BROWARD COUNTY
FLORIDA

Public Works Department - Office of Transportation - TRAFFIC ENGINEERING DIVISION
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Standards and Specifications

Communication Infrastructure

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1.0 Introduction

The Broward County Traffic Engineering Division is responsible for assisting the motoring public in arriving at their destination safely and with minimal delay. This requires the Division to maintain and expand its communications infrastructure along with its traffic signal coordination. The communications infrastructure is comprised of three types of communications media's; copper interconnect cable, fiber optic interconnect cable and cellular (wireless) along with various network elements, i.e.; routers, switches. Signal coordination is accomplished using two traffic control platforms; UTCS (Urban Traffic Control System) and ATMS.now. The UTCS, which is an older platform, uses a centralized computer for control and copper interconnect cable. The ATMS.now, which is the newest platform, also uses distributed intelligence architecture whereas a lot of the intelligence is located in the traffic Controller at the intersection. This platform uses all three communications media's.

The County roads are in a constant state of change. Projects initiated by the State, County, Cities and private companies affect the operational integrity of the infrastructure and in particular, the communications infrastructure. Within the Division, the Communication's group is responsible for maintaining and operating the communication's infrastructure. This communications infrastructure provides the pathway to provide for the coordinated control of both vehicular and pedestrian traffic. Through the use of the County's Standards and Specifications, as outlined in this document, we are ensured that the communication's infrastructure is reliable and capable of supporting the Traffic Engineering Division's objectives. Any comments to this document shall be addressed to the Communications Manager by telephone or email.

2.0 Objectives

The two main objectives of this document is to convey Broward County's requirements for maintaining, operating and expanding the communication's infrastructure and to establish guidelines that must be followed by all Engineering, Consulting and Contracting companies doing business in Broward County. These Standards and Specifications will be the basis for determining the passing or failing of a communication inspection performed on completed projects.

3.0 Communication Infrastructure Standards and Specifications

The following are the standards and specifications that **shall** be followed by any Engineering or Contracting company performing business in Broward County which affects the communication's infrastructure.   Information provided here is in addition to Federal, State, and other recognized agencies and organizations which provide standards and specifications. The standards and specifications include, but are not limited to FDOT Standard Specifications for Road and Bridge Construction, State of Florida DOT Minimum Specifications for Traffic Control Signal Devices, Rural Utilities Association, American Society of Testing and Materials, etc.

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4.0 Standards and Specifications

4.1 Conduit (Pay Item # 630-2-1x)

All conduit material shall meet FDOT's "Standard Specifications for Road and Bridge Construction" requirements of section 630 of the current minimum specifications for the Traffic Control Signal Devices.

In addition to the above, the following shall meet Broward County's requirements;

4.1.1   Conduit shall be 2" inches in diameter.
4.1.2   All underground conduit installed by open trenching methods shall be identified by a conduit identification tape with the message "WARNING, BCTED BURIED FIBER OPTIC CABLE BELOW".

4.2 Copper Interconnect Cable (Twisted Pair Cable) (Pay Item # 633-4-x)

All copper interconnect cable material shall meet FDOT's "Standard Specifications for Road and Bridge Construction" requirements of section 633 of the current minimum specifications for the Traffic Control Signal Devices. This covers REA (Rural Electrification Administration) PE-39 filled cable.

In addition to the above, the following shall meet Broward County's requirements;

4.2.1   Shielding: The cable shall employ a solid copper shield
4.2.2   Cable shall be free of any physical damage (i.e.: kinks, twists, cuts)
4.2.3   Cable direction designation using color marking tape shall be provided within two feet of any termination point and shall be labeled at below:
        4.2.3.1 Northbound: GREEN
        4.2.3.2 Southbound: RED
        4.2.3.3 Eastbound: YELLOW
        4.2.3.4 Westbound: BLUE
        4.2.3.5 Local: WHITE
4.2.4   75 Pair cables come with three wraps, Blue, Orange and Green.
4.2.5   Install a quantity of cable coiled up in the fiber optic pull box (635-1-15) adjacent to a controller cabinet or junction box as per below: Note: the cable specified below is allocated for emergency use only and not to be used for construction or modifications.
        4.2.5.1 40 feet of 12 pair cable
        4.2.5.2 40 feet of 25 pair cable
        4.2.5.3 10 feet of 50 & 75 pair cable
4.2.6   For fiber optic pull boxes (635-1-15) not adjacent to a controller cabinet or junction box, install a quantity of cable coiled up in the fiber optic pull box as per below:
        4.2.6.1 20 feet of 12 pair cable

4.2.6.2 20 feet of 25 pair cable

4.2.6.3 10 feet of 50 & 75 pair cable

4.2.7   All interconnect cable shall be installed in dedicated conduit and pull boxes

4.2.8   Identification and Length Marking of cable with the following: (Embossed when possible)

4.2.8.1 Manufacturer's cable code

4.2.8.2 Number of pairs and AWG

4.2.8.3 Sequential length marking every two feet

4.2.8.4 Shield type

4.2.9   If cable termination is greater than 3,000 feet, a junction box is required.

4.2.10 When terminating the cable, the following shall be complied to;

4.2.11.1 Strip the insulation back from the copper wire ½ inch.

4.2.11.2 Install the copper wire between the washers.

4.2.11.3 Wrap the copper wire around the nut down lug 360 degrees (wire shall not cross itself between the washers).

4.2.11.4 Each pair of matched wire shall have a minimum of 10 twists after leaving the cable sheath.

4.2.11.5 A ground boot shall be attached to the shield of the cable and use #6 copper, insulated, stranded wire and attach to ground rod in first fiber optic pull box next to the cabinet.

4.2.11.6 All copper pairs are to be properly cleaned to remove residue.

4.2.11 Cable shall be installed free of kinks, cuts or other damages.

4.2.12 Cables larger than 12 pair shall be terminated in a ground mount junction box.

4.2.13 If only arterial cables (2), both may be terminated to a single nut-down block.

4.2.14 If cables are running away from the arterial, each direction will require a separate nut-down block.

4.2.15 Local cables (extending from the junction box to control a single controller cabinet) do not require a separate block. Terminate only required pairs.

4.2.16 Only 2 cables shall be terminated in a controller cabinet. Any location with more than 2 cables (excluding local cable) requires installation of a junction box.

4.2.1.7 Copper interconnect cable installed that will be used to provide a path/connection between two network layer 2 or 3 Ethernet switches or routers must have a TDR test performed with the results submitted for review.

4.3 Fiber Optic Cable System (Pay Item # 633-1-xxx)

The fiber optic interconnect cable system shall meet FDOT's "Standard Specifications for Road and Bridge Construction" requirements of section 633.

In addition to the above, the following shall meet Broward County's requirements;

4.3.1 Fiber optic trunk cable shall be armored.

4.3.2 Fiber optic local cable shall not be armored. If the distance from the fiber optic trunk cable is greater than 20 feet, a Locate wire must be install within the same

conduit with the fiber cable.

4.3.3 Mark the jacket with the cable manufacturer's name, fiber type, fiber count, date of manufacture, the words "BCTED FIBER OPTIC CABLE" unless otherwise shown in the Plans, and the sequential cable lengths marked in feet.

4.3.4 Splicing of fibers shall be performed using a "Fiber Optic Fusion Splicer". Mechanical splicing is not allowed due to the added insertion loss and added back reflection.

4.4 <u>Ground Mount Junction Box (Pay Item # 635-3-xx)</u>

The ground mount junction box shall meet FDOT's "Standard Specifications for Road and Bridge Construction" requirements of section 635.

In addition to the above, the following shall meet Broward County's requirements;

All ground level communications cable terminations and connecting terminal blocks shall be contained in a weather-proof aluminum enclosure that shall meet the applicable requirements for a Type IV cabinet as specified in the FDOT Standard Specifications for Road and Bridge Construction as it relates to the physical requirements of the cabinet, door and lock operations, and weatherproofing, with the following exception. The door must be solid, with no ventilation louvers or police door/panel allowed. The lock and key (#2) shall be the same type as supplied with Controller cabinets.

The junction box shall have a 10' grounding rod and connecting wire (exothermically welded), to the junction box. The fiber optic pull box next to the junction box shall have a 10' grounding rod and connecting wire (exothermically welded) to the communications cable shield within the junction box. Ground rods shall attain a resistance to ground measurement of 25 ohms or less as specified in the National Electric Code Handbook, section 250.56.

A "Tech Pad" shall be installed in the front of the junction box. The dimensions are 36 inches by 36 inches and a minimum of 4 inches deep. 45 degree chamfers shall be used on all exposed corners.

Cable shall be installed using a minimal amount of tie wraps to allow for easy break-away of the cable to minimize damage to the cable when the junction box is hit by a vehicle.

All conduit entrances shall be secured with duct seal after cable installation to exclude moisture. A caulking compound shall be placed between the cabinet and concrete slab foundation to prevent dust, dirt and water from entering the cabinet. Master junction boxes shall be furnished with nut down, surge protected terminal blocks, the protection module to be supplied for each conductor pair, in the cable, for the above terminal block

assembly shall be Reliable Electric VSR2 gas tube protector unless specified differently by the Communication's Manager.

The location of the junction box shall be specifically reviewed by the Contractor and the Communication's Manager to ensure that it will be mounted in an area which will reduce its susceptibility to knock-down damage. Junction box door shall be installed facing away from the traffic when possible after consulting with the Communication's Manager. Junction boxes shall not be spaced less than 2200 feet apart or more than 3000 feet unless otherwise approved by the Communication's Manager.

4.5 Fiber Optic Pull and Splice Boxes (Pay Item # 635-2-xx)

The fiber optic pull box shall meet FDOT's "Standard Specifications for Road and Bridge Construction" requirements of section 635.

In addition to the above, the following shall meet Broward County's requirements;

Fiber optic pull boxes shall be utilized for all communications installations and shall be spaced at a distance of 1000 feet +/- 50 feet or at a distance agreed by the Communication's Manager.   Fiber optic pull boxes shall be a minimum of 10' from curb radius and driveway entrances, right-of-way permitting. Fiber optic pull boxes shall be "Heavy Duty", non-metallic, of polymer material, with an open bottom and rated for a static design load of at least 22,500 lbs. over a 10" square area. The cover (lid) shall be heavy duty with a minimum ANSI TIER 22 rating, of polymer material and shall be flush seated. Fiber optic pull box dimension are 24"x 36"x 36" Deep. One fiber optic pull box shall be installed at or within 10 feet of the traffic controller cabinet. This fiber optic pull box shall have a 10' grounding rod and connecting wire (exothermically welded), to the communications cable shield within the cabinet. Ground rods shall attain a resistance to ground measurement of 25 ohms or less as specified in the National Electric Code Handbook, section 250.56. Install a 12" wide x 6" deep concrete apron, outwardly sloped, around the pull box in grassy areas as per Index No. 17500 and 17501 or areas not paved or in sidewalks. Fiber optic pull boxes shall not contain electrical conductors other than the specified wire. Fiber optic pull box covers shall be stamped "**TRAFFIC FIBER OPTICS**".   Refer to the "BCTED Fiber Optic Pull Box" drawings.

Fiber optic splice boxes shall be utilized at all splice locations and will have the same specifications as pull boxes except with a 2 part cover (lid) with 2 bolts and the dimensions shall be 30" x 48" x 36" Deep or larger if required as approved by the communications manager.

4.5.1 Existing Conduit/Cable Installation

When a fiber optic pull box is installed in an area where the communications cable is shallow, two methods of installation can be used. Please note that we do not allow a pull box to be sliced open at each end to slip over the conduit/cable beyond 9 inches as this

will severely affect the 22,500 lbs. design load of the pull box and may cause it to collapse in.

Method One – Pull the communications cable out of the conduit and cut the conduit back at both ends so that the pull box can slip in. Drill a 2 ½ inch hole at each end of the pull box so that a piece of 2 inch conduit, 4 inches long can be installed. Cement the two, 4 inch pieces of conduit to the existing conduit outside the box using a coupler. Pull the communications cable back through the pull box being careful not to kink the cable. See Figure 1 below.

**Fiber Optic Pull Box Installation
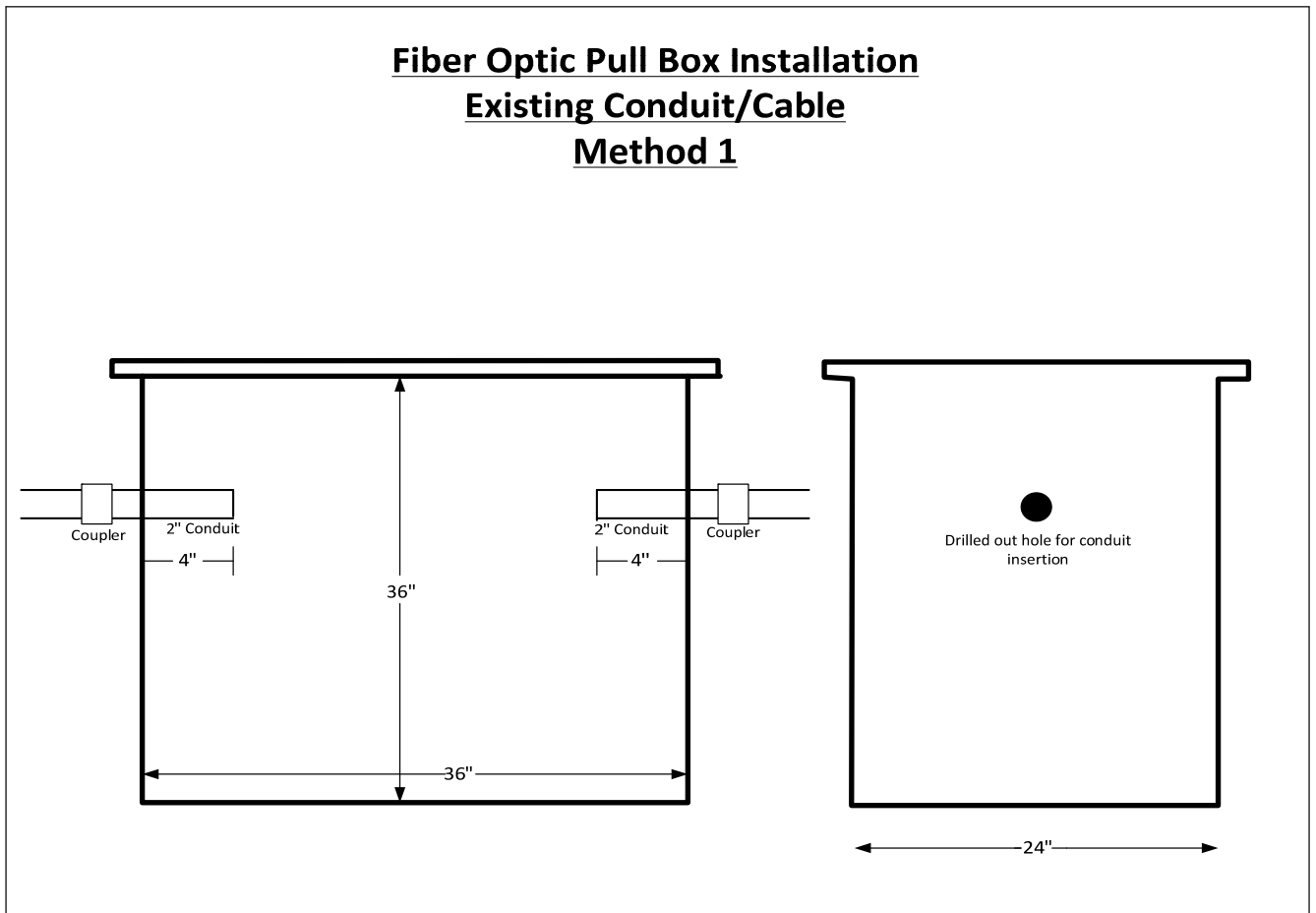Existing Conduit/Cable
Method 1**

Figure 1

Method Two – Two fiber optic pull boxes are stack on top of each other. The depth of each pull box is 18 inches. The lower pull box is placed under the existing conduit/cable. The top pull box will have 2 ½ inch wide openings cut out at each end. Any wider opening will severely affect the design load of the pull box thus presenting the possible of the pull box collapsing in. The height of the openings is dependent on the depth of the

conduit/cable but is limited to a maximum height of 9 inches. The top pull box is placed over the conduit/cable and set securely over the bottom pull box. Refer to Figure 2.
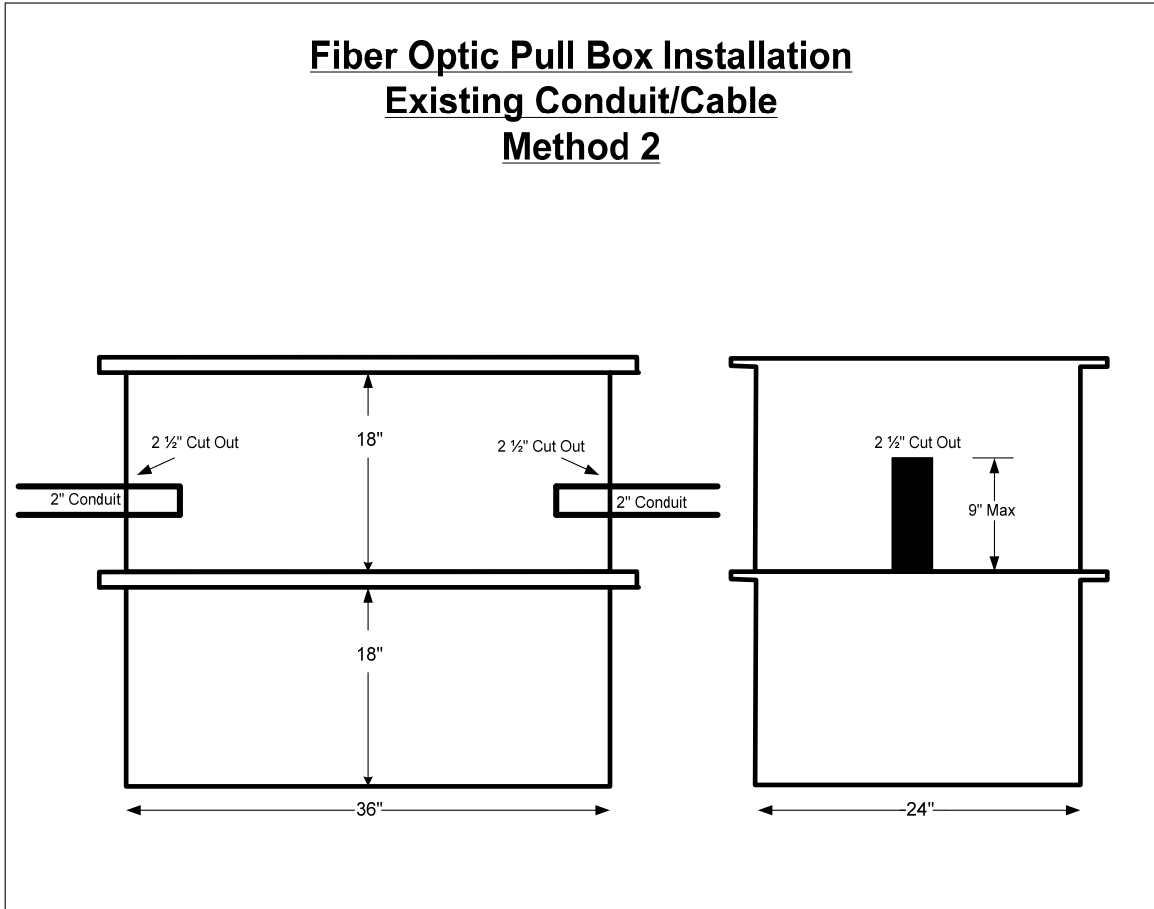
Fiber Optic Pull Box Installation
Existing Conduit/Cable
Method 2

Figure 2

4.6 Layer 2 Hardened Ethernet Switch

Field Switch Requirements
The Field Switch shall:
- Contain six (8) port (minimum) 10/100BaseTX RJ45 ports.
- Support for two (2) 1000-LX, EX, ZX, DWDM SFP optical fiber ports (The type and quantity of fiber optic ports will be dependent on installation conditions, and will be determined by Communications Manager).
- Support for 1000-LX Single Mode SFP optics operating at 1310nm up to 10Km.
- Support for 1000-EX Single Mode SFP optics operating at 1310nm up to 40Km.
- Support for 1000-ZX Single Mode SFP optics operating at 1550nm up to 70Km.
- Support for 1000-CWDM Single Mode SFP optics operating at 1550 up to 80Km.
- Operate non-blocking, at full wire speed.
- Support remote reset and remote management.
- Support IGMP snooping.
- Support IP Multicast filtering.
- Support remote turn on/off of all Ethernet ports.
- Full support and compatibility with the county owned Network monitoring software.
- Fully compatible with the County's current installed fiber optic switches.
- Field upgradable with Software to Layer 3 with full routing capabilities.
- Support for Digital Optical Monitoring

The Field Switch shall also meet the following functionality and requirements.

- 10/100BaseTX Ports: Each 10/100BaseTX port shall connect via RJ45 connector. The ports shall operate as half-duplex or full-duplex (IEEE 802.3x) over 100m segment lengths and provide auto-negotiation and MDI/MDIX capability.

Optical Fiber Ports:
- Each optical fiber port shall connect via fiber connectors and 9/125um single-mode fiber. Fiber connectors shall be type LC. The ports shall operate as full duplex (IEEE 802.3x).

- For 1Gb LX optical ports over a maximum of 10Km distance the typical link loss budget (OPB = Tx(min) – Rx(min) – LED aging) shall be $\geq$6dB.

- For 1Gb FX optical ports over a maximum of 40Km distance the typical link loss budget (OPB = Tx(min) – Rx(min) – LED aging) shall be $\geq$18dB.

- For 1Gb ZX optical ports over a maximum of 70Km distance the typical link loss budget (OPB = Tx(min) – Rx(min) – LED aging) shall be $\geq$21dB.

- For 1Gb CWDM optical ports over a maximum of 80Km distance the typical link loss budget (OPB = Tx(min) – Rx(min) – LED aging) shall be $\geq$23dB.

Layer 2 Functions
The Field Switch shall provide the following advanced Layer 2 functions:
- IEEE 802.1Q VLAN with support for a minimum of 128 VLANs.
- IEEE 802.1P priority queuing.

❑ IEEE 802.1D Spanning Tree.
❑ IEEE 802.1W rapid spanning tree (required).
❑ IEEE 802.3X flow control ≥ 1028.
❑ Support automatic address learning of a minimum of 4096 MAC addresses and ≥ 1028 static Mac address.
❑ IEEE 802.1AB Link Layer Discovery Protocol.
❑ Digital Optical Monitoring for all Fiber ports.

Port Security

The Field Switch shall provide the following Port Security function:
❑ Ability to configure static MAC addresses.
❑ Ability to disable automatic address learning per ports; known hereafter as secure port. Secure Ports only forward statically configured Mac addresses.
❑ Trap and alarm upon any unauthorized Mac address and shutdown for programmable duration. Port shutdown requires administrator to manually reset the port before communications are allowed.
❑ All the above activities are done remotely.

Network Management Functions

The Field Switch shall provide the following network management functions:
❑ SNMPv3 (RFC 2273)
❑ RMON (RFC 1757)
❑ Port Mirroring (RFC 1757)

Remote Management and Configuration

The Field Switch shall support:
❑ Telnet
❑ TFTP or FTP
❑ CLI
❑ SNMP V3
❑ SSH

The Field Switch shall have an integrated Web Interface.

Reset/Reboot and firmware upload shall be supported via all methods listed above.

All parameters and settings (network management, security, Layer 2 features, etc) shall be user configurable through the maintenance port, web interface, Telnet, SSH and all other supported remote management tools.

Mounting Options

The Field Switch shall allow for stand-alone shelf mounting unit and optional DIN Rail mounting.

Electrical

The Field Switch shall support the following:
❑ Power: nominal 120Vac, 60 Hz. The unit shall be provided with all power conversion and regulation necessary to support electronics operation. The power input circuitry shall be designed to protect the electronics from damage by a power surge or under-voltage condition. External power adapters are not acceptable.

Power Consumption: shall not exceed 50W.

The Field Switch shall include a power status indicator.

Physical Characteristics
The Field Switch shall not exceed 6" x 10" x 6" (D).
The weight shall not exceed 5lbs.

Environmental
The Field Switch shall conform to functional and performance specifications as defined below:

Cooling shall be by convection with case acting as heat sink. No cooling fan shall be used.

Must comply with FDOT's Intelligent Transportation Systems Network Devices for Managed Field Ethernet Switch, section 784-1.2.8 Environmental Specifications.

Status Indicators
The Field Switch shall have the following minimum indicators:
❑ Power: On, Off
❑ Network Status per port: Transmit, Receive, Link, Speed

Status indicators shall be LED.

External Markings
All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number, and manufacturer's name.

Mean Time Between Failures
The Field Switch shall have a minimum MTBF of 40,000 hours.

MAC Address
Each unit shall be delivered with a unique MAC address.

Network Management Software
Network Management software shall be provided and shall support the following:
❑ Stand-alone operation
❑ Client will operate on Windows XP, Windows 7 or higher platform
❑ Server will operate on a Windows Server 2008 or higher.
❑ SNMPv3
❑ RMON
❑ Auto-Discovery of network devices
❑ Fault Management: Ability to see link state changes
  − Failed Link
  − Pre-Set threshold exceeded for utilization
  − Errors
❑ Configuration Management
❑ Security Management

The Network Management software shall manage all Field Switches in the ATMS.

All custom MIBs required for networking management shall be provided for use with third party network management software.

<u>Industry Specifications and Standards</u>
The following industry specifications depicted in the following tables shall apply to the Field Switch.

Institute of Electrical and Electronic Engineers

Specification/Standard Number	Title/Subject and/or Applicability
IEEE 802.1Q	Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks
IEEE 802.1P	Traffic Class Expediting and Dynamic Multicast Filtering – Draft 8
IEEE 802.3X	IEEE Standards for Local and Metropolitan Area Networks: Specifications for 802.3 Full Duplex Operation
IEEE 802.1W	IEEE Standards for Local and Metropolitan Area Networks – Common Specifications – Part 3: Media Access Control (MAC) Bridges – Amendment 2 Rapid Reconfiguration

Federal Communications Commission

Specification/Standard Number	Title/Subject and/or Applicability
FCC Rules and Regulations, Vol. II, Part 15 for Class A Equipment	Electromagnetic Compatibility and Susceptibility (Product electromagnetic compatibility is required)

National Electrical Manufacturers Association

Specification/Standard Number	Title/Subject and/or Applicability
TS-1, Section 2	Traffic Control System. The following clauses apply: 2.1.2: Voltage 2.1.3: Frequency Range 2.1.4.1: Power Interruption 2.1.5: Temperature and Humidity, as modified herein 2.1.6: Transients, Power Service 2.1.7: Transients, Input-output Terminals 2.1.8: Non-destruct Transient Immunity 2.1.12: Vibration 2.1.13: Shock

Underwriters Laboratory

Specification/Standard Number	Title/Subject and/or Applicability
UL 60950	Safety Requirements for IT Equipment (Applicable to equipment safety)

International Electrotechnical Commission

Specification/Standard Number	Title/Subject and/or Applicability
IEC 61850-3	Communications Networks and Systems in Substations (Applicable to EMI immunity, Section 5.7 applies)

Military Handbook

Specification/Standard Number	Title/Subject and/or Applicability
MIL-HDBK-217F-2	Military Handbook for "Reliability Prediction of Electronic Equipment", Notice 2

4.7 Layer 3 Switch/Router

Router/Switch Requirements
The Routing Switch shall:
❑ Support full redundancy features in its hardware-switching platform.

❑ Provide hardware redundancy in the Switch Fabric modules, and power supplies (dual).
❑ Have a passive backplane.
❑ Have a chassis with a minimum of ten (7) slots suitable for mounting in a 19-inch rack.
❑ Have a minimum of two (2) Gigabit-Ethernet GBIC interface modules.
❑ Have a minimum of six (6) SMFO GBIC interfaces.
❑ Have a minimum of one (1) MMFO GBIC interface.
❑ Have a minimum of one (1) Ethernet copper interface module with a minimum of thirty-two (48) 10/100/1000 BaseT ports.
❑ Have a minimum of two (2) Switch-Fabric modules.
❑ Have an ASIC-based wire speed routing architecture.
❑ Be non-blocking and switch traffic at wire-speed operation.
❑ Be NEBS Level 3 conformant (Bellcore special report, SR-3580) with the following exception: power supplies shall be powered from 120/240VAC, 60Hz source; NEBS air filtration is not required.
❑ Broward County desires a highly reliable system with maximum up time. The goal is "Five Nines" reliability. Vendors may provide a demonstration of "Five Nines" reliability, which if accepted by the County, can be used to satisfy the NEBS Level 3 requirement.

CPU/Switch Fabric Architecture

The CPU/Switch Fabric Architecture shall perform system configuration for High-Availability mode (Redundancy). This architecture shall support the following:
❑ Minimum forwarding rate of 48Mpps.
❑ Packet switching rate greater or equal to 48,000,000 64-byte packets per second.
❑ Minimum Switching Fabric rate of 32Gbps.
❑ Fully redundant Switch Fabric modules.
❑ Minimum of eight (5) I/O slots in High-Availability mode.
❑ Allow the total number of ports to operate without over subscription.

Gigabit-Ethernet SFP Interface Module

Each module shall have a minimum of eight (12) SFP 1000Base ports.

SFP

The SFP shall:
❑ Allow for hot swapping failed component.
❑ Operate as its own switched port.
❑ Operate over SMFO and MMFO media.
❑ Support detecting and shutting down one-way link failures, using the FEFI or Auto-Negotiation method.
❑ Support signaling up to a distance of:
  − 275m for MMFO
  − 70km for SMFO
❑ Utilize fiber connectors (Fiber connectors shall be available as SC, LC.).

Ethernet Copper Interface Module

Each Ethernet Copper Interface Module shall have a minimum of thirty-two (48) Fast-Ethernet copper interfaces.

Each Ethernet Copper Interface shall:
❑ Operate as its own switched port.
❑ Operate at 10/100/1000Mbps at 10/100/1000Base-T.

❑ Auto-Negotiate up to Full-Duplex operation.
❑ Support Cat5 cabling media up to 100m.
❑ Utilize RJ-45 Connector.

Software Requirements

The Routing Switch shall support and provide the following minimum software features:
❑ Wire-speed Packet Filtering capabilities for Layers 2 through 4
❑ Flow-control (IEEE 802.1x)
❑ STP (IEEE 802.1s)
❑ Link aggregation (IEEE 802.3ad)
❑ VLAN (IEEE 802.1Q)
❑ Broadcast and Multicast rate limiting
❑ Standards-based Multicast routing protocols
  − DVMRP
  − PIM-SM
  − PIM-DM
  − IGMP (Version 1 & 2)
  − IGMP Multicast Router Discovery
  − Minimum of 512 Multicast Groups
  − Providing management of video streaming
❑ VRRP (IETF RFC2338)
❑ OSPF Protocol
❑ OSPF MD5 Cryptographic Authentication
❑ OSPF NSSA
❑ IP routing based on Port-based and MAC-based VLANs
❑ UDP Broadcast Forwarding
❑ Supernet Address Configuration
❑ RARP
❑ IP Prefix Flow Filters
❑ Router Interface
❑ Flushing Routing Tables
❑ ECMP
❑ Port-mirroring
❑ High-Availability mode operation. (The Routing Switch shall be able to recover from a failed Switch Fabric module within 1-minute boot-up operation, and within 2-minute route-table recovery).

QoS

The Routing Switch shall support QoS methods and de-queuing techniques as follows:
❑ IEEE 802.1p
❑ Diff-Serv
❑ IEEE 802.1p to Diff-Serv re-marking
❑ Prioritize the traffic through the switching architecture, so as to allow traffic to be managed across a minimum of eight (8) service queues (Hardware).
❑ Strict and Weighted-Round-Robin or Weighted Fair de-queuing
❑ Layer 2 through Layer 4 filtering

Management

The Routing Switch shall support the following Management features:
❑ NTP (RFC 1305) and SNTP

❑ CLI, Telnet, Web-base, and SNMP management
❑ FLASH configuration and operating storage
❑ Storing multiple configuration files and operating software images on running FLASH storage areas
❑ TFTP or FTP
❑ Minimum of four levels of RMON (Alarm, Events, Statistics, and History)
❑ Feature to "turn on or off" additional software/hardware feature sets without rebooting (i.e., enabling OSPF, disabling DVMRP, etc.)
❑ ACLs or filtering for network control and security at wire-speed

Security

The Routing Switch shall support the following security features:
❑ RADIUS
❑ Secure Shell version 2 (SSH2)

Voice Over IP

The Routing Switch shall support VoIP.

Environmental

The Routing Switch shall conform to performance specification as stated herein when operated in the following environment:
❑ Temperature: 0ºC to +40ºC
❑ Humidity: 5 to 95 percent relative humidity, non-condensing

Physical

The Routing Switch shall not exceed a height of 23 RMU.
The weight shall not exceed 400lbs.

Mounting Options

The Routing Switch shall be mountable in a 19" Rack Assembly.

Redundant Power Supply

The Redundant Power Supply shall:
❑ Operate from 120/240 VAC 60HZ input power
❑ Be hot swappable
❑ Support load sharing

Mean Time Between Failures

The Routing Switch shall have a minimum MTBF of 25,000 hours. The MTBF shall be calculated in accordance with the methods described in Mil-Std HDBK 217F for a temperature of 55ºC for ground benign.

Labeling and Markings

All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number, and manufacturer's name.

Network Management Software

Network Management software shall be provided and shall support the following:

- ❑ Stand-alone operation
- ❑ Operate on Windows XP/Windows 7 or higher platform
- ❑ GIS Map
- ❑ SNMP
- ❑ RMON
- ❑ Auto-Discovery of network devices
- ❑ Fault Management
  - − Ability to drill down to a node to identify a faulty card or power supply
  - − Ability to see the following link state changes:
    - ▪ Failed Link
    - ▪ Pre-Set threshold exceeded for utilization
    - ▪ Errors
- ❑ Performance Management
  - − Bandwidth utilization per router link and VLAN
  - − Bandwidth utilization per IP address and TCP/UDP port
- ❑ Configuration Management
- ❑ Security Management

All custom MIBs required for network management shall be provided for use with third party network management software.

Industry Specifications and Standards

The following industry specifications apply to the Routing Switch. Latest issues of these industry specifications apply unless otherwise noted.

Federal Communications Commission

Specification/Standard Number	Title/Subject and/or Applicability
FCC Rules and Regulations, Vol. II, Part 15 for Class A Equipment	Electromagnetic Compatibility and Susceptibility (Product electromagnetic compatibility is required)

Underwriters Laboratory

Specification/Standard Number	Title/Subject and/or Applicability
UL 60950	Safety Requirements for IT Equipment (Applicable to equipment safety)

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Institute of Electrical and Electronic Engineers

Specification/Standard Number	Title/Subject and/or Applicability
IEEE 802.3 CSMA/CD (ISO/IEC 8802-3)	Layer 1 conformance: Ethernet
IEEE 802.3i (ISO/IEC 8802-3)	Layer 1 conformance: 10BaseT
IEEE 802.3u (ISO/IEC 8802-3)	Layer 1 conformance: 100BaseT
IEEE 802.3z	Layer 1 conformance: Gigabit Ethernet 1000Base SX and LX
IEEE 802.3ab	Layer 1 conformance: Gigabit Ethernet 1000BaseT 4 pair Cat5 UTP
IEEE 802.1Q & 802.1p	Layer 1 conformance: VLAN tagging & Prioritization
IEEE 802.1D	Layer 1 conformance: MAC bridges/Spanning Tree Protocol
IEEE 802.1s	Multiple Spanning Trees
IEEE 802.1w	Rapid Reconfiguration of Spanning Tree
IEEE 802.3x	Layer 1 conformance: Flow Control
IEEE 802.1X	Layer 1 conformance: EAPOL

Military Handbook

Specification/Standard Number	Title/Subject and/or Applicability
MIL-HDBK-217F-2	Military Handbook for "Reliability Prediction of Electronic Equipment", Notice 2

Internet Engineering Task Force

Specification/Standard Number	Title/Subject and/or Applicability
RFC 1123	Layer 2 conformance: IGMPv1 for snooping
RFC 2236	Layer 2 conformance: IGMPv2 for snooping
RFC 1493	Layer 2 conformance: Bridge MIB
RFC 951	Layer 3 & 4 conformance: BootP
RFC 2131	Layer 3 & 4 conformance: Dynamic Host Control Protocol: DHCP
RFC 1058	Layer 3 & 4 conformance: RIP version 1
RFC 1723	Layer 3 & 4 conformance: RIP version 2
RFC 1389	Layer 3 & 4 conformance: RIP 2 Management Information Base
RFC 1213	Layer 3 & 4 conformance: TCP/IP Management Information Base
RFC 1253	Layer 3 & 4 conformance: OSPF
RFC 1583	Layer 3 & 4 conformance: OSPFv2
RFC 2178	Layer 3 & 4 conformance: OSPF v2
RFC 1850	Layer 3 & 4 conformance: OSPF Management Information Base
RFC 2178	Layer 3 & 4 conformance: OSPF MD5 cryptographic authentication
RFC 2338	Layer 3 & 4 conformance: VRRP: Virtual Redundancy Router Protocol
RFC 2362	PIM-SM
RFC 1757	RMON 4 groups
RFC 1643	Ethernet MIB
RFC 1112	IGMPv1
RFC 1587	OSPF NSSA
RFC 2787	VRRP MIB
RFC 2030	SNTPv4
RFC 2138	RADIUS authentication
RFC 2474 & 2475	Layer 3 & 4 conformance: DiffServ
RFC 2597 & 2598	DiffServ Per Hop Behavior

4.8 Copper & Fiber Managed Ethernet Layer 2 Switch

Interfaces
- ❑ Minimum of 4ea. 10/100Base-T ports with RJ45 connectors
- ❑ 1ea. 100/1000Base-FX port with SC connector
- ❑ 1ea. 10/100Base-T management port with RJ45 connector
- ❑ 1ea. EIA RS-232 (DCE) craft port, DB9 connector

High Speed Line (bonded copper pairs)
- ❑ Bandwidth: at least 45 Mbps (symmetrical)
- ❑ Copper Cable Interface: (RJ45 to open ended, 22 gauge wire)
- ❑ End-to-end Delay: less than 4 ms

LAN Protocols
- ❑ Discovery Mechanisms: LLDP
- ❑ VLAN Tagging: IEEE 802.1Q
- ❑ RSTP, STP: IEEE 802.1d
- ❑ Link Aggregation: IEEE 802.3ad
- ❑ IGMP Snooping

Management Protocols
- ❑ SNMP: SNMP v1 and v2c
- ❑ Command Line Interface: TL1
- ❑ Remote Access: Telnet
- ❑ Time Synchronization: SNTP v3
- ❑ Web Access: HTTP
- ❑ File Transfer: FTP, TFTP
- ❑ User Authentication: RADIUS and/or local passwords

Front Panel Indicators (LEDS)
- ❑ Power, Status, Alarm, MLP per modem pair, ACT (activity), LKN (Link) per Ethernet port

Physical
- ❑ Height: No greater than 2 1/2 inches
- ❑ Depth: No greater than 12 inches
- ❑ Width: No greater than 10 inches
- ❑ Weight: No greater than 7lbs
- ❑ Power: 110VAC
- ❑ AC/DC Power Supply

Environmental
- ❑ Must comply with FDOT's Intelligent Transportation Systems Network Devices for Managed Field Ethernet Switch, section 784-1.2.8 Environmental Specifications

Regulatory Approval/Certifications
- ❑ NEBS Level III (GR-1089-CORE, GR-63-CORE)

Element Management Software to include:
- ❑ Graphical User Interface (GUI)
- ❑ Graphical Bandwidth Utilization
- ❑ Real-time visual alarm display
- ❑ History log of active and cleared alarms
- ❑ Performance Monitoring
- ❑ Configuration Management
- ❑ Security Access Control
- ❑ Fault Management
- ❑ Windows Server Based

Testing & Fault Isolation
- ❑ Built in TDR
- ❑ Bit-Error-Rate
- ❑ Remote modem loopback

Hardware Warranty
The switch shall be warranted for a period of three (3) years. The warranty shall guarantee the switch to be free from defects from assembly, fabrication, and materials. The warranty shall be provided in writing. If the normal manufacturer's warranty extends for a longer period, the switch shall be warranted for that period. The warranty shall be measured from the date of receipt by the County. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract.

Switches or replaceable components found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs of all equipment under warranty. The replacement of defective switches or replaceable components shall occur with ten (10) calendar days of notification by the County. Notification by the County will be in the form of an electric mail or official letter. A failure rate with in the three year warranty period in excess of ten percent (10%) of the purchased quantities shall result in an overall replacement of all units by the manufacturer at no additional cost to the county.

Technical support shall be included in the warranty and the coverage period shall be the same as the duration of the warranty. No additional payment shall be required.

Software

Support: Vendor support shall include (1) diagnosis of problems or performance deficiencies of the Software and (2) a resolution of the problem or performance deficiencies of the Software. Vendor will provide telephone software support on a business day basis. Business day is defined as 7:00 AM through 5:00 PM Eastern Standard Time from Monday through Friday.

Maintenance: The vendor will provide patches, updates and new versions of the Software along with generally available technical material.

Warranty: Vendor will support/maintain the Software for a period of twelve (12) months. Vendor will undertake all efforts to provide technical assistance to rectify or provide solution to problems where the Software does not function as described in the Software documentation.

4.9 Cellular 3G/4G LTE Router with Embedded Modem

Cellular 3G/4G LTE Router Requirements
The Cellular 3G/4G LTE Router shall:

❑ Have an integrated 3G/4G LPE modem with Gobi functionality to function with the following cellular technologies;
   ❑ LTE Bands 2,4, 5, 13, 17, 25
   ❑ HSPA+
   ❑ CDMA EVDO Rev. A/1xRTT
❑ External 3G/4G LTE antenna with two SMA connectors
❑ Minimum of two 10/100 RJ-45 Ethernet ports
❑ Minimum of one USB port
❑ Firewall Capability
❑ Ruggedized (Hardened)
   ❑ Temperature: operate up to 140 degrees F
   ❑ Relative Humidity: (non-condensing) 10% to 85%
❑ GRE Tunneling
❑ Web-Based GUI
❑ WAN (remote) Web-Based Management Access
❑ WAN Security;
   ❑ NAT
   ❑ Port Blocking
   ❑ Service Filtering (FTP, SMTP, HTTP, RPL, SNMP, DNS, ICMP, POP3, SSH)
   ❑ Protocol Filtering
❑ Non-WiFi
❑ WAN Port Speed Control