math> = nominal torque of the motor<br/> <math>f_N</math> = nominal frequency of the motor (par. <a href="#">9907</a>)</p> <p>Underload curve types</p>   | 1          |
|                                       | 1...5           | Number of the load curve type in the figure  |            |
| 3016                                  | SUPPLY PHASE    | Selects how the drive reacts to supply phase loss, that is when DC voltage ripple is excessive.  | 0 = FAULT  |
|                                       | 0 = FAULT       | The drive trips on fault <a href="#">INPUT PHASE LOSS</a> (code: <a href="#">F0022</a> ) and the motor coasts to stop when the DC voltage ripple exceeds 14% of the nominal DC voltage.  |            |
|                                       | 1 = LIMIT/ALARM | <p>Drive output current is limited and alarm <a href="#">INPUT PHASE LOSS</a> (code: <a href="#">A2026</a>) is generated when the DC voltage ripple exceeds 14% of the nominal DC voltage.</p> <p>There is a 10 s delay between the activation of the alarm and the output current limitation. The current is limited until the ripple drops under the minimum limit, <math>0.3 \cdot I_{hd}</math>.</p>   |            |
|                                       | 2 = ALARM       | The drive generates alarm <a href="#">INPUT PHASE LOSS</a> (code: <a href="#">A2026</a> ) when the DC ripple exceeds 14% of the nominal DC voltage.  |            |
| 3017                                  | EARTH FAULT     | Selects how the drive reacts when an earth (ground) fault is detected in the motor or the motor cable. The protection is active only during start. An earth fault in the input power line does not activate the protection<br><b>Note:</b> Disabling earth (ground) fault may void the warranty.   | 1 = ENABLE |
|                                       | 0 = DISABLE     | No action  |            |
|                                       | 1 = ENABLE      | The drive trips on fault <a href="#">EARTH FAULT</a> (code: <a href="#">F0016</a> ).   |            |
| 3021                                  | AI1 FAULT LIMIT | <p>Defines the fault or alarm level for analog input AI1. If parameter <a href="#">3001</a> AI&lt;MIN&gt;FUNCTION is set to 1 (FAULT), 2 (CONST SP 7) or 3 (LAST SPEED), the drive generates alarm or fault <a href="#">AI1 LOSS</a> (code: <a href="#">A2006</a> or <a href="#">F0007</a>), when the analog input signal falls below the set level.</p> <p>Do not set this limit below the level defined by parameter <a href="#">1301</a> MINIMUM AI1.</p> | 0.0%       |
|                                       | 0.0...100.0%    | Value in percent of the full signal range  |            |

| Parameters in the Long parameter mode |                        |  |             |
|---------------------------------------|------------------------|--|-------------|
| Index                                 | Name/Selection         | Description  | Def         |
| 3023                                  | WIRING FAULT           | Selects how the drive reacts when incorrect input power and motor cable connection is detected (that is the input power cable is connected to the motor connection of the drive).<br><b>Note:</b> Disabling wiring fault (ground fault) may void the warranty.   | 1 = ENABLE  |
|                                       | 0 = DISABLE            | No action  |             |
|                                       | 1 = ENABLE             | The drive trips on fault <i>OUTP WIRING</i> (code <i>F0035</i> ).  |             |
| <b>31</b>                             | <b>AUTOMATIC RESET</b> | Automatic fault reset. Automatic resets are possible only for certain fault types and when the automatic reset function is activated for that fault type.  |             |
| 3101                                  | NR OF TRIALS           | Defines the number of automatic fault resets the drive performs within the time defined by parameter <i>3102 TRIAL TIME</i> .<br>If the number of automatic resets exceeds the set number (within the trial time), the drive prevents additional automatic resets and remains stopped. The drive must be reset from the control panel or from a source selected by parameter <i>1604 FAULT RESET SEL</i> .<br>Example: Three faults have occurred during the trial time defined by parameter <i>3102 TRIAL TIME</i> . Last fault is reset only if the number defined by parameter <i>3101 NR OF TRIALS</i> is 3 or more.<br> | 0           |
|                                       | 0...5                  | Number of the automatic resets   |             |
| 3102                                  | TRIAL TIME             | Defines the time for the automatic fault reset function. See parameter <i>3101 NR OF TRIALS</i> .  | 30.0 s      |
|                                       | 1.0...600.0 s          | Time   |             |
| 3103                                  | DELAY TIME             | Defines the time that the drive waits after a fault before attempting an automatic reset. See parameter <i>3101 NR OF TRIALS</i> . If delay time is set to zero, the drive resets immediately.   | 0.0 s       |
|                                       | 0.0...120.0 s          | Time   |             |
| 3104                                  | AR OVERCURRENT         | Activates/deactivates the automatic reset for the overcurrent fault. Automatically resets fault <i>OVERCURRENT</i> (code: <i>F0001</i> ) after the delay set by parameter <i>3103 DELAY TIME</i> .   | 0 = DISABLE |
|                                       | 0 = DISABLE            | Inactive   |             |
|                                       | 1 = ENABLE             | Active   |             |
| 3105                                  | AR OVERVOLTAGE         | Activates/deactivates the automatic reset for the intermediate link overvoltage fault. Automatically resets fault <i>DC OVERVOLT</i> (code: <i>F0002</i> ) after the delay set by parameter <i>3103 DELAY TIME</i> .   | 0 = DISABLE |
|                                       | 0 = DISABLE            | Inactive   |             |
|                                       | 1 = ENABLE             | Active   |             |
| 3106                                  | AR UNDERVOLTAGE        | Activates/deactivates the automatic reset for the intermediate link undervoltage fault. Automatically resets fault <i>DC UNDERVOLT</i> (code: <i>F0006</i> ) after the delay set by parameter <i>3103 DELAY TIME</i> .   | 0 = DISABLE |
|                                       | 0 = DISABLE            | Inactive   |             |
|                                       | 1 = ENABLE             | Active   |             |

| Parameters in the Long parameter mode |                 |   |             |
|---------------------------------------|-----------------|---|-------------|
| Index                                 | Name/Selection  | Description   | Def         |
| 3107                                  | AR AI<MIN       | Activates/deactivates the automatic reset for AI<MIN (analog input signal under the allowed minimum level) fault <i>AI1 LOSS</i> (code: <i>F0007</i> ). Automatically resets the fault after the delay set by parameter <i>3103</i> DELAY TIME.             | 0 = DISABLE |
|                                       | 0 = DISABLE     | Inactive  |             |
|                                       | 1 = ENABLE      | Active<br> <b>WARNING!</b> The drive may restart even after a long stop if the analog input signal is restored. Ensure that the use of this feature will not cause danger. |             |
| 3108                                  | AR EXTERNAL FLT | Activates/deactivates the automatic reset for faults <i>EXT FAULT 1/EXT FAULT 2</i> (code: <i>F0014/F0015</i> ). Automatically resets the fault after the delay set by parameter <i>3103</i> DELAY TIME.  | 0 = DISABLE |
|                                       | 0 = DISABLE     | Inactive  |             |
|                                       | 1 = ENABLE      | Active  |             |

| Parameters in the Long parameter mode |                |  |     |
|---------------------------------------|----------------|--|-----|
| Index                                 | Name/Selection | Description  | Def |
| <b>32 SUPERVISION</b>                 |                | Signal supervision. The drive monitors whether certain user selectable variables are within the user-defined limits. The user may set limits for speed, current etc. Supervision status can be monitored with relay output. See parameter group <a href="#">14 RELAY OUTPUTS</a> .   |     |
| 3201                                  | SUPERV 1 PARAM | <p>Selects the first supervised signal. Supervision limits are defined by parameters <a href="#">3202 SUPERV 1 LIM LO</a> and <a href="#">3203 SUPERV 1 LIM HI</a>.</p> <p>Example 1: If <math>3202 \text{ SUPERV 1 LIM LO} \leq 3203 \text{ SUPERV 1 LIM HI}</math></p> <p><b>Case A</b> = <a href="#">1401 RELAY OUTPUT 1</a> value is set to SUPRV 1 OVER. Relay energizes when value of the signal selected with <a href="#">3201 SUPERV 1 PARAM</a> exceeds the supervision limit defined by <a href="#">3203 SUPERV 1 LIM HI</a>. The relay remains active until the supervised value drops below the low limit defined by <a href="#">3202 SUPERV 1 LIM LO</a>.</p> <p><b>Case B</b> = <a href="#">1401 RELAY OUTPUT 1</a> value is set to SUPRV 1 UNDER. Relay energizes when value of the signal selected with <a href="#">3201 SUPERV 1 PARAM</a> drops below the supervision limit defined by <a href="#">3202 SUPERV 1 LIM LO</a>. The relay remains active until the supervised value rises above the high limit defined by <a href="#">3203 SUPERV 1 LIM HI</a>.</p> <p>Example 2: If <math>3202 \text{ SUPERV 1 LIM LO} &gt; 3203 \text{ SUPERV 1 LIM HI}</math></p> <p>The lower limit <a href="#">3203 SUPERV 1 LIM HI</a> remains active until the supervised signal exceeds the higher limit <a href="#">3202 SUPERV 1 LIM LO</a>, making it the active limit. The new limit remains active until the supervised signal drops below the lower limit <a href="#">3203 SUPERV 1 LIM HI</a>, making it the active limit.</p> <p><b>Case A</b> = <a href="#">1401 RELAY OUTPUT 1</a> value is set to SUPRV 1 OVER. Relay is energized whenever the supervised signal exceeds the active limit.</p> <p><b>Case B</b> = <a href="#">1401 RELAY OUTPUT 1</a> value is set to SUPRV 1 UNDER. Relay is de-energized whenever the supervised signal drops below the active limit.</p> | 103 |

| Parameters in the Long parameter mode |                   |  |                |
|---------------------------------------|-------------------|--|----------------|
| Index                                 | Name/Selection    | Description  | Def            |
|                                       | 0, x...x          | Parameter index in group <a href="#">01 OPERATING DATA</a> . For example, 102 = <a href="#">0102 SPEED</a> .<br>0 = not selected.  |                |
| 3202                                  | SUPERV 1 LIM LO   | Defines the low limit for the first supervised signal selected by parameter <a href="#">3201 SUPERV 1 PARAM</a> . Supervision wakes up if the value is below the limit.  | -              |
|                                       | x...x             | Setting range depends on parameter <a href="#">3201 SUPERV 1 PARAM</a> setting.  | -              |
| 3203                                  | SUPERV 1 LIM HI   | Defines the high limit for the first supervised signal selected by parameter <a href="#">3201 SUPERV 1 PARAM</a> . Supervision wakes up if the value is above the limit.   | -              |
|                                       | x...x             | Setting range depends on parameter <a href="#">3201 SUPERV 1 PARAM</a> setting.  | -              |
| 3204                                  | SUPERV 2 PARAM    | Selects the second supervised signal. Supervision limits are defined by parameters <a href="#">3205 SUPERV 2 LIM LO</a> and <a href="#">3206 SUPERV 2 LIM HI</a> . See parameter <a href="#">3201 SUPERV 1 PARAM</a> . | 104            |
|                                       | x...x             | Parameter index in group <a href="#">01 OPERATING DATA</a> . For example, 102 = <a href="#">0102 SPEED</a> .   |                |
| 3205                                  | SUPERV 2 LIM LO   | Defines the low limit for the second supervised signal selected by parameter <a href="#">3204 SUPERV 2 PARAM</a> . Supervision wakes up if the value is below the limit.   | -              |
|                                       | x...x             | Setting range depends on parameter <a href="#">3204 SUPERV 2 PARAM</a> setting.  | -              |
| 3206                                  | SUPERV 2 LIM HI   | Defines the high limit for the second supervised signal selected by parameter <a href="#">3204 SUPERV 2 PARAM</a> . Supervision wakes up if the value is above the limit.  | -              |
|                                       | x...x             | Setting range depends on parameter <a href="#">3204 SUPERV 2 PARAM</a> setting.  | -              |
| 3207                                  | SUPERV 3 PARAM    | Selects the third supervised signal. Supervision limits are defined by parameters <a href="#">3208 SUPERV 3 LIM LO</a> and <a href="#">3209 SUPERV 3 LIM HI</a> . See parameter <a href="#">3201 SUPERV 1 PARAM</a> .  | 105            |
|                                       | x...x             | Parameter index in group <a href="#">01 OPERATING DATA</a> . For example, 102 = <a href="#">0102 SPEED</a> .   |                |
| 3208                                  | SUPERV 3 LIM LO   | Defines the low limit for the third supervised signal selected by parameter <a href="#">3207 SUPERV 3 PARAM</a> . Supervision wakes up if the value is below the limit.  | -              |
|                                       | x...x             | Setting range depends on parameter <a href="#">3207 SUPERV 3 PARAM</a> setting.  | -              |
| 3209                                  | SUPERV 3 LIM HI   | Defines the high limit for the third supervised signal selected by parameter <a href="#">3207 SUPERV 3 PARAM</a> . Supervision wakes up if the value is above the limit.   | -              |
|                                       | x...x             | Setting range depends on parameter <a href="#">3207 SUPERV 3 PARAM</a> setting.  | -              |
| <b>33 INFORMATION</b>                 |                   | Firmware package version, test date etc.   |                |
| 3301                                  | FIRMWARE          | Displays the version of the firmware package.  |                |
|                                       | 0000...FFFF (hex) | For example, 135B hex  |                |
| 3302                                  | LOADING PACKAGE   | Displays the version of the loading package.   | Type dependent |
|                                       | 2001...20FF hex   | 2021 hex = ACS150-0nE-<br>2022 hex = ACS150-0nU-   |                |
| 3303                                  | TEST DATE         | Displays the test date.  | 00.00          |
|                                       |                   | Date value in format YY.WW (year, week)  |                |

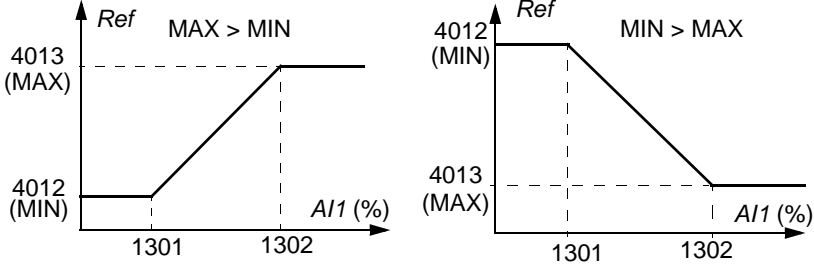
| Parameters in the Long parameter mode |                 |   |            |
|---------------------------------------|-----------------|---|------------|
| Index                                 | Name/Selection  | Description   | Def        |
| 3304                                  | DRIVE RATING    | Displays the drive current and voltage ratings.   | 0x0000 hex |
|                                       | 0000...FFFF hex | Value in format XXXY hex:<br>XXX = Nominal current of the drive in amperes. An "A" indicates decimal point. For example if XXX is 8A8, nominal current is 8.8 A.<br>Y = Nominal voltage of the drive:<br>1 = 1-phase 200...240 V<br>2 = 3-phase 200...240 V<br>4 = 3-phase 380...480 V  |            |
| <b>34 PANEL DISPLAY</b>               |                 |   |            |
| 3401                                  | SIGNAL1 PARAM   | Selects the first signal to be displayed on the control panel in the Output mode.   | 103        |
|                                       |                 |   |            |
|                                       | 0, 101...162    | Parameter index in group <i>01 OPERATING DATA</i> . For example, 102 = <i>0102 SPEED</i> . If value is set to 0, no signal is selected.<br>If parameter <i>3401 SIGNAL1 PARAM</i> , <i>3408 SIGNAL2 PARAM</i> and <i>3415 SIGNAL3 PARAM</i> values are all set to 0, n.A. is displayed. |            |
| 3402                                  | SIGNAL1 MIN     | Defines the minimum value for the signal selected by parameter <i>3401 SIGNAL1 PARAM</i> .  | -          |
|                                       |                 | <p><b>Note:</b> Parameter is not effective if parameter <i>3404 OUTPUT1 DSP FORM</i> setting is 9 (DIRECT).</p>   |            |
|                                       | x...x           | Setting range depends on parameter <i>3401 SIGNAL1 PARAM</i> setting.   | -          |
| 3403                                  | SIGNAL1 MAX     | Defines the maximum value for the signal selected by parameter <i>3401 SIGNAL1 PARAM</i> . See the figure for parameter <i>3402 SIGNAL1 MIN</i> .   | -          |
|                                       |                 | <b>Note:</b> Parameter is not effective if parameter <i>3404 OUTPUT1 DSP FORM</i> setting is 9 (DIRECT).  |            |
|                                       | x...x           | Setting range depends on parameter <i>3401 SIGNAL1 PARAM</i> setting.   | -          |

| Parameters in the Long parameter mode |                  |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|---------------------------------------|------------------|---|-----------------|---------|-------|------|---------|-----------------|--------|-----------|---------|------------|----------|-------------|----|---|------------|------|-----|-------|------|--------|-------|--|
| Index                                 | Name/Selection   | Description   | Def             |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| 3404                                  | OUTPUT1 DSP FORM | Defines the format for the displayed signal selected by parameter <a href="#">3401</a> SIGNAL1 PARAM.   | 9 = DIRECT      |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 0 = +/-0         | Signed/Unsigned value. Unit is selected by parameter <a href="#">3405</a> OUTPUT 1 UNIT.<br>Example PI (3.14159):<br><table border="1"> <thead> <tr> <th>3404 value</th> <th>Display</th> <th>Range</th> </tr> </thead> <tbody> <tr> <td>+/-0</td> <td><math>\pm 3</math></td> <td rowspan="4">-32768...+32767</td> </tr> <tr> <td>+/-0.0</td> <td><math>\pm 3.1</math></td> </tr> <tr> <td>+/-0.00</td> <td><math>\pm 3.14</math></td> </tr> <tr> <td>+/-0.000</td> <td><math>\pm 3.142</math></td> </tr> <tr> <td>+0</td> <td>3</td> <td rowspan="4">0....65535</td> </tr> <tr> <td>+0.0</td> <td>3.1</td> </tr> <tr> <td>+0.00</td> <td>3.14</td> </tr> <tr> <td>+0.000</td> <td>3.142</td> </tr> </tbody> </table> | 3404 value      | Display | Range | +/-0 | $\pm 3$ | -32768...+32767 | +/-0.0 | $\pm 3.1$ | +/-0.00 | $\pm 3.14$ | +/-0.000 | $\pm 3.142$ | +0 | 3 | 0....65535 | +0.0 | 3.1 | +0.00 | 3.14 | +0.000 | 3.142 |  |
| 3404 value                            | Display          |   | Range           |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +/-0                                  | $\pm 3$          |   | -32768...+32767 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +/-0.0                                | $\pm 3.1$        |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +/-0.00                               | $\pm 3.14$       |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +/-0.000                              | $\pm 3.142$      |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +0                                    | 3                |   | 0....65535      |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +0.0                                  | 3.1              |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +0.00                                 | 3.14             |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| +0.000                                | 3.142            |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 1 = +/-0.0       |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 2 = +/-0.00      |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 3 = +/-0.000     |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 4 = +0           |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 5 = +0.0         |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 6 = +0.00        |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 7 = +0.000       |   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 8 = BAR METER    | Bar graph is not available for this application.  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 9 = DIRECT       | Direct value. Decimal point location and units of measure are the same as for the source signal.<br><b>Note:</b> Parameters <a href="#">3402</a> , <a href="#">3403</a> and <a href="#">3405...3407</a> are not effective.  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| 3405                                  | OUTPUT1 UNIT     | Selects the unit for the displayed signal selected by parameter <a href="#">3401</a> SIGNAL1 PARAM.<br><b>Note:</b> Parameter is not effective if parameter <a href="#">3404</a> OUTPUT1 DSP FORM setting is 9 (DIRECT).<br><b>Note:</b> Unit selection does not convert values.  | -               |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 0 = NO UNIT      | No unit selected  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 1 = A            | Ampere  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 2 = V            | Volt  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 3 = Hz           | Hertz   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 4 = %            | Percent   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 5 = s            | Second  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 6 = h            | Hour  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 7 = rpm          | Revolutions per minute  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 8 = kh           | Kilohour  |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 9 = °C           | Celsius   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 11 = mA          | Milliampere   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | 12 = mV          | Millivolt   |                 |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| 3406                                  | OUTPUT1 MIN      | Sets the minimum display value for the signal selected by parameter <a href="#">3401</a> SIGNAL1 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.<br><b>Note:</b> Parameter is not effective if parameter <a href="#">3404</a> OUTPUT1 DSP FORM setting is 9 (DIRECT).  | -               |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | x...x            | Setting range depends on parameter <a href="#">3401</a> SIGNAL1 PARAM setting.  | -               |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
| 3407                                  | OUTPUT1 MAX      | Sets the maximum display value for the signal selected by parameter <a href="#">3401</a> SIGNAL1 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.<br><b>Note:</b> Parameter is not effective if parameter <a href="#">3404</a> OUTPUT1 DSP FORM setting is 9 (DIRECT).  | -               |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |
|                                       | x...x            | Setting range depends on parameter <a href="#">3401</a> SIGNAL1 PARAM setting.  | -               |         |       |      |         |                 |        |           |         |            |          |             |    |   |            |      |     |       |      |        |       |  |

| Parameters in the Long parameter mode |                  |  |            |
|---------------------------------------|------------------|--|------------|
| Index                                 | Name/Selection   | Description  | Def        |
| 3408                                  | SIGNAL2 PARAM    | Selects the second signal to be displayed on the control panel in the Output mode. See parameter <a href="#">3401</a> SIGNAL1 PARAM.   | 104        |
|                                       | 0, 102...162     | Parameter index in group <a href="#">01 OPERATING DATA</a> . For example, 102 = <a href="#">0102</a> SPEED. If value is set to 0, no signal is selected.<br>If parameter <a href="#">3401</a> SIGNAL1 PARAM, <a href="#">3408</a> SIGNAL2 PARAM and <a href="#">3415</a> SIGNAL3 PARAM values are all set to 0, n.A. is displayed. |            |
| 3409                                  | SIGNAL2 MIN      | Defines the minimum value for the signal selected by parameter <a href="#">3408</a> SIGNAL2 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.   | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3408</a> setting.   | -          |
| 3410                                  | SIGNAL2 MAX      | Defines the maximum value for the signal selected by parameter <a href="#">3408</a> SIGNAL2 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.   | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3408</a> SIGNAL2 PARAM setting.   | -          |
| 3411                                  | OUTPUT2 DSP FORM | Defines the format for the displayed signal selected by parameter <a href="#">3408</a> SIGNAL2 PARAM.  | 9 = DIRECT |
|                                       |                  | See parameter <a href="#">3404</a> OUTPUT1 DSP FORM.   | -          |
| 3412                                  | OUTPUT2 UNIT     | Selects the unit for the displayed signal selected by parameter <a href="#">3408</a> SIGNAL2 PARAM.  | -          |
|                                       |                  | See parameter <a href="#">3405</a> OUTPUT1 UNIT.   | -          |
| 3413                                  | OUTPUT2 MIN      | Sets the minimum display value for the signal selected by parameter <a href="#">3408</a> SIGNAL2 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.  | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3408</a> SIGNAL2 PARAM setting.   | -          |
| 3414                                  | OUTPUT2 MAX      | Sets the maximum display value for the signal selected by parameter <a href="#">3408</a> SIGNAL2 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.  | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3408</a> SIGNAL2 PARAM setting.   | -          |
| 3415                                  | SIGNAL3 PARAM    | Selects the third signal to be displayed on the control panel in the Output mode. See parameter <a href="#">3401</a> SIGNAL1 PARAM.  | 105        |
|                                       | 0, 102...162     | Parameter index in group <a href="#">01 OPERATING DATA</a> . For example, 102 = <a href="#">0102</a> SPEED. If value is set to 0, no signal is selected.<br>If parameter <a href="#">3401</a> SIGNAL1 PARAM, <a href="#">3408</a> SIGNAL2 PARAM and <a href="#">3415</a> SIGNAL3 PARAM values are all set to 0, n.A. is displayed. |            |
| 3416                                  | SIGNAL3 MIN      | Defines the minimum value for the signal selected by parameter <a href="#">3415</a> SIGNAL3 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.   | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3415</a> SIGNAL 3 PARAM setting.  | -          |
| 3417                                  | SIGNAL3 MAX      | Defines the maximum value for the signal selected by parameter <a href="#">3415</a> SIGNAL3 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.   | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3415</a> SIGNAL3 PARAM setting.   | -          |
| 3418                                  | OUTPUT3 DSP FORM | Defines the format for the displayed signal selected by parameter <a href="#">3415</a> SIGNAL3 PARAM.  | 9 = DIRECT |
|                                       |                  | See parameter <a href="#">3404</a> OUTPUT1 DSP FORM.   | -          |
| 3419                                  | OUTPUT3 UNIT     | Selects the unit for the displayed signal selected by parameter <a href="#">3415</a> SIGNAL3 PARAM.  | -          |
|                                       |                  | See parameter <a href="#">3405</a> OUTPUT1 UNIT.   | -          |
| 3420                                  | OUTPUT3 MIN      | Sets the minimum display value for the signal selected by parameter <a href="#">3415</a> SIGNAL3 PARAM. See parameter <a href="#">3402</a> SIGNAL1 MIN.  | -          |
|                                       | x...x            | Setting range depends on parameter <a href="#">3415</a> SIGNAL3 PARAM setting.   | -          |

| Parameters in the Long parameter mode |                  |  |        |
|---------------------------------------|------------------|--|--------|
| Index                                 | Name/Selection   | Description  | Def    |
| 3421                                  | OUTPUT3 MAX      | Sets the maximum display value for the signal selected by parameter 3415 SIGNAL3 PARAM. See parameter 3402 SIGNAL1 MIN.  | -      |
|                                       | x...x            | Setting range depends on parameter 3415 SIGNAL3 PARAM setting.   | -      |
| <b>40 PROCESS PID SET 1</b>           |                  | Process PID (PID1) control parameter set 1.  |        |
| 4001                                  | GAIN             | Defines the gain for the process PID controller. High gain may cause speed oscillation.  | 1.0    |
|                                       | 0.1...100.0      | Gain. When value is set to 0.1, the PID controller output changes one-tenth as much as the error value. When value is set to 100, the PID controller output changes one hundred times as much as the error value.  |        |
| 4002                                  | INTEGRATION TIME | Defines the integration time for the process PID1 controller. The integration time defines the rate at which the controller output changes when the error value is constant. The shorter the integration time, the faster the continuous error value is corrected. Too short an integration time makes the control unstable.   | 60.0 s |
|                                       |                  | <p>A = Error<br/>B = Error value step<br/>C = Controller output with gain = 1<br/>D = Controller output with gain = 10</p>   |        |
|                                       | 0.0...3600.0 s   | Integration time. If parameter value is set to zero, integration (I-part of the PID controller) is disabled.   |        |
| 4003                                  | DERIVATION TIME  | Defines the derivation time for the process PID controller. Derivative action boosts the controller output if the error value changes. The longer the derivation time, the more the speed controller output is boosted during the change. If the derivation time is set to zero, the controller works as a PI controller, otherwise as a PID controller.<br><br>The derivation makes the control more responsive for disturbances.<br><br>The derivative is filtered with a 1-pole filter. Filter time constant is defined by parameter 4004 PID DERIV FILTER. | 0.0 s  |
|                                       |                  | <p>Error<br/>Process error value<br/>100%<br/>0%<br/>t<br/>PID output<br/>Gain 4001<br/>D-part of controller output<br/>4003</p>   |        |
|                                       | 0.0...10.0 s     | Derivation time. If parameter value is set to zero, the derivative part of the PID controller is disabled.   |        |

| Parameters in the Long parameter mode |                  |  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|---------------------------------------|------------------|--|------------|-------|---------|---|-------|---|---|-------|-----|---|-------|------|---|-------|-------|---|-------|--------|--|
| Index                                 | Name/Selection   | Description  | Def        |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4004                                  | PID DERIV FILTER | Defines the filter time constant for the derivative part of the process PID controller. Increasing the filter time smooths the derivative and reduces noise.   | 1.0 s      |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 0.0...10.0 s     | Filter time constant. If parameter value is set to zero, the derivative filter is disabled.  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4005                                  | ERROR VALUE INV  | Selects the relationship between the feedback signal and drive speed (drive output frequency).   | 0 = NO     |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 0 = NO           | Normal: A decrease in feedback signal increases drive speed (drive output frequency). Error = Ref - Fbk  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 1 = YES          | Inverted: A decrease in feedback signal decreases drive speed (drive output frequency). Error = Fbk - Ref  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4006                                  | UNITS            | Selects the unit for PID controller actual values.   | 4 = %      |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 0...12           | See parameter 3405 OUTPUT1 UNIT selections 0...12 (NO UNIT...mV).  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4007                                  | UNIT SCALE       | Defines the decimal point location for the display parameter selected by parameter 4006 UNITS.   | 1          |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 0...4            | Example PI (3.14159) <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>4007 value</th> <th>Entry</th> <th>Display</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>00003</td> <td>3</td> </tr> <tr> <td>1</td> <td>00031</td> <td>3.1</td> </tr> <tr> <td>2</td> <td>00314</td> <td>3.14</td> </tr> <tr> <td>3</td> <td>03142</td> <td>3.142</td> </tr> <tr> <td>4</td> <td>31416</td> <td>3.1416</td> </tr> </tbody> </table> | 4007 value | Entry | Display | 0 | 00003 | 3 | 1 | 00031 | 3.1 | 2 | 00314 | 3.14 | 3 | 03142 | 3.142 | 4 | 31416 | 3.1416 |  |
| 4007 value                            | Entry            | Display  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 0                                     | 00003            | 3  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 1                                     | 00031            | 3.1  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 2                                     | 00314            | 3.14   |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 3                                     | 03142            | 3.142  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4                                     | 31416            | 3.1416   |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4008                                  | 0% VALUE         | Defines together with parameter 4009 100% VALUE the scaling applied to the PID controller's actual values. <div style="text-align: center;"> </div>  | 0          |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | x...x            | Unit and range depend on the unit and scale defined by parameters 4006 UNITS and 4007 UNIT SCALE.  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4009                                  | 100% VALUE       | Defines together with parameter 4008 0% VALUE the scaling applied to the PID controller's actual values.   | 100        |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | x...x            | Unit and range depend on the unit and scale defined by parameters 4006 UNITS and 4007 UNIT SCALE.  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
| 4010                                  | SET POINT SEL    | Selects the source for the process PID controller reference signal.  | 2 = POT    |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 0 = KEYPAD       | Control panel  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 1 = AI1          | Analog input AI1   |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |
|                                       | 2 = POT          | Potentiometer  |            |       |         |   |       |   |   |       |     |   |       |      |   |       |       |   |       |        |  |

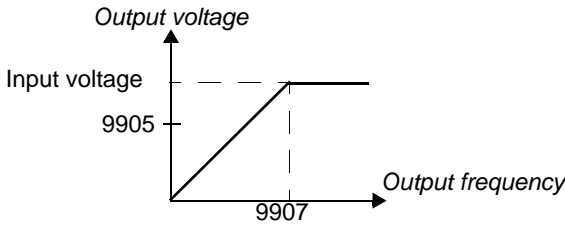
| Parameters in the Long parameter mode |                   |  |          |
|---------------------------------------|-------------------|--|----------|
| Index                                 | Name/Selection    | Description  | Def      |
|                                       | 11 = DI3U,4D(RNC) | Digital input DI3: Reference increase. Digital input DI4: Reference decrease. Stop command resets the reference to zero. When this selection becomes active (in change from EXT1 to EXT2), the reference initializes to the value used when this control location (and this selection) was active the last time.   |          |
|                                       | 12 = DI3U,4D(NC)  | Digital input DI3: Reference increase. Digital input DI4: Reference decrease. The program stores the active reference (not reset by a stop command). When this selection becomes active (in change from EXT1 to EXT2), the reference initializes to the value used when this control location (and this selection) was active the last time.   |          |
|                                       | 14 = AI1+POT      | Reference is calculated with the following equation:<br>$REF = AI1(\%) + POT(\%) - 50\%$   |          |
|                                       | 15 = AI1*POT      | Reference is calculated with the following equation:<br>$REF = AI1(\%) \cdot (POT(\%) / 50\%)$   |          |
|                                       | 16 = AI1-POT      | Reference is calculated with the following equation:<br>$REF = AI1(\%) + 50\% - POT(\%)$   |          |
|                                       | 17 = AI1/POT      | Reference is calculated with the following equation:<br>$REF = AI1(\%) \cdot (50\% / POT(\%))$   |          |
|                                       | 19 = INTERNAL     | A constant value defined by parameter <a href="#">4011</a> INTERNAL SETPNT   |          |
|                                       | 31 = DI4U,5D(NC)  | See selection DI3U,4D(NC).   |          |
|                                       | 32 = FREQ INPUT   | Frequency input  |          |
| 4011                                  | INTERNAL SETPNT   | Selects a constant value as process PID controller reference, when parameter <a href="#">4010</a> SET POINT SEL value is set to 19 (INTERNAL).   | 40       |
|                                       | x...x             | Unit and range depend on the unit and scale defined by parameters <a href="#">4006</a> UNITS and <a href="#">4007</a> UNIT SCALE.  |          |
| 4012                                  | SETPOINT MIN      | Defines the minimum value for the selected PID reference signal source. See parameter <a href="#">4010</a> SET POINT SEL.  | 0.0%     |
|                                       | -500.0...500.0%   | Value in percent.<br><b>Example:</b> Analog input AI1 is selected as the PID reference source (value of parameter <a href="#">4010</a> SET POINT SEL is 1 = AI1). The reference minimum and maximum correspond to the <a href="#">1301</a> MINIMUM AI1 and <a href="#">1302</a> MAXIMUM AI1 settings as follows:<br> |          |
| 4013                                  | SETPOINT MAX      | Defines the maximum value for the selected PID reference signal source. See parameters <a href="#">4010</a> SET POINT SEL and <a href="#">4012</a> SETPOINT MIN.   | 100.0%   |
|                                       | -500.0...500.0%   | Value in percent   |          |
| 4014                                  | FBK SEL           | Selects the process actual value (feedback signal) for the process PID controller: The sources for the variables ACT1 and ACT2 are further defined by parameters <a href="#">4016</a> ACT1 INPUT and <a href="#">4017</a> ACT2 INPUT.  | 1 = ACT1 |
|                                       | 1 = ACT1          | ACT1   |          |
|                                       | 2 = ACT1-ACT2     | Subtraction of ACT1 and ACT 2  |          |

| Parameters in the Long parameter mode |                  |  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|---------------------------------------|------------------|--|---------------------|--------|-------------|-------------|---|----------------|------------------|------------------|---|---------------|---|---|---|---------|---|---------------------|---|--------|---------------------|--------------------|---|-------|--------------------|-------------------|----|
| Index                                 | Name/Selection   | Description  | Def                 |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 3 = ACT1+ACT2    | Addition of ACT1 and ACT2  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 4 = ACT1*ACT2    | Multiplication of ACT1 and ACT2  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 5 = ACT1/ACT2    | Division of ACT1 and ACT2  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 6 = MIN(ACT1,2)  | Selects the smaller of ACT1 and ACT2   |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 7 = MAX(ACT1,2)  | Selects the higher of ACT1 and ACT2  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 8 = sqrt(ACT1-2) | Square root of the subtraction of ACT1 and ACT2  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 9 = sqA1+sqA2    | Addition of the square root of ACT1 and the square root of ACT2  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 10 = sqrt(ACT1)  | Square root of ACT1  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 4015                                  | FBK MULTIPLIER   | Defines an extra multiplier for the value defined by parameter <a href="#">4014</a> FBK SEL. Parameter is used mainly in applications where feedback value is calculated from an other variable (for example, flow from pressure difference).  | 0.000               |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | -32.768...32.767 | Multiplier. If parameter value is set to zero, no multiplier is used.  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 4016                                  | ACT1 INPUT       | Defines the source for actual value 1 (ACT1). See also parameter <a href="#">4018</a> ACT1 MINIMUM.  | 1 = AI1             |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 1 = AI1          | Uses analog input 1 for ACT1   |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 2 = POT          | Uses potentiometer for ACT1  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 3 = CURRENT      | Uses current for ACT1  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 4 = TORQUE       | Uses torque for ACT1   |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | 5 = POWER        | Uses power for ACT1  |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 4017                                  | ACT2 INPUT       | Defines the source for actual value 2 (ACT2). See also parameter <a href="#">4020</a> ACT2 MINIMUM.  | 1 = AI1             |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       |                  | See parameter <a href="#">4016</a> ACT1 INPUT.   |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 4018                                  | ACT1 MINIMUM     | <p>Sets the minimum value for ACT1.</p> <p>Scales the source signal used as the actual value ACT1 (defined by parameter <a href="#">4016</a> ACT1 INPUT).</p> <table border="1"> <thead> <tr> <th>Par 4016</th> <th>Source</th> <th>Source min.</th> <th>Source max.</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Analog input 1</td> <td>1301 MINIMUM AI1</td> <td>1302 MAXIMUM AI1</td> </tr> <tr> <td>2</td> <td>Potentiometer</td> <td>-</td> <td>-</td> </tr> <tr> <td>3</td> <td>Current</td> <td>0</td> <td>2 · nominal current</td> </tr> <tr> <td>4</td> <td>Torque</td> <td>-2 · nominal torque</td> <td>2 · nominal torque</td> </tr> <tr> <td>5</td> <td>Power</td> <td>-2 · nominal power</td> <td>2 · nominal power</td> </tr> </tbody> </table> <p>A= Normal; B = Inversion (ACT1 minimum &gt; ACT1 maximum)</p> | Par 4016            | Source | Source min. | Source max. | 1 | Analog input 1 | 1301 MINIMUM AI1 | 1302 MAXIMUM AI1 | 2 | Potentiometer | - | - | 3 | Current | 0 | 2 · nominal current | 4 | Torque | -2 · nominal torque | 2 · nominal torque | 5 | Power | -2 · nominal power | 2 · nominal power | 0% |
| Par 4016                              | Source           | Source min.  | Source max.         |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 1                                     | Analog input 1   | 1301 MINIMUM AI1   | 1302 MAXIMUM AI1    |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 2                                     | Potentiometer    | -  | -                   |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 3                                     | Current          | 0  | 2 · nominal current |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 4                                     | Torque           | -2 · nominal torque  | 2 · nominal torque  |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
| 5                                     | Power            | -2 · nominal power   | 2 · nominal power   |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |
|                                       | -1000...1000%    | Value in percent   |                     |        |             |             |   |                |                  |                  |   |               |   |   |   |         |   |                     |   |        |                     |                    |   |       |                    |                   |    |

| Parameters in the Long parameter mode |                 |   |             |
|---------------------------------------|-----------------|---|-------------|
| Index                                 | Name/Selection  | Description   | Def         |
| 4019                                  | ACT1 MAXIMUM    | Defines the maximum value for the variable ACT1 if an analog input is selected as a source for ACT1. See parameter <a href="#">4016</a> ACT1 INPUT. The minimum ( <a href="#">4018</a> ACT1 MINIMUM) and maximum settings of ACT1 define how the voltage/current signal received from the measuring device is converted to a percentage value used by the process PID controller.<br>See parameter <a href="#">4018</a> ACT1 MINIMUM. | 100%        |
|                                       | -1000...1000%   | Value in percent  |             |
| 4020                                  | ACT2 MINIMUM    | See parameter <a href="#">4018</a> ACT1 MINIMUM.  | 0%          |
|                                       | -1000...1000%   | See parameter <a href="#">4018</a> ACT1 MINIMUM.  |             |
| 4021                                  | ACT2 MAXIMUM    | See parameter <a href="#">4019</a> ACT1 MAXIMUM.  | 100%        |
|                                       | -1000...1000%   | See parameter <a href="#">4019</a> ACT1 MAXIMUM.  |             |
| 4022                                  | SLEEP SELECTION | Activates the sleep function and selects the source for the activation input.   | 0 = NOT SEL |
|                                       | 0 = NOT SEL     | No sleep function selected  |             |
|                                       | 1 = DI1         | The function is activated/deactivated through digital input DI1. 1 = activation, 0 = deactivation.<br>The internal sleep criteria set by parameters <a href="#">4023</a> PID SLEEP LEVEL and <a href="#">4025</a> WAKE-UP DEV are not effective. The sleep start and stop delay parameters <a href="#">4024</a> PID SLEEP DELAY and <a href="#">4026</a> WAKE-UP DELAY are effective.   |             |
|                                       | 2 = DI2         | See selection 1 (DI1).  |             |
|                                       | 3 = DI3         | See selection 1 (DI1).  |             |
|                                       | 4 = DI4         | See selection 1 (DI1).  |             |
|                                       | 5 = DI5         | See selection 1 (DI1).  |             |
|                                       | 7 = INTERNAL    | Activated and deactivated automatically as defined by parameters <a href="#">4023</a> PID SLEEP LEVEL and <a href="#">4025</a> WAKE-UP DEV.   |             |
|                                       | -1 = DI1(INV)   | The function is activated/deactivated through inverted digital input DI1. 1 = deactivation, 0 = activation.<br>The internal sleep criteria set by parameters <a href="#">4023</a> PID SLEEP LEVEL and <a href="#">4025</a> WAKE-UP DEV are not effective. The sleep start and stop delay parameters <a href="#">4024</a> PID SLEEP DELAY and <a href="#">4026</a> WAKE-UP DELAY are effective.  |             |
|                                       | -2 = DI2(INV)   | See selection DI1(INV).   |             |
|                                       | -3 = DI3(INV)   | See selection DI1(INV).   |             |
|                                       | -4 = DI4(INV)   | See selection DI1(INV).   |             |
|                                       | -5 = DI5(INV)   | See selection DI1(INV).   |             |

| Parameters in the Long parameter mode |                  |   |                  |
|---------------------------------------|------------------|---|------------------|
| Index                                 | Name/Selection   | Description   | Def              |
| 4023                                  | PID SLEEP LEVEL  | <p>Defines the start limit for the sleep function. If the motor speed is below a set level (4023) longer than the sleep delay (4024), the drive shifts to the sleeping mode: The motor is stopped and the control panel shows alarm <i>PID SLEEP</i> (code: A2018 1).</p> <p>Parameter 4022 SLEEP SELECTION must be set to 7 (INTERNAL).</p>  | 0.0 Hz           |
|                                       | 0.0...500.0 Hz   | Sleep start level   |                  |
| 4024                                  | PID SLEEP DELAY  | <p>Defines the delay for the sleep start function. See parameter 4023 PID SLEEP LEVEL. When the motor speed falls below the sleep level, the counter starts. When the motor speed exceeds the sleep level, the counter is reset.</p>  | 60.0 s           |
|                                       | 0.0...3600.0 s   | Sleep start delay   |                  |
| 4025                                  | WAKE-UP DEV      | <p>Defines the wake-up deviation for the sleep function. The drive wakes up if the process actual value deviation from the PID reference value exceeds the set wake-up deviation (4025) longer than the wake-up delay (4026). Wake-up level depends on parameter 4005 ERROR VALUE INV settings.</p> <p>If parameter 4005 ERROR VALUE INV is set to 0:<br/>Wake-up level = PID reference (4010) - Wake-up deviation (4025).<br/>If parameter 4005 ERROR VALUE INV is set to 1:<br/>Wake-up level = PID reference (4010) + Wake-up deviation (4025)</p> <p>See also figures for parameter 4023 PID SLEEP LEVEL.</p> | 0                |
|                                       | x...x            | Unit and range depend on the unit and scale defined by parameters 4026 WAKE-UP DELAY and 4007 UNIT SCALE.   |                  |
| 4026                                  | WAKE-UP DELAY    | <p>Defines the wake-up delay for the sleep function. See parameter 4023 PID SLEEP LEVEL.</p>  | 0.50 s           |
|                                       | 0.00...60.00 s   | Wake-up delay   |                  |
| <b>99 START-UP DATA</b>               |                  | Application macro. Definition of motor set-up data.   |                  |
| 9902                                  | APPLIC MACRO     | <p>Selects the application macro or activates FlashDrop parameter values. See chapter <i>Application macros</i> on page 69.</p>   | 1 = ABB STANDARD |
|                                       | 1 = ABB STANDARD | Standard macro for constant speed applications  |                  |

| Parameters in the Long parameter mode |                   |  |     |
|---------------------------------------|-------------------|--|-----|
| Index                                 | Name/Selection    | Description  | Def |
|                                       | 2 = 3-WIRE        | 3-wire macro for constant speed applications   |     |
|                                       | 3 = ALTERNATE     | Alternate macro for start forward and start reverse applications   |     |
|                                       | 4 = MOTOR POT     | Motor potentiometer macro for digital signal speed control applications  |     |
|                                       | 5 = HAND/AUTO     | Hand/Auto macro to be used when two control devices are connected to the drive:<br>- Device 1 communicates through the interface defined by external control location EXT1.<br>- Device 2 communicates through the interface defined by external control location EXT2.<br>EXT1 or EXT2 is active at a time. Switching between EXT1/2 through digital input.   |     |
|                                       | 6 = PID CONTROL   | PID control. For applications in which the drive controls a process value. For example, pressure control by the drive running the pressure boost pump. Measured pressure and the pressure reference are connected to the drive.  |     |
|                                       | 31 = LOAD FD SET  | FlashDrop parameter values as defined by the FlashDrop file. Parameter view is selected by parameter <a href="#">1611</a> PARAMETER VIEW.<br>FlashDrop is an optional device for fast copying of parameters to unpowered drives. FlashDrop allows easy customisation of the parameter list, for example, selected parameters can be hidden. For more information, see <i>MFDT-01 FlashDrop user's manual</i> (3AFE68591074 [English]). |     |
|                                       | 0 = USER S1 LOAD  | User 1 macro loaded into use. Before loading, check that the saved parameter settings and the motor model are suitable for the application.  |     |
|                                       | -1 = USER S1 SAVE | Save User 1 macro. Stores the current parameter settings and the motor model.  |     |
|                                       | -2 = USER S2 LOAD | User 2 macro loaded into use. Before loading, check that the saved parameter settings and the motor model are suitable for the application.  |     |
|                                       | -3 = USER S2 SAVE | Save User 2 macro. Stores the current parameter settings and the motor model.  |     |
|                                       | -4 = USER S3 LOAD | User 3 macro loaded into use. Before loading, check that the saved parameter settings and the motor model are suitable for the application.  |     |
|                                       | -5 = USER S3 SAVE | Save User 3 macro. Stores the current parameter settings and the motor model.  |     |

| Parameters in the Long parameter mode |   |   |  |
|---------------------------------------|---|---|--|
| Index                                 | Name/Selection  | Description   | Def  |
| 9905                                  | MOTOR NOM VOLT  | <p>Defines the nominal motor voltage. Must be equal to the value on the motor rating plate. The drive cannot supply the motor with a voltage greater than the input power voltage.</p> <p>Note that the output voltage is not limited by the nominal motor voltage but increased linearly up to the value of the input voltage.</p>  <p><b>WARNING!</b> Never connect a motor to a drive which is connected to power line with voltage level higher than the rated motor voltage.</p> | 200 V<br>E units:<br>200 V<br><br>230 V<br>U units:<br>230 V<br><br>400 V<br>E units:<br>400 V<br><br>460 V<br>U units:<br>460 V |
|                                       | 200 V E units/<br>230 U units:<br>100...300 V<br><br>400 V E units /<br>460 V U units:<br>230...690 V | Voltage.<br><br><b>Note:</b> The stress on the motor insulations is always dependent on the drive supply voltage. This also applies to the case where the motor voltage rating is lower than the rating of the drive and the supply of the drive.   |  |
| 9906                                  | MOTOR NOM CURR  | Defines the nominal motor current. Must be equal to the value on the motor rating plate.  | $I_{2N}$   |
|                                       | $0.2...2.0 \cdot I_{2N}$  | Current   |  |
| 9907                                  | MOTOR NOM FREQ  | Defines the nominal motor frequency, that is the frequency at which the output voltage equals the motor nominal voltage:<br><br>Field weakening point = Nom. frequency · Supply voltage / Mot nom. voltage  | E: 50.0 Hz /<br>U: 60.0 Hz   |
|                                       | 10.0...500.0 Hz   | Frequency   |  |
| 9908                                  | MOTOR NOM SPEED   | Defines the nominal motor speed. Must be equal to the value on the motor rating plate.  | Type dependent   |
|                                       | 50...30000 rpm  | Speed   |  |
| 9909                                  | MOTOR NOM POWER   | Defines the nominal motor power. Must equal the value on the motor rating plate.  | $P_N$  |
|                                       | $0.2...3.0 \cdot P_N$ kW/hp   | Power   |  |

# Fault tracing

---

## What this chapter contains

The chapter tells how to reset faults and view fault history. It also lists all alarm and fault messages including the possible cause and corrective actions.

## Safety



---


**WARNING!** Only qualified electricians are allowed to maintain the drive. Read the safety instructions in chapter [Safety](#) on page [11](#) before you work on the drive.

---

## Alarm and fault indications

An alarm or fault message on the panel display indicates abnormal drive status. Using the information given in this chapter most alarm and fault causes can be identified and corrected. If not, contact an ABB representative.

## How to reset

The drive can be reset either by pressing the keypad key  on the control panel, through digital input, or by switching the supply voltage off for a while. When the fault has been removed, the motor can be restarted.

## Fault history

When a fault is detected, it is stored in the fault history. The latest faults are stored together with a time stamp.

Parameters [0401](#) LAST FAULT, [0412](#) PREVIOUS FAULT 1 and [0413](#) PREVIOUS FAULT 2 store the most recent faults. Parameters [0404](#)...[0409](#) show drive operation data at the time the latest fault occurred.

## Alarm messages generated by the drive

| CODE        | ALARM  | CAUSE   | WHAT TO DO   |
|-------------|--|---|--|
| A2001       | OVERCURRENT<br>(programmable fault function, parameter <a href="#">1610</a> DISPLAY ALARMS)                                      | Output current limit controller is active.  | Check motor load.<br>Check acceleration time (parameters <a href="#">2202</a> ACCELER TIME 1 and <a href="#">2205</a> ACCELER TIME 2).<br>Check motor and motor cable (including phasing).<br>Check ambient conditions. Load capacity decreases if installation site ambient temperature exceeds 40 °C. See section <a href="#">Derating</a> on page <a href="#">138</a> . |
| A2002       | OVERVOLTAGE<br>(programmable fault function, parameter <a href="#">1610</a> DISPLAY ALARMS)                                      | DC overvoltage controller is active.  | Check deceleration time (parameters <a href="#">2203</a> DECELER TIME 1 and <a href="#">2206</a> DECELER TIME 2).<br>Check input power line for static or transient overvoltage.   |
| A2003       | UNDERVOLTAGE<br>(programmable fault function, parameter <a href="#">1610</a> DISPLAY ALARMS)                                     | DC undervoltage controller is active.   | Check input power supply.  |
| A2004       | DIRLOCK  | Change of direction is not allowed.   | Check parameter <a href="#">1003</a> DIRECTION settings.   |
| A2006       | AI1 LOSS<br>(programmable fault function, parameters <a href="#">3001</a> AI<MIN FUNCTION, <a href="#">3021</a> AI1 FAULT LIMIT) | Analog input AI1 signal has fallen below limit defined by parameter <a href="#">3021</a> AI1 FAULT LIMIT.   | Check fault function parameter settings.<br>Check for proper analog control signal levels.<br>Check connections.   |
| A2009       | DEVICE OVERTEMP  | Drive IGBT temperature is excessive. Alarm limit is 120 °C.   | Check ambient conditions. See also section <a href="#">Derating</a> on page <a href="#">138</a> .<br>Check air flow and fan operation.<br>Check motor power against drive power.   |
| A2010       | MOTOR TEMP<br>(programmable fault function, parameters <a href="#">3005...3009</a> )   | Motor temperature is too high (or appears to be too high) due to excessive load, insufficient motor power, inadequate cooling or incorrect start-up data. | Check motor ratings, load and cooling.<br>Check start-up data.<br>Check fault function parameter settings.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc.  |
| A2011       | UNDERLOAD<br>(programmable fault function, parameters <a href="#">3013...3015</a> )  | Motor load is too low due to, for example, release mechanism in driven equipment.   | Check for problem in driven equipment.<br>Check fault function parameter settings.<br>Check motor power against drive power.   |
| A2012       | MOTOR STALL<br>(programmable fault function, parameters <a href="#">3010...3012</a> )  | Motor is operating in stall region due to, for example, excessive load or insufficient motor power.   | Check motor load and drive ratings.<br>Check fault function parameter settings.  |
| A2013<br>1) | AUTORESET  | Automatic reset alarm   | Check parameter group <a href="#">31</a> <b>AUTOMATIC RESET</b> settings.  |

| CODE        | ALARM  | CAUSE   | WHAT TO DO  |
|-------------|--|---|---|
| A2017       | OFF BUTTON   | Drive stop command has been given from control panel when local control lock is active.   | Disable the local control mode lock by parameter <a href="#">1606</a> LOCAL LOCK and retry.                         |
| A2018<br>1) | PID SLEEP  | Sleep function has entered the sleeping mode.   | See parameter group <a href="#">40 PROCESS PID SET 1</a> .  |
| A2023       | EMERGENCY STOP   | Drive has received emergency stop command and ramps to stop according to ramp time defined by parameter <a href="#">2208</a> EMERG DEC TIME.  | Check that it is safe to continue operation.<br>Return emergency stop push button to normal position.               |
| A2026       | INPUT PHASE LOSS<br>(programmable fault function, parameter <a href="#">3016</a> SUPPLY PHASE) | Intermediate circuit DC voltage is oscillating due to missing input power line phase or blown fuse.<br>Alarm is generated when DC voltage ripple exceeds 14% of nominal DC voltage. | Check input power line fuses.<br>Check for input power supply imbalance.<br>Check fault function parameter setting. |

1) Even when the relay output is configured to indicate alarm conditions (for example, parameter [1401](#) RELAY OUTPUT 1 = 5 [ALARM] or 16 [FLT/ALARM]), this alarm is not indicated by a relay output.

| CODE  | CAUSE  | WHAT TO DO   |
|-------|--|--|
| A5011 | Drive is controlled from another source.                                 | Change drive control to the local control mode.  |
| A5012 | Direction of rotation is locked.   | Enable change of direction. See parameter <a href="#">1003</a> DIRECTION.  |
| A5013 | Panel control is disabled because start inhibit is active.               | Start from the panel is not possible. Reset the emergency stop command or remove the 3-wire stop command before starting from the panel.<br><br>See section <a href="#">3-wire macro</a> on page <a href="#">72</a> and parameters <a href="#">1001</a> EXT1 COMMANDS, <a href="#">1002</a> EXT2 COMMANDS and <a href="#">2109</a> EMERG STOP SEL. |
| A5014 | Panel control is disabled because of drive fault.                        | Reset drive fault and retry.   |
| A5015 | Panel control is disabled because the local control mode lock is active. | Deactivate the local control mode lock and retry. See parameter <a href="#">1606</a> LOCAL LOCK.   |
| A5019 | Writing non-zero parameter value is prohibited.                          | Only parameter reset is allowed.   |
| A5022 | Parameter is write protected.  | Parameter value is read-only and cannot be changed.  |
| A5023 | Parameter change is not allowed, when drive is running.                  | Stop drive and change parameter value.   |
| A5024 | Drive is executing task.   | Wait until task is completed.  |
| A5026 | Value is at or below minimum limit.                                      | Contact your local ABB representative.   |
| A5027 | Value is at or above maximum limit.                                      | Contact your local ABB representative.   |
| A5028 | Invalid value  | Contact your local ABB representative.   |
| A5029 | Memory is not ready.   | Retry.   |
| A5030 | Invalid request  | Contact your local ABB representative.   |
| A5031 | Drive is not ready for operation, for example, due to low DC voltage.    | Check input power supply.  |
| A5032 | Parameter error  | Contact your local ABB representative.   |

## Fault messages generated by the drive

| CODE  | FAULT  | CAUSE  | WHAT TO DO   |
|-------|--|--|--|
| F0001 | OVERCURRENT  | Output current has exceeded trip level.<br>Overcurrent trip limit for drive is 325% of drive nominal current.  | Check motor load.<br>Check acceleration time (parameters <a href="#">2202 ACCELER TIME 1</a> and <a href="#">2205 ACCELER TIME 2</a> ).<br>Check motor and motor cable (including phasing).<br>Check ambient conditions. Load capacity decreases if installation site ambient temperature exceeds 40 °C. See section <a href="#">Derating</a> on page <a href="#">138</a> .  |
| F0002 | DC OVERVOLT  | Excessive intermediate circuit DC voltage. DC overvoltage trip limit is 420 V for 200 V drives and 840 V for 400 V drives.                                   | Check that overvoltage controller is on (parameter <a href="#">2005 OVERVOLT CTRL</a> ).<br>Check brake chopper and resistor (if used). DC overvoltage control must be deactivated when brake chopper and resistor are used.<br>Check deceleration time (parameters <a href="#">2203 DECELER TIME 1</a> and <a href="#">2206 DECELER TIME 2</a> ).<br>Check input power line for static or transient overvoltage.<br>Retrofit frequency converter with brake chopper and brake resistor. |
| F0003 | DEV OVERTEMP   | Drive IGBT temperature is excessive. Fault trip limit is 135 °C.   | Check ambient conditions. See also section <a href="#">Derating</a> on page <a href="#">138</a> .<br>Check air flow and fan operation.<br>Check motor power against drive power.   |
| F0004 | SHORT CIRC   | Short circuit in motor cable(s) or motor   | Check motor and motor cable.   |
| F0006 | DC UNDERVOLT   | Intermediate circuit DC voltage is not sufficient due to missing input power line phase, blown fuse, rectifier bridge internal fault or too low input power. | Check that undervoltage controller is on (parameter <a href="#">2006 UNDERVOLT CTRL</a> ).<br>Check input power supply and fuses.  |
| F0007 | AI1 LOSS<br>(programmable fault function, parameters <a href="#">3001 AI&lt;MIN FUNCTION, 3021 AI1 FAULT LIMIT</a> ) | Analog input AI1 signal has fallen below limit defined by parameter <a href="#">3021 AI1 FAULT LIMIT</a> .   | Check fault function parameter settings.<br>Check for proper analog control signal levels.<br>Check connections.   |
| F0009 | MOT OVERTEMP<br>(programmable fault function, parameters <a href="#">3005...3009</a> )                               | Motor temperature is too high (or appears to be too high) due to excessive load, insufficient motor power, inadequate cooling or incorrect start-up data.    | Check motor ratings, load and cooling.<br>Check start-up data.<br>Check fault function parameter settings.<br>Let motor cool down. Ensure proper motor cooling: Check cooling fan, clean cooling surfaces, etc.  |
| F0012 | MOTOR STALL<br>(programmable fault function, parameters <a href="#">3010...3012</a> )                                | Motor is operating in stall region due to, for example, excessive load or insufficient motor power.  | Check motor load and drive ratings.<br>Check fault function parameter settings.  |

| CODE  | FAULT  | CAUSE  | WHAT TO DO   |
|-------|--|--|--|
| F0014 | EXT FAULT 1<br>(programmable fault function, parameter <a href="#">3003</a> EXTERNAL FAULT 1)  | External fault 1   | Check external devices for faults.<br>Check fault function parameter setting.  |
| F0015 | EXT FAULT 2<br>(programmable fault function, parameter <a href="#">3004</a> EXTERNAL FAULT 2)  | External fault 2   | Check external devices for faults.<br>Check fault function parameter setting.  |
| F0016 | EARTH FAULT<br>(programmable fault function, parameter <a href="#">3017</a> EARTH FAULT)       | Drive has detected earth (ground) fault in motor or motor cable.   | Check motor.<br>Check motor cable. Motor cable length must not exceed maximum specifications. See section <a href="#">Motor connection data</a> on page <a href="#">144</a> .<br><b>Note:</b> Disabling earth fault (ground fault) may damage drive. |
| F0017 | UNDERLOAD<br>(programmable fault function, parameters <a href="#">3013...3015</a> )            | Motor load is too low due to, for example, release mechanism in driven equipment.  | Check for problem in driven equipment.<br>Check fault function parameter settings.<br>Check motor power against drive power.   |
| F0018 | THERM FAIL   | Drive internal fault. Thermistor used for drive internal temperature measurement is open or short-circuited.   | Contact your local ABB representative.   |
| F0021 | CURR MEAS  | Drive internal fault. Current measurement is out of range.   | Contact your local ABB representative.   |
| F0022 | INPUT PHASE LOSS<br>(programmable fault function, parameter <a href="#">3016</a> SUPPLY PHASE) | Intermediate circuit DC voltage is oscillating due to missing input power line phase or blown fuse.<br>Fault trip occurs when DC voltage ripple exceeds 14% of nominal DC voltage.   | Check input power line fuses.<br>Check for input power supply imbalance.<br>Check fault function parameter setting.  |
| F0026 | DRIVE ID   | Internal drive ID fault  | Contact your local ABB representative.   |
| F0027 | CONFIG FILE  | Internal configuration file error  | Contact your local ABB representative.   |
| F0035 | OUTP WIRING<br>(programmable fault function, parameter <a href="#">3023</a> WIRING FAULT)      | Incorrect input power and motor cable connection (that is input power cable is connected to drive motor connection).<br>Fault can be erroneously declared if drive is faulty or input power is delta grounded system and motor cable capacitance is large. | Check input power connections.   |
| F0036 | INCOMPATIBLE SW  | Loaded software is not compatible.   | Contact your local ABB representative.   |
| F0101 | SERF CORRUPT   | Corrupted Serial Flash chip file system  | Contact your local ABB representative.   |
| F0103 | SERF MACRO   | Active macro file missing from Serial Flash chip   | Contact your local ABB representative.   |

| CODE  | FAULT              | CAUSE  | WHAT TO DO   |
|-------|--------------------|--|--|
| F0201 | DSP T1<br>OVERLOAD | System error   | Contact your local ABB representative.   |
| F0202 | DSP T2<br>OVERLOAD |  |  |
| F0203 | DSP T3<br>OVERLOAD |  |  |
| F0204 | DSP STACK<br>ERROR |  |  |
| F0206 | MMIO ID ERROR      | Internal I/O Control board (MMIO)<br>fault           | Contact your local ABB representative.   |
| F1000 | PAR HZRPM          | Incorrect speed/frequency limit<br>parameter setting | Check parameter settings. Following must apply:<br><a href="#">2007</a> MINIMUM FREQ < <a href="#">2008</a> MAXIMUM FREQ,<br><a href="#">2007</a> MINIMUM FREQ/ <a href="#">9907</a> MOTOR NOM FREQ<br>and <a href="#">2008</a> MAXIMUM FREQ/ <a href="#">9907</a> MOTOR NOM<br>FREQ are within range. |
| F1003 | PAR AI SCALE       | Incorrect analog input AI signal<br>scaling          | Check parameter group <a href="#">13 ANALOG INPUTS</a><br>settings. Following must apply:<br><a href="#">1301</a> MINIMUM AI1 < <a href="#">1302</a> MAXIMUM AI1.  |

# Maintenance

---

## What this chapter contains

The chapter contains preventive maintenance instructions.

## Maintenance intervals

If installed in an appropriate environment, the drive requires very little maintenance. The table lists the routine maintenance intervals recommended by ABB.

| Maintenance                                   | Interval               | Instruction   |
|---|------------------------|---|
| Reforming of capacitors                       | Every year when stored | See section <i>Capacitors</i> on page 135.  |
| Check of dustiness, corrosion and temperature | Every year             | .   |
| Cooling fan replacement (frame sizes R1...R2) | Every three years      | See section <i>Cooling fan</i> on page 134.   |
| Check and tightening of the power terminals   | Every six years        | Check that tightening torque values given in chapter <i>Technical data</i> are met. |

Consult your local ABB Service representative for more details on the maintenance. On the Internet, go to <http://www.abb.com/drives> and select Drive Services – Maintenance and Field Services.

## Cooling fan

The life span of the cooling fan depends on the drive usage and ambient temperature.

Fan failure can be predicted by the increasing noise from the fan bearings. If the drive is operated in a critical part of a process, fan replacement is recommended once these symptoms start appearing. Replacement fans are available from ABB. Do not use other than ABB specified spare parts.

### Fan replacement (R1 and R2)

Only frame sizes R1 and R2 include a fan; frame size R0 has natural cooling.

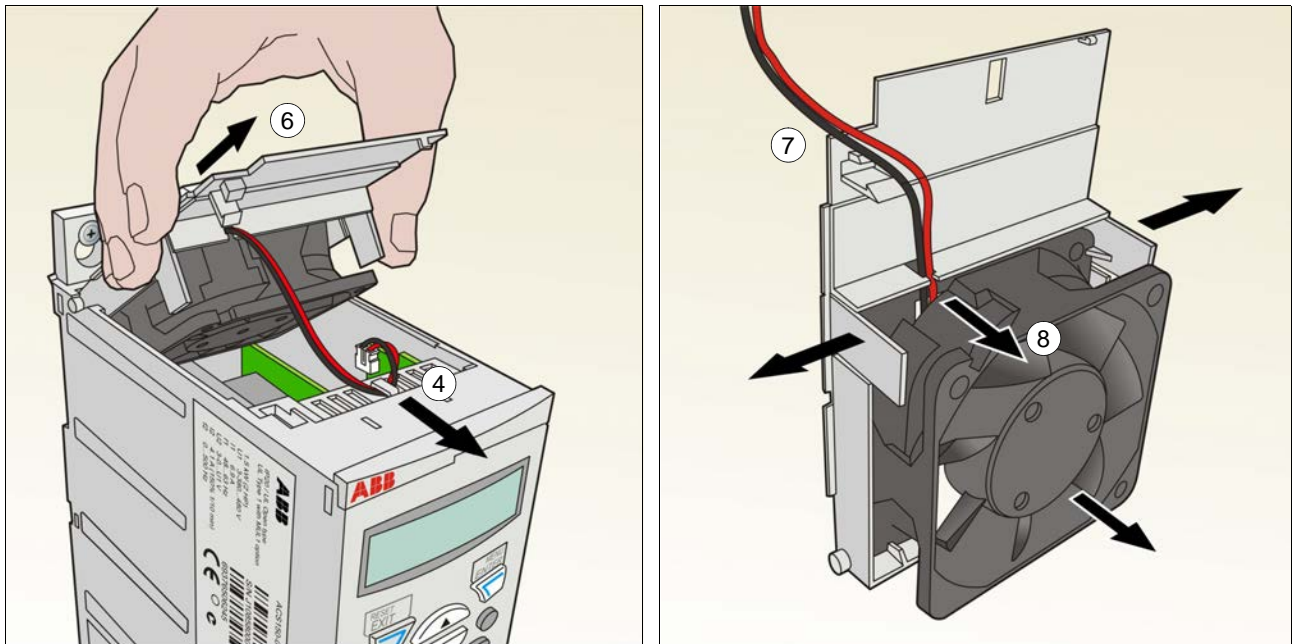


**WARNING!** Read and follow the instructions in chapter [Safety](#) on page 11. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Stop the drive and disconnect it from the AC power source.
2. Remove the hood if the drive has the NEMA 1 option.
3. Lever the fan holder off the drive frame with for example, a screwdriver and lift the hinged fan holder slightly upward from its front edge.



4. Free the fan cable from the clip.
5. Disconnect the fan cable.
6. Remove the fan holder from the hinges.
7. Free the fan cable from the clip in the fan holder.
8. Remove the fan from the holder.



9. Install the fan holder including the fan in reverse order.
10. Restore power.

## Capacitors

### Reforming the capacitors

The capacitors must be reformed if the drive has been stored for a year. See section [Type designation label](#) on page 22 for how to find out the manufacturing time from the serial number. For information on reforming the capacitors, refer to *Guide for capacitor reforming in ACS50, ACS55, ACS150, ACS310, ACS320, ACS350, ACS550 and ACH550* (3AFE68735190 [English]), available on the internet (go to <http://www.abb.com> and enter the code in the Search field).

## Power connections



**WARNING!** Read and follow the instructions in chapter [Safety](#) on page [11](#). Ignoring the instructions can cause physical injury or death, or damage to the equipment.

---

1. Stop the drive and disconnect it from the power line. Wait for five minutes to let the drive DC capacitors discharge. Ensure by measuring with a multimeter (impedance at least 1 Mohm) that there is no voltage present.
2. Check the tightness of the power cable connections. Use the tightening torques given in section [Terminal and lead-through data for the power cables](#) on page [143](#).
3. Restore power.

## Control panel

### Cleaning

Use a soft damp cloth to clean the control panel. Avoid harsh cleaners which could scratch the display window.

# Technical data

## What this chapter contains

The chapter contains the technical specifications of the drive, for example, the ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE and other marks.

## Ratings

### Current and power

The current and power ratings are given below. The symbols are described below the table.

| Type<br>ACS150-<br>x = E/U <sup>1)</sup>                                       | Input         |                       | Output        |                         |                 |       |      | Frame size |
|--|---------------|-----------------------|---------------|-------------------------|-----------------|-------|------|------------|
|  | $I_{1N}$<br>A | $I_{1N}$ (480 V)<br>A | $I_{2N}$<br>A | $I_{2,1min/10min}$<br>A | $I_{2max}$<br>A | $P_N$ |      |            |
|  |               |                       |               |                         |                 | kW    | hp   |            |
| <b>1-phase <math>U_N = 200...240</math> V (200, 208, 220, 230, 240 V)</b>      |               |                       |               |                         |                 |       |      |            |
| 01x-02A4-2   | 6.1           | -                     | 2.4           | 3.6                     | 4.2             | 0.37  | 0.5  | R0         |
| 01x-04A7-2   | 11.4          | -                     | 4.7           | 7.1                     | 8.2             | 0.75  | 1    | R1         |
| 01x-06A7-2   | 16.1          | -                     | 6.7           | 10.1                    | 11.7            | 1.1   | 1.5  | R1         |
| 01x-07A5-2   | 16.8          | -                     | 7.5           | 11.3                    | 13.1            | 1.5   | 2    | R2         |
| 01x-09A8-2   | 21.0          | -                     | 9.8           | 14.7                    | 17.2            | 2.2   | 3    | R2         |
| <b>3-phase <math>U_N = 200...240</math> V (200, 208, 220, 230, 240 V)</b>      |               |                       |               |                         |                 |       |      |            |
| 03x-02A4-2   | 4.3           | -                     | 2.4           | 3.6                     | 4.2             | 0.37  | 0.5  | R0         |
| 03x-03A5-2   | 6.1           | -                     | 3.5           | 5.3                     | 6.1             | 0.55  | 0.75 | R0         |
| 03x-04A7-2   | 7.6           | -                     | 4.7           | 7.1                     | 8.2             | 0.75  | 1    | R1         |
| 03x-06A7-2   | 11.8          | -                     | 6.7           | 10.1                    | 11.7            | 1.1   | 1.5  | R1         |
| 03x-07A5-2   | 12.0          | -                     | 7.5           | 11.3                    | 13.1            | 1.5   | 2    | R1         |
| 03x-09A8-2   | 14.3          | -                     | 9.8           | 14.7                    | 17.2            | 2.2   | 3    | R2         |
| <b>3-phase <math>U_N = 380...480</math> V (380, 400, 415, 440, 460, 480 V)</b> |               |                       |               |                         |                 |       |      |            |
| 03x-01A2-4   | 2.2           | 1.8                   | 1.2           | 1.8                     | 2.1             | 0.37  | 0.5  | R0         |
| 03x-01A9-4   | 3.6           | 3.0                   | 1.9           | 2.9                     | 3.3             | 0.55  | 0.75 | R0         |
| 03x-02A4-4   | 4.1           | 3.4                   | 2.4           | 3.6                     | 4.2             | 0.75  | 1    | R1         |
| 03x-03A3-4   | 6.0           | 5.0                   | 3.3           | 5.0                     | 5.8             | 1.1   | 1.5  | R1         |
| 03x-04A1-4   | 6.9           | 5.8                   | 4.1           | 6.2                     | 7.2             | 1.5   | 2    | R1         |
| 03x-05A6-4   | 9.6           | 8.0                   | 5.6           | 8.4                     | 9.8             | 2.2   | 3    | R1         |
| 03x-07A3-4   | 11.6          | 9.7                   | 7.3           | 11.0                    | 12.8            | 3     | 4    | R1         |
| 03x-08A8-4   | 13.6          | 11.3                  | 8.8           | 13.2                    | 15.4            | 4     | 5    | R1         |

00353783.xls J

<sup>1)</sup> E = EMC filter connected (metal EMC filter screw installed),

U = EMC filter disconnected (plastic EMC filter screw installed), US parametrization.

## Symbols

### Input

|                        |  |
|------------------------|--|
| $I_{1N}$               | continuous rms input current (for dimensioning cables and fuses)                                     |
| $I_{1N}(480\text{ V})$ | continuous rms input current (for dimensioning cables and fuses) for drives with 480 V input voltage |

### Output

|                                  |  |
|----------------------------------|--|
| $I_{2N}$                         | continuous rms current. 50% overload is allowed for one minute every ten minutes.  |
| $I_{2,1\text{min}/10\text{min}}$ | maximum (50% overload) current allowed for one minute every ten minutes  |
| $I_{2\text{max}}$                | maximum output current. Available for two seconds at start, otherwise as long as allowed by the drive temperature.   |
| $P_N$                            | typical motor power. The kilowatt ratings apply to most IEC 4-pole motors. The horsepower ratings apply to most NEMA 4-pole motors.  |
| <b>R0...R2</b>                   | The ACS150 is manufactured in frame sizes R0...R2. Some instructions, technical data and dimensional drawings which only concern certain frame sizes are marked with the symbol of the frame size (R0...R2). |

## Sizing

Drive sizing is based on the rated motor current and power. To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current. Also the rated power of the drive must be higher than or equal to compared to the rated motor power. The power ratings are the same regardless of the supply voltage within one voltage range.

**Note 1:** The maximum allowed motor shaft power is limited to  $1.5 \cdot P_N$ . If the limit is exceeded, motor torque and current are automatically restricted. The function protects the input bridge of the drive against overload.

**Note 2:** The ratings apply at ambient temperature of 40 °C (104 °F).

In multimotor systems, the drive output current rating  $I_{2N}$  must be equal to or greater than the calculated sum of the input currents of all motors.

## Derating

**$I_{2N}$ :** The load capacity decreases if the installation site ambient temperature exceeds 40 °C (104 °F) or if the altitude exceeds 1000 meters (3300 ft) or the switching frequency is changed from 4 kHz to 8, 12 or 16 kHz.

### Temperature derating, $I_{2N}$

In the temperature range +40 °C...+50 °C (+104 °F...+122 °F), the rated output current ( $I_{2N}$ ) is decreased by 1% for every additional 1 °C (1.8 °F). The output current is calculated by multiplying the current given in the rating table by the derating factor.

**Example** If the ambient temperature is 50 °C (+122 °F), the derating factor is  $100\% - 1 \frac{\%}{\text{°C}} \cdot 10 \text{ °C} = 90\%$  or 0.90. The output current is then  $0.90 \cdot I_{2N}$ .

### Altitude derating, $I_{2N}$

In altitudes 1000...2000 m (3300...6600 ft) above sea level, the derating is 1% for every 100 m (330 ft). For 3-phase 200 V drives, the maximum altitude is 3000 m (9800 ft) above sea level. In altitudes 2000...3000 m (6600...9800 ft), the derating is 2% for every 100 m (330 ft).

Switching frequency derating,  $I_{2N}$

The drive derates itself automatically when parameter 2607 SWITCH FREQ CTRL = 1 (ON).

| Switching frequency | Drive voltage rating            |  |
|---------------------|---------------------------------|--|
|                     | $U_N = 200 \dots 240 \text{ V}$ | $U_N = 380 \dots 480 \text{ V}$  |
| 4 kHz               | No derating                     | No derating  |
| 8 kHz               | $I_{2N}$ derated to 90%.        | $I_{2N}$ derated to 75% for R0 or to 80% for R1 and R2.  |
| 12 kHz              | $I_{2N}$ derated to 80%.        | $I_{2N}$ derated to 50% for R0, or to 65% for R1 and R2, and the maximum ambient temperature derated to 30 °C (86 °F). |
| 16 kHz              | $I_{2N}$ derated to 75%.        | $I_{2N}$ derated to 50% and the maximum ambient temperature to 30 °C (86 °F).  |

When parameter 2607 SWITCH FREQ CTRL = 2 (ON (LOAD)), the drive controls the switching frequency towards the selected switching frequency 2606 SWITCHING FREQ if the drive's internal temperature allows.

## Power cable sizes and fuses

Cable dimensioning for rated currents ( $I_{1N}$ ) is shown in the table below together with the corresponding fuse types for short-circuit protection of the input power cable.

**The rated fuse currents given in the table are the maximums for the mentioned fuse types. If smaller fuse ratings are used, check that the fuse rms current rating is larger than the rated  $I_{1N}$  current given in section [Ratings](#) on page 137.** If 150% output power is needed, multiply current  $I_{1N}$  by 1.5. See also section [Selecting the power cables](#) on page 30.

**Check that the operating time of the fuse is below 0.5 seconds.** The operating time depends on the fuse type, the supply network impedance as well as the cross-sectional area, material and length of the supply cable. In case the 0.5 seconds operating time is exceeded with the gG or T fuses, ultra rapid (aR) fuses in most cases reduce the operating time to an acceptable level.

**Note:** Larger fuses must not be used when the input power cable is selected according to this table.

| Type<br>ACS150-<br>x = E/U   | Fuses               |                       | Size of CU conductor in cabling |     |                       |     |                 |     |                          |     |
|--|---------------------|-----------------------|---------------------------------|-----|-----------------------|-----|-----------------|-----|--------------------------|-----|
|  | gG                  | UL Class<br>T (600 V) | Supply<br>(U1, V1, W1)          |     | Motor<br>(U2, V2, W2) |     | PE              |     | Brake<br>(BRK+ and BRK-) |     |
|  | A                   | A                     | mm <sup>2</sup>                 | AWG | mm <sup>2</sup>       | AWG | mm <sup>2</sup> | AWG | mm <sup>2</sup>          | AWG |
| <b>1-phase <math>U_N = 200...240</math> V (200, 208, 220, 230, 240 V)</b>      |                     |                       |                                 |     |                       |     |                 |     |                          |     |
| 01x-02A4-2   | 10                  | 10                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 01x-04A7-2   | 16                  | 20                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 01x-06A7-2   | 16/20 <sup>1)</sup> | 25                    | 2.5                             | 10  | 1.5                   | 14  | 2.5             | 10  | 2.5                      | 12  |
| 01x-07A5-2   | 20/25 <sup>1)</sup> | 30                    | 2.5                             | 10  | 1.5                   | 14  | 2.5             | 10  | 2.5                      | 12  |
| 01x-09A8-2   | 25/35 <sup>1)</sup> | 35                    | 6                               | 10  | 2.5                   | 12  | 6               | 10  | 6                        | 12  |
| <b>3-phase <math>U_N = 200...240</math> V (200, 208, 220, 230, 240 V)</b>      |                     |                       |                                 |     |                       |     |                 |     |                          |     |
| 03x-02A4-2   | 10                  | 10                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 03x-03A5-2   | 10                  | 10                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 03x-04A7-2   | 10                  | 15                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 03x-06A7-2   | 16                  | 15                    | 2.5                             | 12  | 1.5                   | 14  | 2.5             | 12  | 2.5                      | 12  |
| 03x-07A5-2   | 16                  | 15                    | 2.5                             | 12  | 1.5                   | 14  | 2.5             | 12  | 2.5                      | 12  |
| 03x-09A8-2   | 16                  | 20                    | 2.5                             | 12  | 2.5                   | 12  | 2.5             | 12  | 2.5                      | 12  |
| <b>3-phase <math>U_N = 380...480</math> V (380, 400, 415, 440, 460, 480 V)</b> |                     |                       |                                 |     |                       |     |                 |     |                          |     |
| 03x-01A2-4   | 10                  | 10                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 03x-01A9-4   | 10                  | 10                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 03x-02A4-4   | 10                  | 10                    | 2.5                             | 14  | 0.75                  | 18  | 2.5             | 14  | 2.5                      | 14  |
| 03x-03A3-4   | 10                  | 10                    | 2.5                             | 12  | 0.75                  | 18  | 2.5             | 12  | 2.5                      | 12  |
| 03x-04A1-4   | 16                  | 15                    | 2.5                             | 12  | 0.75                  | 18  | 2.5             | 12  | 2.5                      | 12  |
| 03x-05A6-4   | 16                  | 15                    | 2.5                             | 12  | 1.5                   | 14  | 2.5             | 12  | 2.5                      | 12  |
| 03x-07A3-4   | 16                  | 20                    | 2.5                             | 12  | 1.5                   | 14  | 2.5             | 12  | 2.5                      | 12  |
| 03x-08A8-4   | 20                  | 25                    | 2.5                             | 12  | 2.5                   | 12  | 2.5             | 12  | 2.5                      | 12  |

00353783.xls J

<sup>1)</sup> If 50% overload capacity is needed, use the larger fuse alternative.

## Dimensions, weights and free space requirements

### Dimensions and weights

| Frame size | Dimensions and weights   |      |     |      |     |      |     |      |     |      |                       |                       |
|------------|--------------------------|------|-----|------|-----|------|-----|------|-----|------|-----------------------|-----------------------|
|            | IP20 (cabinet) / UL open |      |     |      |     |      |     |      |     |      |                       |                       |
|            | H1                       |      | H2  |      | H3  |      | W   |      | D   |      | Weight                |                       |
|            | mm                       | in   | mm  | in   | mm  | in   | mm  | in   | mm  | in   | kg                    | lb                    |
| R0         | 169                      | 6.65 | 202 | 7.95 | 239 | 9.41 | 70  | 2.76 | 142 | 5.59 | 1.1                   | 2.4                   |
| R1         | 169                      | 6.65 | 202 | 7.95 | 239 | 9.41 | 70  | 2.76 | 142 | 5.59 | 1.3/1.2 <sup>1)</sup> | 2.9/2.6 <sup>1)</sup> |
| R2         | 169                      | 6.65 | 202 | 7.95 | 239 | 9.41 | 105 | 4.13 | 142 | 5.59 | 1.5                   | 3.3                   |

<sup>1)</sup>  $U_N = 200...240$  V: 1.3 kg / 2.9 lb,  $U_N = 380...480$  V: 1.2 kg / 2.6 lb

00353783.xls J

| Frame size | Dimensions and weights |       |     |       |     |      |     |      |                       |                       |
|------------|------------------------|-------|-----|-------|-----|------|-----|------|-----------------------|-----------------------|
|            | IP20 / NEMA 1          |       |     |       |     |      |     |      |                       |                       |
|            | H4                     |       | H5  |       | W   |      | D   |      | Weight                |                       |
|            | mm                     | in    | mm  | in    | mm  | in   | mm  | in   | kg                    | lb                    |
| R0         | 257                    | 10.12 | 280 | 11.02 | 70  | 2.76 | 142 | 5.59 | 1.5                   | 3.3                   |
| R1         | 257                    | 10.12 | 280 | 11.02 | 70  | 2.76 | 142 | 5.59 | 1.7/1.6 <sup>2)</sup> | 3.7/3.5 <sup>2)</sup> |
| R2         | 257                    | 10.12 | 282 | 11.10 | 105 | 4.13 | 142 | 5.59 | 1.9                   | 4.2                   |

<sup>2)</sup>  $U_N = 200...240$  V: 1.7 kg / 3.7 lb,  $U_N = 380...480$  V: 1.6 kg / 3.5 lb

00353783.xls J

### Symbols

#### IP20 (cabinet) / UL open

H1 height without fastenings and clamping plate

H2 height with fastenings, without clamping plate

H3 height with fastenings and clamping plate

#### IP20 / NEMA 1

H4 height with fastenings and connection box

H5 height with fastenings, connection box and hood

### Free space requirements

| Frame size | Free space required |    |       |    |              |    |
|------------|---------------------|----|-------|----|--------------|----|
|            | Above               |    | Below |    | On the sides |    |
|            | mm                  | in | mm    | in | mm           | in |
| R0...R2    | 75                  | 3  | 75    | 3  | 0            | 0  |

00353783.xls J

## Losses, cooling data and noise

### Losses and cooling data

Frame size R0 has natural convection cooling. Frame sizes R1...R2 are provided with an internal fan. The air flow direction is from bottom to top.

The table below specifies the heat dissipation in the main circuit at nominal load and in the control circuit with minimum load (I/O not in use) and maximum load (all digital inputs in the on state and the fan in use). The total heat dissipation is the sum of the heat dissipation in the main and control circuits.

| Type<br>ACS150-<br>x = E/U   | Heat dissipation            |     |                 |    |        |    | Air flow          |                      |
|--|-----------------------------|-----|-----------------|----|--------|----|-------------------|----------------------|
|  | Main circuit                |     | Control circuit |    |        |    |                   |                      |
|  | Rated $I_{1N}$ and $I_{2N}$ |     | Min             |    | Max    |    | m <sup>3</sup> /h | ft <sup>3</sup> /min |
| W  | BTU/Hr                      | W   | BTU/Hr          | W  | BTU/Hr |    |                   |                      |
| <b>1-phase <math>U_N = 200...240</math> V (200, 208, 220, 230, 240 V)</b>      |                             |     |                 |    |        |    |                   |                      |
| 01x-02A4-2   | 25                          | 85  | 6.3             | 22 | 12.3   | 42 | -                 | -                    |
| 01x-04A7-2   | 46                          | 157 | 9.6             | 33 | 16.0   | 55 | 24                | 14                   |
| 01x-06A7-2   | 71                          | 242 | 9.6             | 33 | 16.0   | 55 | 24                | 14                   |
| 01x-07A5-2   | 73                          | 249 | 10.6            | 36 | 17.1   | 58 | 21                | 12                   |
| 01x-09A8-2   | 96                          | 328 | 10.6            | 36 | 17.1   | 58 | 21                | 12                   |
| <b>3-phase <math>U_N = 200...240</math> V (200, 208, 220, 230, 240 V)</b>      |                             |     |                 |    |        |    |                   |                      |
| 03x-02A4-2   | 19                          | 65  | 6.3             | 22 | 12.3   | 42 | -                 | -                    |
| 03x-03A5-2   | 31                          | 106 | 6.3             | 22 | 12.3   | 42 | -                 | -                    |
| 03x-04A7-2   | 38                          | 130 | 9.6             | 33 | 16.0   | 55 | 24                | 14                   |
| 03x-06A7-2   | 60                          | 205 | 9.6             | 33 | 16.0   | 55 | 24                | 14                   |
| 03x-07A5-2   | 62                          | 212 | 9.6             | 33 | 16.0   | 55 | 21                | 12                   |
| 03x-09A8-2   | 83                          | 283 | 10.6            | 36 | 17.1   | 58 | 21                | 12                   |
| <b>3-phase <math>U_N = 380...480</math> V (380, 400, 415, 440, 460, 480 V)</b> |                             |     |                 |    |        |    |                   |                      |
| 03x-01A2-4   | 11                          | 38  | 6.7             | 23 | 13.3   | 45 | -                 | -                    |
| 03x-01A9-4   | 16                          | 55  | 6.7             | 23 | 13.3   | 45 | -                 | -                    |
| 03x-02A4-4   | 21                          | 72  | 10.0            | 34 | 17.6   | 60 | 13                | 8                    |
| 03x-03A3-4   | 31                          | 106 | 10.0            | 34 | 17.6   | 60 | 13                | 8                    |
| 03x-04A1-4   | 40                          | 137 | 10.0            | 34 | 17.6   | 60 | 13                | 8                    |
| 03x-05A6-4   | 61                          | 208 | 10.0            | 34 | 17.6   | 60 | 19                | 11                   |
| 03x-07A3-4   | 74                          | 253 | 14.3            | 49 | 21.5   | 73 | 24                | 14                   |
| 03x-08A8-4   | 94                          | 321 | 14.3            | 49 | 21.5   | 73 | 24                | 14                   |

00353783.xls J

### Noise

| Frame size | Noise level |
|------------|-------------|
|            | dBA         |
| R0         | <35         |
| R1         | 52...55     |
| R2         | <62         |

00353783.xls J

## Terminal and lead-through data for the power cables

| Frame size | Max cable diameter for NEMA 1 |      | U1, V1, W1, U2, V2, W2, BRK+ and BRK- |     |                   |        | PE                                |     |                   |        |
|------------|-------------------------------|------|---------------------------------------|-----|-------------------|--------|-----------------------------------|-----|-------------------|--------|
|            | U1, V1, W1, U2, V2, W2        |      | Max. terminal size flexible/rigid     |     | Tightening torque |        | Max. clamp size solid or stranded |     | Tightening torque |        |
|            | mm                            | in   | mm <sup>2</sup>                       | AWG | N·m               | lbf·in | mm <sup>2</sup>                   | AWG | N·m               | lbf·in |
| R0         | 16                            | 0.63 | 4.0/6.0                               | 10  | 0.8               | 7      | 25                                | 3   | 1.2               | 11     |
| R1         | 16                            | 0.63 | 4.0/6.0                               | 10  | 0.8               | 7      | 25                                | 3   | 1.2               | 11     |
| R2         | 16                            | 0.63 | 4.0/6.0                               | 10  | 0.8               | 7      | 25                                | 3   | 1.2               | 11     |

00353783.xls J

## Terminal data for the control cables

| Conductor size    |         |   |         |  |         | Tightening torque  |
|-------------------|---------|---|---------|--|---------|--|
| Solid or stranded |         | Stranded, with ferrule without plastic sleeve |         | Stranded, with ferrule with plastic sleeve |         |  |
| Min/Max           | Min/Max | Min/Max                                       | Min/Max | Min/Max                                    | Min/Max |  |
| mm <sup>2</sup>   | AWG     | mm <sup>2</sup>                               | AWG     | mm <sup>2</sup>                            | AWG     | See section <a href="#">Control connection data</a> on page 146. |
| 0.14/1.5          | 26/16   | 0.25/1.5                                      | 23/16   | 0.25/1.5                                   | 23/16   |  |

## Electric power network specification

|                                   |  |
|-----------------------------------|--|
| <b>Voltage (<math>U_1</math>)</b> | 200/208/220/230/240 V AC 1-phase for 200 V AC drives<br>200/208/220/230/240 V AC 3-phase for 200 V AC drives<br>380/400/415/440/460/480 V AC 3-phase for 400 V AC drives<br>Regular 10% variation from converter nominal voltage is allowed as default.                            |
| <b>Short-circuit capacity</b>     | Maximum allowed prospective short-circuit current at the input power connection as defined in IEC 60439-1 and UL 508C is 100 kA. The drive is suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes at the drive maximum rated voltage. |
| <b>Frequency</b>                  | 50/60 Hz $\pm$ 5%, maximum rate of change 17%/s  |
| <b>Imbalance</b>                  | Max. $\pm$ 3% of nominal phase-to-phase input voltage  |

## Motor connection data

|  |  |
|--|--|
| <b>Motor type</b>  | AC induction motor   |
| <b>Voltage (<math>U_2</math>)</b>                        | 0 to $U_1$ , 3-phase symmetrical, $U_{max}$ at the field weakening point   |
| <b>Short-circuit protection (IEC 61800-5-1, UL 508C)</b> | The motor output is short-circuit proof by IEC 61800-5-1 and UL 508C.  |
| <b>Frequency</b>   | Scalar control: 0...500 Hz   |
| <b>Frequency resolution</b>                              | 0.01 Hz  |
| <b>Current</b>   | See section <a href="#">Ratings</a> on page 137.   |
| <b>Power limit</b>                                       | $1.5 \cdot P_N$  |
| <b>Field weakening point</b>                             | 10...500 Hz  |
| <b>Switching frequency</b>                               | 4, 8, 12 or 16 kHz   |
| <b>Maximum recommended motor cable length</b>            | <b>Operational functionality and motor cable length</b><br>The drive is designed to operate with optimum performance with the following maximum motor cable lengths. The motor cable lengths may be extended with output chokes as shown in the table. |

| Frame size                                      | Maximum motor cable length |     |
|---|----------------------------|-----|
|   | m                          | ft  |
| <b>Standard drive, without external options</b> |                            |     |
| R0  | 30                         | 100 |
| R1...R2   | 50                         | 165 |
| <b>With external output chokes</b>              |                            |     |
| R0  | 60                         | 195 |
| R1...R2   | 100                        | 330 |

### EMC compatibility and motor cable length

To comply with the European EMC Directive (standard IEC/EN 61800-3), use the following maximum motor cable lengths for 4 kHz switching frequency.

| All frame sizes                                 | Maximum motor cable length, 4 kHz |                              |
|---|-----------------------------------|------------------------------|
|   | m                                 | ft                           |
| <b>With internal EMC filter</b>                 |                                   |                              |
| Second environment (category C3 <sup>1)</sup> ) | 30                                | 100                          |
| First environment (category C2 <sup>1)</sup> )  | -                                 | -                            |
| First environment (category C1 <sup>1)</sup> )  | -                                 | -                            |
| <b>With optional external EMC filter</b>        |                                   |                              |
| Second environment (category C3 <sup>1)</sup> ) | 30 (at least) <sup>2)</sup>       | 100 (at least) <sup>2)</sup> |
| First environment (category C2 <sup>1)</sup> )  | 30 (at least) <sup>2)</sup>       | 100 (at least) <sup>2)</sup> |
| First environment (category C1 <sup>1)</sup> )  | 10 (at least) <sup>2)</sup>       | 30 (at least) <sup>2)</sup>  |

<sup>1)</sup> See the new terms in section [Definitions](#) on page 148.

<sup>2)</sup> Maximum motor cable length is determined by the drive's operational factors. Contact your local ABB representative for the exact maximum lengths when using external EMC filters

**Note 1:** In multimotor systems, the calculated sum of all motor cable lengths must not exceed the maximum motor cable length given in the table.

**Note 2:** The internal EMC filter must be disconnected by removing the EMC screw (see section [Connection procedure](#) on page 42) while using an external EMC filter.

**Note 3:** Radiated emissions are according to C2 with and without an external EMC filter.

**Note 4:** Category C1 with conducted emissions only. Radiated emissions are not compatible when measured with standard emission measurement setup and should be checked or measured on cabinet and machine installations case by case.

## Control connection data

|  |  |  |
|--|--|--|
| <b>Analog input X1A: AI(1)</b>                                 | Voltage signal, unipolar                                     | 0 (2)...10 V, $R_{in} > 312 \text{ kohm}$        |
|  | Current signal, unipolar                                     | 0 (4)...20 mA, $R_{in} = 100 \text{ ohm}$        |
|  | Potentiometer reference value<br>(X1A: +10V)                 | 10 V $\pm$ 1%, max. 10 mA, $R < 10 \text{ kohm}$ |
|  | Resolution   | 0.1%   |
|  | Accuracy   | $\pm$ 1%   |
| <b>Auxiliary voltage X1A: +24V</b>                             |  | 24 V DC $\pm$ 10%, max. 200 mA                   |
| <b>Digital inputs X1A: DI1...DI5<br/>(frequency input DI5)</b> | Voltage  | 12...24 V DC with internal or external supply    |
|  | Max. voltage for digital inputs                              | 30 V DC  |
| <b>Frequency input X1A: DI5</b>                                | Type   | PNP and NPN                                      |
|  | Input impedance  | 2.4 kohm   |
|  | DI5 can be used either as a digital or as a frequency input. |  |
| <b>Relay output X1A:<br/>COM, NC, NO</b>                       | Frequency input  | Pulse train 0...16 kHz (DI5 only)                |
|  | Type   | NO + NC  |
| <b>Wire size</b>   | Max. switching voltage                                       | 250 V AC / 30 V DC                               |
|  | Max. switching current                                       | 0.5 A / 30 V DC; 5 A / 230 V AC                  |
|  | Max. continuous current                                      | 2 A rms  |
| <b>Torque</b>  | Relay connections  | 1.5...0.20 mm <sup>2</sup> / 16...24 AWG         |
|  | I/O connections  | 1... 0.14mm <sup>2</sup> / 16...26 AWG           |
| <b>Torque</b>  | Relay connections  | 0.5 N·m / 4.4 lbf·in                             |
|  | I/O connections  | 0.22 N·m / 2 lbf·in                              |

## Brake resistor connection

|   |   |
|---|---|
| <b>Short-circuit protection<br/>(IEC 61800-5-1, IEC 60439-1,<br/>UL 508C)</b> | The brake resistor output is conditionally short-circuit proof by IEC/EN 61800-5-1 and UL 508C. For correct fuse selection, contact your local ABB representative. Rated conditional short-circuit current as defined in IEC 60439-1 and the short-circuit test current by UL 508C is 100 kA. |
|---|---|

## Efficiency

Approximately 95 to 98% at nominal power level, depending on the drive size and options

## Degrees of protection

IP20 (cabinet installation) / UL open: Standard enclosure. The drive must be installed in a cabinet to fulfil the requirements for shielding from contact.

IP20 / NEMA 1: Achieved with an option kit (MUL1-R1) including a hood and a connection box.

## Ambient conditions

Environmental limits for the drive are given below. The drive is to be used in a heated indoor controlled environment.

|  | <b>Operation</b><br>installed for stationary use  | <b>Storage</b><br>in the protective package  | <b>Transportation</b><br>in the protective package                                     |
|--|---|--|--|
| <b>Installation site altitude</b>  | 0 to 2000 m (6600 ft) above sea level<br>(above 1000 m [3300 ft], see section <i>Derating</i> on page 138)  | -  | -  |
| <b>Air temperature</b>   | -10 to +50 °C (14 to 122 °F).<br>No frost allowed. See section <i>Derating</i> on page 138.   | -40 to +70 °C ±2%<br>(-40 to +158 °F) ±2%  | -40 to +70 °C<br>(-40 to +158 °F)  |
| <b>Relative humidity</b>   | 0 to 95%<br>No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.   | Max. 95%   | Max. 95%   |
| <b>Contamination levels</b><br>(IEC 60721-3-3,<br>IEC 60721-3-2,<br>IEC 60721-3-1) | No conductive dust allowed.<br>According to IEC 60721-3-3,<br>chemical gases: Class 3C2<br>solid particles: Class 3S2.<br><b>Note:</b> The drive must be installed in clean air according to enclosure classification.<br><b>Note:</b> Cooling air must be clean, free from corrosive materials and electrically conductive dust. | According to IEC 60721-3-1,<br>chemical gases: Class 1C2<br>solid particles: Class 1S2 | According to IEC 60721-3-2,<br>chemical gases: Class 2C2<br>solid particles: Class 2S2 |
| <b>Sinusoidal vibration</b><br>(IEC 60721-3-3)                                     | Tested according to IEC 60721-3-3, mechanical conditions: Class 3M4<br>2...9 Hz, 3.0 mm (0.12 in)<br>9...200 Hz, 10 m/s <sup>2</sup> (33 ft/s <sup>2</sup> )  | -  | -  |
| <b>Shock</b><br>(IEC 60068-2-27, ISTA 1A)  | Not allowed during operation  | According to ISTA 1A.<br>Max. 100 m/s <sup>2</sup> (330 ft/s <sup>2</sup> ),<br>11 ms. | According to ISTA 1A.<br>Max. 100 m/s <sup>2</sup> (330 ft/s <sup>2</sup> ),<br>11 ms. |
| <b>Free fall</b>   | Not allowed   | 76 cm (30 in)  | 76 cm (30 in)  |

## Materials

### Drive enclosure

- PC/ABS 2 mm, PC+10%GF 2.5...3 mm and PA66+25%GF 1.5 mm, all in color NCS 1502-Y (RAL 9002 / PMS 420 C)
- hot-dip zinc coated steel sheet 1.5 mm, thickness of coating 20 micrometers
- extruded aluminium AlSi.

### Package

Corrugated cardboard.

**Disposal**

The drive contains raw materials that should be recycled to preserve energy and natural resources. The package materials are environmentally compatible and recyclable. All metal parts can be recycled. The plastic parts can either be recycled or burned under controlled circumstances, according to local regulations. Most recyclable parts are marked with recycling marks.

If recycling is not feasible, all parts excluding electrolytic capacitors and printed circuit boards can be landfilled. The DC capacitors contain electrolyte, which is classified as hazardous waste within the EU. They must be removed and handled according to local regulations.

For further information on environmental aspects and more detailed recycling instructions, please contact your local ABB distributor.

**Applicable standards**


---

|                          |  |
|--------------------------|--|
|                          | The drive complies with the following standards:   |
| • IEC/EN 61800-5-1: 2003 | Electrical, thermal and functional safety requirements for adjustable frequency a.c. power drives  |
| • IEC/EN 60204-1: 2006   | Safety of machinery. Electrical equipment of machines. Part 1: General requirements.<br><i>Provisions for compliance:</i> The final assembler of the machine is responsible for installing<br>- an emergency-stop device<br>- a supply disconnecting device. |
| • IEC/EN 61800-3: 2004   | Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods  |
| • UL 508C                | UL Standard for Safety, Power Conversion Equipment, third edition.   |

**CE marking**

See the type designation label for the valid markings of your drive.

A CE mark is attached to the drive to verify that the drive follows the provisions of the European Low Voltage and EMC Directives.

**Compliance with the European EMC Directive**

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3:2004) covers requirements stated for drives. See section [Compliance with the EN 61800-3:2004](#) on page 148.

**Compliance with the EN 61800-3:2004****Definitions**

EMC stands for **Electromagnetic Compatibility**. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

*First environment* includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

*Second environment* includes establishments connected to a network not directly supplying domestic premises.

*Drive of category C1:* drive of rated voltage less than 1000 V, intended for use in the first environment.

*Drive of category C2:* drive of rated voltage less than 1000 V and intended to be installed and commissioned only by a professional when used in the first environment.

**Note:** A professional is a person or organization having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects.

Category C2 has the same EMC emission limits as the earlier class first environment restricted distribution. EMC standard IEC/EN 61800-3 does not any more restrict the distribution of the drive, but the using, installation and commissioning are defined.

*Drive of category C3:* drive of rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.

Category C3 has the same EMC emission limits as the earlier class second environment unrestricted distribution.

## Compliance

### Category C1

The emission limits are complied with the following provisions:

1. The optional EMC filter is selected according to the ABB documentation and installed as specified in the EMC filter manual.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. For the maximum motor cable length with 4 kHz switching frequency, see section [Motor connection data](#) on page 144.

**WARNING!** In a domestic environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

### Category C2

The emission limits are complied with the following provisions:

1. The optional EMC filter is selected according to the ABB documentation and installed as specified in the EMC filter manual.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. For the maximum motor cable length with 4 kHz switching frequency, see section [Motor connection data](#) on page 144.

**WARNING!** In a domestic environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

### Category C3

The immunity performance of the drive complies with the demands of IEC/EN 61800-3, second environment (see page 148 for IEC/EN 61800-3 definitions).

The emission limits are complied with the following provisions

1. The internal EMC filter is connected (the screw at EMC is in place) or the optional EMC filter is installed.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. With the internal EMC filter: motor cable length 30 m (100 ft) with 4 kHz switching frequency. For the maximum motor cable length with an optional external EMC filter, see section [Motor connection data](#) on page 144.

**WARNING!** A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

**Note:** It is not allowed to install a drive with the internal EMC filter connected on IT (ungrounded) systems. The supply network becomes connected to ground potential through the EMC filter capacitors which may cause danger or damage the drive.

**Note:** It is not allowed to install a drive with the internal EMC filter connected on a corner-grounded TN system as this would damage the drive.

## UL marking

See the type designation label for the valid markings of your drive.

The UL mark is attached to the drive to verify that it meets UL requirements.

### *UL checklist*

**Input power connection** – See section [Electric power network specification](#) on page 144.

**Disconnecting device (disconnecting means)** – See section [Selecting the supply disconnecting device \(disconnecting means\)](#) on page 29.

**Ambient conditions** – The drives are to be used in a heated indoor controlled environment. See section [Ambient conditions](#) on page 147 for specific limits.

**Input cable fuses** – For installation in the United States, branch circuit protection must be provided in accordance with the National Electrical Code (NEC) and any applicable local codes. To fulfil this requirement, use the UL classified fuses given in section [Power cable sizes and fuses](#) on page 140.

For installation in Canada, branch circuit protection must be provided in accordance with Canadian Electrical Code and any applicable provincial codes. To fulfil this requirement, use the UL classified fuses given in section [Power cable sizes and fuses](#) on page 140.

**Power cable selection** – See section [Selecting the power cables](#) on page 30.

**Power cable connections** – For the connection diagram and tightening torques, see section [Connecting the power cables](#) on page 41.

**Overload protection** – The drive provides overload protection in accordance with the National Electrical Code (US).

**Braking** – The drive has an internal brake chopper. When applied with appropriately sized brake resistors, the brake chopper allows the drive to dissipate regenerative energy (normally associated with quickly decelerating a motor). Brake resistor selection is discussed in section [Brake resistors](#) on page 151.

## C-Tick marking

See the type designation label for the valid markings of your drive.

C-Tick marking is required in Australia and New Zealand. A C-Tick mark is attached to the drive to verify compliance with the relevant standard (IEC 61800-3 (2004) – Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods), mandated by the Trans-Tasman Electromagnetic Compatibility Scheme.

The Trans-Tasman Electromagnetic Compatibility Scheme (EMCS) was introduced by the Australian Communication Authority (ACA) and the Radio Spectrum Management Group (RSM) of the New Zealand Ministry of Economic Development (NZMED) in November 2001. The aim of the scheme is to protect the radio frequency spectrum by introducing technical limits for emission from electrical/electronic products.

For fulfilling the requirements of the standard, see section [Compliance with the EN 61800-3:2004](#) on page 148.

## RoHS marking

See the type designation label for the valid markings of your drive.

The RoHS mark is attached to the drive to verify that drive follows the provisions of the European RoHS directive. RoHS = the restriction of the use of hazardous substances in electrical and electronic equipment.

## Brake resistors

ACS150 drives have an internal brake chopper as standard equipment. The brake resistor is selected using the table and equations presented in this section.

### Selecting the brake resistor

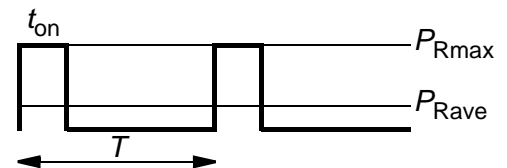
1. Determine the required maximum braking power  $P_{Rmax}$  for the application.  $P_{Rmax}$  must be smaller than  $P_{BRmax}$  given in the table on page 152 for the used drive type.
2. Calculate resistance  $R$  with Equation 1.
3. Calculate energy  $E_{Rpulse}$  with Equation 2.
4. Select the resistor so that the following conditions are met:
  - The rated power of the resistor must be greater than or equal to  $P_{Rmax}$ .
  - Resistance  $R$  must be between  $R_{min}$  and  $R_{max}$  given in the table for the used drive type.
  - The resistor must be able to dissipate energy  $E_{Rpulse}$  during the braking cycle  $T$ .

Equations for selecting the resistor:

$$\text{Eq. 1. } U_N = 200 \dots 240 \text{ V: } R = \frac{150000}{P_{Rmax}}$$

$$U_N = 380 \dots 415 \text{ V: } R = \frac{450000}{P_{Rmax}}$$

$$U_N = 415 \dots 480 \text{ V: } R = \frac{615000}{P_{Rmax}}$$



$$\text{Eq. 2. } E_{Rpulse} = P_{Rmax} \cdot t_{on}$$

$$\text{Eq. 3. } P_{Rave} = P_{Rmax} \cdot \frac{t_{on}}{T}$$

For conversion, use 1 hp = 746 W.

where

$R$  = selected brake resistor value (ohm)

$P_{Rmax}$  = maximum power during the braking cycle (W)

$P_{Rave}$  = average power during the braking cycle (W)

$E_{Rpulse}$  = energy conducted into the resistor during a single braking pulse (J)

$t_{on}$  = length of the braking pulse (s)

$T$  = length of the braking cycle (s).

Resistor types shown in the following table are pre-dimensioned resistors using the maximum braking power with cyclic braking shown in the table. Resistors are available from ABB. Information is subject to change without further notice.

| Type<br>ACS150-<br>x = E/U <sup>1</sup>                                     | R <sub>min</sub><br>ohm | R <sub>max</sub><br>ohm | P <sub>BRmax</sub> |      | Selection table by resistor type |     |     |                                 |
|---|-------------------------|-------------------------|--------------------|------|----------------------------------|-----|-----|---------------------------------|
|   |                         |                         |                    |      | CBR-V                            |     |     | Braking time <sup>2)</sup><br>s |
|   |                         |                         | kW                 | hp   | 160                              | 210 | 460 |                                 |
| <b>1-phase U<sub>N</sub> = 200...240 V (200, 208, 220, 230, 240 V)</b>      |                         |                         |                    |      |                                  |     |     |                                 |
| 01x-02A4-2  | 70                      | 390                     | 0.37               | 0.5  | •                                |     |     | 90                              |
| 01x-04A7-2  | 40                      | 200                     | 0.75               | 1    | •                                |     |     | 45                              |
| 01x-06A7-2  | 40                      | 130                     | 1.1                | 1.5  | •                                |     |     | 28                              |
| 01x-07A5-2  | 30                      | 100                     | 1.5                | 2    | •                                |     |     | 19                              |
| 01x-09A8-2  | 30                      | 70                      | 2.2                | 3    | •                                |     |     | 14                              |
| <b>3-phase U<sub>N</sub> = 200...240 V (200, 208, 220, 230, 240 V)</b>      |                         |                         |                    |      |                                  |     |     |                                 |
| 03x-02A4-2  | 70                      | 390                     | 0.37               | 0.5  | •                                |     |     | 90                              |
| 03x-03A5-2  | 70                      | 260                     | 0.55               | 0.75 | •                                |     |     | 60                              |
| 03x-04A7-2  | 40                      | 200                     | 0.75               | 1    | •                                |     |     | 42                              |
| 03x-06A7-2  | 40                      | 130                     | 1.1                | 1.5  | •                                |     |     | 29                              |
| 03x-07A5-2  | 30                      | 100                     | 1.5                | 2    | •                                |     |     | 19                              |
| 03x-09A8-2  | 30                      | 70                      | 2.2                | 3    | •                                |     |     | 14                              |
| <b>3-phase U<sub>N</sub> = 380...480 V (380, 400, 415, 440, 460, 480 V)</b> |                         |                         |                    |      |                                  |     |     |                                 |
| 03x-01A2-4  | 200                     | 1180                    | 0.37               | 0.5  |                                  | •   |     | 90                              |
| 03x-01A9-4  | 175                     | 800                     | 0.55               | 0.75 |                                  | •   |     | 90                              |
| 03x-02A4-4  | 165                     | 590                     | 0.75               | 1    |                                  | •   |     | 60                              |
| 03x-03A3-4  | 150                     | 400                     | 1.1                | 1.5  |                                  | •   |     | 37                              |
| 03x-04A1-4  | 130                     | 300                     | 1.5                | 2    |                                  | •   |     | 27                              |
| 03x-05A6-4  | 100                     | 200                     | 2.2                | 3    |                                  | •   |     | 17                              |
| 03x-07A3-4  | 70                      | 150                     | 3.0                | 3    |                                  |     | •   | 29                              |
| 03x-08A8-4  | 70                      | 110                     | 4.0                | 5    |                                  |     | •   | 20                              |

<sup>1)</sup> E=EMC filter connected (metal EMC filter screw installed), 00353783.xls J  
 U=EMC filter disconnected (plastic EMC filter screw installed), US parametrization.

<sup>2)</sup> Braking time = maximum allowed braking time in seconds at P<sub>BRmax</sub> every 120 seconds, at 40 °C ambient temperature.

**Note:** The brake resistors listed in the table are available in Europe. They do not apply to the USA. Contact your local ABB representative for more information.

**Symbols**

- R<sub>min</sub> = minimum allowed brake resistor that can be connected to the brake chopper
- R<sub>max</sub> = maximum allowed brake resistor that allows R<sub>max</sub>
- P<sub>BRmax</sub> = maximum braking capacity of the drive, must exceed the desired braking power.

| Ratings by resistor type | CBR-V | CBR-V | CBR-V |
|--------------------------|-------|-------|-------|
|                          | 160   | 210   | 460   |
| Nominal power (W)        | 280   | 360   | 790   |
| Resistance (ohm)         | 70    | 200   | 80    |



**WARNING!** Never use a brake resistor with a resistance below the minimum value specified for the particular drive. The drive and the internal chopper are not able to handle the overcurrent caused by the low resistance.

### Selecting the brake resistor cables

Use a shielded cable with the same conductor size as for drive input cabling (see section [Terminal and lead-through data for the power cables](#) on page 143). The maximum length of the resistor cable(s) is 5 m (16 ft).

### Placing the brake resistor

Install all resistors in a place where they will cool.



**WARNING!** The materials near the brake resistor must be non-flammable. The surface temperature of the resistor is high. Air flowing from the resistor is of hundreds of degrees Celsius. Protect the resistor against contact.

### Protecting the system in brake circuit fault situations

#### *Protection of the system in cable and brake resistor short-circuit situations*

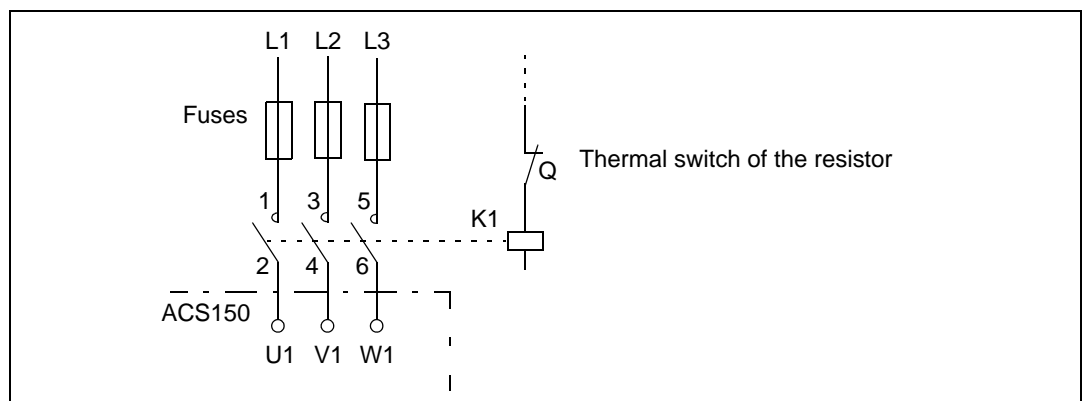
For short-circuit protection of the brake resistor connection, see [Brake resistor connection](#) on page 146. Alternatively, a two-conductor shielded cable with the same cross-sectional area can be used.

#### *Protection of the system in brake resistor overheating situations*

The following setup is essential for safety – it interrupts the main supply in fault situations involving chopper shorts:

- Equip the drive with a main contactor.
- Wire the contactor so that it opens if the resistor thermal switch opens (an overheated resistor opens the contactor).

Below is a simple wiring diagram example.



### Electrical installation

For the brake resistor connections, see the power connection diagram of the drive on page 41.

**Start-up**

To enable resistor braking, switch off the drive's overvoltage control by setting parameter [2005](#) OVERVOLT CTRL to 0 (DISABLE).

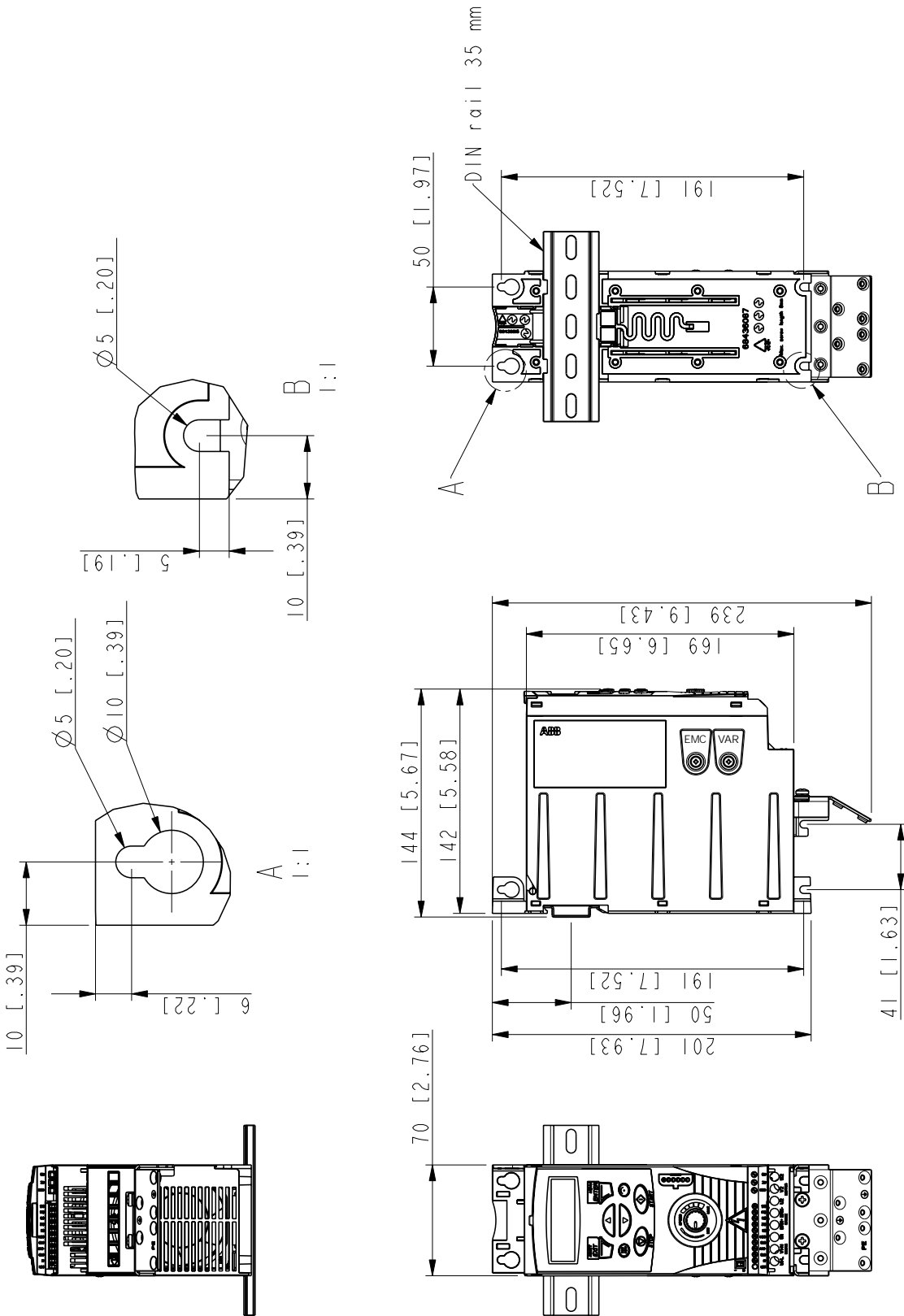
# Dimension drawings

---

Dimensional drawings of the ACS150 are shown below. The dimensions are given in millimeters and [inches].

### Frame sizes R0 and R1, IP20 (cabinet installation) / UL open

R1 and R0 are identical except for the fan at the top of R1.

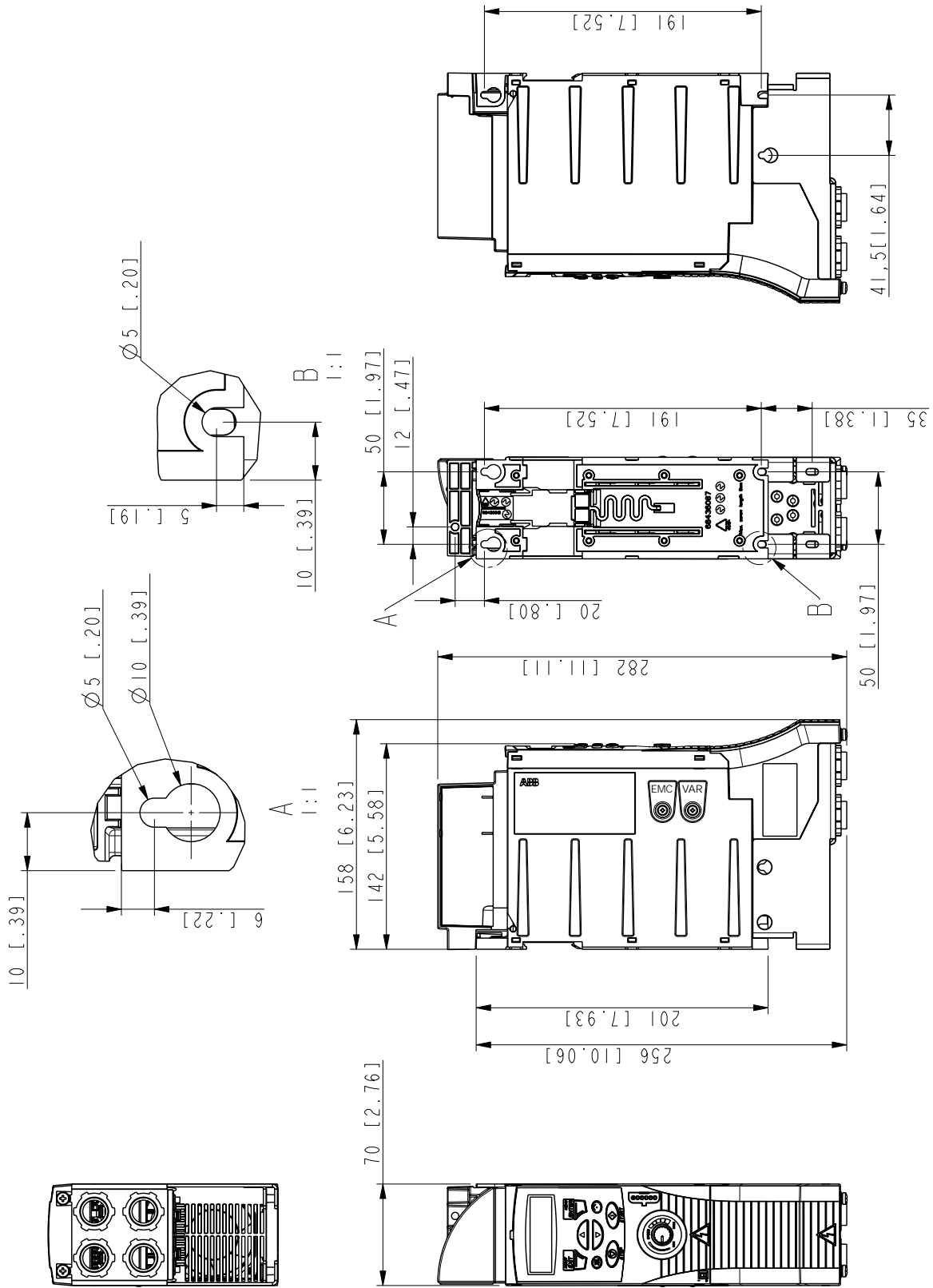


Frame sizes R0 and R1, IP20 (cabinet installation) / UL open

3AFE68637902-A

# Frame sizes R0 and R1, IP20 / NEMA 1

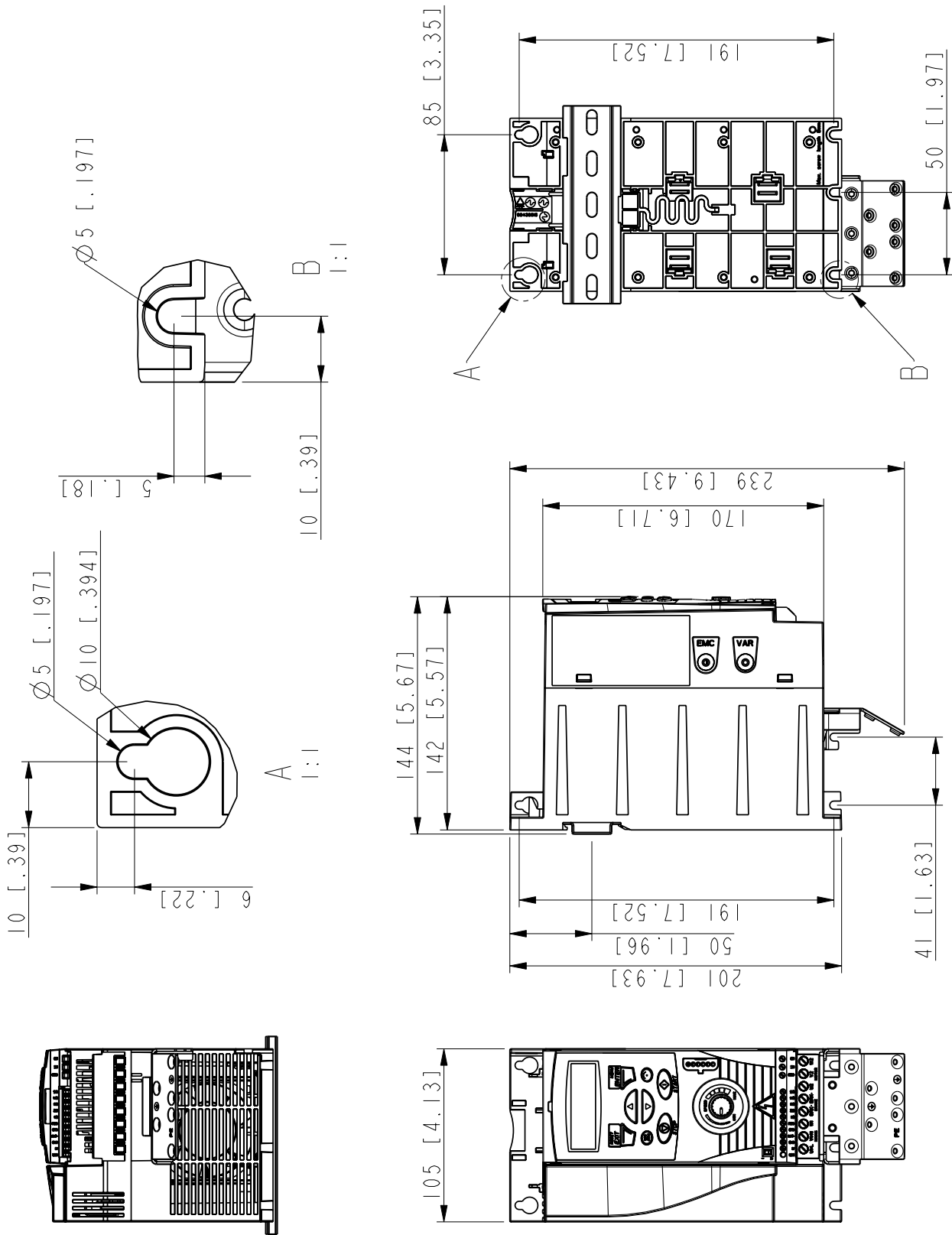
R1 and R0 are identical except for the fan at the top of R1.



Frame sizes R0 and R1, IP20 / NEMA 1

3AFE68637929-A

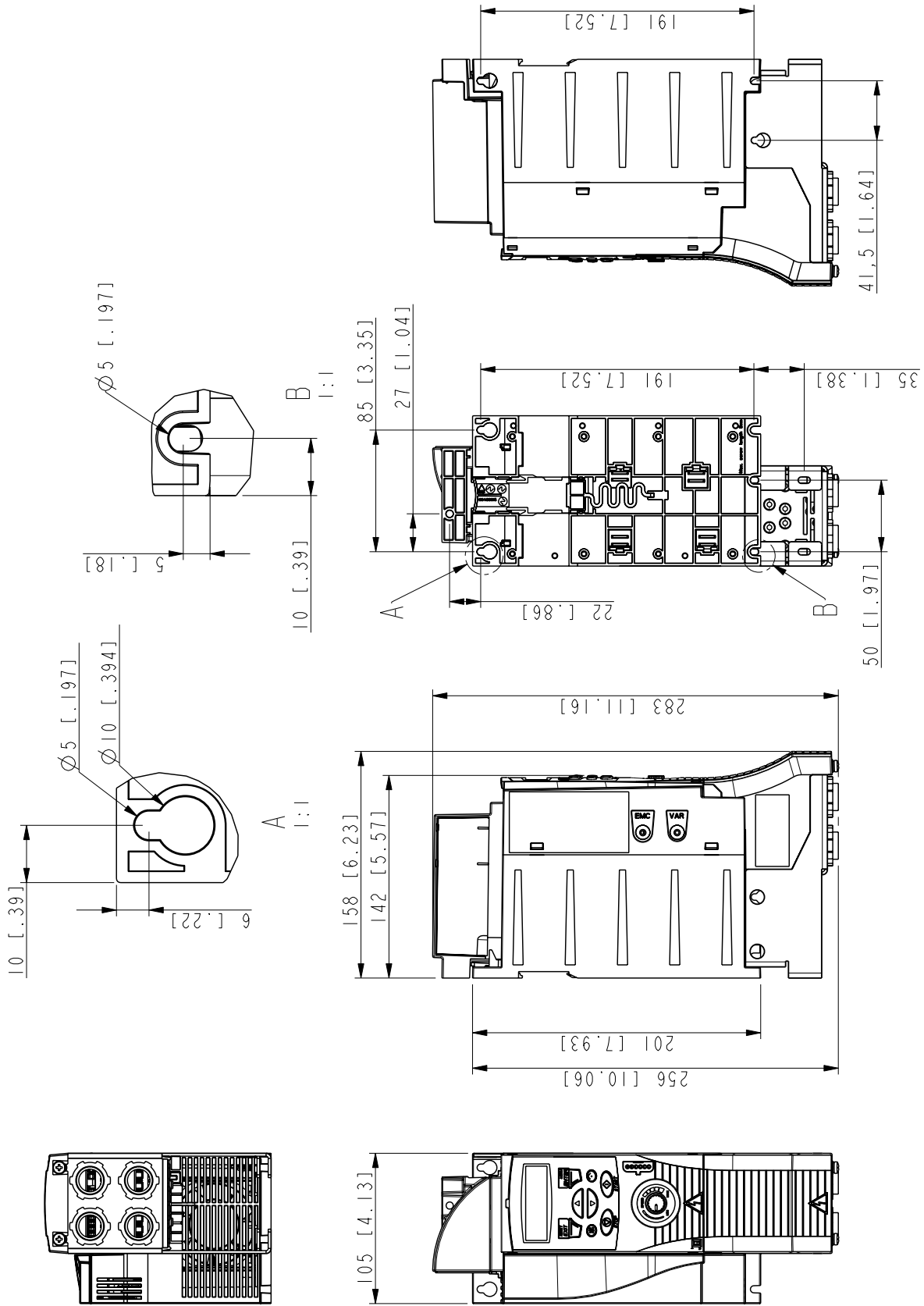
**Frame size R2, IP20 (cabinet installation) / UL open**



Frame size R2, IP20 (cabinet installation) / UL open

3AFE68613264-A

# Frame size R2, IP20 / NEMA 1



Frame size R2, IP20 / NEMA 1

3AFE68633931-A



## Appendix: Process PID control

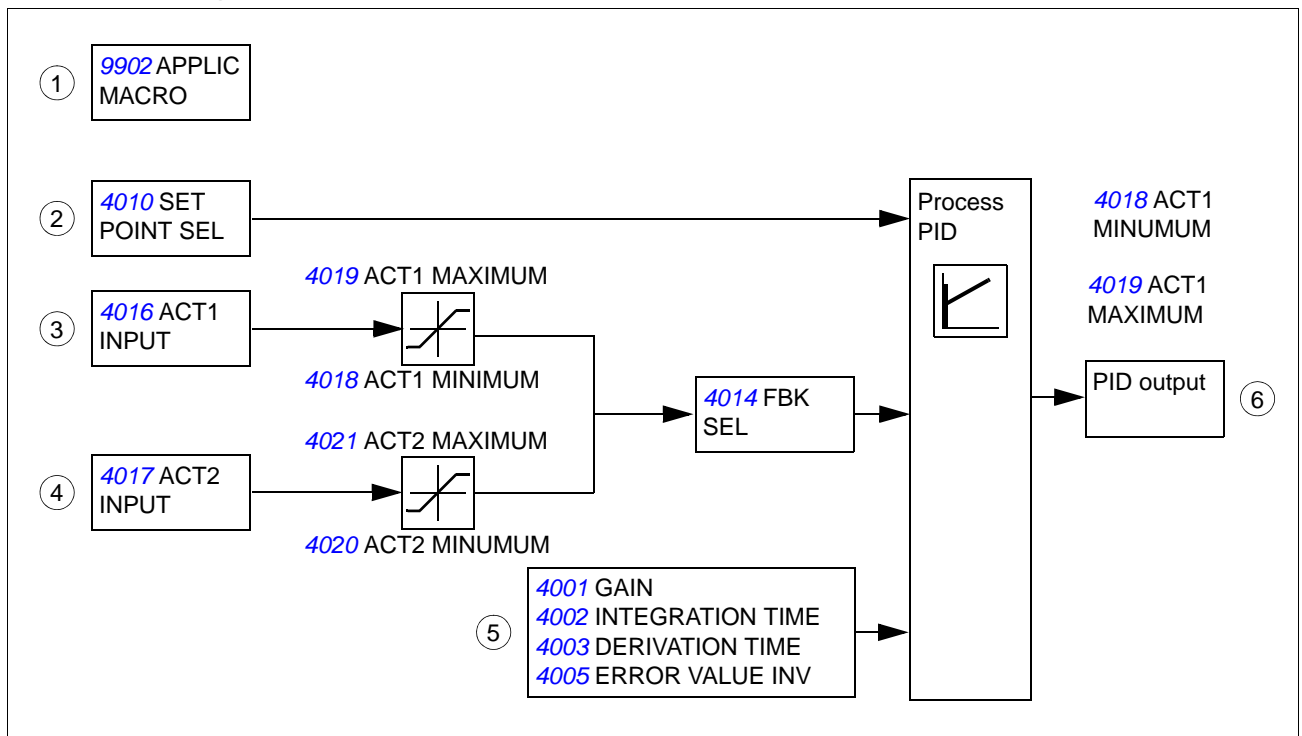
### What this chapter contains

The chapter contains instructions on quick configuration of the process control, gives an application example and describes the PID sleep functionality.

### Process PID control

There is a built-in PID controller in the drive. The controller can be used to control process variables such as pressure, flow or fluid level. In process PID control, a process reference (setpoint) is set with drive's integrated potentiometer. An actual value (process feedback) is connected to the drive's analog input. The process PID control adjusts the drive speed in order to keep the measured process quantity (actual value) at the desired level (setpoint).

### Quick configuration of process PID control

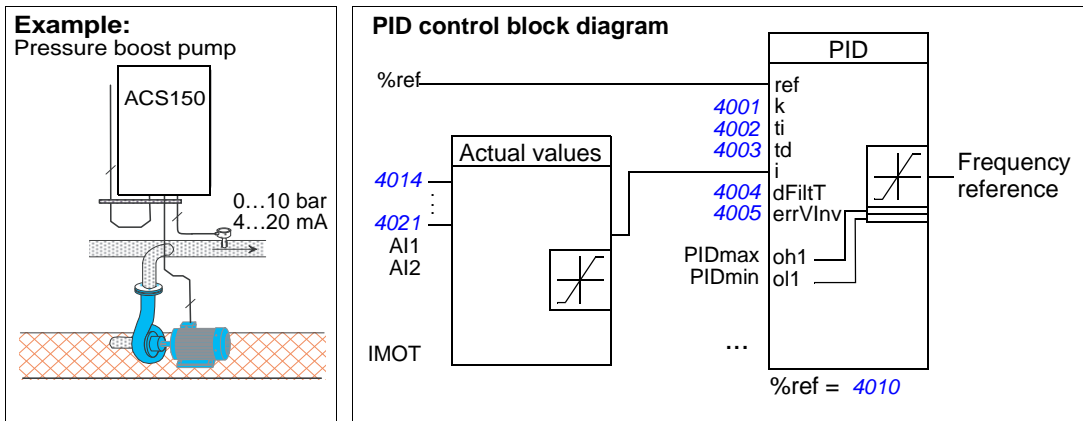


- 1. 9902 APPLIC MACRO:** Set **9902 APPLICATION MACRO** to 6 (PID CONTROL).
- 2. 4010 SET POINT SEL:** Determine the source for the PID reference signal (PID setpoint) and define its scale (**4006 UNITS**, **4007 UNIT SCALE**).
- 3. 4014 FBK SEL and 4016 ACT1 INPUT:** Select the process actual value (feedback signal) for the system and configure feedback levels (**4018 ACT1 MINIMUM**, **4019 ACT1 MAXIMUM**).

4. **4017 ACT2 INPUT:** If a second feedback is used, configure also this actual value 2 (**4020 ACT2 MINIMUM** and **4021 ACT2 MAXIMUM**).
5. **4001 GAIN, 4002 INTEGRATION TIME, 4003 DERIVATION TIME, 4005 ERROR VALUE INV:** Configure the desired gain, integration time, derivation time and error value inversion when needed.
6. **Activate PID output:** Check that **1106 REF2 SELECT** is set to 19 (PID1OUT).

**Pressure boost pump**

The figure below shows an application example: The controller adjusts the speed of a pressure boost pump according to the measured pressure and the set pressure reference.



*How to scale the PID actual (feedback) signal 0...10 bar / 4...20 mA*

PID feedback is connected to AI1 and 4016 ACT1 INPUT is set to AI1.

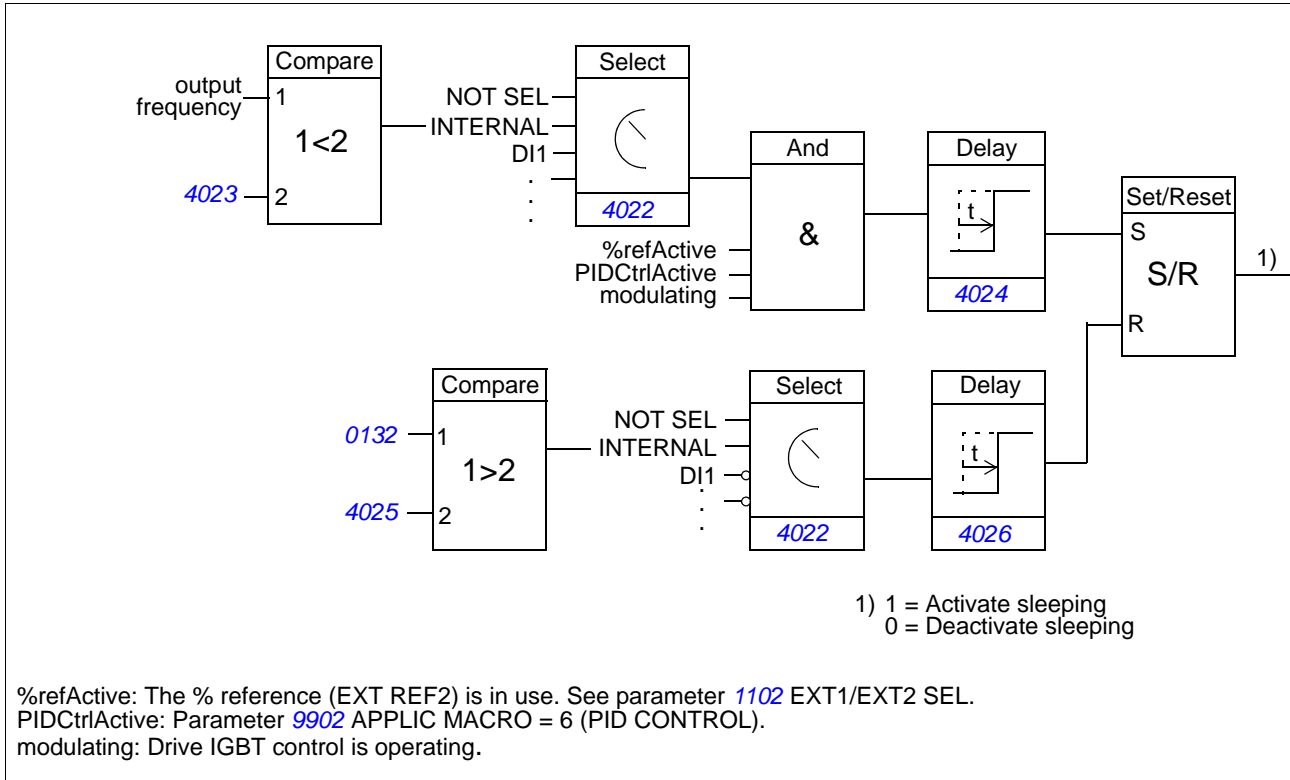
1. Set 9902 APPLICATION MACRO to 6 (PID CONTROL). Check scaling: 1301 MINIMUM AI1 as default 20% and 1302 MAXIMUM AI1 as default 100%. Check that 1106 REF2 SELECT is set to 19 (PID1OUT).
2. Set 3408 SIGNAL2 PARAM to 130 (PID1 FBK).
3. Set 3409 SIGNAL2 MIN to 0.
4. Set 3410 SIGNAL2 MAX to 10.
5. Set 3411 OUTPUT2 DSP FORM to 9 (DIRECT).
6. Set 3412 OUTPUT2 UNIT to 0 (NO UNIT).
7. Set 4006 UNITS to 0 (NO UNIT).
8. Set 4007 UNIT SCALE to 1.
9. Set 4008 0% VALUE to 0.
10. Set 4009 100% VALUE to 10.

*How to scale the PID setpoint signal*

1. Set 4010 SET POINT SEL to 19 (INTERNAL).
2. Set 4011 INTERNAL SETPNT to 5.0 ("bar" is not displayed on the drive control panel) as an example.

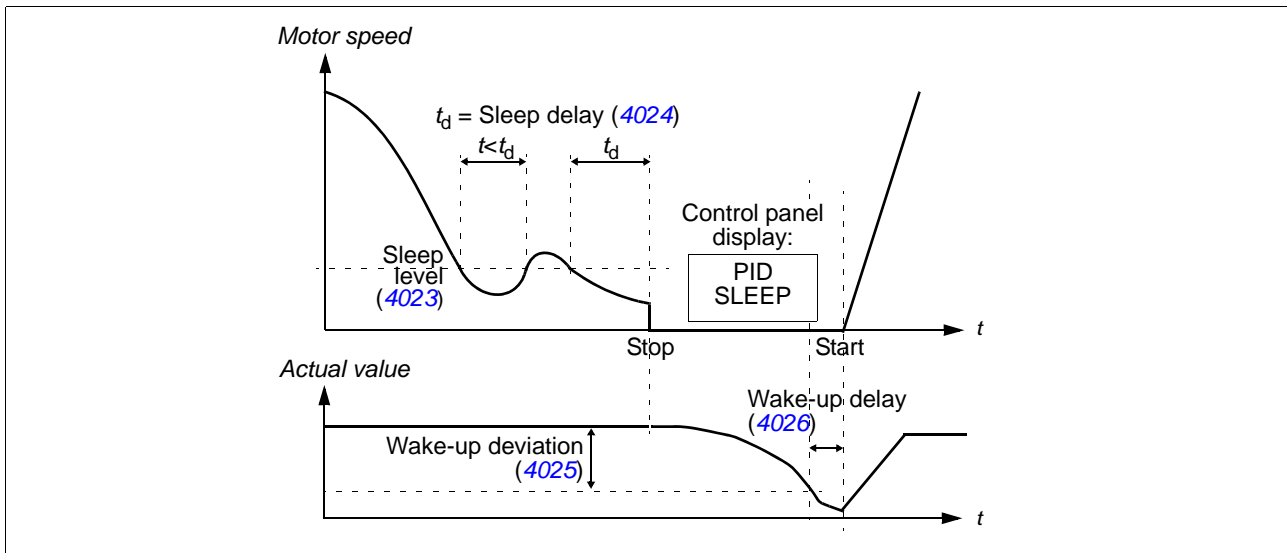
## PID sleep functionality

The block diagram below illustrates the sleep function enable/disable logic. The sleep function can be put into use only when the PID control is active.



### Example

The time scheme below visualizes the operation of the sleep function.



Sleep function for a PID controlled pressure boost pump (when parameter [4022 SLEEP SELECTION](#) is set to 7 = INTERNAL): The water consumption falls at night. As a consequence, the PID process controller decreases the motor speed. However, due to natural losses in the pipes and the low efficiency of the centrifugal pump at low speeds, the motor does not stop but keeps rotating. The sleep function detects the slow rotation, and stops the unnecessary pumping after the sleep delay has passed. The drive shifts into the sleep mode, still monitoring the pressure. The pumping restarts when the pressure falls under the allowed minimum level and the wake-up delay has passed.

#### Settings:

| Parameter                            | Additional information                                     |
|--------------------------------------|--|
| <a href="#">9902</a> APPLIC MACRO    | PID control activation                                     |
| <a href="#">4022</a> SLEEP SELECTION | Sleep function activation and source selection             |
| <a href="#">4023</a> PID SLEEP LEVEL | Definition of the start limit for the sleep function       |
| <a href="#">4024</a> PID SLEEP DELAY | Definition of the delay for the sleep start function       |
| <a href="#">4025</a> WAKE-UP DEV     | Definition of the wake-up deviation for the sleep function |
| <a href="#">4026</a> WAKE-UP DELAY   | Definition of the wake-up delay for the sleep function     |

#### Parameters:

| Parameter                           | Additional information                             |
|-------------------------------------|--|
| <a href="#">1401</a> RELAY OUTPUT 1 | PID sleep function status through the relay output |
| <b>Alarm</b>                        | <b>Additional information</b>                      |
| <a href="#">PID SLEEP</a>           | Sleep mode   |





## Declaration of Incorporation

(According to Machinery Directive 2006/42/EC)

Manufacturer: ABB Oy  
Address: P.O Box 184, FIN-00381 Helsinki, Finland. Street address: Hiomotie 13,

herewith declare under our sole responsibility that the frequency converters with type markings:

ACS150-...  
ACS350-...  
ACS355-...

are intended to be incorporated into machinery or to be assembled with other machinery to constitute machinery covered by Machinery Directive 2006/42/EC and relevant essential health and safety requirements of the Directive and its Annex I have been complied with.

The technical documentation is compiled in accordance with part B of Annex VII, the assembly instructions are prepared according Annex VI and the following harmonised European standard has been applied:

EN 60204-1:2006 + A1:2009  
*Safety of machinery - Electrical equipment of machines- Part 1: general requirements*

and that the following technical standard have been used:

EN 60529 (1991 + corrigendum May 1993 + amendment A1:2000)  
*Degrees of protection provided by enclosures (IP codes)*

The person authorized to compile the technical documentation:

Name: Jukka Päri  
Address: P.O Box 184, FIN-00381 Helsinki

The products referred in this Declaration of Incorporation are in conformity with Low voltage directive 2006/95/EC and EMC directive 2004/108/EC. The Declaration of Conformity according to these directives is available from the manufacturer.

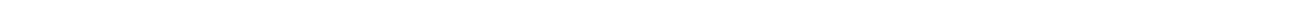
ABB Oy furthermore declares that it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, i.e. as a whole, including the equipment referred to in this Declaration.

ABB Oy gives an undertaking to the national authorities to transmit, in response to a reasoned request by the national authorities, relevant information on the partly completed machinery. The method of transmission can be either electrical or paper format and it shall be agreed with the national authority when the information is asked. This transmission of information shall be without prejudice to the intellectual property rights of the manufacturer.

Helsinki, 29.12.2009

Panu Virolainen

Vice President  
ABB Oy



## Further information

### Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to [www.abb.com/drives](http://www.abb.com/drives) and selecting *Sales, Support and Service network*.

### Product training

For information on ABB product training, navigate to [www.abb.com/drives](http://www.abb.com/drives) and select *Training courses*.

### Providing feedback on ABB Drives manuals

Your comments on our manuals are welcome. Go to [www.abb.com/drives](http://www.abb.com/drives) and select *Document Library – Manuals feedback form (LV AC drives)*.

### Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet. Go to [www.abb.com/drives](http://www.abb.com/drives) and select *Document Library*. You can browse the library or enter selection criteria, for example a document code, in the search field.

# Contact us

**ABB Oy**

Drives  
P.O. Box 184  
FI-00381 HELSINKI  
FINLAND  
Telephone +358 10 22 11  
Fax +358 10 22 22681  
[www.abb.com/drives](http://www.abb.com/drives)

**ABB Inc.**

Automation Technologies  
Drives & Motors  
16250 West Glendale Drive  
New Berlin, WI 53151, USA  
Telephone 262 785-3200  
1-800-HELP-365  
Fax 262 780-5135  
[www.abb.com/drives](http://www.abb.com/drives)

**ABB Beijing Drive Systems Co. Ltd.**

No. 1, Block D, A-10 Jiuxianqiao Beilu  
Chaoyang District  
Beijing, P.R. China, 100015  
Telephone +86 10 5821 7788  
Fax +86 10 5821 7618  
[www.abb.com/drives](http://www.abb.com/drives)



# PART 7: CALIBRATION COLUMN



**Griffco Valve Inc.**

6010 N. Bailey Ave, Ste 1B  
 Amherst, NY 14226 USA  
 Phone: +1 716-835-0891  
 Fax: +1 716-835-0893  
[sales@griffcovalve.com](mailto:sales@griffcovalve.com)  
[www.griffcovalve.com](http://www.griffcovalve.com)

# PVC CALIBRATION COLUMNS



Griffco calibration cylinders are designed to enhance the performance of chemical feed systems by providing a verification of the flow rate of the chemical feed pump. Robust construction of clear PVC with an easy to read graduation in mL and gph. Available in three models: EZ-Clean, Vented, and Open Top; and in 15 sizes: 100 mL through 40,000 mL as detailed here.

**Features:**

- High Reliability / Low Cost
- High Contrast Graduation Markings
- Clear Easy-View Tube
- Robust Schedule 40 Pipe Construction
- Direct GPH Readout
- Sealed Top with Overflow Connection
- Optional EZ-Clean Model
- Optional Open Top with Dust Cap

**Operation:**

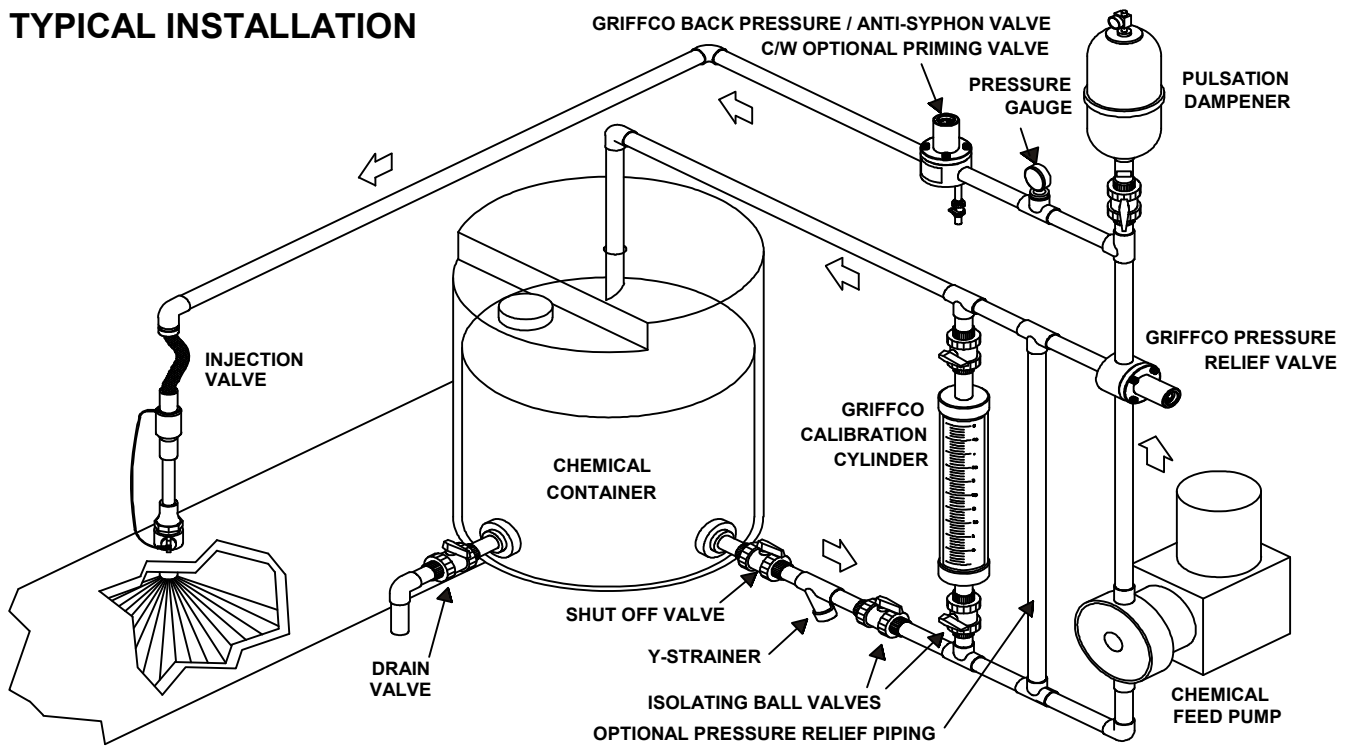
Griffco calibration cylinders are installed in the suction line to the chemical metering pump. Two isolating valves, (not supplied) must be installed in the suction line as per the drawing below. The top of the cylinder should be vented back to the storage tank or to drain. Fill the cylinder to the top mark then close the valve from the chemical tank. Switch on the chemical feed pump and draw down the chemical in the cylinder for 30 seconds. Switch the pump off. The reading on the right side of the cylinder is a direct readout of USgph. Alternatively, observe the volume withdrawn on the mL scale. To convert to LPH or GPH use this formula:

$$\text{LPH} = 3.6 \times [\text{mL}] \div \text{Time (sec)}$$

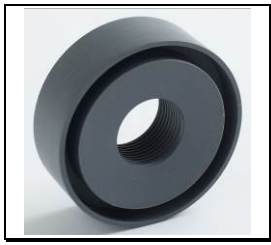
$$\text{GPH} = 0.951 \times [\text{mL}] \div \text{Time (sec)}$$

**Note: Max. cylinder pressure is 15 psi.**

## TYPICAL INSTALLATION

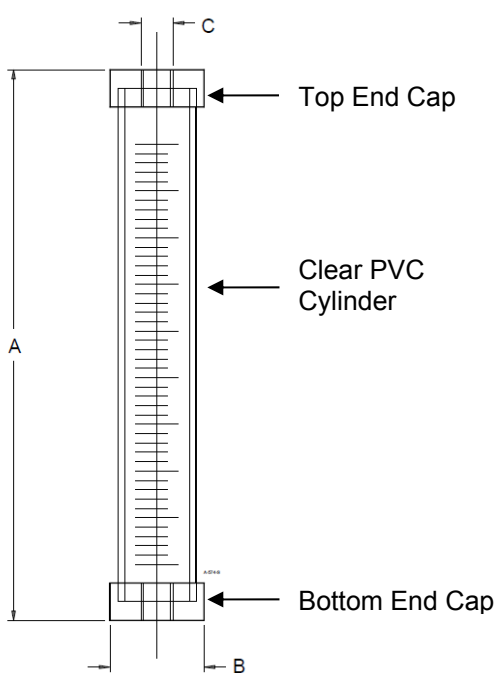


## Description of models:



### Sealed:

Top is glued to cylinder and contains a vent or overflow connection. (FNPT).  
Used in applications where there is a positive suction head and a permanent installation is desired.



| Capacity<br>(mL) ◇ | Max Flow ▲<br>(USgph) | (lph) | Scale<br>(mL) | Scale ▲<br>(gph) | A<br>(in) | B<br>(in) | C<br>(in) |
|--------------------|-----------------------|-------|---------------|------------------|-----------|-----------|-----------|
|--------------------|-----------------------|-------|---------------|------------------|-----------|-----------|-----------|

|        |       |      |     |   |    |      |   |
|--------|-------|------|-----|---|----|------|---|
| 10,000 | 317.0 | 1200 | 100 | 5 | 25 | 6.95 | 2 |
|--------|-------|------|-----|---|----|------|---|

▲ Max Flow and gph scale are based on 30 second drawdown  
◇ For 60 sec draw down, double capacity in mL or flow size

\* Reference only

## Codes for Ordering PVC Calibration Columns:

CC □□□□ □ □ □  
1 2 3 4

1 = Size

2 = Top End Cap Style  
(Top Cap Only)

3 = Connections

4 = Oring Material  
(Union & EZ end cap orings)

S – Sealed

Blank – Threaded

Blank – FKM (Viton®)

10000 – 10000 mL

# PART 8: PRESSURE RELIEF VALVE



**Griffco Valve Inc.**  
 6010 N. Bailey Ave., Ste 1B  
 Amherst, NY 14226 USA  
 Phone: +1 716 835-0891  
 Fax: +1 716 835-0893  
[sales@griffcovalve.com](mailto:sales@griffcovalve.com)  
[www.griffcovalve.com](http://www.griffcovalve.com)

# G - SERIES PRESSURE RELIEF VALVE



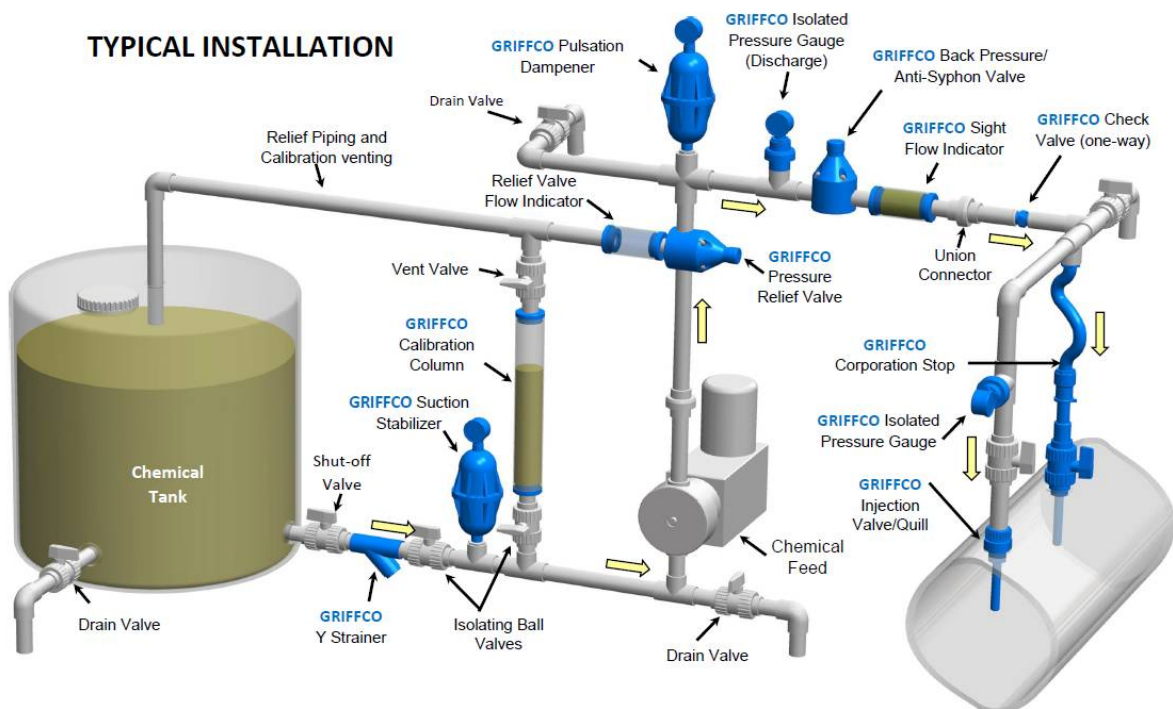
**Griffco G-Series** diaphragm pressure relief valves are designed to protect chemical feed systems from over pressure damage caused by defective equipment or a blockage in the chemical feed line. Robust construction ensures reliability in the rigorous service of municipal and industrial applications. Wetted materials include: **PVC, CPVC, PP, PVDF, PTFE, Halar, 316 SS, A20 and Hastalloy C.** Available sizes: 1/2" - 4".

## Features:

- Molded Noryl Top
- High Reliability / Low Cost
- Molded PTFE/EPDM Diaphragm
- Adjustable 10 - 150 PSI
- Optional: Other PSI Rated Valves
- 2 & 3 Port Configurations
- Ventable to Suction Line
- Robust, Machined Construction
- Wide Range of Materials

## Operation:

**Griffco** diaphragm pressure relief valves operate when the pressure in the chemical system exceeds the preset pressure of the valve. The diaphragm is held against the valve seat by an internal spring. When the preset pressure is exceeded the diaphragm is forced up and the chemical flows out the relief port, back to the chemical tank or to the suction side of the pump. The valves are pre-set at 50 psi, however they are field adjustable from 10 - 150 psi, (up to 350 psi) via the adjustment screw. The relief valve should be set approximately 15 psi higher than the system pressure. Installation should be made as close to the pump as possible, without any valves or accessories between the relief valve and the pump. Consult your pump manufacturer for their recommendations.





# PART 9: PRESSURE GAUGE AND DIAPHRAGM SEAL

## Type 1009SW Stainless Case Gauge with Stainless Steel System



**PLUS!**  
Performance



### FEATURES

- Patented PowerFlex™ movement
- All stainless steel welded construction
- True Zero™ pointer indication
- NEW ventable plug
- NEW patent pending through-dial calibration
- NEW MSL helium leak tested to  $1 \times 10^{-6}$  ATM <sup>-cc/sec</sup>
- Meets ASME B40.100 standard
- RoHS Compliant
- CRN Approved
- 5 year limited warranty

Ashcroft is pleased to reintroduce the 1009SW Duralife® pressure gauge. This gauge has been upgraded with many new features outlined above while maintaining the tried and true performance and quality you have come to expect.

Duralife 1009SW gauges provide significant features and benefits. New features include a ventable plug that can be sealed or vented depending on your environment and a patent pending through-dial recalibration that reduces recalibration time.

The combination of features including the patented PowerFlex™ movement and optional PLUS!™ Performance dampening system in the 1009SW is the finest gauge technology for vibration, shock and pulsation applications. Available in pressure ranges from vacuum to 15,000 psi, including compound and metric ranges.

### PRODUCT SPECIFICATIONS

|                            |  |
|----------------------------|--|
| <b>Ashcroft Type No.:</b>  | 1009SW   |
| <b>Sizes:</b>              | 2½"  |
| <b>Case:</b>               | 304SS  |
| <b>Ring:</b>               | 304SS polished bayonet   |
| <b>Window:</b>             | Polycarbonate  |
| <b>Dial:</b>               | Black figures on white background, aluminum  |
| <b>Pointer:</b>            | Friction adjust, black, aluminum   |
| <b>Bourdon Tube:</b>       | 316L stainless steel   |
| <b>Socket:</b>             | 316L Stainless Steel   |
| <b>Movement:</b>           | 300 series stainless steel, PowerFlex™, polyester segment, overload/underload stops                          |
| <b>Connections:</b>        | ¼ NPT, lower   |
| <b>Ranges:</b>             | Vac-15,000 psi and compound  |
| <b>Accuracy:</b>           | 1% full scale. ASME Grade 1A <sup>(1)</sup>  |
| <b>Fill Plug:</b>          | Ventable   |
| <b>Protection:</b>         | Nema 4X / IP65 plug sealed<br>Nema 3 / IP54 plug vented  |
| <b>Ambient Temperature</b> | -40°F to 200°F dry   |
| <b>Limitations:</b>        | +20°F to 150°F glycerin filled<br>-40°F to 150°F silicone filled<br>(based on standard polycarbonate window) |
| <b>OPTIONAL FEATURES</b>   |  |
| <b>Liquid fill:</b>        | Glycerin (includes throttle plug)  |
| <b>Dampening:</b>          | PLUS!™ Performance (LL) (includes throttle plug)   |
| <b>Window:</b>             | Safety Glass (SG)  |
| <b>Pointer:</b>            | Micrometer (MP)  |
| <b>Connections:</b>        | Metric and SAE on request  |
| <b>Mounting:</b>           | U-clamp (UC), Front flange (FF), Back flange (FW)  |
| <b>Dials:</b>              | Receiver ranges, refrigerant ranges. Custom dials  |

<sup>(1)</sup>When these gauges are liquid filled the total gauge accuracy may be as much as 1.5%

### HOW TO ORDER (Typical example)

|   |           |             |               |            |            |             |
|---|-----------|-------------|---------------|------------|------------|-------------|
|   | <b>25</b> | <b>1009</b> | <b>SW (L)</b> | <b>02L</b> | <b>XXX</b> | <b>160#</b> |
| <b>Dial Size:</b> 2½" (25)                          | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Case Type:</b> 1009                              | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Tube and Socket Material:</b> 316L SS            | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Liquid Filled:</b> (glycerin) leave blank if dry | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Connection Size:</b> ¼ (02)                      | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Connection Location:</b> Lower (L)               | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Options:</b>                                     | _____     | _____       | _____         | _____      | _____      | _____       |
| <b>Range:</b> 0/100 psi                             | _____     | _____       | _____         | _____      | _____      | _____       |

**ISO 9001**  
REGISTERED FIRM

BULLETIN GS-3

All specifications are subject to change without notice.  
All sales subject to standard terms and conditions.  
© Ashcroft Inc. 2009 11/09

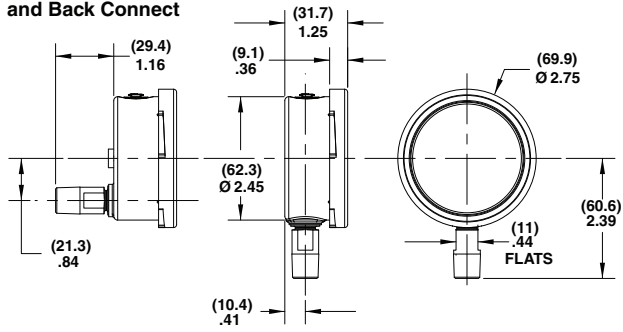
Ashcroft Inc., 250 East Main Street, Stratford, CT 06614 USA  
Tel: 203-378-8281 • Fax: 203-385-0408  
email: info@ashcroft.com • www.ashcroft.com

# Type 1009SW Stainless Case Gauge with Stainless Steel System



## DIMENSIONS

### 2 1/2" 1009 Lower and Back Connect



## Maximum Gauges (PSI) Recommended At Given Fluid Line Temperatures\*

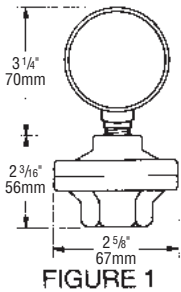
| LIQUID LINE TEMPERATURES**              | 77°F<br>22°C | 104°F<br>40°C | 140°F<br>60°C | 158°F<br>70°C | 185°F<br>85°C | 212°F<br>100°C | 239°F<br>115°C | 284°F<br>140°C |
|---|--------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|
| <b>GEON PVC</b><br>(Polyvinyl Chloride) | 0-250 PSI    | 0-177 PSI     | 0-57 PSI      | N/R           | N/R           | N/R            | N/R            | N/R            |

\* Measurements conducted at a maximum ambient temperature of 80°F (26°C).

\*\* If actual fluid line temperature is in between listed ratings, use the next column to the right for maximum recommended gauge.

## Gauge Guards & Model Numbers

| TYPE OF SERVICE | FIG. NO. | AVAILABLE GAUGE RANGES AS SHOWN | BARS | DIAPHRAGM MATERIALS | GAUGE GUARD MODEL NUMBERS |
|-----------------|----------|---------------------------------|------|---------------------|---------------------------|
|-----------------|----------|---------------------------------|------|---------------------|---------------------------|



|          |   |             |           |      |            |
|----------|---|-------------|-----------|------|------------|
| Pressure | 1 | 0 - 160 PSI | 0 - 11.04 | PTFE | GGTS160-PV |
|----------|---|-------------|-----------|------|------------|

Part numbers shown are for Geon PVC. For Corzan CPVC, change suffix -PV to -CP. For Natural Polypro, change suffix -PV to -NP. For Glass-Filled Polypro change suffix -PV to PP. For Kynar PVDF, change suffix -PV to -PF. Example: GGTS1-PF

\* For other diaphragm materials, please consult factory.

\*\* Viton FKM diaphragms used for additional sensitivity required on vacuum and low pressure (0-15 PSI) applications. When ordering Viton FKM in place of PTFE simply change the "T" in model number to "V".

### Additional Model Number Information

If center back mounted gauge is ordered, conclude above model number with "-C" and use dimensional figure #2.

If a removable housing is ordered, conclude above model number with "-R" and add 1/4" to overall height of dimensional figure #1.

If both center back mounted gauge and removable housing are ordered, conclude above model number with "-CR" and add 1/4" to the overall height of dimension figure #2. Not available with Transparent Acrylic gauge shields.

If a Transparent Acrylic gauge shield is ordered, conclude above model number with "-S" and use dimensional figure #3.

If both center back mounted gauge and gauge shield are ordered, conclude above model number with "-CS" and use dimensional figure #4.

**Note:** Polypro models suitable for one diaphragm service/replacement only.

**NOTE:** For other gauge guard information refer to:

CATALOG GGME: Miniature Diaphragm Seal/Gauge Guard    Catalog GGMU: Ultra-Pure Gauge Guards

**PLAST-O-MATIC**  
VALVES, INC.

1384 Pompton Avenue, Cedar Grove, NJ 07009

(973) 256-3000 • Fax (973) 256-4745

www.plastomatic.com • info@plastomatic.com

AUTHORIZED PLAST-O-MATIC DISTRIBUTOR

# PART 10: PULSATION DAMPENER

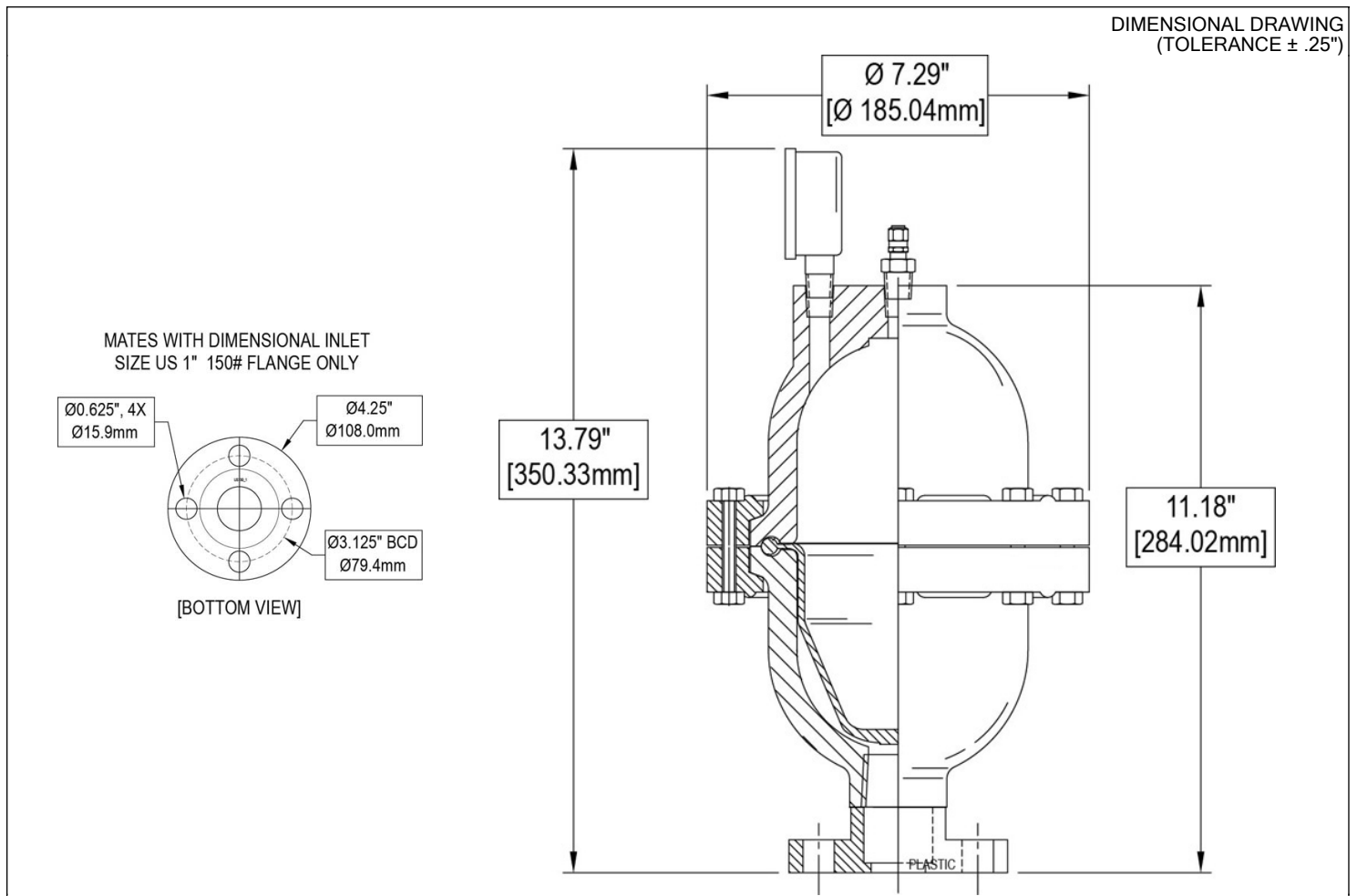
|                       |                            |
|-----------------------|----------------------------|
| MODEL #:              | C421NDF                    |
| AIR CONTROL:          | CHARGE                     |
| BLADDER:              | EPDM                       |
| CAPACITY:             | 85 CUBIC INCHES/1.4 LITERS |
| INLET:                | 1" FLANGE, US, 150# CLASS  |
| MAXIMUM PRESSURE:     | 150 PSI/10.3 BAR           |
| NONWETTED HOUSING:    | PVDF                       |
| WETTED HOUSING:       | PVDF                       |
| EST SHIP WEIGHT EACH: | 11 LB                      |

DISCLAIMER

ALTHOUGH THE INFORMATION ON THIS SHEET IS BELIEVED TO HAVE BEEN ACCURATE WHEN THE SHEET WAS FIRST PREPARED, SOME INFORMATION ON THIS SHEET MAY NOT BE ENTIRELY ACCURATE NOW. PLEASE VERIFY MATERIAL COMPONENTS, DIMENSIONS, AND PRESSURE RATING ON THE CURRENT BROCHURE FOR THIS PRODUCT BY BLACOH FLUID CONTROL, INC. ("BLACOH") OR, IF NECESSARY, CONTACT BLACOH DIRECTLY. PRESSURE TOLERANCES, INCLUDING BUT NOT LIMITED TO, ON MODELS MADE OF PLASTIC, MAY BE REDUCED BY TEMPERATURE VARIATION AND BY THE COMPOSITION OF THE SUBSTANCE BEING PUMPED.

USE OF AN INCOMPATIBLE OR UNSUITABLE DAMPENER ON A PUMP MAY BE DANGEROUS TO PERSONS AND PROPERTY. BY WAY OF EXAMPLE BUT NOT LIMITATION, USE OF AN INCOMPATIBLE OR UNSUITABLE DAMPENER MAY RESULT IN EXPLOSIONS, LEAKAGE OF LIQUIDS OR GASES (WHICH MAY BE HAZARDOUS), OR MALFUNCTIONING EQUIPMENT.

THE USER IS SOLELY RESPONSIBLE FOR (AND BLACOH IS NOT RESPONSIBLE FOR) VERIFYING THE COMPATIBILITY AND SUITABILITY OF A PARTICULAR DAMPENER FOR A PARTICULAR PUMP AND APPLICATION. AS WELL AS DETERMINING WHETHER TESTING OF A DAMPENER IS ADVISABLE PRIOR TO USE IN A PARTICULAR APPLICATION.



# INSTALLATION & OPERATION MANUAL



## SENTRY™ PULSATION & SURGE CONTROL

### DAMPENER (CHARGEABLE MODEL)

**SENTRY dampeners are pressure vessels** containing a flexible bladder or bellows inside that separates an inert pressurized gas (air or Nitrogen) from a system fluid in the lower chamber. Depending on how dampeners are configured, they are used as PULSATION DAMPENERS, INLET STABILIZERS or SURGE SUPPRESSORS to control pressure fluctuations and spikes in liquid piping systems.

Dampeners work on the principle that volume is inversely proportional to pressure ( $P_1V_1=P_2V_2$ ). Compressed air or Nitrogen (**never** Oxygen) is introduced into the non-wetted side of the dampener. The gas charge is contained by the bladder or bellows preventing contact between the system fluid and the gas.

When the dampener is sized correctly, properly installed and charged according to the instructions provided, it will greatly reduce the damaging effects of pressure variations in piping systems and significantly improve the efficiency of transferring liquids.

**All dampeners manufactured by BLACOH use pressure bodies made in the USA to insure quality. Prior to shipment, each and every dampener is factory tested at design pressure or higher to assure proper function and leak-free operation.**

Foreign language versions available online at:  
<http://blacoh.com/literature.aspx>

**BLACOH™**  
FLUID CONTROL

## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>Model Specifications &amp; Installation Information .....</b>                    | <b>1</b>  |
| <b>SAFETY Warnings .....</b>  | <b>2</b>  |
| Safety Symbols .....  | 2         |
| General Safety .....  | 2         |
| Equipment Misuse Hazard .....   | 3         |
| <b>GENERAL Information .....</b>  | <b>3</b>  |
| Must Read Before Installation .....   | 3         |
| Installation Notes .....  | 4         |
| ATEX Standard .....   | 4         |
| Maintenance .....   | 4         |
| Temperature Limits .....  | 5         |
| <b>Installation &amp; Operation Instructions: Dampener (Chargeable Model) .....</b> | <b>6</b>  |
| Pre-Charge Notes .....  | 6         |
| Installation for Pump Discharge Pulsation .....                                     | 6         |
| Installation for Pump Inlet .....   | 7         |
| Installation for Surge / Water Hammer .....   | 8         |
| <b>Manufacturer's Limited Warranty &amp; Return Policy .....</b>                    | <b>10</b> |

---

**THE WORD "DAMPENER", AS USED IN THIS MANUAL, HAS THE SAME MEANING AS PULSATION DAMPENER, INLET STABILIZER, OR SURGE SUPPRESSOR.**

---

Copyright © 2010 Blacoh Fluid Controls, Inc. All rights reserved.

Information in this document is subject to change without notice. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means electronic or mechanical, including photocopying and recording for any purpose other than the purchaser's personal use without the express written permission of Blacoh Fluid Controls, Inc.

## SAFETY WARNINGS

Dampeners should only be installed, operated and repaired by experienced and trained professional mechanics. Read and observe all instructions and safety warnings in this Manual before installing, operating or repairing dampeners.

### SAFETY SYMBOLS

The following symbols indicate cautions, warnings and notes that must be observed for safe and satisfactory installation, operation and maintenance of dampener.



**WARNINGS** Danger of serious injury or death could occur if these warnings are ignored.



**CAUTIONS** Equipment damage, injury or death could occur if these cautions are not observed.



**NOTES** Special instructions for safe and satisfactory installation, operation and maintenance.

### GENERAL SAFETY



#### CAUTION!

- Observe all safety symbols in installation and operation instructions.
- The internal dampener pressure will equal the maximum fluid pressure of the system in which it is installed.
- **DO NOT** exceed maximum allowable working pressure (MAWP) specified on dampener serial tag or marked on dampener. If serial tag is missing, **DO NOT** use dampener without consulting distributor or factory for maximum pressure rating.
- Always make sure safety shutoff valves, regulators, pressure relief valves, gauges, etc. are working properly before starting system or assembly.
- Verify dampener model received against purchase order and shipper.
- Before starting a system or assembly make certain the discharge point of the piping system is clear and safe, and all persons have been warned to stand clear.
- **DO NOT** put your face or body near dampener when the system or assembly is operating, or dampener is pressurized.
- **DO NOT** operate a dampener that is leaking, damaged, corroded or otherwise unable to contain internal fluid, air or gas pressure.
- **DO NOT** pump incompatible fluids through dampener. Consult distributor or factory if you are not sure of the compatibility of system fluids with dampener materials.
- Dampeners are designed to operate with compressed air or clean dry Nitrogen **only**. Other compressed gases have not been tested and may be unsafe to use. **DO NOT USE OXYGEN.**
- Always shut off air supply, remove internal dampener pressure, and shut dampener isolation valve before performing dampener maintenance or repair.
- Remove all pressure from dampener AND pumping system before disassembly, removal or maintenance.
- **Static spark can cause an explosion resulting in severe injury or death. Ground dampeners and pumping system when pumping flammable fluids or operating in flammable environments.**
- **NOTE:** EC standard EN-13463-1 and EN-13463-5 (ATEX) require grounding (earthing) on dampeners when the potential for static sparking is present. A grounding point is located and marked on ATEX specific dampener models.

## EQUIPMENT MISUSE HAZARD

### ⚠ CAUTION!

#### General Safety

**DO NOT** misuse dampener, including but not limited to over-pressurization, modification of parts, using incompatible chemicals, or operating with worn or damaged parts. **DO NOT** use any gases other than compressed air or clean dry Nitrogen to charge dampener. **DO NOT USE OXYGEN.** Any misuse could result in serious bodily injury, death, fire, explosion or property damage.

#### Over-Pressurization

Never exceed the maximum pressure rating for the dampener model being used. Maximum allowable working pressure (MAWP) is specified on dampener serial tag or marked on dampener. Maximum allowable working pressure (MAWP) is rated at 70°F (21°C).

#### Temperature Limits

**DO NOT** exceed the operating temperature limits for the body and/or elastomer materials being used. Excessive temperature will result in dampener failure. For temperature limits, refer to the "Temperature Limits" section of the Manual. Temperature limits are stated at zero psi/bar.

#### Installation and Start-Up Hazards

Install dampener before charging or pressurizing. **DO NOT** start system or assembly without first charging or pressurizing dampener. Failure to charge may result in damage to the elastomeric bladder or PTFE bellows.

#### Temperature & Pressure Hazard

Temperature and pressure reduce the strength and chemical resistance of plastic, metal, elastomers and PTFE.

#### Charging / Pressurization

Charge or pressurize dampener with compressed air or clean dry Nitrogen only. **DO NOT USE OXYGEN.**

#### Dampener Bladder/Bellows Failure

Dampeners utilize an elastomeric membrane (bladder) or PTFE bellows to separate system fluid from the air supply or gas charge. When failure occurs, system fluid may be expelled from the air valve. Always perform preventive maintenance and replace bladder/bellows before excessive wear occurs. O-rings for PTFE bellows cannot be re-used.

#### Maintenance Hazards

Never over-tighten fasteners. This may cause leakage of system fluid and damage to dampener body. Bolts on metal models should not be reused as re-torquing reduces bolt strength. **AFTER MAINTENANCE OR RE-ASSEMBLY OF METAL MODELS, USE NEW FASTENERS AND TORQUE FASTENERS ACCORDING TO SPECIFICATION ON DAMPENER TAG.**

## GENERAL INFORMATION



For safe and satisfactory operation of dampener, read all safety warnings and caution statements, and this complete Manual before installation, startup, operation or maintenance.

### MUST READ BEFORE INSTALLATION



**DO NOT use Oxygen to charge dampener. Use compressed air or clean dry Nitrogen only.**



**DO NOT** exceed maximum allowable working pressure (MAWP) specified on dampener serial tag or marked on dampener.



Turn pump off and remove all pressure from system prior to dampener installation.



Always wear safety glasses and other appropriate safety equipment when installing, charging or repairing dampener.



**Danger of static spark!** Grounding precautions must be considered when dampener is used in flammable or explosive environments.



ATEX Models must be grounded (earthed) before operation.



**DO NOT** operate a dampener that is leaking, damaged, corroded or otherwise unable to contain internal fluid, air or gas pressure.



Temperature, pressure and chemicals affect the strength of plastic, elastomer, and metal components.



Many plastics lose strength rapidly as temperature increases. Consult factory if in doubt.

## INSTALLATION NOTES

- △ Dampening of flow pulsations can only be effective if 5 to 10 psi (0.4 to 0.7 bar) back pressure downstream of dampener is available. A BLACOH back pressure valve may be required downstream of dampener.
- △ It is recommended that a BLACOH pressure relief valve be installed in all pump systems to ensure compliance with pressure limits on system equipment.
- △ To avoid possible damage to bladder/bellows from a system pressure test, do the following: **Adjustable and Chargeable models** — charge dampener to 80% of the system test pressure prior to test. **Automatic models** — dampener must be equipped with a constant source of compressed air prior to test; connect a compressed air line and dampener will pressurize itself.
- △ Install dampener in-line, as close to the pump discharge/inlet or quick closing valve as possible. Dampener installation should be no more than ten pipe diameters from pump discharge/inlet or quick closing valve.
- △ It is recommended that an isolation valve be installed between the dampener and system piping.

## ATEX STANDARD

- △ Certain models made for the European market comply with the ATEX standard for use in potentially explosive atmospheres. These models have the AT designation at the end of the part number and comply with EC standard EN-13463-5 with protection degree of II 2GD TXC. AT models have a grounding lug and must be grounded (earthed) before operation.

## MAINTENANCE



Remove all pressure from dampener AND pumping system before disassembly, removal or maintenance.

Dampeners require very little maintenance. There is only ONE wear part – the elastomeric bladder or the PTFE bellows. There is no need for lubrication.

Elastomeric bladder replacement should be part of a preventive maintenance program. Dampeners used in conjunction with diaphragm pumps should have the bladders replaced at least every second time the diaphragms in the pump are replaced. As with any pumping system, wear is dependent on many factors including material, temperature, chemicals, fluid abrasiveness and system design. This suggested maintenance program may need to be adjusted according to specific applications.

Periodic inspection of the dampener and fasteners should be conducted to visually check for signs of over-pressurization, fatigue, stress, or corrosion. Body housings and fasteners must be replaced at first indication of deterioration.



**CAUTION! Replace nut and bolt fasteners on metal models at each re-assembly with fasteners of equal grade/strength value. DO NOT re-use old nuts and bolts.**

After the initial torque of fasteners, bolts will usually lose up to 20% of their strength when re-torqued. Failure to replace both nuts and bolts upon each vessel reassembly will void the product warranty given by Blacoh Fluid Control, Inc. and Blacoh Fluid Control, Inc. will have no liability whatsoever for any vessel failure or malfunction.

Where dampeners are used in corrosive environments, nut and bolt fasteners should be regularly inspected and replaced with nut and bolt fasteners of equal grade/strength value if corrosion is observed. Failure to conduct such regular inspections and replacement will void the product warranty given by Blacoh Fluid Control, Inc. and Blacoh Fluid Control, Inc. will have no liability whatsoever for any vessel failure or malfunction.



**IMPORTANT! AFTER MAINTENANCE OR RE-ASSEMBLY OF METAL MODELS, USE NEW FASTENERS AND TORQUE FASTENERS ACCORDING TO SPECIFICATION ON DAMPENER TAG.**



**DO NOT** use dampener if the fasteners (nuts and bolts) are corroded. Check for fastener corrosion frequently, especially in atmospheres containing salt or corrosive chemicals, or if dampener leakage has occurred.

## TEMPERATURE LIMITS

**!** Operating temperatures are based on the maximum temperature of the wetted dampener components only. Non-wetted dampener components may have a lower temperature limit. Temperature and certain chemicals may reduce the maximum allowable working pressure (MAWP) of the dampener.

| Elastomer Materials | Temperature Limits                | Applications   |
|---------------------|-----------------------------------|--|
| Aflas               | 0°F to +400°F (-18°C to +204°C)   | High temperature, petroleum based chemicals, strong acids and bases.             |
| Buna                | +10°F to +180°F (-12°C to +82°C)  | Good flex life; use with petroleum, solvents and oil-based fluids.               |
| FDA Buna            | +10°F to +180°F (-12°C to +82°C)  | FDA-approved food grade; similar characteristics of regular Buna.                |
| EPDM                | -60°F to +280°F (-51°C to +138°C) | Use in extreme cold; good chemical resistance with ketones, caustics.            |
| Hypalon             | -20°F to +275°F (-29°C to +135°C) | Excellent abrasion resistance; good in aggressive acid applications.             |
| Neoprene            | 0°F to +200°F (-18°C to +93°C)    | Good abrasion resistance and flex; use with moderate chemicals.                  |
| PTFE                | +40°F to +220°F (+4°C to +104°C)  | Bellows design; excellent flex life; use with highly aggressive fluids.          |
| Santoprene          | -20°F to +225°F (-29°C to +107°C) | Excellent choice as a low cost alternative for PTFE in many applications.        |
| FDA Silicone        | -20°F to +300°F (-29°C to +149°C) | FDA-approved food grade material; for use in food and pharmaceutical processing. |
| Viton               | -10°F to +350°F (-23°C to +177°C) | Use in hot and aggressive fluids; good with aromatics, solvents, acids and oils. |

**!** **CAUTION!** Plastic materials lose strength as temperature increases which reduces the maximum pressure sustainable by the material.

| Non-Metallic Body Materials | Temperature Limits               | Applications   |
|-----------------------------|----------------------------------|--|
| PVC                         | See chart below.                 | Good general chemical resistance; loses strength quickly as temperature rises.       |
| CPVC                        | +32°F to +180°F (0°C to +82°C)   | Chlorinated PVC (CPVC) retains strength to higher temperatures.                      |
| Acetal*                     | +32°F to +175°F (0°C to +79°C)   | Good flex life; low moisture sensitivity; high resistance to solvents and chemicals. |
| Noryl                       | +32°F to +220°F (0°C to +104°C)  | Good resistance to acids and bases; good temperature stability.                      |
| Polypropylene*              | +32°F to +175°F (0°C to +79°C)   | Good general purpose plastic; broad chemical compatibility at medium temperatures.   |
| PTFE                        | +40°F to +220°F (+4°C to +104°C) | Use with highly aggressive fluids.   |
| PVDF                        | +10°F to +200°F (-12°C to +93°C) | Excellent resistance to most acids and bases; highest temperature plastic available. |

\* Conductive Acetal and Conductive Polypropylene available.

**!** **CAUTION!** PVC loses strength more rapidly than other plastic materials as temperature increases. Certain chemicals can also affect material strength reducing maximum pressure ratings. The chart below shows reduced maximum pressure ratings based on temperature for **PVC only**. Note that these are general guidelines only; selection of dampener materials must be determined by each individual application to avoid equipment damage and unsafe operation.

### **!** PVC Maximum Pressure Guidelines by Temperature

| Temperature      | 73.4°F (23°C)      | 80°F (27°C)         | 90°F (32°C)       | 100°F (38°C)        | 110°F (43°C)       | 120°F (48°C)     | 130°F (54°C)     |
|------------------|--------------------|---------------------|-------------------|---------------------|--------------------|------------------|------------------|
| Maximum Pressure | 150 psi (10.3 bar) | 142.5 psi (9.8 bar) | 135 psi (9.3 bar) | 112.5 psi (7.6 bar) | 97.5 psi (6.7 bar) | 90 psi (6.2 bar) | 75 psi (5.2 bar) |

## INSTALLATION & OPERATION INSTRUCTIONS: DAMPENER (CHARGEABLE MODEL)

- ⚠ **DO NOT USE PLASTIC MODELS AS SURGE SUPPRESSORS AT QUICK CLOSING VALVES. USE METAL SURGE SUPPRESSORS FOR WATER HAMMER OR QUICK CLOSING VALVE APPLICATIONS. CONSULT FACTORY FOR OPTIONS.**

---

- ⚠ **ATEX MODELS MUST BE GROUNDED (EARTHED) BEFORE OPERATION.**

---

- ⚡ Turn pump off and remove all pressure from system prior to dampener installation.

---

- ⚡ Remove all pressure from dampener AND pumping system before disassembly, removal or maintenance.

---

- ⚡ Use compressed air or clean dry Nitrogen to charge dampener. **DO NOT USE OXYGEN.**

---

- ⚡ **DO NOT** exceed maximum allowable working pressure (MAWP) specified on dampener serial tag.

---

- ⚡ **Always wear safety glasses and other appropriate safety equipment when installing, charging or repairing dampener.**

---

- ⚡ **READ ALL SAFETY WARNINGS AND INSTALLATION & OPERATION INSTRUCTIONS IN THE MANUAL BEFORE INSTALLATION.**

---

- ⚡ **IMPORTANT! AFTER MAINTENANCE OR RE-ASSEMBLY OF METAL MODELS, USE NEW FASTENERS AND TORQUE FASTENERS ACCORDING TO SPECIFICATION ON DAMPENER TAG.**

---

- ⚠ Before performing a system pressure test, dampener must be charged with 80% of system test pressure to avoid possible damage to bladder/bellows.

READ BEFORE INSTALLATION

### PRE-CHARGE NOTES

READ BEFORE INSTALLATION

- ⚠ **The following pre-charge notes are for plastic dampener models with a maximum pressure rating up to 150 psi (10.3 bar) and metal models with a maximum pressure rating up to 2000 psi (138 bar). NOTE: Dampener can be pre-charged with compressed air up to a maximum pressure of 150 psi (10.3 bar). If maximum pressure will exceed 150 psi (10.3 bar), dampener must be pre-charged with Nitrogen only. DO NOT USE OXYGEN.**

Pre-charge pressure should be checked at least monthly as gas molecules will diffuse through elastomeric bladders, the speed of which depends on the elastomer material, temperature and pressure. Checks must occur when no system pressure is present or inaccurate readings will be recorded. If temperature is above 72°F (22°C) and/or pressure is over 300 psi (20.7 bar), checks should be performed more frequently. **To prevent pre-charge loss through the fill valve, always replace the fill valve cap after charging.** A proper gas charge is the key to dampener effectiveness and bladder/bellows life.

READ BEFORE INSTALLATION

### INSTALLATION FOR PUMP DISCHARGE PULSATION

READ BEFORE INSTALLATION

#### Step 1 — Installation Position

Install the dampener in-line, as close to the pump discharge as possible to absorb the pulse at its source and before any downstream equipment such as risers, valves, elbows, meters, or filters. Dampener installation should be no more than ten pipe diameters from pump discharge. If using a flexible connector on the discharge side of the pump between the pump and system piping, the dampener should be installed at the pump discharge manifold. The flexible connector should be attached to the dampener's tee and system piping (see FIGURE 1). Since pressure is equal in all directions, the dampener can be installed in a vertical, horizontal, or upside-down position. A vertical installation is recommended for better drainage of the dampener. Limitations for horizontal and upside-down mounting include high specific gravity, high viscosity, settling of solid material, or possible air entrapment, which could result in shortened bladder/bellows life and/or reduced dampening performance.

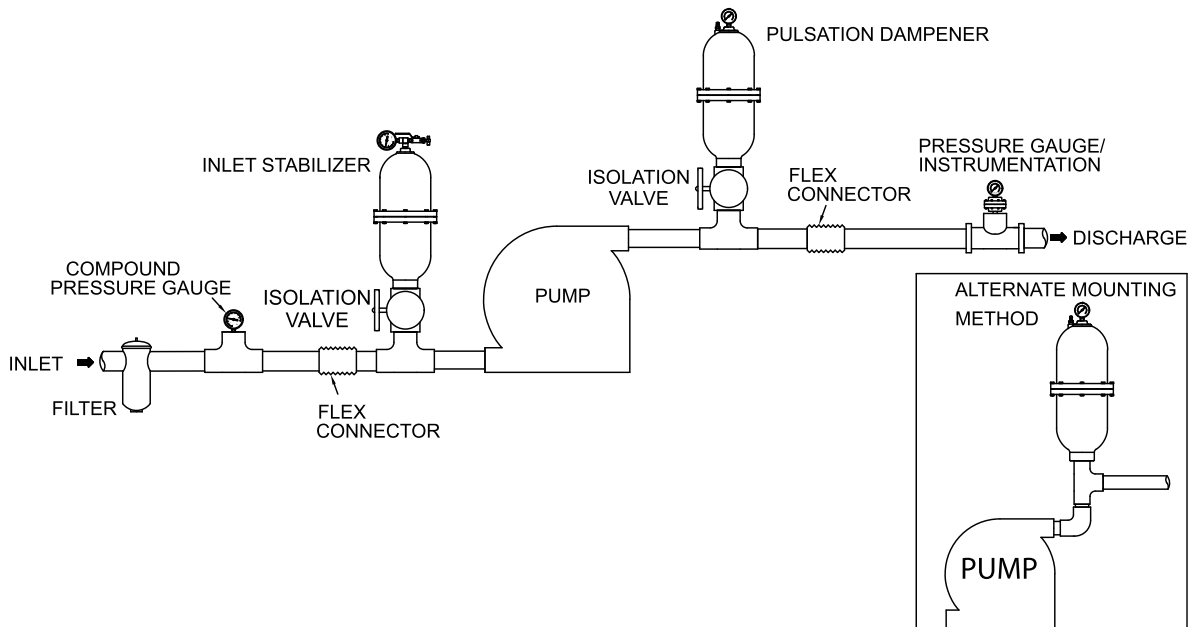
#### Step 2 — Charging and Start-Up (see Pre-Charge Notes)

Chargeable models do not require an air line connection. Dampener can be pre-charged with compressed air up to a maximum pressure of 150 psi (10.3 bar). If maximum pressure will exceed 150 psi (10.3 bar), dampener must be pre-charged with Nitrogen only. Use a hand pump, Nitrogen tank or air compressor to charge dampener. **DO NOT USE OXYGEN.** Charging hose kits are available from BLACOH.

Prior to starting the pump, pre-charge the dampener to approximately 80% of expected system pressure and replace fill valve cap. **DO NOT USE OXYGEN.** The pre-charge pressure in the dampener must always be lower than pump discharge pressure. Generally, pulsation is most effectively minimized when the gas pre-charge is 80% of system pressure. Start the pump to generate system pressure. The dampener charge pressure may need to be adjusted up or down to be most effective in reducing pulsation. **NOTE:** The most effective method to set the proper dampener charge is to install a pressure gauge downstream of the dampener and adjust the dampener to minimize needle movement on the gauge.

Once system pressure is in contact with the bladder/bellows, the gas charge will be compressed to the system pressure and the dampener gauge will read the system pressure, not the initial charge pressure. Once working pressure is achieved, adjustment may be necessary. Gradually increase or decrease the gas charge in the dampener by bleeding or filling through the gas valve. Allow the system to respond to each adjustment (this may take a minute or two) before making further adjustments.

FIGURE 1



## **MANUFACTURER'S LIMITED WARRANTY & RETURN POLICY**

### **Standard Product Limited Warranty**

Subject to the limitations set forth below, Blacoh Fluid Controls, Inc. ("Blacoh") warrants its products to be free from defects in material and workmanship under normal use, service, and maintenance in accord with Blacoh's published specifications for a period of two years from date of shipment by Blacoh (the "Warranty"). The EXCLUSIVE REMEDY for any product defect covered under this Warranty shall be one of the following, as determined by Blacoh in Blacoh's sole discretion: (a) refund of the purchase price; or (b) replacement or repair of the defective part or parts at Blacoh's facility. This Warranty will be null and void if the product is used in an inappropriate application or if the product has been altered, misapplied, improperly installed, or not properly inspected and maintained. To the maximum extent allowed by applicable law, Blacoh will not be responsible for nor have any liability for any "Damage," which means any of the following, whether the claim sounds in breach of contract, breach of warranty, tort, strict liability, implied contractual indemnity, or otherwise: (i) any damage, loss, or injury of any kind, or destruction, or death, whether or not caused by any defect in a Blacoh product and whether or not the Blacoh product is installed, used, operated, and/or maintained in accord with Blacoh instructions, to other products, machinery, buildings, property, or persons, and (ii) any costs, expenses, losses, or incidental, consequential, or special damages of any kind or nature, including but not limited to loss of profits, arising from or related to any Blacoh product, whether or not caused by any defect in a Blacoh product and whether or not the Blacoh product is installed, used, operated, and/or maintained in accord with Blacoh instructions. Damage resulting from chemical incompatibility or from over-pressurization of a product, whether from gas or fluid, is not covered under this Warranty, nor will Blacoh be responsible in any way for any such Damage. Because Blacoh does not determine and cannot anticipate or control the many different conditions under which its products may be used, Blacoh does not warranty the applicability, suitability, or fitness of any of its products for any particular use or purpose. Statements concerning the possible use of Blacoh products are not intended and shall not be interpreted as warranties of fitness for any specific use of such products. Each user of Blacoh products must conduct its own engineering analysis and tests to determine the suitability of each Blacoh product for the user's intended uses or purposes, including but not limited to chemical compatibility and pressurization, and any written or oral assistance from Blacoh in this regard does not relieve the user from exclusive responsibility for such engineering analysis and testing. Blacoh products are sold with only this limited Warranty, and each buyer assumes all responsibility for Damage (as defined above), including but not limited to, Damage arising from defects in Blacoh products and/or from the handling and use of Blacoh products whether used in accordance with Blacoh's directions or otherwise. Any products sold by Blacoh which are manufactured by and sold under the name of another company are NOT WARRANTED by Blacoh under the foregoing Warranty or otherwise. The buyer must rely exclusively on the product warranty, if any, given by such other company. Products manufactured by Blacoh as an original equipment manufacturer (OEM) to be sold by a customer under the customer's brand and name are warranted by Blacoh only under the above Warranty, and Blacoh shall have no liability whatsoever with respect to any representation or warranty given by such customer (or such customer's representatives, distributors, agents, employees, or independent contractors) to any of its buyers which is different in any respect whatsoever from the foregoing Warranty. EXCEPT FOR THE WARRANTY GIVEN ABOVE, WHICH IS SUBJECT TO THE ADDITIONAL LIMITATIONS STATED ABOVE, AND EXCEPT FOR THE ADDITIONAL LIMITED WARRANTY ON BLACOH'S PTFE BELLOWS STATED BELOW, BLACOH GIVES NO WARRANTY OF ANY NATURE WHATSOEVER, EXPRESS OR IMPLIED, WITH RESPECT TO ANY OF ITS PRODUCTS, INCLUDING WITHOUT LIMITATION NO WARRANTY OF MERCHANTABILITY AND NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. NO COURSE OF DEALING, USAGE OF TRADE, OR OTHER ORAL OR WRITTEN STATEMENTS SHALL MODIFY THE FOREGOING WARRANTY PROVISIONS AND LIMITATIONS IN ANY RESPECT WHATSOEVER. This Warranty shall be governed by and construed in accordance with the laws of the State of California.

### **PTFE Bellows Limited Warranty**

In addition to Blacoh's Standard Product Limited Warranty and subject to the limitations set forth below, Blacoh warrants that its PTFE Bellows equipment ("PTFE Bellows") on Blacoh's PTFE Bellows-fitted pulsation dampener will perform in accordance with Blacoh's written product description for three years from date of shipment ("PTFE Bellows Warranty"). This PTFE Bellows Warranty applies only to PTFE Bellows that are sized, charged, installed, used, operated, and maintained strictly in accordance with all installation, use, operation, and maintenance instructions provided by Blacoh, and failure to properly size, charge, install, use, operate, and maintain the PTFE Bellows (or failure to do any of them) shall make the PTFE Bellows Warranty null and void. This PTFE Bellows Warranty does not include applications where failure of performance is due to an unbalanced pressure load or a transient pressure spike (sometimes called a water hammer). The EXCLUSIVE REMEDY for breach of this PTFE Bellows Warranty is replacement of the PTFE Bellows at Blacoh's facility, and not any other equipment or parts whatsoever, and Blacoh will not be responsible for any Damage or any other loss of any kind, including but not limited to incidental, consequential, or special damages (including but not limited to loss of profits), in any way arising from failure of the PTFE Bellows to perform in accordance with Blacoh's written product description. This PTFE Bellows Warranty shall be governed and construed in accordance with the laws of the State of California.

## **Warranty Claims**

1. Prior to returning any product to Blacoh based on a claim of breach of Warranty or PTFE Bellows Warranty, a Blacoh Return Request form must be completed. The form will be reviewed by Blacoh to determine if a Return Merchandise Authorization (RMA) number will be issued. The issuance of an RMA number does not constitute Blacoh's acknowledgment or agreement that the warranty claim is justified or correct.
2. If an RMA number is issued by Blacoh, customer should then deliver the product in question to the address specified on the RMA, freight prepaid.
3. All products so returned to Blacoh based on a claim of breach of Warranty or of PTFE Bellows Warranty must be cleaned, sanitized and neutralized prior to shipment to Blacoh. Blacoh will not accept any part that contains corrosive chemicals, organic cultures, blood, any harmful residue or air borne materials that might contaminate a breathable atmosphere or put at risk any person or property. Any shipment that does not comply will be returned at the expense of the customer, or the customer will be required to arrange for pickup.
4. **HAZMAT SHIPMENTS WILL BE REMOVED AND PROCESSED AT CUSTOMER'S EXPENSE.**
5. Receipt by Blacoh of a return does not constitute Blacoh's agreement that Blacoh is in breach of its Warranty or PTFE Bellows Warranty.
6. If Blacoh determines that a defect in workmanship or material of a part has occurred, customer is not entitled to a complete unit replacement. In the event of such a defect, Blacoh will repair or replace the defective part or parts or refund the purchase price, as Blacoh determines in Blacoh's sole discretion.

## **New Product Returns**

1. If a customer wishes to return a new, unused product, the customer must first request a Return Merchandise Authorization (RMA) number from Blacoh. Blacoh will determine if the unit can be returned for possible credit.
2. Product to be returned must be new, unused, and of current design and purchased within thirty (30) days of the return request. In addition the product must not have been damaged after original shipment by Blacoh.
3. Product returns must be delivered, freight prepaid.
4. Blacoh has the right to inspect all returned products prior to acceptance or rejection.
5. ALL RETURNS are subject to a minimum \$25.00 or 20% restocking fee, whichever is greater. (Higher restocking fees may be charged on special items and some models may not be eligible for return). Returns accepted by Blacoh will be credited to the customer's account less the re-stocking fee. Refunds will not be issued.
6. Any outsourced product supplied by Blacoh will be subject to the warranty, return policy and re-stock fee charged by the manufacturer of the outsourced product.

[L01E71.053]



### **BLACOH FLUID CONTROL, INC.**

601 Columbia Ave, Bldg D  
Riverside, CA 92507 USA

Phone: 951.342.3100  
800.603.7867

Fax: 951.342.3101

Email: [Sales@Blacoh.com](mailto:Sales@Blacoh.com)

[www.blacoh.com](http://www.blacoh.com)

# PART 1 1: TRUE UNION VENTED BALL VALVES



## TBZ Series “Z-Ball” True Union Ball Valves

1/2" TO 6" PVC AND CPVC

### KEY FEATURES

- PVC and CPVC
- Full Port Design
- Reversible PTFE Seats
- Double O-Ring Stem Seals
- For Sodium Hypochlorite Applications
- Adjustable Seat Retainer

### OPTIONS

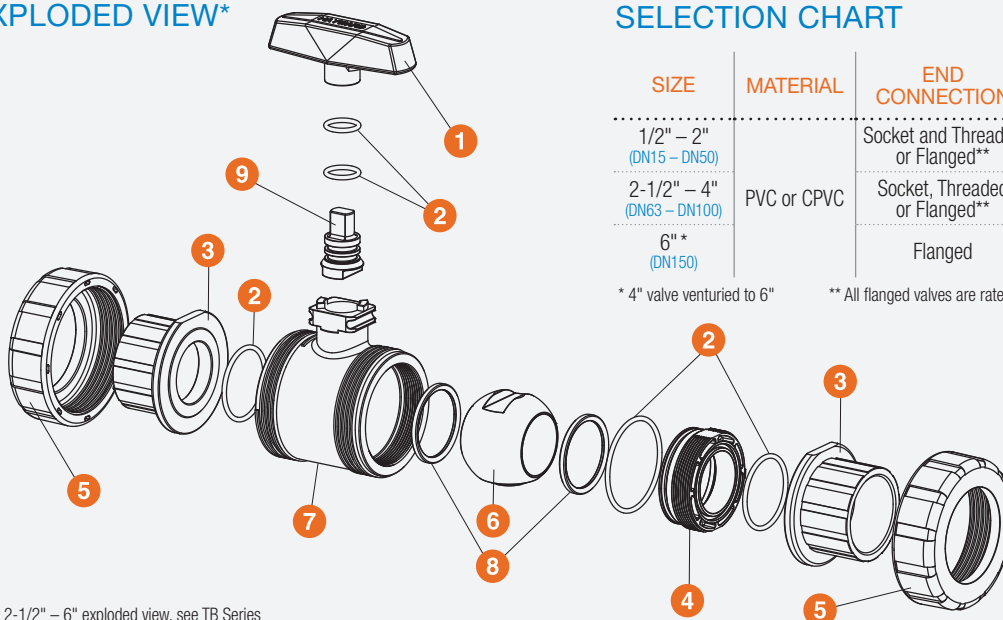
- Lockouts Available
- Stem Extensions
- Spring Return Handle
- Pneumatic and Electric Actuators
- 2" Square Operating Nut

### MATERIALS

- PVC Cell Class 12454 per ASTM D1784
- CPVC Cell Class 23447 per ASTM D1784
- FPM O-Ring Seals

## TECHNICAL INFORMATION

### EXPLODED VIEW\*



\* For 2-1/2" – 6" exploded view, see TB Series

### SELECTION CHART

| SIZE                          | MATERIAL    | END CONNECTION                   | SEALS | PRESSURE RATING          |
|-------------------------------|-------------|----------------------------------|-------|--------------------------|
| 1/2" – 2"<br>(DN15 – DN50)    | PVC or CPVC | Socket and Threaded or Flanged** | FPM   | 250 PSI @ 70°F Non-Shock |
| 2-1/2" – 4"<br>(DN63 – DN100) |             | Socket, Threaded or Flanged**    |       | 235 PSI @ 70°F Non-Shock |
| 6" *<br>(DN150)               |             | Flanged                          |       | 150 PSI @ 70°F Non-Shock |

\* 4" valve venturied to 6"

\*\* All flanged valves are rated to 150 PSI @ 70°F Non-Shock

# TBZ Series "Z-Ball" True Union Ball Valves

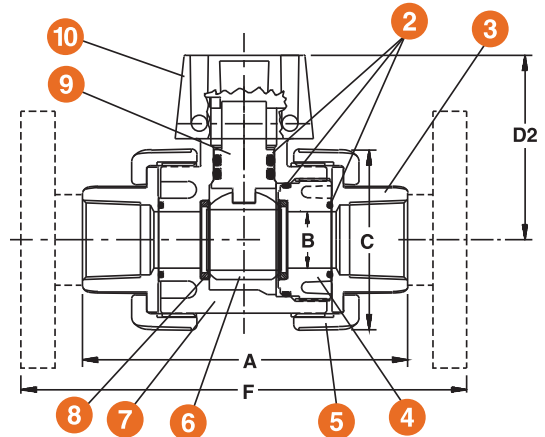
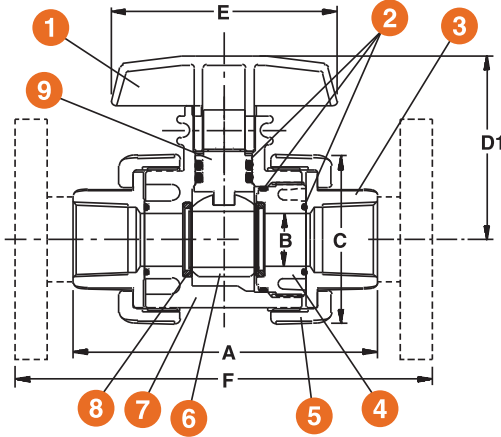
1/2" TO 6" PVC AND CPVC

## TECHNICAL INFORMATION, CONTINUED

### PARTS LIST\*

1. Handle
2. O-Ring Seals
3. End Connector
4. Seal Retainer
5. Union Nut
6. Ball
7. Body
8. PTFE Seat
9. Stem
10. Actuator Mounting Pad

\* For 2-1/2" – 6" Sizes, See TB Series



### DIMENSIONS – INCHES / MILLIMETERS

| SIZE<br>in / DN | A<br>in / mm | B<br>in / mm | C<br>in / mm | D1<br>in / mm | D2<br>in / mm | E<br>in / mm | F<br>in / mm | WEIGHT<br>lbs / kg |               |
|-----------------|--------------|--------------|--------------|---------------|---------------|--------------|--------------|--------------------|---------------|
|                 |              |              |              |               |               |              |              | SOC / THD          | FLANGED       |
| 1/2 / 15*       | 4.77 / 121   | .50 / 13     | 2.25 / 57    | 2.81 / 71     | 2.63 / 67     | 3.50 / 89    | 6.75 / 171   | .75 / .34          | 1.00 / .45    |
| 3/4 / 20*       | 4.85 / 123   | .75 / 19     | 2.63 / 67    | 3.02 / 76     | 2.81 / 71     | 3.50 / 89    | 7.13 / 181   | .75 / .34          | 1.00 / .45    |
| 1 / 25*         | 5.44 / 138   | .93 / 24     | 3.00 / 76    | 3.26 / 83     | 3.05 / 77     | 5.00 / 127   | 8.09 / 205   | 1.15 / .52         | 2.15 / .98    |
| 1-1/4 / 32*     | 6.30 / 160   | 1.50 / 38    | 4.00 / 102   | 3.92 / 100    | 3.48 / 88     | 5.00 / 127   | 9.19 / 233   | 2.15 / .98         | 3.50 / 1.6    |
| 1-1/2 / 40*     | 6.85 / 174   | 1.50 / 38    | 4.00 / 102   | 3.92 / 100    | 3.48 / 88     | 5.00 / 127   | 9.88 / 250   | 2.15 / .98         | 3.75 / 1.7    |
| 2 / 50*         | 8.00 / 203   | 1.94 / 50    | 4.75 / 121   | 4.43 / 113    | 4.00 / 102    | 5.00 / 127   | 11.4 / 290   | 3.80 / 1.7         | 6.30 / 2.9    |
| 2-1/2 / 63      | 10.68 / 271  | 2.75 / 70    | 6.66 / 169   | 6.46 / 164    | 6.17 / 157    | 10.50 / 267  | 14.65 / 372  | 11.30 / 5.12       | 15.30 / 6.94  |
| 3 / 80*         | 10.56 / 268  | 2.75 / 70    | 6.66 / 169   | 6.46 / 164    | 6.17 / 157    | 10.50 / 267  | 14.60 / 371  | 11.30 / 5.12       | 15.30 / 6.94  |
| 4 / 100*        | 12.30 / 312  | 3.81 / 97    | 8.56 / 217   | 7.62 / 194    | 6.64 / 169    | 10.50 / 267  | 17.26 / 438  | 18.50 / 8.39       | 25.70 / 11.65 |
| 6 / 150*        | N/A          | 3.81 / 97    | 8.56 / 217   | 7.62 / 194    | 6.64 / 169    | 10.50 / 267  | 19.26 / 489  | N/A                | 30.75 / 13.95 |

Dimensions are subject to change without notice – consult factory for installation information

\* Metric End Connections Available In: BSP – Straight Thread, BSP TR – Tapered Thread and Metric Socket

### Cv VALUES

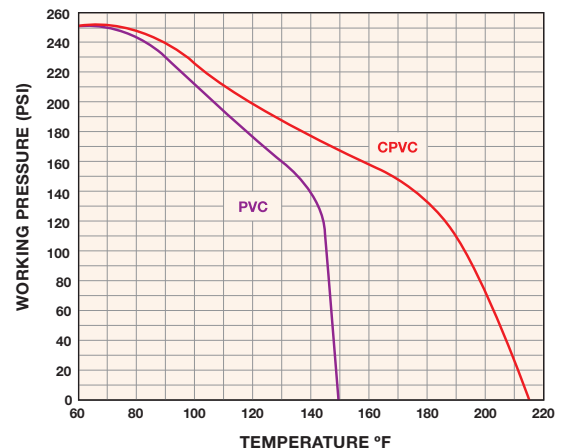
| SIZE<br>in / DN | Cv VALUES<br>GPM | SIZE<br>in / DN | Cv VALUES<br>GPM |
|-----------------|------------------|-----------------|------------------|
| 1/2 / 15        | 8.0              | 2 / 50          | 150.0            |
| 3/4 / 20        | 16.0             | 2-1/2 / 63      | 340.0            |
| 1 / 25          | 29.0             | 3 / 80          | 490.0            |
| 1-1/4 / 32      | 75.0             | 4 / 100         | 600.0            |
| 1-1/2 / 40      | 90.0             | 6 / 150         | 550.0            |

### PRESSURE LOSS CALCULATION FORMULA

$$\Delta P = \left[ \frac{Q}{Cv} \right]^2$$

$\Delta P$  = Pressure Drop  
 $Q$  = Flow in GPM  
 $Cv$  = Flow Coefficient

### OPERATING TEMPERATURE / PRESSURE



Hayward is a registered trademark of Hayward Industries, Inc. © 2011 Hayward Industries, Inc.

Contact Hayward Flow Control with questions: 1-888-429-4635 • Fax: 1-888-778-8410 • One Hayward Industrial Drive • Clemmons, NC 27012 • USA  
Visit us at: [www.haywardflowcontrol.com](http://www.haywardflowcontrol.com) • E-mail: [hflow@haywardnet.com](mailto:hflow@haywardnet.com)

# PART 12: DISCONNECT SWITCHES



---

[Home](#) » [Products](#) » [Disconnect Switches](#) » [Shop Now](#) » [Enclosed](#) » **Enclosed**

Features

Resources

Configure

# Disconnect Switches : Enclosed

---

## Enclosed

**PRODUCT CONFIGURATION THAT'S SIMPLE & ACCURATE**

---

Need additional product or application support, or ready to buy?  
Call us now (724) 775-7926.



## CONFIGURE YOUR ITEM HERE

Note: In order to add products to your cart, you must be logged in.

[Click here to log in or register.](#)

1 Switch Type:

Non-Fused Door Mount Disconnect Switch ▼

2 Number of Power Poles:

4 Poles ▼

3 Current Rating:

16 Amp ▼

4 Enclosure Type:

ABS Plastic ▼

5 Operating Handle Type:

Lever (IP65) ▼

6 Operating Handle Color:

Red Operator / Yellow Bezel ▼

7 Auxiliary Contact Module:

None ▼

Your configured product catalog number and product description:

Catalog Part Number :

EDS2-416-ABS-LRY

Enclosed Disconnect Switches : Non-Fused ; Non-Fused Door Mount  
Disconnect Switch ; 4 Poles ; 16 Amp ; ABS Plastic ; Lever (IP65) ; Red Operator  
/ Yellow Bezel ; None .

**For application support or offline purchase call 724.775.7926**

List Price : 109.00

Your c3 Web Price : 37.34

Quantity :

1

You must [log in or register](#) to add products to the cart.

## Products

**MOTOR CONTROL**

---

**DISCONNECT SWITCHES**

---

**PILOT DEVICES**

---

**TOWER LIGHTS**

---

**CAM SWITCHES**

---

**ENCLOSED CONTROL & CONTROL STATIONS**

---

**TERMINAL BLOCKS**

---

**PROGRAMMABLE RELAYS**

---

**ELECTRONIC TIMING RELAYS**

---

**GENERAL PURPOSE RELAYS**

---

**WIRING/CABLE DUCT**

**PRODUCTS**

**ABOUT C3**

**TESTIMONIALS**

**CAREERS**

**CUSTOMER FIRST**

**BLOG**

**REQUEST A CATALOG**

**PRODUCTS**

Motor Control

Disconnect Switches

Pilot Devices

Tower Lights

Cam Switches

Enclosed Control & Control Stations

Terminal Blocks

Programmable Relays

Electronic Timing Relays

General Purpose Relays

Wiring/Cable Duct

[My Account](#)

[Shopping Cart](#)

**c3controls**

PO Box 496, Beaver, PA 15009, USA

TEL 724.775.7926

FAX 724.775.5283

[info@c3controls.com](mailto:info@c3controls.com)

**CONTACT US**

---



Copyright © 2016 c3controls. All rights reserved.