

TECHNICAL SPECIAL PROVISION

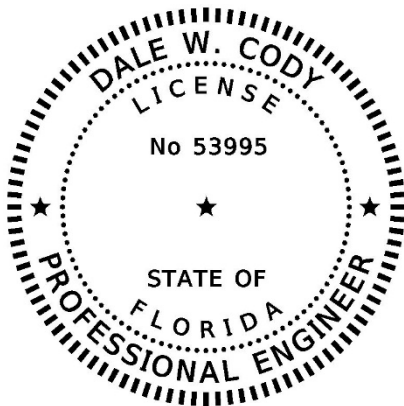
FOR

CONNECTED VEHICLE EQUIPMENT

FINANCIAL PROJECT NO.: 440900-1-52-01/440900-2-52-01

SUMTER AND MARION COUNTIES

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T690 – CONNECTED VEHICLE EQUIPMENT

T690-1 Description.

This section specifies the general material requirements for connected vehicle (CV) equipment. Furnish and install CV equipment at locations as shown on the Plans. All CV equipment must be listed on the Department’s Approved Products List (APL) or must have received a FDOT Traffic Control Device Permit for this project.

T690-2 Materials.

T690-2.1 General: CV equipment includes all hardware and materials, software, and any necessary ancillary equipment for a complete assembly necessary to enable wireless vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication. Only use new equipment and materials, except as specified in the contract.

CV equipment must be compatible with existing traffic controller assemblies unless otherwise shown on the Plans. The CV equipment must create a system that provides the minimum required functions and applications as shown on the Plans.

Ensure the CV equipment is permanently and legibly marked with a serial number, date of manufacture, and part number.

Connected vehicle equipment and systems must support the project goals and applications described on the Central Florida SmartRoads website at <http://www.cflsmartroads.com/projects/CVAV.html> and the National ITS Reference Architecture connected vehicle service packages at <http://local.iteris.com/arc-it/>.

CV equipment must be compatible with a FDOT - approved Security Credential Management System message security solution for V2V and V2I communication and meet the applicable industry standards listed in Table T690-1.

**Table T690-1
CV Equipment Requirements and Standards**

| Document Identifier | Description |
|-----------------------------|--|
| USDOT RSU, Latest Version | DSRC Roadside Unit (RSU) Specifications Document |
| SAE J2735, Latest Version | Dedicated Short Range Communications (DSRC) Message Set Dictionary |
| SAE J2945, Latest Version | On-Board System Requirements for V2V Safety Communications |
| IEEE 802.11, Latest Version | IEEE Standard for Information Technology– Telecommunications and information exchange between systems local and metropolitan area networks – Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications |
| IEEE 1609.0, Latest Version | IEEE Guide for Wireless Access in Vehicular Environments (WAVE) - Architecture |
| IEEE 1609.2, Latest Version | IEEE Standard for WAVE – Security Services for Applications and Management Messages |

| Document Identifier | Description |
|---|--|
| IEEE 1609.3, Latest Version | IEEE Standard for WAVE – Networking Services |
| IEEE 1609.4, Latest Version | IEEE Standard for WAVE – Multi-Channel Operation |
| IEEE 1609.12, Latest Version | IEEE Standard for WAVE – Identifier Allocations |
| IEEE 802.3at, Latest Version | Standard for Power over Ethernet |
| ASTM E2213-03 | Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems — 5-GHz Band Dedicated Short-Range Communications (DSRC), Medium Access Control (MAC), and Physical Layer (PHY) Specifications |
| Federal Communications Commission (FCC) Title 47, Parts 0, 1, 2, 15, 90, and 95 | FCC Code of Federal Regulations |

CV equipment must be capable of remote firmware updates. Device manufacturers must make firmware updates available to the Department and maintaining agency at no cost.

T690-2.2 CV Device Interoperability: Provide standards-based CV devices that are interoperable with CV devices from other manufacturers listed on the Department’s APL or authorized by FDOT Traffic Control Device Permit for this project. Ensure that RSUs and Onboard Units (OBUs) are compatible and interoperable. All proposed CV equipment, consisting of a complete engineered solution meeting the contract requirements must be provided to the Engineer, at no additional cost, within 45 days of notice to proceed for testing. The Engineer will complete testing within 30 days of receipt of all equipment required for testing. The testing will confirm that the proposed CV equipment meets the requirements of the Contract Documents as a part of an overall system. No CV submittal will be approved prior to this testing being successfully completed.

T690-2.3 Wireless Communications: Ensure wireless communications are secure and that cellular communications are compatible with the carrier used by the agency responsible for system operation and maintenance.

T690-2.4 Roadside Unit (RSU): The RSU must be a commercially available production-version device that provides information and supports public safety operations in a V2I/V2V communication environment. RSUs must be successfully demonstrated to the Department and shown to support the functional features and CV applications identified in the Contract Documents. RSU must to be fully compatible with SCMS requirements per USDOT RSU specification, Latest Version.

The RSU must be preconfigured by the manufacturer or an authorized manufacturer’s representative so that it is ready for installation and operation at the site(s) shown on the Plans. Engineer to provide on-site data, such as MAP data. Upon receipt of the RSU(s), the Engineer will validate the configuration of the unit. Provide all required support, throughout the configuration process until approved by the Engineer. The RSU must include antennas for all

radio frequency connectors, surge protection device(s) (SPDs), mounting hardware, all associated cabling, and any other equipment required for a fully functional and complete installation.

The RSU must automatically recover from a power failure once power is restored. Ensure that all programmable settings are restored to their previous configurations and that the system resumes proper operation.

T690-2.4.1 Configuration and Management: RSU must be provided with all hardware, software, configuration tools and software licenses required for local and remote configuration, operation, and management including access to all user-programmable features as well as health and status monitoring, event logging, and diagnostic utilities. Configuration and management functions must be password protected. Access to all user-programmable features, alarm monitoring, configuration parameters, event logging and diagnostic utilities must be through a vendor provided Graphical User Interface (GUI). The RSU must be provided with an open application programming interface (API) and software development kit available to the Department at no additional cost.

Alarm monitoring must include communication failure, power failure, GPS deviations, and time source lost. The RSU must include an event log that includes the date and time of the event(s). The RSU must be capable of storing a minimum of 500 events as defined by USDOT RSU specification (Latest Version).

T690-2.4.2 Device Interfaces: The RSU must include wired (Ethernet) and wireless interfaces specified in the USDOT RSU specification (Latest Version). Provide interfaces, such as Bluetooth® for automatic vehicle identification (AVI) functionality and cellular interfaces for system communication, as shown on the Plans. Ensure that all interfaces are protected by a configurable firewall with a default to be closed.

T690-2.4.2.1 DSRC Interface: The RSU must include a commercial-grade radio that transmits and receives DSRC messages within the 5.9 GHz band per the USDOT RSU specification.

T690-2.4.2.2 Bluetooth® Interface: Bluetooth interfaces used to support automatic vehicle identification functionality must collect and forward anonymous Bluetooth® data, including vehicle identifier, time, and location information.

T690-2.4.2.3 Antennas: The RSU must use antennas that were tested with the device to obtain the FCC Grant of Equipment Authorization (or similar antennas with equal gain). Antennas must be removable to allow for the antennas to be installed at a distance from the RUS unit or replaced as needed. Do not co-locate or operate RSU antennas with any other antenna or transmitter, except in accordance with the FCC multi-transmitter policy.

T690-2.4.3 System Communications: All connected vehicle equipment must be compatible and interoperable with existing FDOT and local agency networks. The RSU must communicate to the network switch via an Ethernet interface.

T690-2.4.4 Ports and Connectors: The RSU must include all necessary ports and connectors for a complete assembly. All ports and connectors must be weather proof and inhibit the ingress of water, dirt, sand and other foreign materials from entering the enclosure. All ports must be legibly and permanently marked designating their intended use. All labels must be weather resistant.

T690-2.4.4.1 Copper Ports: The RSU must include a minimum of one Type RJ-45 Ethernet port. The Type RJ-45 port must be capable of auto-negotiating speed (i.e., 10/100 Base) and duplex (i.e. full or half). All 10/100 Base TX connections must be compliant with the IEEE 802.3 standard pinouts.

T690-2.4.4.2 Radio Frequency (RF) Connectors: The RSU must include at least three Type N weatherproof female RF ports.

T690-2.4.4.3 Power over Ethernet (POE): The RSU must include at least one POE connector. The POE connector must be compliant with the Outdoor IP 66 rating.

T690-2.4.5 Mechanical Specifications: Ensure equipment is permanently marked with manufacturer name or trademark, part number, date of manufacture and serial number. All parts must be made of corrosion-resistant materials.

T690-2.4.6 Electrical Specifications: Ensure that all wiring complies with the latest edition of the National Electrical Code (NEC), National Electrical Safety Code (NESC), any local jurisdictional requirements, and IEEE 802.3.

Ensure that the RSU operates at a nominal voltage between 37 and 57 Voltage Direct Current (VDC).

Ensure that the POE injector used to power the RSU operates using a nominal input voltage of 120 Voltage Alternating Current (VAC). If any system device requires operating voltages other than 120 VAC, supply a voltage converter.

T918-2.4.7 Environmental Specifications: Ensure that the RSU complies with all environmental requirements of the latest edition of the Dedicated Short-Range Communications Roadside Unit Specifications published by the USDOT.

T690-2.4.8 Operating System: The RSU's processor must run the latest version of the Linux operating system, at time of bid, and all applications must be written as Linux based applications.

T690-2.4.9 System Requirements: The RSU must meet the minimum requirements for processing, memory, and storage as required in the USDOT RSU specification, Latest Version.

T690-2.4.10 FCC License: Compile all information required to register RSU devices and locations with the FCC and provide this information to the Engineer for review in accordance with Section 7-2. Support the permitting effort until complete. FCC permitting must be complete and approved prior to turning on the RSU devices.

T690-2.4.11 Central Management Software: Provide Central Management Software that will allow for local and remote configuration of the units, diagnostics, alarms, retrieval and storage of data, etc. The software must function locally as well remotely over an Ethernet network. All licensing to be included to accommodate the requirements of the contract documents.

T690-2.4.12 Other Requirements: The RSU must store and transmit periodic status messages, capture System Status Logs (SSLs) and Communication Message Logs (CMLs) as well as route and forward IPv6 traffic for connected mobile units.

T690-2.5 System Interface Unit: The CV system interface unit must be a specialized device that provides field cabinet monitoring features and protocol translation to facilitate interoperability between multiple traffic signal controllers and RSUs. The system interface unit must also be capable of serving as a computer host for executing third party CV applications and other software.

Ensure that the equipment automatically recovers from power failure after power is restored. Ensure that all programmable system settings return to their previous configurations and the system resumes proper operation.

T690-2.5.1 Interfaces: The system interface unit must include wired and wireless interfaces for traffic controller connections, cabinet monitoring connections, and communication. Wireless devices must be FCC certified. Ensure that the FCC identification number is displayed on an external label and that all wireless devices operate within their FCC frequency allocation.

T690-2.5.1.1 Network Interface: The system interface unit must include at least one Ethernet port that provides a 10/100 Base TX connection. Verify that all copper-based network interface ports utilize registered jack (RJ)-45 connectors.

T690-2.5.1.2 Cellular Interface: The system interface unit must support cellular remote connectivity.

T690-2.5.2 Cabinet Monitoring: The system interface unit must be capable of monitoring cabinet operating conditions, including status of incoming power, cabinet flash, conflict monitor status, and detection.

T690-2.5.3 Remote Power Management: Provide a system interface unit that includes remote power management functions unless otherwise shown on the Plans. The system interface unit must include four 120VAC receptacles and allow power on each receptacle to be remotely set ON or OFF.

T690-2.5.4 Configuration and Management: The system interface unit must be provided with all software required for local and remote configuration and monitoring. The system interface unit must be provided with an open API and software development kit available to the Department at no cost for integration with third party software and systems.

T690-2.5.5 System Communication: The system interface unit must communicate with other devices using the existing traffic control system Ethernet communication network. Ensure the system interface unit is fully compatible and interoperable with the existing network.

T690-2.5.6 Mechanical Specifications: Ensure equipment is permanently marked with manufacturer name or trademark, part number, date of manufacture and serial number.

Do not use self-tapping screws on the exterior of the assembly.

Ensure that all parts are made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

Ensure that the dimensions of the system interface unit accommodate the unit's installation in a traffic cabinet.

T690-2.5.7 Electrical Specifications: Verify that all wiring meets applicable National Electrical Code (NEC) requirements and the system interface unit operates using a nominal input voltage of 120 VAC. If the device requires nominal input voltage of less than 120 VAC, furnish the appropriate voltage converter.

T690-2.5.8 Environmental Specifications: Ensure the system interface unit performs all required functions during and after being subjected to the environmental testing procedures described in National Electrical Manufacturers Association TS2, Sections 2.2.7, 2.2.8, and 2.2.9.

T690-2.6 Industrial Computer for CV Applications: Provide an industrial computer as a component of the roadside equipment (RSE) system to serve as a CV application platform. The RSE system is defined as the roadside field and office elements that send and receive data and information to meet the requirements of the Contract Documents. The industrial computer must be a commercial-off-the-shelf product with a Linux operating system that provides a platform for hosting and executing CV applications and other software.

Ensure that the equipment automatically recovers from power failure after power is restored. Ensure that all applications hosted on the industrial computer automatically start using their previous configurations and the system resumes proper operation. Provide an industrial computer meeting the specifications in Table T690-2.

**Table T690-2
Industrial Computer Minimum Requirements**

| Processor | |
|--------------------------|---|
| CPU | Dual Core SoC |
| Frequency | 1.1 GHz, turbo burst 2.4 GHz |
| L2 Cache | 2 MB |
| Memory | |
| Technology | DDR3L |
| Capacity/Type | SQRAM 8G (1 x 8GB) SO-DDR3L-1600MHz 204PIN Industrial Grade Memory (-40-85°C) |
| Socket | 1 x 204-pin SO-DIMM |
| Network Interface | |
| LAN1 | 10/100/1000 Mbps Intel I210 GbE, support Wake on LAN |
| LAN2 | 10/100/1000 Mbps Intel I210 GbE, support Wake on LAN |
| Audio Interface | |
| Audio | High Definition Audio. Line-out, Line-in |
| I/O | |
| Serial Port | 2 x RS-232/422/485 port with auto flow control |
| USB | 4 x USB 3.0 |
| Expansion | |
| Mini PCIe | 1 x full-size mPCIe for WLAN/WWAN with SIM holder |
| M.2 | 1 x M.2 E-key for WIFI (by CTOS or T-PN) |
| Storage | |
| Drive | 1 x 2.5" 256GB Industrial SATA solid state drive (-40-85°C) |

T690-2.6.1 Mechanical Specifications: Ensure equipment is permanently marked with manufacturer name or trademark, part number, date of manufacture, and serial number.

Do not use self-tapping screws on the exterior of the assembly.

Ensure that all parts are made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

Ensure that the dimensions of the industrial computer accommodate the unit's installation in a traffic cabinet.

T690-2.6.2 Electrical Specifications: Verify that all wiring meets applicable NEC requirements and the industrial computer operates using a nominal input voltage of 120

VAC. If the device requires nominal input voltage of less than 120 VAC, furnish the appropriate voltage converter.

T690-2.7 Onboard Unit: The OBU must be a commercially available production version device that provides information and supports public safety operations in V2I and V2V communication environments. Preconfigure the OBU so that it is ready for installation and operation in a vehicle. Coordinate vehicle-specific configuration settings and installation characteristics with the Department.

T690-2.7.1 Interfaces: The OBU must include wired and wireless communication interfaces. Wireless devices must be FCC-certified. Ensure that the FCC identification number is displayed on an external label and that all wireless devices operate within their FCC frequency allocation.

T690-2.7.1.1 DSRC Interface: The OBU must include a commercial grade radio that transmits and receives DSRC messages within the 5.9GHz band.

T690-2.7.1.2 Controller Area Network Interface: The OBU must include a controller area network interface for vehicle integration.

T690-2.7.1.3 Human-Machine Interface: The OBU must include a human-machine interface that presents CV application information using visual and audible methods. Visual regulatory and warning information displays must substantially comply with the Manual on Uniform Traffic Control Devices graphical design characteristics.

T690-2.7.2 Configuration and Management: The OBU must be provided with all software and software licenses required for configuration and operation. The OBU must be provided with an open API and software development kit available to the Department at no cost for integration with third party software and systems.

T690-2.7.3 Mechanical Specifications: The OBU must be a vibration-resistant automotive-grade device suitable for secure installation within a variety of vehicle types.

T690-2.7.4 Electrical Specifications: The OBU must operate using an input voltage from 9VDC to 30VDC.

T690-2.7.5 Environmental Specifications: The OBU must have an operating temperature range of -34 to 74°C.

T690-2.8 OBU Emulator: The OBU emulator must be a smartphone application that integrates with RSE and provides the CV functionality identified in the Contract Documents. The OBU emulator application must be compatible with the current Google Android and Apple IOS smartphone operating systems. The OBU emulator must be provided as a free download. The OBU emulator license must allow redistribution and incorporation of the OBU emulator application as part of other public agency applications.

T690-2.8.1 Interfaces: The OBU emulator must transmit and receive messages compliant with SAE J2735 and SAE J2945. The OBU emulator must be able to transmit and

receive standards-based, non-DSRC CV messages using existing commercial cellular communication infrastructure. The OBU emulator must be able to wirelessly connect to DSRC OBUs from multiple manufacturers and use the OBU to transmit and receive DSRC CV messages.

T690-2.8.1.1 Human-Machine Interface: The OBU emulator must include a human-machine interface that presents CV application information using visual and audible methods. Visual regulatory and warning information displays must substantially comply with the Manual on Uniform Traffic Control Devices graphical design characteristics.

T690-2.8.2 Configuration and Management: The OBU emulator must be provided with an open API and software development kit available to the Department at no cost for integration with third-party software and systems.

T690-3 Installation.

T690-3.1 General: Install all CV equipment in accordance with the contract documents, manufacturer's recommendations, and as directed by the Engineer. Furnish all equipment with the appropriate power supplies, surge protection devices, power and communication cables, mounting brackets, and mounting hardware according to the manufacturer's recommendations and the Contract Documents.

Configuration of the equipment is to be accomplished per this specification. Provide any necessary technical support, up to and including on-site support, to the Engineer to facilitate configuration for one year after final acceptance. Provide a product manual in the cabinet for each intersection the equipment is installed.

Ensure that status indicators remain unobstructed and visible.

T690-3.2 Cabling: Ensure that cables comply with NEC sizing requirements and meet all other applicable standards, specifications, and local code requirements. Cut all wires to their proper length before assembly. Do not double back any wire to take up slack. Neatly lace wires into cables with nylon lacing or plastic straps. Provide service loops at all connections. Secure drip loops and outdoor cables with self-locking cable ties of UV stabilized black plastic having a minimum tensile strength of 100 pounds. Ensure that all unshielded twisted pair/shielded twisted pair Ethernet network cables are compliant with the EIA/TIA-568-B standard. Ensure that all device cabling is free from defects. Provide slack coils within cabinets and pull boxes to facilitate future re-terminations. Neatly bundle, coil, and band all slack within storage areas using heavy duty cable ties. Provide drip and service loops for RSU and antenna cabling. Provide weatherproof cable tags at all storage points and at cable termination ends. Ensure that all unshielded and shielded twisted pair Ethernet cabling is compliant with the EIA/TIA-568 standard.

T690-3.3 Connectorized Ends: Securely and properly perform all field terminations in accordance with the manufacturer's recommendations.

T690-3.4 Surge Protection: Provide surge protection devices at locations as shown on the plans and in accordance with Section 620. Provide surge protection at the ends of cabling prior to its final destination. Ensure that all cables are protected against surges and induced voltage when entering cabinets. Ensure that all grounding clips or cables are provided and properly grounded. All grounding wires for surge protection within the cabinet shall be connected to the cabinet's grounding busbar.

Provide surge protection and grounding of coaxial cables for the GPS and Omni Antennas at the RSU. Ensure that the antenna cabling is grounded to the site ground in accordance with Section 620.

T690-3.5 RSU Installation: Install RSUs on existing poles or sign structures, or on new poles, as shown on the Plans. The RSU, mounting hardware, and any other related material that is exposed to the environment must be designed for 150 mph wind speeds and meet the requirements of the Department's Structures Manual. Submit electronic configuration file backups to the Engineer following field testing. Backup files must include communication settings, firmware, and all other files and settings required to restore current operation and program a new replacement RSU.

T690-3.5.1 Cabling: Ensure that all device cabling is free from defects. Provide sufficient cabling slack within existing cabinets and pull boxes to facilitate future re-terminations and any required adjustments needed to shift the RSU along the mounting structure. Neatly bundle and coil all slack within storage areas and prior to entering the RSU. Provide weatherproof cable tags at all storage points and at cable termination ends. Ensure that all unshielded and shielded twisted pair Ethernet cabling is compliant with the EIA/TIA-568-B standard. Neatly coil and band all cable slack together using heavy duty cable locking ties. The use of standard zip-ties will not be permitted.

T690-3.6 System Interface Unit Installation: Place the system interface unit inside a field site cabinet. Ensure that the system interface unit is mounted securely and is fully accessible by field technicians.

Submit electronic configuration file backups to the Engineer following field testing. Backup files must include communication settings, firmware, and all other files and settings required to restore current operation and program a new replacement system interface unit.

T690-3.7 Industrial Computer Installation: Place the industrial computer for local CV applications inside a field site cabinet. Ensure that the computer is mounted securely and is fully accessible by field technicians.

Submit electronic configuration file backups to the Engineer following field testing. Backup files must include communication settings, firmware, and all other files and

settings required to restore current operation and program a new replacement industrial computer for local CV applications.

T690-3.8 OBU Installation: Install and configure the OBU in accordance with the Contract Documents, manufacturer's recommendations, and as directed by the Engineer. Submit electronic configuration file backups to the Engineer following field testing. Backup files must include communication settings, firmware, and all other files and settings required to restore current operation and program a new replacement OBU.

T690-4 Testing.

T690-4.1 General: Subject CV equipment to field acceptance tests (FAT). The Engineer reserves the right to witness all FATs. Meet the requirements of T612.

T690-4.2 Field Testing: Once the CV equipment has been installed, conduct local FATs at each field site according to the test plan(s) in T612. Perform the following:

1. Verify that physical construction has been completed as detailed on the Plans.
2. Inspect the installation of the CV Equipment and its associated cabling for a secure installation.
3. Inspect the quality and tightness of ground and surge protector connections.
4. Verify proper voltages for all power supplies and related power circuits.
5. Connect devices to the power sources.
6. Verify all connections, including correct installation of communication and power cables.
7. Verify all wire and cable connections are correct and secure.
8. Verify the configuration of CV device network interfaces.
9. Verify that the CV equipment can be accessed and manipulated using the secured Shell from the remote computer.
10. Verify over the air that the RSU broadcasts using an approved multi-channel test tool (MCTT).
 - a. Ensure data logging is active on all units under test and that data logs are sent to data repository per contract documents.
 - b. Test the DSRC with security on and off. With mismatched security certificates, ensure that messages are logged but payload is not decoded.
 - c. Scan all DSRC channels and document sources of potential interference.

T690-5 Warranty.

Ensure that CV equipment has a manufacturer's warranty covering defects for a minimum of 5 years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

Ensure the warranty includes providing replacements within 10 calendar days of notification for defective parts and equipment during the warranty period at no cost to the Department or the maintaining agency.

T690-6 Training.

Develop and provide for approval a training program for all CV equipment and applications. The training must include both “hands-on” in-house and in the field training. The training must be on-site and address installation, maintenance and administrative needs and responsibilities for the equipment.

T690-7 Method of Measurement.

T690-7.1 CV Equipment: The Contract unit price for each RSU, system interface unit, industrial computer for CV applications, or OBU furnished and installed, will include furnishing, placement, cabling, field adjustment, configuration, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages and firmware, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

T690-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section. Payment will be made under:

Item No. T918-690-XXX Connected Vehicle Equipment – RSU – each.

Item No. T918-690-XXX Connected Vehicle Equipment – In-cabinet RSE – Industrial Computer – each.

Item No. T918-690-XXX Connected Vehicle Equipment – In-cabinet RSE – System Interface Unit – each.