DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

SPECIAL PROVISION

Project Number:

P.I. Number:

County

Add the following:

Section 926—Wireless Communications Equipment

926.1 General Description

This section provides specifications for a variety of wireless communications equipment.

926.1.01 Related References

A. Georgia Specifications

Section 647—Traffic Signal Installation

Section 682—Electrical Wire, Cable and Conduit

Section 833—Joint Fillers and Sealers

Section 922—Electrical Wire and Cable

Section 923—Electrical Conduit

Section 925—Traffic Signal Equipment

Section 927 – Wireless Communications Installation

Section 935—Fiber Optic System

Section 938—Detection

Section 939—Communications and Electronic Equipment

B. Referenced Documents

NEMA TS-2

Traffic Signal Control Equipment Specifications, current edition and addenda, State of California Business, Transportation & Housing Agency

CALTRANS Qualified Products List, QPL, Transportation Electrical Equipment Specifications (TEES).

926.2 Materials

A. Requirements

Ensure that the traffic signal equipment and materials meet the Plans and Specifications.

All equipment furnished shall be new and meet the requirements of the following:

- Underwriter's Laboratory Incorporated (UL)
- Electronic Industries Association (EIA)
- National Electric Code (NEC)
- American Society of Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- International Municipal Signal Association (IMSA)
- National Electrical Manufacturers Association (NEMA)
- Applicable Standards, Specifications, and Regulations of the:

  Georgia Department of Transportation

  Traffic Signal Electrical Facility & NaviGAtor Support (TSEF)
  935 E. Confederate Avenue, Building 5
  Atlanta, GA 30316

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.01 Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection

Provide wireless communications point to point or point to multipoint to support both: FSK communications using 4 wire full duplex or 2 wire half duplex; or RS 232 serial communications. Both interfaces are provided on the unit but only one interface is required to be active in each application. This unit is to be supplied with power supply, and configuration software.

A. Requirements

Furnish a spread spectrum wireless radio unit with all necessary hardware (excluding antennae) to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Radio unit will use a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, frequency hopping spread spectrum technology operating in the 902-928 MHz frequency band.

1. 900MHz Wireless Radio Unit

   Furnish license free 902 – 928 MHz radio modems with configuration software. Design radio modems to work in "point-to-point", "point-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

   - License free (ISM) Spread Spectrum radio band (902 – 928 MHz)

- Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
- Bi-Directional, Full Duplex
- Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
- RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit format or 1200 bps FSK (2 or 4-wire) Bell 202 standard systems configurations DB9-F connector for RS-232 port
- RJ 22 connector for FSK port
- 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Built-in store-and-forward (single radio repeater – no back to back radios set-ups are allowed to accomplish this function)
- 32 Bit encryption
- Receiver Sensitivity of –110dBm @ 10^-6 BER
- Antenna port: Reverse Polarity - Threaded Normalized Connector-Female (RP TNC-F) antenna connector
- Front panel LED indicators
  - Power
  - Transmit Data
  - Receive Data
  - Data Port Indicator
  - RSSI indicator
- Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
- Power supply requirements
- Wall Adaptor: 120 VAC UL/CSA wall cube plug in module with 12 VDC, 1 Amp, nominal output.
- Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
- Radio Sleep mode with a maximum current draw of <1μA
- Shelf Mounted Design not to exceed 9” Long x 2” Wide x 5” High (228.6 mm Long x-50.8 mm Wide x 27 mm High)

Ensure that the wireless radio unit is a fully functional field device (i.e. controller does not require any field device modifications with regards to hardware or software).

2. Configuration Software

   Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide “remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer” features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

   Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers’ warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.

- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.02 Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with RS 232 Connection

Provide wireless communications point to point or point to multipoint to support RS 232 serial communications. This unit is to be supplied with power supply, and configuration software.

A. Requirements

Furnish a spread spectrum wireless radio unit with all necessary hardware (excluding antennae) to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Radio unit will use a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, frequency hopping spread spectrum technology operating in the 902-928 MHz frequency band.

1. 900MHz Wireless Radio Unit
   Furnish license free 902 – 928 MHz radio modems with configuration software. Design radio modems to work in "point-to-point", and "point-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

   - License free (ISM) Spread Spectrum radio band (902 – 928 MHz)
   - Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
   - Bi-Directional, Full Duplex
   - Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
   - RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit format
   - DB9-F connector for RS-232 port
   - 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
   - Built-in store-and-forward (single radio repeater – no back to back radios set-ups are allowed to accomplish this function)
   - 32 Bit encryption
   - Receiver Sensitivity of –110dBm @ 10^-6 BER
   - Antenna port: Reverse Polarity - Threaded Normalized Connector-Female (RP TNC-F) antenna connector
   - Front panel LED indicators
     - Power
     - Transmit Data
     - Receive Data
     - RSSI Indicator
   - Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
   - Power supply requirements
   - Wall Adaptor: 120 VAC UL/CSA wall cube plug in module with 12 VDC, 1 Amp, nominal output.
   - Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
   - Radio Sleep mode with a maximum current draw of $<1\mu A$
   - Shelf Mounted Design not to exceed 4.5" Long x 3.65" Wide x 1.75" High

   Ensure that the wireless radio unit is a fully functional field device (i.e. controller does not require any field device modifications with regards to hardware or software).

2. Configuration Software

   Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

   Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.
- Provide a minimum two-year warranty with each radio assembly to ensure that the products are free of manufacturing defects in material and workmanship. The warranty commences on the date that the radio unit is delivered and accepted.

926.2.03 Rack Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection

Provide wireless communications point to point or point to multipoint to support both: FSK communications using 4 wire full duplex or 2 wire half duplex; or RS 232 serial communications. Both interfaces are provided on the unit but only one interface is required to be active in each application. This unit is to be supplied such that it may be installed in standard 170 input file; or NEMA TS1/ TS 2 Standard Detector Rack. The rack will provide power for the unit. The rack mount unit shall not use any other backplane signals on the rack. This unit is to be supplied with configuration software.

A. Requirements

Furnish a spread spectrum wireless radio unit with all necessary hardware (excluding antennae) to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Radio unit will use a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, frequency hopping spread spectrum technology operating in the 902-928 MHz frequency band.

1. 900MHz Wireless Radio Unit

   Furnish license free 902 – 928 MHz radio modems with configuration software. Design radio modems to work in "point-to-point", and "point-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

- License free (ISM) Spread Spectrum radio band (902 – 928 MHz)
- Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
- Bi-Directional, Full Duplex
- Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
- RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit format or 1200 bps FSK (2 or 4-wire) Bell 202 standard systems configurations
- DB9-F connector for RS-232 port
- RJ 22 connector for FSK port
- 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Built-in store-and-forward (single radio repeater – no back to back radios set-ups are allowed to accomplish this function)
- 32 Bit encryption
- Receiver Sensitivity of –110dBm @ 10^-6 BER
- Antenna port: Reverse Polarity - SMA-Female (RP SMA-F) antenna connector
- Front panel LED indicators
  - Power
  - Transmit Data
  - Receive Data
  - Data Port Indicator
  - RSSI indicator
- Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
- Power
- Powered from rack through edge connector in standard 170 input file or NEMA TS 1/ 2 Detector Rack
- Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
- Radio Sleep mode with a maximum current draw of <1μA
- Rack Mounted Design - 7” Long x 1.25” Wide x 4.5” High
- Rack Connector 2 x 22 pin edge card with 0.156” center

Ensure that the wireless radio unit is a fully functional field device (i.e. controller does not require any field device modifications with regards to hardware or software).

2. Configuration Software

Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide “remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer” features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers’ warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.

- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.04 2070 Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection

Provide wireless communications point to point or point to multipoint, between 2070 controllers. The radio modem is to be plugged into the 2070 communications slot to provide wireless communications.

A. Requirements

Furnish a spread spectrum wireless radio unit with all necessary hardware (excluding antennae) to provide a data link between 2070 controllers. Radio unit will use a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, frequency hopping spread spectrum technology operating in the 902-928 MHz frequency band. This unit will support all 2070 7A communications module functionality as well as providing radio modem functions.

1. 900MHz Wireless Radio Unit

   Furnish license free 902 – 928 MHz radio modems with configuration software. Design radio modems to work in "point-to-point" and "point-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

   - License free (ISM) Spread Spectrum radio band (902 – 928 MHz)
   - Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
   - Bi-Directional, Full Duplex
   - Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
   - RJ 12 RS-232 interface for configuring the radio unit
   - 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
   - Built-in store-and-forward (single radio repeater – no back to back radios set-ups are allowed to accomplish this function)
   - 32 Bit encryption
   - Receiver Sensitivity of –110dBm @ 10^-6 BER
   - Antenna port: Reverse Polarity - Threaded Normalized Connector-Female (RP TNC-F) antenna connector
   - Front panel LED indicators
     - Power
     - Transmit Data
     - Receive Data
     - RSSI
   - Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
   - Power supply requirements
     - Power will be supplied through backplane printed circuit board of the 2070 controller
     - Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
     - Radio Sleep mode with a maximum current draw of $<1\mu A$
   - Card Mount Design – 9.5" Long x 1.625" Wide x 7.0" High
   - 96 Pin Connector - 3 x 32 pin DIN Style with 0.1" centers
   - 2 DB 9 Serial Ports to support 2070 7A communications functionality

Ensure that the wireless radio unit is a fully functional field device (i.e. controller does not require any field device modifications with regards to hardware or software).

3. Configuration Software

   Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

   Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard 2070 traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
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- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.05 Self Contained Spread Spectrum Wireless Radio Transceiver & Repeater Station

Provide wireless communications point to point or point to multipoint. Radio modem & Repeater Station to extend the range of communications within the system. The unit is to be furnished in its own cabinet with all necessary hardware and includes power supply, and configuration software.

A. Requirements

Furnish an operational 900MHz wireless repeater radio system complete with a NEMA-4X enclosure for mounting on a pole. Furnish a spread spectrum wireless radio unit with all necessary hardware including antenna mounting hardware, and cabinet to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Radio unit will use a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, spread spectrum technology operating in the 902-928 MHz frequency band. The repeater function will also allow for a communications drop to a local controller at the repeater location.

1. 900MHz Wireless Radio Unit

   Furnish license free 902 – 928 MHz radio modems with configuration software. Design radio modems to work in "point-to-point", and "point-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

   - License free (ISM) Spread Spectrum radio band (902 – 928 MHz)

- Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
- Bi-Directional, Full Duplex
- Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
- RS-232 interface for configuring the radio unit
- 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Built-in store-and-forward (single radio repeater – no back to back radios set-ups are allowed to accomplish this function)
- 32 Bit encryption
- Receiver Sensitivity of –110dBm @ 10^-6 BER
- Antenna port: N Type Female
- LED indicators
  - Power
  - Transmit Data
  - Receive Data
  - Configuration Indicators
  - RSSI
- Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
- Power supply requirements
  - 120V AC.
  - Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
- Radio Sleep mode with a maximum current draw of <1μA
- Enclosure – Fiberglass NEMA 4X weatherproof enclosure

2. Cabinet:

   Furnish the cabinet shell constructed from unpainted, fiberglass. Ensure that all non-aluminum hardware on the cabinet is stainless steel or an approved non-corrosive alternate.

   Ensure that all components are arranged for easy access during servicing.

   Provide sufficient size so that the equipment installed will not occupy more than 60 percent of the total cabinet volume.

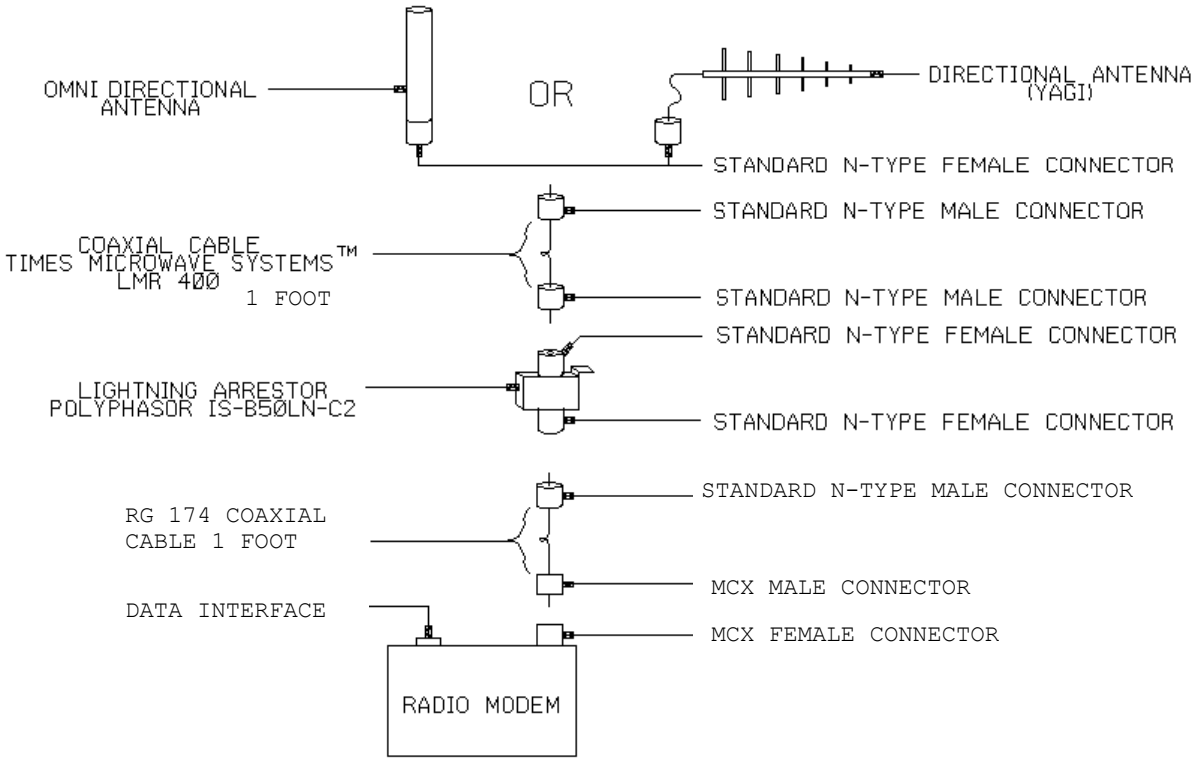
   Provide enclosure latching hardware which will allow for external locking capability.

3. Antenna

   Furnish a 8.5 dB Yagi directional antenna (Cushcraft model # PC906N or approved equal) that is side mounted to the cabinet. Furnish a Radio Frequency Signal Jumper constructed of an RG-174 Coaxial Cable with MCX Male on one end for connection to a radio unit and a Standard N-Type Male Connector on the other end for connection to the lightning arrestor.

   Furnish a lightning arrestor installed in line between each antenna and the radio modem inside the cabinet. Furnish a Polyphaser Model # IS-B50LN-C2 or an approved equivalent.

   Provide the antenna and the lightning arrestor as shown in the antenna schematic shown herein.



4. Configuration Software:

   Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

   Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

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- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.06 Directional Radio Antenna (Yagi) and Connecting Cable

Provide wireless communications antenna with connecting cables including surge protection to the Radio unit.

A. Requirements

Furnish a directional antenna that will interface with a radio unit. Included with this item are the cables to connect with the radio unit and surge protection.

1. Yagi Directional Antenna

   Furnish Cushcraft Model # PC906N antenna or an approved equivalent antenna that meets the following minimum specifications:

Frequency Range	896 – 940 MHz
Nominal Gain	8.5 dBd or 10.64dBi
Front to Back Ratio	18 dB
Horizontal Beamwidth (at half power points)	65 degree
Vertical Beamwidth (at half power points)	55 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Length	24” (612 mm)
Width @896 MHz	6.4” (163 mm)
Rated Wind Velocity	125 mph (200 kph)
Rated Wind Velocity (with .5 inch radial ice)	100 mph (161 kph)
Lateral thrust @ 100 mph Wind Velocity	38 lbs. (17 Grams)
Projected Wind Surface Area (flat plane equivalent)	0.26 ftsq. (0.024 msq)
Number Elements	6 for a nominal 9 dB gain, 9 for a nominal 13 dB gain
Allows for Vertical or Horizontal polarization	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons installing and using an active device	9” (23 cm)
Minimum separation distance from other RF sources including radios and antennas	6.5’ (2 m)
Welded construction	

   Furnish mounting hardware to secure the antenna to the metal pole or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

2. Coaxial Cable:

   Furnish a Times Microwave Systems™ LMR 400 Cable or ANDREW CNT-400 Cinta™ Braided Cable, or equivalent antenna coaxial cable to provide a link between the antenna and the lightning arrestor that meets the following minimum specifications. Furnish a 55 foot cable unless otherwise indicated.

Attenuation (dB per 100 feet) @ 900 MHz	3.9 dB
Power Rating @ 900 MHz	0.58 kW
Center Conductor	0.109" Copper Clad Aluminum
Dielectric: Cellular PE	0.285"
Shield	Aluminum Tape – 0.291" Tinned Copper Braid – 0.320"
Jacket	Black UV protected polyethylene
Bend Radius	1" with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance per foot	23.9 pf/ft
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
End Connectors	Standard N-Type Male Connectors on both ends

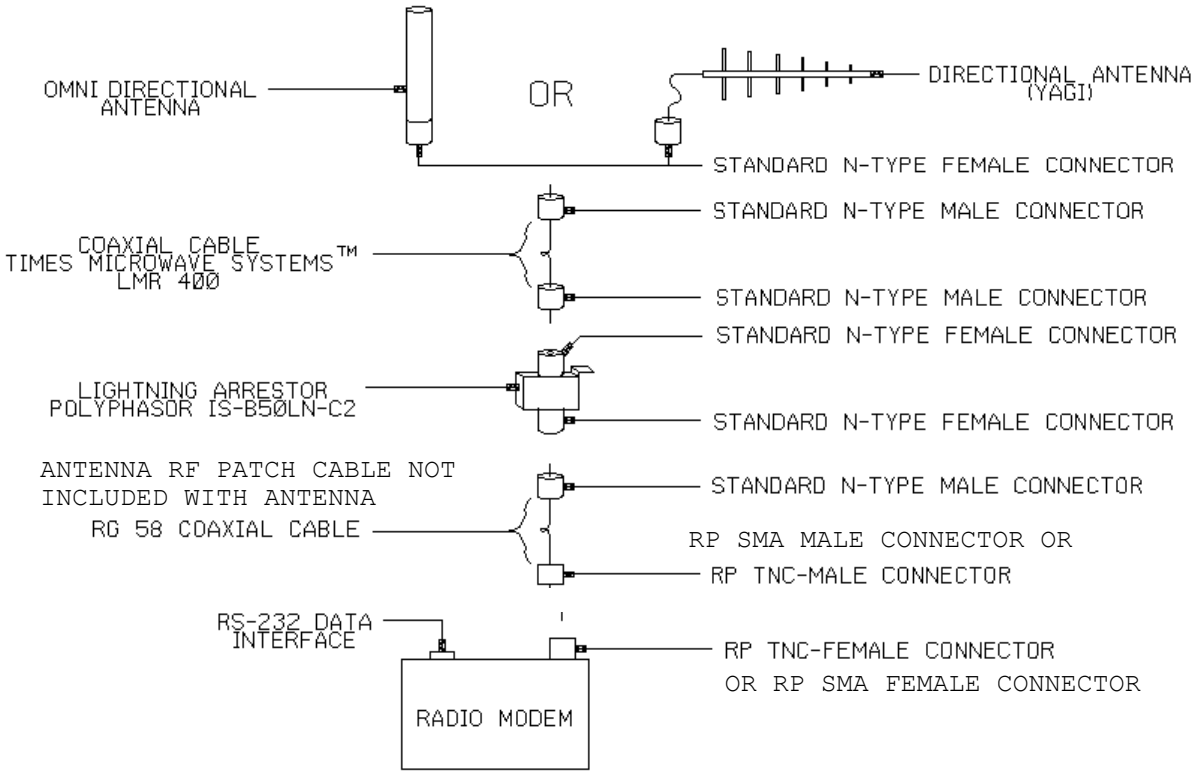
3. Lightning Arrestor:

   Furnish a lightning arrestor installed in line between each antenna and its designated radio modem inside the equipment cabinet. Furnish a Polyphaser Model # IS-B50LN-C2 or ENCOM Model # RA-702 lightning arrestor or an approved equivalent that meets the following minimum specifications:

   - Surge: 50kA IEC 1000-4-5 8/20us waveform 500 Joules
   - Turn-on: 600 VDC ±20% 2.5 ns for 2kV / ns
   - Insertion Loss: ≤0.1 dB over frequency range
   - Temperature: -49 to 185 degrees F Storage/Operating 122 degrees F (-45° C to +85°C Storage/Operating +50°C)
   - Vibration: 1G up to 100Hz
   - Utilizes UL497B listed gas tube
   - Throughput energy: ≤ 200 uJ for 3kA @ 8/20 μs Waveform
   - Throughput voltage: ≤150 Vpk
   - VSWR: 1.1:1
   - Frequency Range: 125 MHz to 1000 MHz
   - Max Power: VHF 375W, UHF (low) 250W, 800MHz to 1GHz, 125W
   - Multistrike capability
   - Low strike throughput energy
   - Flange mount and bulkhead mount options
   - Standard N-Type Female Connector on both the surge side and protected side connectors

4. Antenna and Coaxial Cable Schematic

   Furnish the cable and antenna as shown in the schematic. The cable from the lightning arrestor to the radio modem will be furnished as a separate item that mates with the radio modem.



B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

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- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.07 Omni Directional Radio Antenna and Connecting Cable

Provide wireless communications antenna with connecting cables including surge protection to the Radio unit.

A. Requirements

Furnish a Omni directional antenna that will interface with a radio unit. Included with this item are the cables to connect with the radio unit and surge protection.

1. Omni Directional Antenna

   Furnish an omni directional antenna that will allow the system to function as designed. Furnish 3dB Antenex Model # FG9023 or 6dB Antenex Model # FG9026 antenna or approved equivalent antennas that meet the following minimum specifications:

Frequency Range	902 – 928 MHz
Nominal Gain	Typical gains of 3 or 6 dB (dependent upon gain needed for application)
Termination	Standard N-Type Female Connector
Impedance	50 ohms
VSWR	1.5:1
Vertical Beam Width	3 dB – 33 degrees; 6 dB – 17 degrees
Lightening Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Length	3dB – 25” (63 cm) 6dB – 65” (165 cm)
Rated Wind Velocity	125 mph (241 kph)
Shall be of solid, single piece construction	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons installing and using an active device	9” (23 cm)
Minimum separation distance from other RF sources including radios and antennas	6.5’ (2 meters)
Mount in a vertical direction and limit to vertically polarized RF systems	

   Furnish mounting hardware to secure the antenna to the metal, concrete, or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

2. Coaxial Cable:

   Furnish a Times Microwave Systems™ LMR 400 Cable or ANDREW CNT-400 Cinta™ Braided Cable, or equivalent antenna coaxial cable to provide a link between the antenna and the lightning arrestor that meets the following minimum specifications. Furnish a 55 foot cable unless otherwise indicated.

Attenuation (dB per 100 feet) @ 900 MHz	3.9 dB
Power Rating @ 900 MHz	0.58 kW
Center Conductor	0.109” Copper Clad Aluminum
Dielectric: Cellular PE	0.285”
Shield	Aluminum Tape – 0.291” Tinned Copper Braid – 0.320”
Jacket	Black UV protected polyethylene
Bend Radius	1” with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance per foot	23.9 pf/ft
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
End Connectors	Standard N-Type Male Connectors on both ends

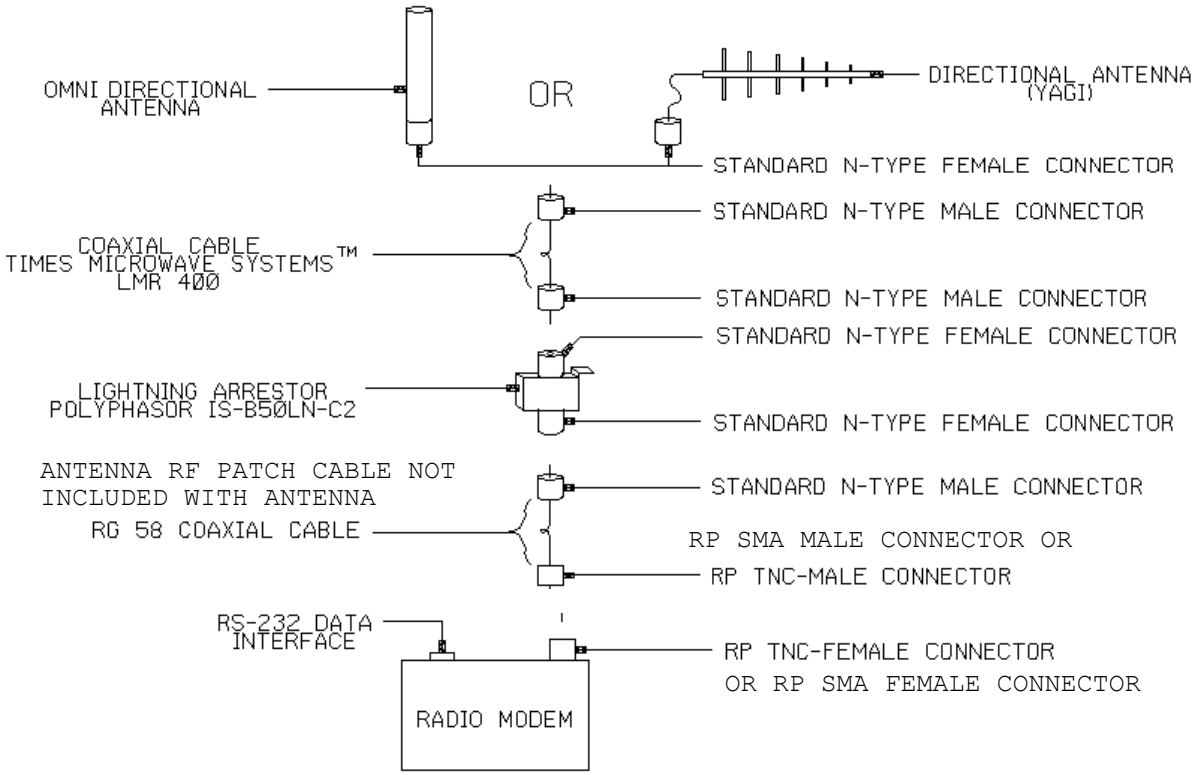
3. Lightning Arrestor:

   Furnish a lightning arrestor installed in line between each antenna and its designated radio modem inside the equipment cabinet. Furnish a Polyphaser Model # IS-B50LN-C2 or ENCOM Model # RA-702 lightning arrestor or an approved equivalent that meets the following minimum specifications:

   - Surge: 50kA IEC 1000-4-5 8/20us waveform 500 Joules
   - Turn-on: 600 VDC ±20% 2.5 ns for 2kV / ns
   - Insertion Loss: ≤0.1 dB over frequency range
   - Temperature: -49 to 185 degrees F Storage/Operating 122 degrees F (-45° C to +85°C Storage/Operating +50°C)
   - Vibration: 1G up to 100Hz
   - Utilizes UL497B listed gas tube
   - Throughput energy: ≤ 200 uJ for 3kA @ 8/20 μs Waveform
   - Throughput voltage: ≤150 Vpk
   - VSWR: 1.1:1
   - Frequency Range: 125 MHz to 1000 MHz
   - Max Power: VHF 375W, UHF (low) 250W, 800MHz to 1GHz, 125W
   - Multistrike capability
   - Low strike throughput energy
   - Flange mount and bulkhead mount options
   - Standard N-Type Female Connector on both the surge side and protected side connectors

4. Antenna and Coaxial Cable Schematic:

   Furnish the cable and antenna as shown in the schematic. The cable from the lightning arrestor to the radio modem will be furnished as a separate item that mates with the radio modem.



B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.08 Antenna RF Patch Cable TNC Connector

Provide the connection from a shelf mount radio unit to the lightning arrestor unit for the antenna. This item is required for configuration of radio units with TNC antenna connectors.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have a Reverse Polarity TNC Male connector on one end for connecting to a shelf mount radio unit and a Standard N Type Male connector on the other end for attaching to the antenna lightning arrestor. The cable shall be labeled as to its function.

1. Cable

   The cable shall use RG 58 COAX.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

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- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.09 Antenna RF Patch Cable SMA Connector

Provide the connection from a rack mount radio unit to the lightning arrestor unit for the antenna. This item is required for configuration of radio units with SMA antenna connectors.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have a Reverse Polarity SMA Male connector on one end for connecting to a shelf mount radio unit and a Standard N Type Male connector on the other end for attaching to the antenna lightning arrestor. The cable shall be labeled as to its function.

1. Cable

   The cable shall use RG 58 COAX.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.10 Antenna Power Divider

Provide item splitting the radio antenna connection for locations where two antennas are required with one radio unit. This item is to include a "T" Splitter and two cables.

A. Requirements

Furnish a "T" Splitter for providing two separate antenna connections to one radio unit. The Splitter shall be weatherproof and provide for low insertion loss. All connectors will be Type N Female. The splitter shall be furnished with two 6 foot cables of Times Microwave Systems LMR 400 Cable or equal. The cables will provide Type N Male connectors on either end. These cables will provide a link between the antennas and the splitter.

1. Power Divider

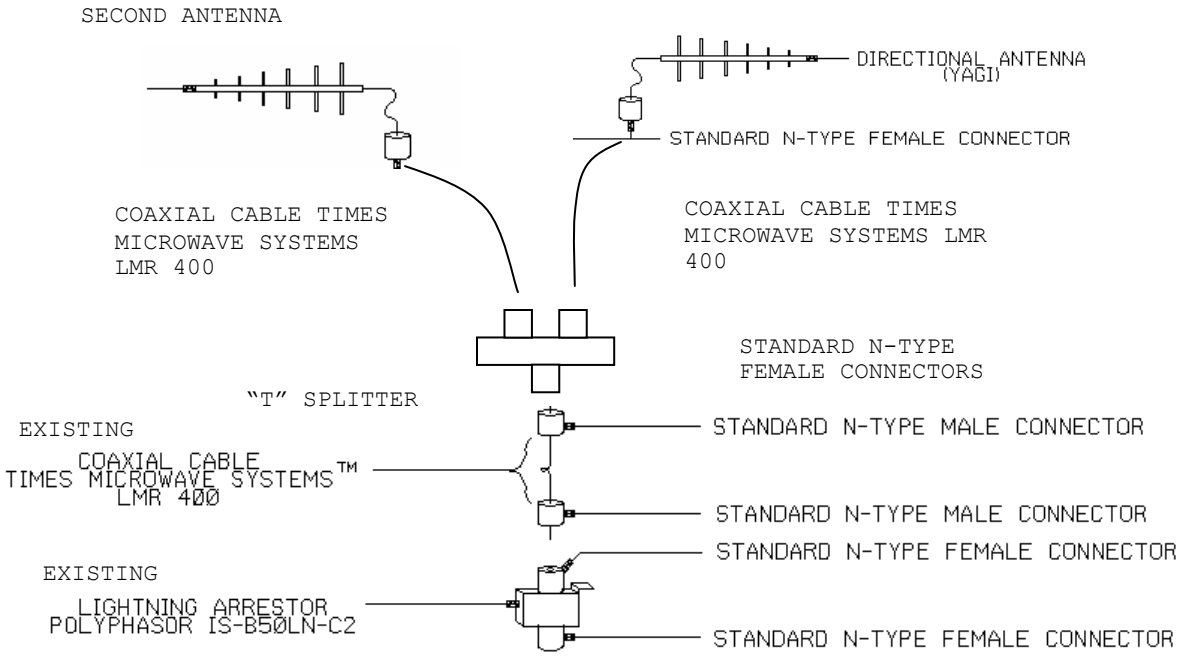
   Furnish a two way weatherproof splitter (Telewave Model #ANTPD29 or approved equal) with the following characteristics.
   - Power Division: 2-Way
   - Frequency = .900 – 1100 MHz
   - Dimensions: less than 5" x 2.5"
   - Insertion Loss: < 0.22 dB

- Max Input Power: 500 Watts
- Impedance: 50 Ohm
- VSWR ref. to 50 Ohm (max): 1.3:1
- Connectors: N Female

2. Cables

Furnish two Times Microwave Systems™ LMR 400 Cable or ANDREW CNT-400 Cinta™ Braided Cable, or equivalent antenna coaxial cable to provide a link between the antenna and the lightning arrestor that meets the following minimum specifications:

Attenuation (dB per 100 feet) @ 900 MHz	3.9 dB
Power Rating @ 900 MHz	0.58 kW
Center Conductor	0.109" Copper Clad Aluminum
Dielectric: Cellular PE	0.285"
Shield	Aluminum Tape – 0.291" Tinned Copper Braid – 0.320"
Jacket	Black UV protected polyethylene
Bend Radius	1" with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance per foot	23.9 pf/ft
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
End Connectors	Standard N-Type Male Connectors on both ends



B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.11 Configuration Cable Radio Unit to Computer DB9 Serial

Provide cable for serial connection from a radio unit to a computer that allows the computer to configure the radio unit. This item is required to configure radio units with DB9 serial connections.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have a DB 9M connector on the end that mates with the radio unit and a DB9F connector on the end that mates with the computer. The cable shall provide the appropriate signal connections to allow the radio unit to be programmed by the computer using the supplied configuration software. The cable shall be labeled as to its function and each end of the connector shall be labeled.

The cable shall use 22 AWG stranded cable that is color coded for connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.12 Configuration Cable Radio Unit (RJ 12) to Computer DB9 Serial

Provide the serial connection cable from a radio unit to a computer and allows the computer to configure the radio unit. This item is required to configure radio units with RJ 12 programming connectors.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have a RJ 12 connector on the end that mates with the radio unit and a DB9F connector on the end that mates with the computer. The cable shall provide the appropriate signal connections to allow the radio unit to be programmed by the computer using the supplied configuration software. The cable shall be labeled as to its function and each end of the connector shall be labeled.

The cable shall use 22 AWG stranded cable that is color coded for connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.13 Connecting Cable (RS 232) from Radio Unit (DB9M) to 2070 7A Comm Module

Provide the serial connection cable from a radio unit to a 2070 Controller 7A module.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have a DB 9 Male Connectors on both ends. The cable shall provide the appropriate signal connections to allow the radio unit to communicate with a 2070 controller using a 7A communications modules. The cable shall be labeled as to its function and each end of the connector shall be labeled.

The cable shall use 22 AWG stranded cable that is color coded for connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.

- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.14 Connecting Cable (RS 232) from existing Fiber Modem Cable to Radio Unit to 2070 7A Comm Module

Provide the serial connection cable from an existing serial cable that connects a fiber modem to a 2070 Controller 7A module. This cable connects the fiber modem with a radio unit and also to a 2070 7A module. The cable has 3 connectors.

A. Requirements

Furnish a cable 6 feet long between all connectors with the appropriate connections. The cable shall have two DB 9 Male Connectors and one DB 9 Female connector. The cable shall provide the appropriate signal connections to allow the radio unit to communicate with a 2070 controller using a 7A communications module and support the serial communications with an existing fiber modem. This cable is intended to be used at locations where fiber communications end. The cable shall be labeled as to its function and each of the three connectors shall be labeled. The cable is a "Y" configuration.

The cable shall use 22 AWG stranded cable that is color coded for connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.15 Connecting Cable from Radio Unit to existing FSK Field Wires

Provide an FSK connection cable to the field communication wires from the radio unit.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have an RJ -22 connector on one end with 4 "pig tails" on the other end. The cable shall provide the appropriate signal connections to allow the radio unit to communicate with a 4 wire or two wire FSK communications network. Each wire shall be color coded and labeled as to its pin number. The wire ends shall be unterminated.

The cable shall use 22 AWG stranded cable that is color coded for connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.16 Connecting Cable (RS 232) from Existing Fiber Modem Cable to 2070 Mount Radio Unit

Provide the serial connection cable from an existing fiber modem cable that was connected to a 2070 7A module; to a 2070 mount radio unit.

A. Requirements

Furnish a cable 6 feet long with the appropriate connections. The cable shall have a DB 9 Male Connector on one end to mate with a 2070 Mount Radio Unit and a DB 9 Female Connector on the other end to mate with an existing fiber modem cable. The cable shall provide the appropriate signal connections to allow the radio unit to communicate with a 2070 mounted radio unit. The cable shall be labeled as to its function and each end of the connector shall be labeled.

The cable shall use 22 AWG stranded cable that is color coded for connections.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.

- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.17 Shelf Mount Spread Spectrum Wireless Radio Transceiver with Ethernet Interface

Provide wireless communications point to point or point to multipoint to support Ethernet communications. This unit is to be supplied with power supply and configuration software.

A. Requirements

Furnish a spread spectrum wireless radio unit with all necessary hardware (excluding antennae) to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Radio unit will use IP/Ethernet or Serial communications channel between two "line-of-sight" antennas using license free, frequency hopping spread spectrum technology operating in the 902-928 MHz frequency band.

1. 900MHz Wireless Radio Unit

   Furnish license free 902 – 928 MHz radio modems with configuration and diagnostic software. Design radio modems to work in "point-to-point", and "point-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:
   - License free (ISM) Spread Spectrum radio band (902 – 928 MHz)
   - Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
   - Selectable Operating modes:
   - Access Point, Dual Gateway, Remote Serial, Remote Ethernet
   - Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
   - 128-bit data encryption
   - DB9-F connectors for RS-232 multiple Serial ports
     - 1200 bps to 512 Kbps, with 8 or 9 bit format
     - Encapsulation over IP for serial devices (IE. Traffic controllers)
   - RJ-45 Ethernet Data Port, 10/100BaseT, IEEE 802.3 compliant
     - 256/512kbps data throughput
     - Spanning Tree, IP(DHCP, ICMP, UDP, TCP, ARP)
   - Receiver Sensitivity
     - –110dBm @ 10^-6 BER, Serial
     - –100dBm @ 10^-6 BER, Ethernet
   - Management Software
     - Supports SNMP, MIBII
     - Telnet, HTTP, Local console (ControlPAK™)
   - Built-in store-and-forward (single radio repeater – no back to back radio set-ups are allowed to accomplish this function)
   - Antenna port: Reverse Polarity - Threaded Normalized Connector-Female (RP TNC-F) antenna connector
   - Front panel LED indicators
     - Power
     - Transmit Data
     - Receive Data
     - Data Port Indicators
   - Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
   - Power supply requirements
     - Wall Adaptor: 120 VAC UL/CSA wall cube plug in module with 12 VDC, 1 Amp, nominal output.
   - Shelf Mounted Design not to exceed 4.5" Long x 3.75" Wide x 1.75" High

Ensure that the wireless radio unit is a fully functional field device (i.e. controller does not require any field device modifications with regards to hardware or software).

2. Configuration Software

Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.18 Spread Spectrum Wireless Radio Site Survey kit

Provide all of the necessary equipment to test the ability to use frequency hopping spread spectrum wireless communications at a site specific location. The Site Survey Kit is to come complete with a rugged carrying case for weatherproofing and transportation purposes.

A. Requirements

Furnish a spread spectrum wireless radio site survey kit in a weather proof carrying case. Included in the kit are: Mounting Hardware, AC Charger, DC Charging Cable, Configuration and Diagnostic Software, Host Radio, Remote Radio, Antenna Masts, RF Coaxial Cable, 2 Yagi antennas, and 1 Omni Directional Antenna. The site survey kit is to allow the obtainment of the following results for the site specific locations: Signal Strength (dBm), Fade margin (dB), S/N Ratio, Data integrity (poll test), and a Complete Frequency Spectrum Scan.

1. 900MHz Wireless Radio Units (Host and Remote)

Furnish license free 902 – 928 MHz radio modems with configuration software. Design radio modems to work in "point-to-point", "point-to-multipoint" "multipoint-to-point", and "multipoint-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

- License free (ISM) Spread Spectrum radio band (902 – 928 MHz)

- Frequency Hopping Spread Spectrum Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
- Bi-Directional, Full Duplex
- Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
- RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit format
- DB9-F connector for RS-232 port
- 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Built-in store-and-forward (single radio repeater – no back to back radios set-ups are allowed to accomplish this function)
- 32 Bit encryption
- Receiver Sensitivity of –110dBm @ 10^-6 BER
- Antenna port: N-Female antenna connector
- LED indicators
  - Power
  - Low Battery
  - RSSI
- Operating temperature of –40 to +176 degrees F (-40 to +80 degrees C) at 0 to 95% Humidity
- Power supply requirements
  - 12 Volt Rechargeable Battery
  - Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
  - Radio Sleep mode with a maximum current draw of <1μA
- Mounted in a rugged carrying case Design not to exceed 10.5” Long x 11” Wide x 5” High
- ON/OFF Switch and 12 VDC Charge Input

2. Site Survey Carrying Case

   Furnish a carrying case for the site survey kit. The carrying case is to contain the radio modems,, antennas, mounting hardware, coaxial cables, and assorted cables. Overall dimensions of the carrying case are not to exceed 21” x 33” x 11” ands weight not to exceed 60lbs.

3. Configuration Software

   Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide “remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer” features. Provide no cost configuration and diagnostic software that can be upgraded in the future at no additional charge.

   Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the Georgia Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

4. RF Coaxial Cables

   Furnish a Times Microwave Systems™ LMR 400 Cable or ANDREW CNT-400 Cinta™ Braided Cable, or equivalent antenna coaxial cable to provide a link between the antenna and the portable radio units that meets the following minimum specifications:

Attenuation (dB per 100 feet) @ 900 MHz	3.9 dB
Power Rating @ 900 MHz	0.58 kW
Center Conductor	0.109” Copper Clad Aluminum
Dielectric: Cellular PE	0.285”
Shield	Aluminum Tape – 0.291” Tinned Copper Braid – 0.320”
Jacket	Black UV protected polyethylene

Bend Radius	1” with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance per foot	23.9 pf/ft
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
End Connectors	Standard N-Type Male Connectors on both end

5. Yagi Antenna

Furnish 2 Cushcraft Model # PC906N antennas or an approved equivalent antennas that meets the following minimum specifications:

Frequency Range	896 – 940 MHz
Nominal Gain	8.5 dBd or 10.64 dBi
Front to Back Ratio	18 dB
Horizontal Beamwidth (at half power points)	65 degree
Vertical Beamwidth (at half power points)	55 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Length	24” (612 mm)
Width @896 MHz	6.4” (163 mm)
Rated Wind Velocity	125 mph (200 kph)
Rated Wind Velocity (with .5 inch radial ice)	100 mph (161 kph)
Lateral thrust @ 100 mph Wind Velocity	38 lbs. (17 Grams)
Projected Wind Surface Area (flat plane equivalent)	0.26 ftsq. (0.024 msq)
Number Elements	6 for a nominal 9 dB gain, 9 for a nominal 13 dB gain
Allows for Vertical or Horizontal polarization	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons installing and using an active device	9” (23 cm)
Minimum separation distance from other RF sources including radios and antennas	6.5’ (2 m)
Welded construction	

Furnish mounting hardware to temporarily secure the antenna to the metal, wood or concrete pole (included with the kit).

6. Omni Directional Antenna

Furnish an omni directional antenna that will allow the system to function as designed. Furnish 3dB Antenex Model # FG9023 or 6dB Antenex Model # FG9026 antenna or approved equivalent antennas that meet the following minimum specifications:

Frequency Range	902 – 928 MHz
Nominal Gain	Typical gains of 3 or 6 dB (dependent upon gain needed for application)
Termination	Standard N-Type Female Connector

Impedance	50 ohms
VSWR	1.5:1
Vertical Beam Width	3 dB – 33 degrees; 6 dB – 17 degrees
Lightening Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Length	3dB – 25" (63 cm) 6dB – 65" (165 cm)
Rated Wind Velocity	125 mph (241 kph)
Shall be of solid, single piece construction	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons installing and using an active device	9" (23 cm)
Minimum separation distance from other RF sources including radios and antennas	6.5' (2 meters)
Mount in a vertical direction and limit to vertically polarized RF systems	

Furnish mounting hardware to temporarily secure the antenna to the metal, concrete, or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

926.2.19 Spread Spectrum Wireless Radio Training

Provide training as required herein. Include with training all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training. Provide training agenda at least two months prior to requesting to conduct training.

A. Requirements

Provide installation, operations and maintenance training for up to 12 people. Include in this training both classroom training and hands-on-training. Limit in-shop training and field training to group sizes to 4 people at a time. Conduct training in half-day sessions. Two half-day sessions may be held on the same day. The total training shall consist of at least 6 hours of training for each participant. Equipment provider is to determine the specific length of the training course but it may not be less than 6 hours. Provide a course content which includes as a minimum, the following:

- General theory of operation

- Operation of wireless communications equipment
- Programming of unit
- Conducting a Site Survey
- Discussion of warranties
- Hands-on use of equipment

Request to conduct training at least thirty days prior to first training session. With request to conduct training provide a detailed course outline with training materials to be used. Arrange for and submit location of training for approval.