

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	87 N-0720-01	2023	348	517

**16.2.3 ANTENNA CABLE - DIRECTIONAL ANTENNA**

Provide riser cables that are of a low-loss co-axial design. Ensure loss per 100 feet does not exceed 5 dB at 1800 MHz. Jumper cables may be used inside cabinets between cellular modems and lightning protection devices. Jumper cables may not exceed three feet in length and may not have losses greater than 18 dB per 100 feet. Provide outdoor rated RF cables with UV resistant outer jacket. Provide plenum rated cable for installations inside of buildings or shelters.

**16.2.4 OMNIDIRECTIONAL ANTENNA - LOW PROFILE**

Provide an antenna that is a PCTEL BMLPVMBLTENGP, BMLPVMBLTENGP-VP or approved equal to meet the following minimum requirements. Where specified, use antenna assemblies with cellular modems that are of low-profile, omnidirectional design. Antenna shall not exceed 4 1/2" in height (excluding mounting base, if used) and 1 1/2" in diameter. Provide antenna assemblies that are dual band (700-960/1710-2700 MHz), have a temperature rating of -35°C to +50°C. If mounting directly through a cabinet shelf or other surface, provide an antenna with an integrated Type-N female connector and appropriate Type-N to SMA adapter cable. If mounting to an exterior bracket, provide bracket and suitable antenna base with an integrated lead that includes an SMA connector.

**16.2.5 SURGE PROTECTION**

Provide lightning protection Wilson 859902 or approved equal.

**16.3 CONSTRUCTION REQUIREMENTS**

**16.3.1 GENERAL**

Incidental items include all connectors, adaptors, and cables; including but not limited to RF co-axial cables, DC power cables, AC power cables, Ethernet cables, or any other interface cables. There will be no separate payment for incidental items. KDOT will provide IP addressing. Construct and make all necessary network configurations. Coordinate with KDOT and receive approval for any downtime necessary to connect the cellular modems.

**16.3.2 ANTENNA INSTALLATION**

Install antennas as per manufacturer's instruction and in accordance with any applicable electrical or construction codes. Align antennas to optimize signal quality (received signal strength indication (RSSI) and signal to noise ratio (S/N)). Determine the appropriate antenna azimuth and align the antenna toward the appropriate cellular communication tower. Supply the necessary test equipment for antenna alignment to achieve the maximum signal transfer.

**17.0 POINT-TO-POINT (P2P) ETHERNET RADIO (LICENSED BAND)**

**17.1 DESCRIPTION**

Furnish, install, configure, and test an Ethernet radio. If required to supply a radio, provide an Ethernet radio that meets these specifications. Ensure that the radio provides an acceptable wireless Ethernet communication link when combined with another radio.

**17.2 SPECIFICATIONS AND REQUIREMENTS**

Provide wireless equipment that meets the following specifications and requirements:

- Point-to-Point (P2P).
- Operate in 11 GHz FCC licensed frequency band.
- Use Time Division Multiplexing (TDM) wireless modulation.
- Allow Quality of Service (QoS) management.
- Support 802.1Q headers to carry VLAN tags and priority markings shall support VLAN tagging per port.
- Use a native Ethernet technology for Payload Interface. Mapping of Ethernet over TDM will not be accepted. Equipment will support FE and GE autosensing interfaces. Frame Length Support: Support for "Baby Jumbo" frames up to 1632 Bytes.
- Buffer Size: overall buffer size (used to manage traffic queues) of at least 1 Mb. Usable by a single service, if required by traffic profile.
- RF Bandwidth: 10 MHz, 30 MHz capable.
- Receive sensitivity (BER 10-6): With 10MHz channel spacing, range between -90.5 dBm at QPSK to -73.0 dBm at 256 QAM.
- Support forward error correction.
- Fade and Intermodulation Countermeasures: Support for adaptive equalization, adaptive modulation and space diversity.
- Minimum supplied bandwidth 100Mbps. Software expandable to 200Mbps without hardware changes. During testing, actual bandwidth to be verified with RFC2544 throughput and latency tests.
- FCC Part 15 compliant and certified for EMC.
- Type of emission: Licensed only (compliant with FCC Part 101).
- Provide 10/100 BaseT RJ-45 Ethernet port.
- Minimum operating temperature range for P2P radio Outdoor Unit (ODU): -35°C to 50°C. Minimum operating temperature range for P2P radio Indoor Unit (IDU): -20°F (-28°C) to 165°F (74°C).
- Security: Provide user-controlled levels and privileges and user access control.
- Management: Ethernet SNMP remotely, ASCII RS-232 locally or equivalent. Fully managed remotely, allowing downloading of system configuration, equipment software or system operation firmware changes.
- Rack mounted
- Warranty: In-warranty product repairs are covered up to 5 years.
- Advance replacement: Replacement product is shipped express overnight (in most cases) in case of a verified product issue.

**17.3 CONSTRUCTION**

Provide all radio channel planning, communication path analysis, power level settings, antenna positioning (X, Y and Z axis including tilt), and Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI) resolution so that fully functional, operational, and secure communication links are provided. A preliminary design plan has been provided in the plan set, but it is understood that the design may need to change based on field conditions encountered. Take into consideration existing licensed radio networks operated by others. Install, orient, and align the P2P radios in order to optimize performance. Reference and follow installation guidelines provided by the radio manufacturer. Provide all antennas, pipes, mounts, cabling, lightning protection, grounding, configuration, testing, and other subsidiary items and include in this individual bid item.

Furnish all tools, equipment, materials, supplies, and manufactured articles and all operations necessary to install wireless equipment and construct, configure, and test the wireless communications facilities as shown on the plans and as specified herein. Use stainless steel for all hardware and fasteners.

Lightning Protection: For protection of the P2P radio equipment, provide and install bi-directional replaceable gas tube lightning arrestors (Polyphaser Model RGT or equivalent).

Mount the ground level network interface, power supply, and grounding block in the cabinet or data closet at the site. Contact the Engineer to coordinate FCC required prior coordination notice and FCC License Application. Contact the Engineer to obtain network configuration information including: IP addresses, VLAN tags and security key info for equipment installed.

Connect the P2P Ethernet radio to the Ethernet switch or other Ethernet-enabled device at the site.

**17.4 TESTING/SUBMITTALS**

Develop a test plan to demonstrate that each P2P Ethernet Radio is providing a wireless link capable of a continuous data rate of 100 Mbps. Complete a minimum 15-day test period before final acceptance. Submit test plan to the Engineer for approval. Incorporate any changes requested by the Engineer into the test plan and test each link. Document all test results and submit these to the Engineer for approval. Provide an Excel spreadsheet (electronically) that details all equipment received and installed as well as all configuration settings, including VLAN's.

**18.0 POINT TO MULTIPOINT (P2M) ETHERNET RADIO**

**18.1 DESCRIPTION**

Furnish, install, configure, and test a P2M Ethernet Radio. Ensure that the P2M radio provides an acceptable wireless Ethernet communication link when combined with another P2M radio.

**18.2 SPECIFICATIONS AND REQUIREMENTS**

Provide wireless equipment that meets the following specifications and requirements:

- Operates in unlicensed frequency band, 5.15-5.35 GHz, 5.47-5.725 GHz, 5.725-5.850 GHz or in the 4.94-4.99 GHz band
- Radio Access Method: Time Division Duplex (TDD)
- Channel: 10 MHz, 20 MHz
- Central Frequency Resolution: 5 MHz, 10 MHz
- Typical Sensitivity (dBm at antenna port):

Modulation	1	2	3	4	5	6	7	8
Level* 20 MHz	-89	-88	-86	-84	-81	-77	-73	-71
Level* 10 MHz	-92	-91	-89	-87	-84	-80	-76	-74

\*Modulation Level combines modulation scheme and coding gain.
- Modulation Scheme (Adaptive): OFDM: BPSK, QPSK, QAM16, QAM64
- VLAN Support: Based on IEEE 802.1q, QinQ 802.3ad
- Layer-2 Traffic Prioritization: Based on IEEE 802.1p
- Layer-3 Traffic Prioritization: IP ToS according to RFC791 and DSCP according to RFC2474
- Layer-4 Traffic Prioritization: UDP/TCP port range
- Security: WEP 128-bit authentication, AES128, WEP 128, and certified FIPS-197 mode built-in encryption
- Remote Management Access: From wired LAN or wireless link
- Management Access Protection: Multilevel password; configuration of remote direction (from Ethernet only, wireless only, or both sides); configuration of IP addresses of authorized stations
- Software Upgrade: via TFTP and FTP
- SNMP Agents: SNMP v1 client, MIB II, Bridge MIB
- Allows Quality of Service (QoS) management
- Ethernet Interface: 10/100 BaseT RJ-45 port
- Operating Temperature, SU/AU Outdoor Units: -35° C to 50° C
- Power over Ethernet (POE)
- Point-to-Multipoint (P2M)
- Minimum rated/actual bandwidth of 54/24 Mbps
- EMC and Radio: FCC Part 15 compliant

**18.3 CONSTRUCTION**

Install P2M Ethernet Radios at locations as shown on the plans.

Provide for all radio channel planning, communication path work, power level settings, antenna positioning (X, Y and Z axis including tilt), Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI) resolution so that fully functional, operational, and secure communication links are provided. A design plan has been provided in the plan set but it is understood that that design may need to change based on field conditions encountered. Take into consideration existing unlicensed radio networks operated by others. Install the radios and orient to maximize the Signal-to-Noise Ratio (SNR) levels. Reference and follow installation guidelines provided by the radio manufacturer. Provide all antennas, pipes, mounts, cabling, lightning protection, grounding, configuration, and testing to provide a fully functional system.

Furnish all tools, equipment, materials, supplies, and manufactured articles and all operations necessary to install wireless equipment and construct, configure, and test the wireless communications facilities as shown on the plans and as specified herein. Use stainless steel for all hardware and fasteners.

Mount the P2M Radio Outdoor Unit/Antenna as high on the supporting structure as practical, while remaining within the 30 degree protected radius beneath the air terminal (if installed). Do not allow the mounting of the radio to interfere with the camera lowering device or with the lightning air terminal.

Use outdoor-plant rated industrial Cat 6 cable (Commscope 2003 Black or approved equivalent) with shielded RJ-45 end connectors (Digi-Key A9115-ND or approved equivalent) between the radio outdoor unit and the cabinet or data closet surge protector.

Mount the network interface, power supply, surge suppression, and grounding block neatly in the cabinet or data closet at the site.

Contact the Engineer to obtain network configuration information including; IP addresses, VLAN tags, and security key info for equipment installed.

Connect the P2M Ethernet radio to the Ethernet switch or other Ethernet-enabled device at the site.

Apply permanent external labeling on radio equipment in the cabinet according to information to be provided by the Engineer.

**19.0 ITS COMMUNICATIONS INTEGRATION**

**19.1 DESCRIPTION**

This work consists of the installation of communication equipment and configuration of hardware settings and software parameters (both wireless and fiber optic), such as IP addressing and serial port definitions, VLAN definitions and network management parameters of KDOT furnished and Contractor furnished communications equipment as defined herein, in KDOT designated facilities, or ITS cabinets as shown on the Plans, or as directed by the Engineer.

Configure all communication equipment based on a template provided by the Engineer for each type of ITS component such as Ethernet switches, modems, CCTV cameras, and DMS.

Provide a complete, functional, wireless, fiber optic, and electronic communications system, including all necessary cables, connections, surge suppressors, antenna alignments and configurations in accordance with the KDOT and equipment manufacturers' specifications and as specified on the Plans and Specifications. Provide equipment as specified on the Plans and Specifications, integrate, test, demonstrate, and receive KDOT's approval of the complete system.

Provide troubleshooting, reinstallation, and reconfiguration of all KDOT furnished and Contractor furnished communication equipment in the event of communication equipment failure. Receive approval by the Engineer for any reconfiguration.

There will be no separate payment for troubleshooting, reinstallation, or reconfiguration of devices. If an issue outside of contractor control causes delay of more than 8 hours in completing integration, additional payment may be requested from KDOT.

**19.1.1 CERTIFICATION OF CONTRACTOR PERSONNEL**

Use a CISCO certified technician, or in the presence of and under the responsible charge of an employee or subcontractor who is a CISCO certified technician, for all configuration of Cisco switches. Before starting work, provide the Engineer with the names of the personnel assigned to perform switch configuration and a copy of their certification card.

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KANSAS DEPARTMENT OF TRANSPORTATION			
ITS EQUIPMENT SPECIFICATIONS			
ITS-S11		VERSION DATE: 08-23-21	
APPD	DESIGNED	QUANTITIES	TRACED
	DETAILED	QUAN. CK.	TRACE CK.
NO.	DATE	REVISIONS	BY APPD