# ORIGINATION FORM

**Date:** May 14, 2013
**Originator:** Jeff Morgan
**Contact Information:**
Traffic Engineering and Operations, Traffic Systems Section
850-410-5600

**Specification Title:**
NETWORK DEVICES
**Specification Section, Article, or Subarticle Number:** 684 (formerly Section 784)

**Why does the existing language need to be changed?** The specification is being renumbered and updated as a planned part of an ongoing specification consolidation effort. Minor changes have been made to update functional requirements and for consistency. Added content for media converters that transition between one media to another as part of a network communication system. Method of measurement section shortened to remove duplicate text previously contained in separate "Furnish" and "Install" subarticles. The current content in Section 784 must also be deleted in its entirety to coincide with content being renumbered and moved to Section 684.

**Summary of the changes:** The changes update and move content from section 784 to Section 684 as part of an ongoing specification consolidation and restructuring effort.

**Are these changes applicable to all Department jobs? If not, what are the restrictions?** This requirement is typically applicable to all jobs, but specifically those including network equipment.

**Will these changes result in an increase or decrease in project costs? If yes, what is the estimated change in costs?** No increase or decrease in project costs is expected.

**With who have you discussed these changes?** In-house stakeholders (Traffic Engineering and Operations Office staff, Specifications Office staff, C-team).

**What other offices will be impacted by these changes?** Specifications and Estimates, Construction, Maintenance, and Roadway Design.

**Are changes needed to the PPM, Design Standards, SDG, CPAM or other manual?** Yes. Coordination of changes is an ongoing effort of the Consolidation of Products and Specifications (COPS) working group in conjunction with the C-team.

**Is a Design Bulletin, Construction Memo, or Estimates Bulletin needed?** Yes. Stakeholders should be notified of changes to the location of these requirements and impacted pay items.

Contact the State Specifications Office for assistance in completing this form.
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**M E M O R A N D U M**

**DATE:** June 18, 2013

**TO:** Specification Review Distribution List

**FROM:** Daniel Scheer, P.E., State Specifications Engineer

**SUBJECT:** Proposed Specification: **6840000 Network Devices.**

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change.

The changes are proposed by Jeff Morgan of the State Traffic Engineering and Operations Office as a part of the ongoing specifications consolidation effort. The changes update and move content from Section 784 to Section 684.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or to my attention via e-mail at ST986DS, or daniel.scheer@dot.state.fl.us. Comments received after **July16, 2013,** may not be considered. Your input is encouraged.

DS/ft
Attachment

**NETWORK DEVICES.**
**(REV 5-15-13)**

PAGE 818. The following new Section is added after Section 678.

**SECTION ~~7~~6~~84~~**
**~~INTELLIGENT TRANSPORTATION SYSTEMS~~**
**NETWORK DEVICES**

**~~7~~6~~84~~-1 Managed Field Ethernet Switch.**

**~~7~~6~~84~~-1.1 Description~~.~~:** Furnish and install a hardened, device-level managed field Ethernet switch (MFES) for intelligent transportation system (ITS) projects. Ensure that the MFES provides wire-speed fast Ethernet connectivity at transmission rates of 100 megabits per second from the remote ITS device installation location to the ITS network trunk interconnection point. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

**~~7~~6~~84~~-1.2 Materials:**

**~~7~~6~~84~~-1.2.1 General:** Ensure that the ITS network administrator will be able to manage each MFES individually and as a group for switch configuration, performance monitoring, and troubleshooting. Ensure that the MFES includes Layer 2+ capabilities, including, QoS, IGMP, rate limiting, security filtering, and general management.

Ensure that the furnished MFES is fully compatible and interoperable with the ITS trunk Ethernet network interface, and that the MFES supports half and full duplex Ethernet communications.

Furnish an MFES that provides 99.999% error-free operation, and that complies with the Electronic Industries Alliance (EIA) Ethernet data communication requirements using single-mode fiber optic transmission medium and Category 5E copper transmission medium. Provide a switched Ethernet connection for each remote ITS field device.

Ensure that the MFES has a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

**~~7~~6~~84~~-1.2.2 Networking Standards:** Ensure that the MFES complies with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

1. IEEE 802.1D Standard for Media Access Control (MAC) Bridges used with the Rapid Spanning Tree Protocol (RSTP).
2. IEEE 802.1Q standard for port-based virtual local area networks (VLANs).
3. IEEE 802.1P standard for Quality of Service (QoS).
4. IEEE 802.3 standard for local area network (LAN) and metropolitan area network (MAN) access and physical layer specifications.
5. IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX.
6. IEEE 802.3x standard regarding flow control with full duplex operation.

**~~7~~6~~84~~-1.2.3 Optical Ports:** Ensure that all fiber optic link ports operate at 1,310 or 1,550 nanometers in single mode. Ensure that the optical ports are Type ST, SC, LC, or FC only,

as specified in the plans or by the Engineer. Do not use mechanical transfer registered jack (MTRJ) type connectors.

Provide an MFES having a minimum of two optical 100 Base FX ports capable of transmitting data at 100 megabits per second *unless otherwise shown in the plans*. Ensure the MFES is configured with the number and type of ports detailed in the Contract Documents. Provide optical ports designed for use with a pair of fibers; one fiber will transmit (TX) data and one fiber will receive (RX) data. The optical ports shall have an optical power budget of at least 15 dB, or as detailed in the Contract Documents.

~~7~~*6***84-1.2.4 Copper Ports:** Provide an MFES that includes a minimum of four copper ports *unless otherwise shown in the plans*. All copper ports shall be Type RJ-45 and shall auto-negotiate speed (i.e., 10/100 Base) and duplex (i.e., full or half). All 10/100 Base TX ports shall meet the specifications detailed in this section and shall be compliant with the IEEE 802.3 standard pinouts.

*Ethernet over very high speed digital subscriber line (EoVDSL) ports are permitted for use in applications where fiber optic cable is not available. EoVDSL ports must support standard telephone-grade twisted copper pair and automatically negotiate the fastest data rate possible depending on cable length and quality.*

~~All Category 5E unshielded twisted pair/shielded twisted pair network cables shall be compliant with the EIA/TIA-568-B standard.~~

~~7~~*6***84-1.2.5 Management Capability:** Ensure that the MFES supports all Layer 2 management features and certain Layer 3 features related to multicast data transmission and routing. These features shall include, but not be limited to:

1. An MFES that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard, and has a minimum 4-kilobit VLAN address table.
2. A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second.
3. A minimum 4 kilobit MAC address table.
4. Support of, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).
5. Support of remote and local setup and management via telnet and secure Web-based GUI.
6. Support of the Simple Network Management Protocol (SNMP). Verify that the MFES can be accessed using the resident EIA-232 management port, a telecommunication network, or the Trivial File Transfer Protocol (TFTP).
7. Port security through controlling access by the users. Ensure that the MFES has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network.
8. Support of remote monitoring (RMON) of the Ethernet agent and the ability to be upgraded to switch monitoring (SMON), if necessary.
9. Support of TFTP and either Network Time Protocol (NTP) or the Simple Network Time Protocol (SNTP). Ensure that the MFES supports port mirroring for troubleshooting purposes when combined with a network analyzer.

~~7~~*6***84-1.2.6 Mechanical Specifications:** ~~Ensure that all wiring complies with NEC requirements and standards.~~ *Ensure equipment is permanently marked with manufacturer*

*name or trademark, part number, date of manufacture, ~~and~~or serial number.*~~Furnish and identify all equipment and appurtenances by name, model number, serial number, technical support and warranty telephone numbers, and any other pertinent information required to facilitate equipment maintenance.~~

Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting, conductive metal.

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

All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

**~~7~~*6*84-1.2.7 Electrical Specifications:** *MFES must operate on a nominal voltage of 120 volts alternating current ($V_{AC}$). Supply an appropriate voltage converter for devices that require operating voltages of less than 120 $V_{AC}$.*
~~Ensure that the MFES operates and power is supplied with 115 volts of alternating current (VAC). Ensure that the MFES operates over an input voltage range from 89 VAC to135 VAC. If the device requires operating voltages other than 120 VAC, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 50 watts.~~

Ensure that the MFES has diagnostic light emitting diodes (LEDs), including link, TX, RX, and power LEDs.

**~~7~~*6*84-1.2.8 Environmental Specifications:** Ensure that the MFES operates properly during and after being subjected to the environmental testing procedures described in NEMA TS 2, Sections 2.2.7, 2.2.8., and 2.2.9.

**~~7~~*6*84-1.3 Installation Requirements:** ~~*Install all equipment and software according to the manufacturer's recommendations.*~~ Mount the MFES inside a field site cabinet. Ensure that the MFES is resistant to all electromagnetic interference (EMI). Ensure that the MFES is mounted securely ~~in 19 inches EIA racking~~ and is fully accessible by field technicians. *Ensure that all unshielded twisted pair/shielded twisted pair Ethernet network cables are compliant with the EIA/TIA-568-B standard.*

~~Due to the nature of the equipment, complexity of the electronics, and harsh environmental conditions at installation locations, use MFES units that can be serviced or replaced immediately when defective or damaged units must be removed and replaced.~~

**~~7~~*6*84-1.4 Testing:**

**~~7~~*6*84-1.4.1 General:** Subject the MFES to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.

**~~7~~*6*84-1.4.2 Field Testing:** Once the MFES has been installed, conduct local FATs at the MFES field site according to the submitted test plan. Perform the following:

1. Verify that physical construction has been completed as detailed in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify configuration of the MFES Internet Protocol (IP) addresses and subnetwork mask.

7. Verify the network connection to the MFES through ping and telnet sessions from a remote personal computer (PC).

8. Perform testing on multicast routing functionality.

**~~7~~*6*84-2 Device Server.**

**~~7~~*6*84-2.1 Description.** Furnish and install a device server as shown in the plans. Provide a device server that ~~includes a central processing unit (CPU), realtime operating system (RTOS), Transmission Control Protocol/Internet Protocol (TCP/IP) stack, and Ethernet and serial data ports to~~ allow*s* connection of serial devices with EIA-232, EIA-422, and EIA-485 connections to an Ethernet network. ~~Ensure that the device server (also referred to as a terminal server) encapsulates serial data in network packets and transports them across IP networks.~~ Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the APL.

**~~7~~*6*84-2.2 Materials:**

**~~7~~*6*84-2.2.1 General:** Ensure that the device server provides a TCP/IP interface to one or more field devices using EIA-232/422/485 standard connections. Ensure that the device server supports TCP/IP, User Datagram Protocol (UDP)/IP, Dynamic Host Configuration Protocol (DHCP), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), Simple Network Management Protocol (SNMP), Hypertext Transfer Protocol (HTTP), and telnet.

Ensure that the device server provides 99.999% error-free operation and EIA-compatible Ethernet data communication by way of a Category 5E copper or fiber optic transmission medium, as shown in the plans.

Ensure that the device server is resistant to all electromagnetic interference.

Use a device server having an encryption feature that provides data security and prevents interception or “sniffing” of transmitted information by unauthorized parties. Data security shall comply with Version 2 of the Secure Shell Protocol (SSHv2), or the NIST requirements as defined in the Federal Information Processing Standard (FIPS) Publication (PUB)-197 for the Advanced Encryption Standard (AES).

Ensure that the device server has a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours.

**~~7~~*6*84-2.2.2 Serial Interface:** Ensure that the device server provides a minimum of one serial data interface and connector as specified in the plans that conforms to EIA-232/422/485 standards. Ensure that the serial interface supports 2-wire and 4-wire EIA-485 connections. Ensure that the serial ports support data rates up to 230 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that the device server provides flow control (request to send [RTS]/clear to send [CTS] and transmit on/transmit off [XON/XOFF]), as well as allow control of the data terminal ready (DTR), data carrier detect (DCD), data set ready (DSR), CTS, and RTS signals. Ensure that the device server supports RTS toggle for half-duplex emulation.

**~~7~~*6*84-2.2.3 Network Interface:** Ensure that the device server includes a minimum of one Ethernet port, which must provide a 10/100 Base TX or a 10/100 Base FX connection as specified in the plans. ~~Verify that all Category 5E, unshielded twisted pair/shielded twisted pair network cables and connectors comply with the EIA and Telecommunications Industry Association (TIA) requirements as detailed in the EIA/TIA-568-B standard.~~ Verify that all copper-based network interface ports utilize registered jack (RJ)-45 connectors. Verify that the

optical ports are Type ST, SC, LC, or FC only, as specified in the plans or by the Engineer. Mechanical transfer registered jack (MTRJ) type connectors are not allowed.

**~~7~~*6*84-2.2.4 Configuration and Management:** Provide a device server that supports local and remote configuration and management, which must include access to all user-programmable features, including but not limited to addressing, port configuration, device monitoring, diagnostic utilities, and security functions. Ensure that the device server supports configuration and management via serial login, SNMP, telnet login, and browser-based interface.

**~~7~~*6*84-2.2.5 Mechanical Specifications:** *Ensure equipment is permanently marked with manufacturer name or trademark, part number, date of manufacture~~, and~~ or 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 device server accommodate the unit's installation in a control cabinet as specified in the plans.

**~~7~~*6*84-2.2.6 Electrical Specifications:** Verify that all wiring meets applicable NEC requirements and that the device server operates using a nominal input voltage of 120 volts alternating current ($V_{AC}$). The input voltage range shall be 89 to 135 $V_{AC}$. If the device requires nominal input voltage of less than 120 $V_{AC}$, furnish the appropriate voltage converter. Verify that the maximum power consumption does not exceed 12 watts.

*Ensure that the device server has diagnostic LEDs, including link, TX, RX, and power LEDs.*~~Ensure that the device server includes diagnostic status indicators in the form of LEDs that provide link, transmit (TX), receive (RX), and power status information.~~

**~~7~~*6*84-2.2.7 Environmental Specifications:** *Ensure the device server performs all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.*~~Verify that the device server meets all specifications and is capable of performing all of its functions during and after being subjected to an ambient operating temperature range of minus 31° to 165°F, as required in the NEMA TS 2 standard, with a noncondensing relative humidity of 0% to 95%.~~

~~Install the device server in an enclosure that provides protection from moisture and airborne contaminants, blowing rain, wind, blowing dust, temperature, humidity, roadside pollutants, vandalism, pests, and theft of equipment.~~

~~Verify that the device server meets the vibration and shock resistance specifications as provided in Section 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.~~

**~~7~~*6*84-2.3 Installation Requirements:** ~~Install all equipment and software according to the manufacturer's recommendations or as directed by the Engineer~~. Mount the device server securely in a location in the equipment cabinet that allows the unit to be fully accessible by field technicians. *Ensure that all unshielded twisted pair/shielded twisted pair Ethernet network cables are compliant with the EIA/TIA-568-B standard*

~~Due to the nature of the equipment, complexity of the electronics, and harsh environmental conditions at installation locations, use device servers that can be replaced immediately when defective or damaged units must be removed and replaced.~~

**~~7~~*6*84-2.4 Testing:**

~~7~~6**84-2.4.1 General:** Subject the Device Server to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.

~~7~~6**84-2.4.2 Field Testing:** Perform local field operational tests at device server field sites according to the test procedures stated herein.

1. Verify that physical construction has been completed as specified in the plans.
2. Verify the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify the network connection to the device server through ping and telnet session from a remote PC.
7. Verify serial data transmission through the device server.

**~~7~~6 84-3 Digital Video Encoder and Decoder.**

~~7~~6**84-3.1 Description:** Furnish and install digital video encoder (DVE) and digital video decoder (DVD) hardware and software to create a video-over-IP network system, as shown in the plans~~, and as directed by the Engineer~~. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the APL.

~~7~~6**84-3.2 Materials:**

~~7~~6**84-3.2.1 General:** Use DVEs and DVDs that are specialized network-based hardware devices and software which allow video and data signals to be transmitted across IP networks. Ensure that the video and data packets produced by the DVE and placed onto the network allow reconstruction of digital video signals by hardware-based and software-based DVDs that are also attached to the network.

Ensure that the complete video and data transmission system, defined as the combination of DVE and DVD hardware together with the existing or planned network infrastructure, simultaneously transports video and data from multiple remote field locations to multiple monitoring locations for roadway surveillance and traffic management.

~~7~~6**84-3.2.2 Software:** Provide a software decoding and control package that allows the viewing of any video source connected to the network through a DVE, and which allows the pan-tilt-zoom (PTZ) control of any PTZ camera on the network, the discovery of DVE and DVD devices on the network, and the control and adjustment of programmable parameters in the DVE and DVD equipment, including the network addresses of these devices, at no additional cost.

Provide all setup, control programs, and diagnostic software related to the DVE or DVD. Provide all equipment licenses, where required for any software or hardware in the system.

~~7~~6**84-3.2.3 MPEG-2 Format:** Furnish DVE and DVD components that utilize the Moving Picture Experts Group's MPEG-2 video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 13818 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation. Ensure DVEs support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF)

RFC 2974. Ensure that the DVE provides 99.999% error-free operation. Ensure MPEG-2 DVE and DVD equipment supports programmable bit rates. Ensure that MPEG-2 equipment supports fixed bit rate mode.

**~~7~~*6*84-3.2.4 H.264 Format:** Furnish DVE and DVD components that utilize video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard. Ensure that the DVE and DVD are capable of unicast and multicast operation. Ensure that DVEs support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, and Real Time Streaming Protocol (RTSP). Ensure that the DVE provides 99.999% error-free operation. Ensure H.264 DVE and DVD equipment supports programmable bit rates. Ensure that H.264 equipment supports fixed bit rate mode.

**~~7~~*6*84-3.2.5 Digital Video Encoder:** Provide a DVE that is a hardware-based network device able to accept a minimum of one analog National Television System Committee (NTSC) video input and digitize it for transport across IP networks. Use a DVE that provides a minimum of one serial data interface for transmission of command and control data to other devices (typically camera PTZ commands), as well as console and configuration functions. Provide compatible decoder software along with the DVE at no additional cost~~, as shown in the plans, or as directed by the Engineer~~.

**~~7~~*6*84-3.2.6 Digital Video Decoder:** Provide a DVD that is either a hardware-based network device or a software application that resides on a workstation PC.

**~~7~~*6*84-3.2.6.1 Hardware-based Decoder:** Provide a hardware-based decoder that has a minimum of one analog NTSC video output and decodes digital video and data streams present on an IP network into analog formats for interconnection with other devices. Use a DVD that has a minimum of one serial data interface for transmission of command and control data to other devices, as well as console and configuration functions. Use a DVD that includes an Ethernet interface for connection to IP networks.

**~~7~~*6*84-3.2.6.2 Software-based Decoder:** Ensure that any software-based decoder applications do not interfere with SunGuide® software operating when installed and used together on a shared hardware platform. Ensure that the software application provides PC desktop display of IP network video streams. Ensure that the software-based decoder offers an open Application Programming Interface (API) and software development kit available to the Department at no cost for integration with third party software and systems.

**~~7~~*6*84-3.2.7 Interoperability:** Provide DVE and DVD devices and software that are interoperable and interchangeable with DVE and DVD devices and software from other manufacturers. Ensure that the DVE is compatible and fully interoperable with software and hardware DVDs from the DVE manufacturer, as well as a minimum of two software and hardware DVDs from other manufacturers. Ensure that the DVD is compatible and fully interoperable with DVEs from the DVD manufacturer, as well as a minimum of two other DVEs from other manufacturers. Ensure DVE and DVD can be controlled using SunGuide® or support stream selection and switching using ONVIF commands.

**~~7~~*6*84-3.2.8 Video Specifications:** Ensure that composite video inputs and outputs utilize BNC connectors. Ensure video inputs and outputs support 1 volt peak-to-peak (Vp-p) NTSC composite video. Ensure that the DVE and DVD operate with both color and monochrome video, and that DVEs allow the user to select and adjust video resolution. Ensure that the DVE and DVD support resolutions that include, but are not limited to, those defined in

Table 3.1. Ensure that the DVE and DVD are capable of delivering color and monochrome video at 30 fps regardless of resolution.

| Table ~~3.~~1 – Resolution Requirements | |
|---|---|
| Format | Resolutions |
| MPEG-2 | 352 x 240, 352 x 480, 720 x 480 |
| H.264 | 176 x 120, 352 x 240, 720 x 480 |
| Note: The resolutions attained depend on the data transmission rate. | |

**~~7~~~~6~~84-3.2.9 Serial Interface:** Ensure that hardware-based DVEs and DVDs provide a minimum of one serial data interface that supports EIA/TIA-232 and TIA-422. Ensure that the serial ports support data rates up to 115 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that hardware-based DVEs and DVDs provide a TCP/IP interface to their serial port using a network socket connection with configurable IP address and port number. Serial interface ports may utilize RJ-45 connectors, D-sub connectors, or screw terminals.

**~~7~~~~6~~84-3.2.10 Network Interface:** Ensure that the DVE/DVD local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. Provide a DVE/DVD having a minimum of one Ethernet port, which shall be a 10/100 Base TX connection or a 100 Base FX ST, SC, LC or FC interface. Ensure that the connector complies with applicable EIA and TIA requirements. Provide copper-based network interface ports that utilize RJ-45 connectors. Ensure that fiber ports are single mode with a minimum link budget of 30 dB or the type and power detailed in the Contract Documents.

~~Ensure that all Category 5E, unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard.~~ Ensure that the network communication conforms to User Datagram Protocol (UDP), Version 4 of the Internet Protocol (IP) and Version 2 of the Internet Group Multicast Protocol (IGMP).

**~~7~~~~6~~84-3.2.11 Front Panel Status Indicators:** Provide DVEs and DVDs that have LED displays, liquid crystal displays (LCDs), or similar illuminated displays to indicate status for power, data activity, link status, and video transmission.

**~~7~~~~6~~84-3.2.12 Configuration and Management:** Provide DVEs and DVDs that support local and remote configuration and management. Configuration and management functions shall include access to all user-programmable features, including but not limited to addressing, serial port configuration, video settings, device monitoring, and security functions. Ensure that the DVE and DVD support configuration and management via serial login, telnet login, web browser, or Simple Network Management Protocol (SNMP).

***~~7~~684-3.2.13 Mechanical Specifications:*** *Ensure equipment is permanently marked with manufacturer name or trademark, part number, date of manufacture~~, and~~or 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 DVE accommodate the unit's installation in a control cabinet as specified in the plans.*

**~~7~~*6*84-3.2.1~~3~~*4* Electrical Specifications:** ~~Ensure that all wiring meets NEC requirements and standards.~~ Provide equipment that operates on a nominal voltage of 120 volts alternating current ($V_{AC}$). The equipment shall operate within a voltage range of 89 $V_{AC}$ to 135 $V_{AC}$. The operating frequency range for power shall be 60 hertz plus or minus 3 Hz. If the device requires operating voltages of less than 120 $V_{AC}$, supply the appropriate voltage converter.

**~~7~~*6*84-3.2.1~~4~~*5* Environmental Specifications:** *Ensure DVEs and DVDs installed in roadside cabinets perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.*~~Except as may be stated otherwise in the plans, provide DVEs and hardware DVDs that meet all specifications during and after being subjected to an ambient operating temperature range of minus 30° to 165°F as defined in the environmental requirements section of the NEMA TS 2 standard, with a maximum non-condensing relative humidity of 95%.~~

~~Ensure that cabinets housing system components comply with the environmental requirements detailed in the NEMA TS 2 standard. House the DVE in a field cabinet with protection from moisture and airborne contaminants, blowing rain, wind, blowing sand, blowing dust, humidity, roadside pollutants, vandalism, and theft. Ensure that the DVE is resistant to vibration and shock, and conforms to Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.~~

Ensure that a hardware DVD installed in a climate-controlled environment, such as a TMC computer room, ~~meets all specifications~~*performs all required functions* during and after being subjected to an ambient operating temperature range of 32° to 113°F.

**~~7~~*6*84-3.3 Installation Requirements:** ~~*Install all equipment and software according to the manufacturer's recommendations.*~~ Ensure that the DVE is shelf- and/or rack-mountable, and designed for use in roadside control cabinets without climate control. Ensure that the dimensions of the DVE allow installation in a control cabinet as specified in the plans. Ensure that front panel status indicators remain unobstructed and visible. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized or painted aluminum, brass, or gold-plated metal. *Ensure that all unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard.*

Because a DVD may be hardware or software-based, these mechanical specifications apply only to hardware-based DVDs. Field-hardened DVDs shall be shelf- and rack-mountable, and designed for use in roadside control cabinets without climate control. The dimensions of the DVD shall allow installation in a control cabinet as specified in the plans.

Non-hardened DVDs shall be shelf- and rack-mountable, and designed for use in a climate-controlled TMC. The rack-mounted DVD shall be designed to fit in a standard EIA 19 inch rack and shall not require shielding from other electronic devices, such as power supplies and other communication equipment. The dimensions of the DVD shall allow installation as specified in the plans.

~~Due to the nature of the equipment, complexity of the electronics, and harsh environmental conditions at installation locations, use DVEs and DVDs that can be replaced immediately when defective or damaged units must be removed and replaced.~~

**~~7~~*6*84-3.4 Testing:**

**~~7~~*6*84-3.4.1 General:** Subject the DVEs and DVDs to field acceptance tests (FATs). Develop and submit a test plan for FATs to the Engineer for consideration and approval. The Engineer reserves the right to witness all FATs. Complete the tests within five calendar days.

**~~7~~*6*84-3.4.2 Field Testing:** Perform local field operational tests at the device field site and end-to-end video streaming tests~~ as required by the Engineer~~ in order to demonstrate compliance with Department specifications. Testing will include, but not be limited to, the following:

1. Verify that physical construction has been completed as detailed in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Verify proper voltages for all power supplies and related power circuits.
4. Connect devices to the power sources.
5. Verify all connections, including correct installation of communication and power cables.
6. Verify video image is present and free from oversaturation and any other image defect in both color and monochrome mode.
7. Verify network connection to the DVE and DVD through ping and telnet session from a remote PC.
8. Verify serial data transmission through the DVE and DVD serial ports.
9. Verify support of unicast, multicast, and SAP.

***684-4 Media Converter.***

***684-4.1 Description:*** *Furnish and install a media converter as shown in the plans. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the APL.*

***684-4.2 Materials:***

***684-4.2.1 General:*** *Use a media converter that connects different transmission media for the purpose of transmitting Ethernet data. The media converter must allow transition between the transmission media shown in the plans or required to construct a functional system, such as conversion from twisted pair to optical fiber or from twisted pair to coaxial cable.*

***684-4.2.2 Network Interface:*** *Ensure that the media converter local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. Provide a media converter having a minimum of one Ethernet port, which shall be, at a minimum, -a 10/100 Base TX connection or a 100 Base FX ST, SC, LC or FC interface. Ensure that the connector complies with applicable EIA and TIA requirements. Provide copper-based network interface ports that utilize RJ-45 connectors. Ensure that fiber ports are single mode with a minimum link budget of 30 dB or the type and power detailed in the Contract Documents.*

***684-4.2.3 Mechanical Specifications:*** *Ensure equipment is permanently marked with manufacturer name or trademark, part number, date of manufacture~~, and~~or serial number.*

*Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting, conductive metal.*

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

*All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.*

***684-4.2.3 Electrical Specifications:*** *~~Twisted pair~~Ethernet to coax media converters must operate using power over Ethernet (POE). Media converters must operate on a nominal voltage of 120 volts alternating current ($V_{AC}$) if POE is unavailable. Supply an appropriate voltage converter for devices that require operating voltages of less than 120 $V_{AC}$.*

*Ensure that the media converter has diagnostic LEDs, including link, TX, RX, and power LEDs.*

***684-4.2.14 Environmental Specifications:*** *Ensure media converters perform all required functions during and after being subjected to the environmental testing procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9.*

***684-4.3 Installation Requirements:*** *~~Install all equipment and software according to the manufacturer's recommendations.~~ Ensure that status indicators remain unobstructed and visible. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized or painted aluminum, brass, or gold-plated metal. Ensure that all unshielded twisted pair/shielded twisted pair Ethernet network cables are compliant with the EIA/TIA-568-B standard.*

**~~7~~*6*84-4 Warranty.**

**~~7~~*6*84-4.1 General:** Ensure that the manufacturer will furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department or the maintaining agency within 10 calendar days of notification.

**~~7~~*6*84-4.2 MFES:** Ensure that the MFES has a manufacturer's warranty covering defects for five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

**~~7~~*6*84-4.3 Device Server:** Ensure that the device server has a manufacturer's warranty covering defects for five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608**.**

**~~7~~*6*84-4.4 Digital Video Encoder and Decoder:** Ensure that the DVE or DVD has a manufacturer's warranty covering defects for two years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

***~~7~~684-4.5 Media Converter:*** *Ensure that the media converter has a manufacturer's warranty covering defects for five years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.*

**~~7~~*6*84-5 Method of Measurement.**

~~**784-5.1 General:** The MFES, device server, DVE and DVD shall be measured for payment in accordance with the following tasks.~~

~~Provide software-based decoders at no additional cost when furnished in conjunction with DVEs, as shown in the plans or as directed by the Engineer.~~

~~A software-based DVD provided individually shall be paid under the pay item below.~~

~~**784-5.2 Furnish and Install:**~~ The Contract unit price for each MFES, device server, DVE~~, or~~ DVD, *or media converter* furnished and installed, will include furnishing, placement, and testing of all equipment and materials, and for all tools, labor, hardware, operational software packages and firmwares, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

*Provide software-based decoders at no additional cost when furnished in conjunction with DVEs.*

*A software-based DVD provided individually shall be paid under the pay item below*

~~**784-5.3 Furnish:** The Contract unit price per each MFES, device server, DVE or DVD, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.~~

~~**784-5.4 Install:** The Contract unit price per each MFES, device server, DVE or DVD, installed, will include placement and testing of all equipment and materials, and for all tools, labor, hardware, operational software packages and firmwares, supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.~~

**~~7~~*6*84-6 Basis of Payment.**

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

| | |
|---|---|
| Item No. ~~7~~*6*84-1- | ~~ITS~~ Managed Field Ethernet Switch-each. |
| Item No. ~~7~~*6*84-2- | ~~ITS~~ Device Server-each. |
| Item No. ~~7~~*6*84-3- | ~~ITS~~ Digital Video Encoder with Software Decoder-each. |
| Item No. ~~7~~*6*84-4- | ~~ITS~~ Digital Video Decoder-each. |
| *Item No. 684-5-* | *Media Converter-each.* |