
Enable Renters



cost: \$700.00/ pair

Enable-IT 860 Pro



- Voice
- Video
- Data



Extends Full-Duplex 100MB Ethernet up to 8,000' or 2.44km

Small footprint for simple installation

Saves costs of re-wiring and expensive LAN equipment

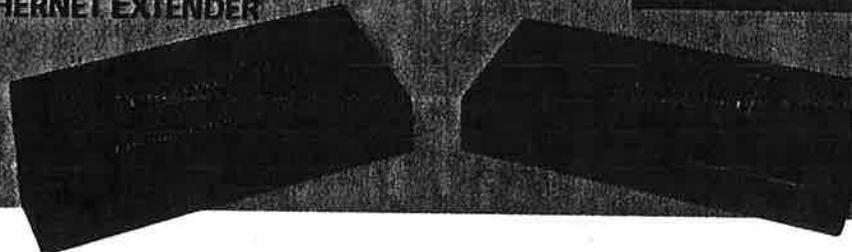
Plug and Play installation allows rapid connectivity of your extended network

Interlink cabling can be any 1-pair copper wiring

Superior performance over any competing technology

860 PRO – EXTREME DISTANCE ETHERNET EXTENDER

Next Generation Broadband



The Enable-IT 860 Pro Extreme Distance Ethernet Extension Kit is a professional grade, ruggedized industrial version of the 860 it and drives 100Mbps Ethernet up to 1.5 miles (2.44 km) away over copper wiring. This cost-effective solution eliminates many of the limitations and high costs for extending LAN cabling today.

Hands down these are the highest throughput performing and most versatile Ethernet Extenders on the planet, bar none. These units are the most reliable and easy to install on any wiring. They put the overpriced and underperforming competition to shame. **Made in the USA with quality and pride - the only manufacturer to do so in this industry.**

HIGHLIGHTS

- Extends 100MB Ethernet 24x the IEEE specs for Ethernet distance
- Extended Ethernet with single voice over 1 pair minimum over existing Telephone wiring/Category rated wiring at a fraction of the previously costly fiber options
- Can be used on all LAN devices including switches, routers, hubs, gateways and end nodes
- Rapid and Easy Installation on any copper wiring – using RJ-11
- Sustained full-duplex service delivery end to end.

FEATURES & SPECIFICATIONS

Features:

- Extends standard 100baseT Ethernet 24x beyond the 328ft or 100m limitation of twisted pair Ethernet over existing 1-pair phone wiring or better
- Supports digital VoD channels
- 100 Mbps full-duplex service
- Quad RJ-45 100MB Ethernet ports
- MPEG over IP support

Specifications:

LAN interface: Quad RJ-45 100Mbps

Dimensions:

Height: 1.5" (38mm)
Depth: 3.75" (95mm)
Width: 5.75" (146mm)

Functionality:

Up to 1,313ft(400m) - 100Mbps
1,400ft(426m) to 2,624ft(800m) - 90Mbps
Up to 6,000ft(1,828m) - 40Mbps

Max Distance 2,440m / 8,000ft
Interfaces

- 860 Units – (4) 100Mbps Ethernet
- (1) RJ-45 Interlink port
- (1) 4 position DIP switch

Environment

Operating Temp:

-45° to 76°C/-49° to 168°F

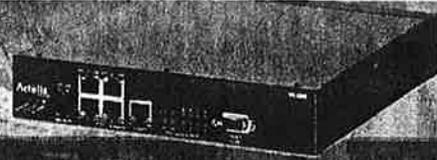
Humidity

5% to 95%, non-condensing

Power consumption: 6.3W / 21BTU max



ML688



Specifications

Interfaces

Ethernet (Network/User)

- 10/100Base-T 4 ports
Connector: RJ45, Auto-MDIX
- 100/1000Base-FX 1 port (option) SFP Based
Connector: MSA compliant

High Speed Link (Bonded Copper Pairs)

- Protocol IEEE 802.3ah 2Base-TL
- Line code ITU-T G.991.2 rev. 2
- Bandwidth Up to 100 Mbps (symmetrical)
- Number of Copper Pairs 8 (2 high speed links each of 4 copper pairs)
Connector: RJ45 (per modem/pair)
- End-to-end Delay 2-4 ms (typical)
- Spectral Compliance ITU-T G.991.2 (Annex A, B, F)
ETSI TS 101 524 (Annex E)
ANSI T1.417, T1.426
Per-country regulatory compliant spectral modes
- Sealing Current 48VDC/1.5mA nominal

Management (Out-of-Band)

- 10/100Base-T
Connector: RJ45, Auto-MDIX
- Craft
Connector: EIA RS-232 (DCE)
DB9

LAN Protocols

- Dynamic Bridging IEEE 802.1, 8K MAC addresses
- Discovery Mechanisms LLDP
- VLAN Tagging IEEE 802.1Q
- Double Tagging Q-in-Q
- RSTP, STP IEEE 802.1d
- Link Aggregation IEEE 802.3ad
- Provider Bridges IEEE 802.1ad
- OAM IEEE 802.3ah clause 57
(EFM OA&M)
IEEE 802.1ag

Management

Protocols

- SNMP SNMP v1 and v2c
- Command Line Interface TL1
- Remote Access Telnet
- Secure Access (option) SSH v2
- Time Synchronization SNTP v3
- Web Access HTTP
- File transfer FTP, TFTP
- IEEE 802.3ah EFM OAM Dying Gasp
- User Authentication RADIUS and/or local passwords

Metro Ethernet Forum – Advanced Service Provisioning and Traffic Management

Quality of Service

- Classes of Service 4
- Scheduler WFQ, SP
- Classification L2 802.1p/Q priorities, L3 ToS/Diff Serv

Applications

- EMS MetaASSIST EMS
- Craft GUI MetaASSIST View

Front Panel Indicators (LEDs)

- Power
- Status
- Alarm
- MLP per modem/pair
- ACT (Activity) • LNK (Link) per Ethernet/HSL

Alarm Contacts

- Terminal Block 2 Input, 1 Output

Physical

- Dimensions Height: 1.6" / 40mm (1U)
Depth: 11.0" / 280mm
Width: 8.4" / 213mm
- Weight 3.75 lbs / 1.7 Kg
- Mounting Rack: 2 units in 19", 23" or ETSI rack
Desktop, Wall Mount
- Power DC: -48/-60 VDC nominal,
17 Watt (per model)
AC: 90-264 VAC, 47-63 Hz,
21 Watt

Environmental

- Operating Temp. -40° to +74°C
- Storage Temp. -40° to +70°C
- Relative humidity Up to 95%, non-cond.

Regulatory Approval/Certifications

Metro Ethernet Forum

- MEF 9, 14

Safety

- UL 60950, CSA C22.2 60950
- EN 60950, IEC 60950

EMC

- FCC Part 15 Class B
- ICES-003 Class B
- ETSI EN 300 386 Class B
- ETSI ETS 300 132-2
- ITU-T K.20, K.21

NEBS

- Level III (GR-1089-CORE, GR-63-CORE)

CE

- EMC and Safety

Environmental

- GR-63-CORE
- ETSI ETS 300 019

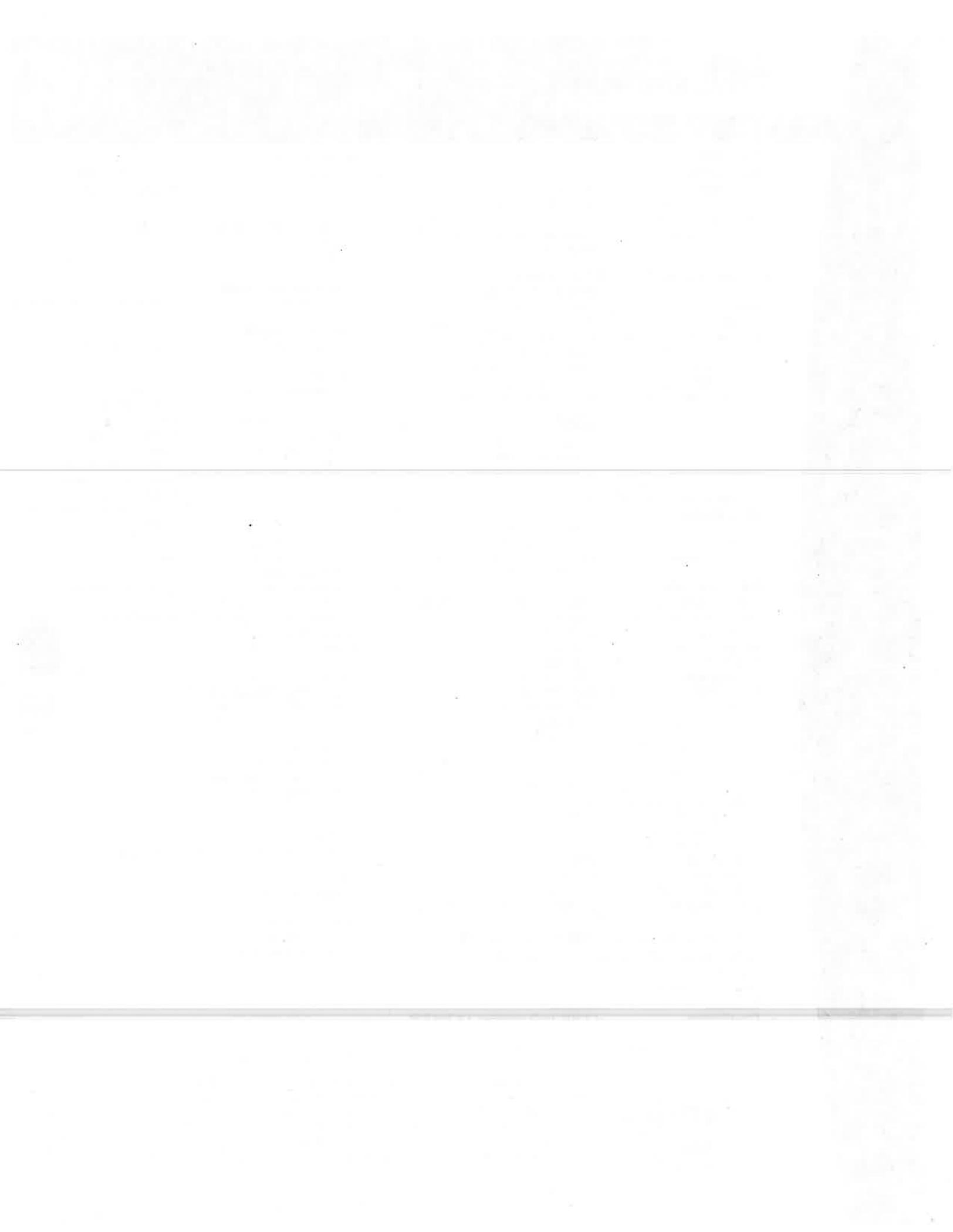


ACTML680DS_020409
Updated March 4, 2009

Corporate Headquarters
Americas Sales Office
6150 Stevenson Blvd.
Fremont, CA 94538, USA
Tel. 1.866.ACTELIS
Tel. 1.510.545.1045
Fax. 1.510.545.1075
sales@actelis.com

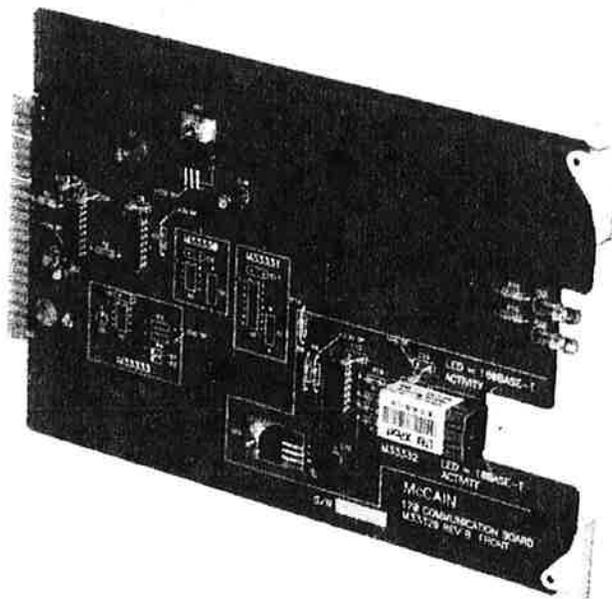
International Sales Office
25 Bazel P.O.B. 10173
Petach-Tikva 49103, Israel
Tel. +972.3. 924.3491
Fax. +972.3.924.3492
sales@actelis.com

©2009 Actelis Networks Inc. Actelis Networks is a registered trademark of Actelis Networks, Inc. MetaASSIST, EFMplus and Carrier Ethernet over Copper are trademarks of Actelis Networks, Inc. All other trademarks used herein are the property of their respective owners. Actelis Networks reserves the right to change product specifications at any time without notice.



Ethernet – to - Serial

Ethernet-to-Serial Interface Card



INSTALLATION & SETUP GUIDE

Version: 1.5

Product specifications: www.mccain-inc.com
Customer support: support@mccain-inc.com
Product Inquiries: 888-2-McCain (888-262-2246)

McCain[®]

This page was intentionally left blank

REVISIONS

Rev	By	Date	Comments
1.0		October 26, 2004	Initial release
1.1-1.4		November 2004	Corrections and edits
1.5	ARubin	May 11, 2010	Add new intro pages

DISCLAIMERS

User Responsibility

This document is subject to revision. Users of this document are responsible for verifying the current version status before using this document and or discarding all older revisions.

McCain Inc. shall not be liable for errors contained herein or for incidental or consequential damages in connection with furnishing, performance or use of this material. MCCAIN MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

This document contains proprietary and confidential information and is the sole property of McCain. No part of this document may be photo copied, reproduced, or translated to another language without the prior written consent of McCain.

This manual is copyright © 2010 by McCain Inc. All rights reserved.

McCain Inc. // 2365 Oak Ridge Way // Vista, CA 92081
PH 760-727-8100

Product Specifications: www.mccain-inc.com
Customer Support: support@mccain-inc.com
Product Inquiries: 888-2-McCain (888-262-2246)

TABLE OF CONTENTS

1	INITIAL CONFIGURATION OF THE ETHERNET-TO-SERIAL INTERFACE CARD.....	1
2	CONFIGURING USING THE LANTRONIX DEVICEINSTALLER	1
2.1	Assign the IP Address.....	1
2.2	Connect the Ethernet Card	2
2.3	Run the DeviceInstaller	2
3	QUICNET/4 SETUP.....	9
4	OPTIONAL CONFIGURATION USING INTERNET EXPLORER.....	10
5	OPTIONAL CONFIGURATION USING TELNET	14
6	INDEX.....	17

TABLE OF FIGURES

Figure 1. DeviceInstaller 3.6, Search button.....	3
Figure 2. The Assign IP button on the DeviceInstaller Main Toolbar	3
Figure 3. Assignment Method dialog box.....	4
Figure 4. IP Settings dialog box.....	4
Figure 5. Assignment dialog box.....	5
Figure 6. Assignment dialog box with progress indicator	5
Figure 7. The Configure button on the DeviceInstaller Main Toolbar	6
Figure 8. Configure Device dialog box, Ports tab	6
Figure 9. Port Properties dialogue box, Port Settings tab.....	7
Figure 10. Port Properties dialog box, Advanced tab	8
Figure 11. QuicNet/4 Controller Configuration dialog box	9
Figure 12. The Web button on the DeviceInstaller Main Toolbar	10
Figure 13. Server Properties Menu.....	11
Figure 14. Menu for Selected Channel: 1	12
Figure 15. Port Properties Remaining Settings.....	13

1 INITIAL CONFIGURATION OF THE ETHERNET-TO-SERIAL INTERFACE CARD

For a new installation, the Ethernet-to-Serial Card does not have an assigned IP address. Use the Lantronix DeviceInstaller to configure the card and install Microsoft's .NET framework 1.1. The DeviceInstaller is available from the Lantronix website at www.lantronix.com. Search for "DeviceInstaller" and select **Lantronix > Support > Downloads**. On the DeviceInstaller download page, there is also a link to download Microsoft .NET Framework. Once you have downloaded both of these programs, proceed with configuration.

1. Install the card in the modem slot in the controller.
2. Turn on the power.
3. For new installation, follow the steps in Section 2.
4. For an existing installation where the IP address of the card is known, follow the steps in Section 4 to complete the configuration using Internet Explorer.

2 CONFIGURING USING THE LANTRONIX DEVICEINSTALLER

2.1 Assign the IP Address

Verify that the computer running the Lantronix DeviceInstaller is not set to obtain an IP address automatically.

1. Click on **Start**, then **Control Panel**, then **Network and Internet Connections**, then **Network Connections** and then double-click on **Local Area Connection** to open the dialog box.
2. When the **Local Area Connection Status** dialog box opens, click on the **Properties** button.
3. When the **Local Area Connection Properties** dialog box opens, scroll down and double-click on the item labeled **Internet Protocol (TCP/IP)**.
4. When the **Internet Protocol (TCP/IP) Properties** dialog box opens, click on the **General** tab.
5. Clear the **Obtain IP address automatically** option. Then, entries can be made to the **Use the following IP address** portion of the dialog box.
6. Assign a specific IP address using the same network address that will be assigned to the card. The host address should be unique.
7. If changes were made to the computer's IP settings, the computer may have to be restarted for the changes to take effect.

2.2 Connect the Ethernet Card

Connect the Ethernet card in the controller either through a hub or with a crossover cable to the computer running QuicNet/4.

2.3 Run the DeviceInstaller

Run Lantronix DeviceInstaller on the computer that is being used with QuicNet/4.



1. Click on the **Search** toolbar button (shown in Figure 1). Device Installer will search for the attached device.

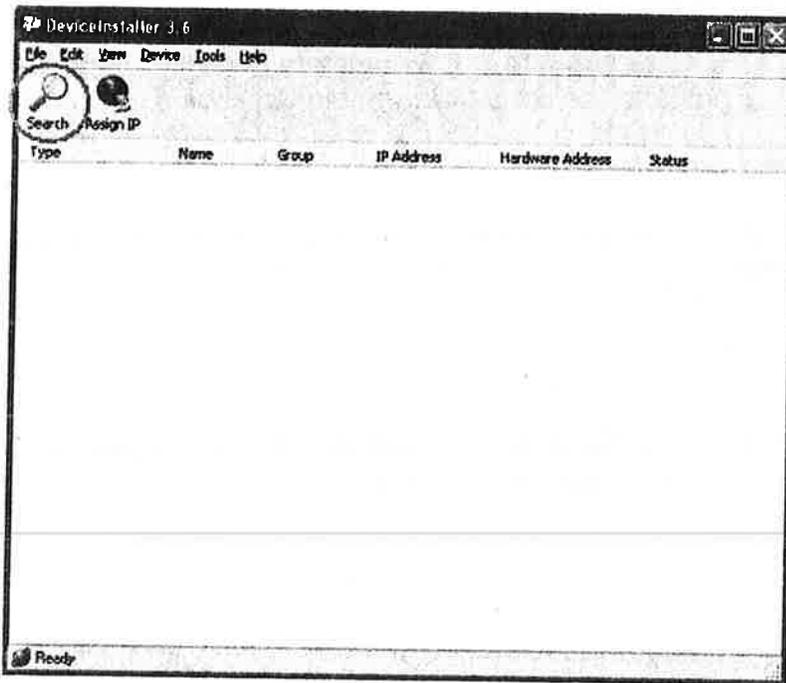


Figure 1. DeviceInstaller 3.6, Search button

2. When found, the device should be listed in the window below the toolbar.

3. Select the device and click the **Assign IP** toolbar button (shown in Figure 2).



Figure 2. The Assign IP button on the DeviceInstaller Main Toolbar

4. When the **Assignment Method** dialog box appears, select **Assign a specific IP address** and click the **Next** button (shown in Figure 3).

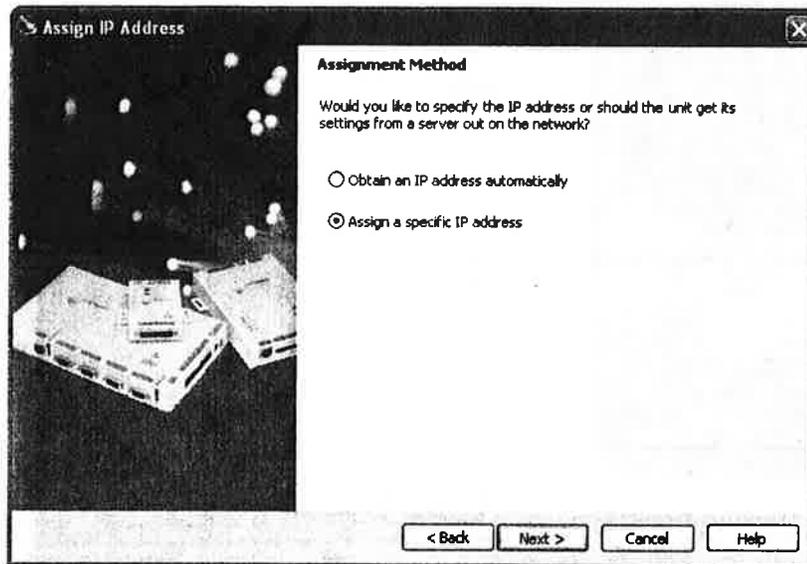


Figure 3. Assignment Method dialog box

5. In the **IP Settings** dialog box (shown in Figure 4), enter the IP address, Subnet mask, and the Default gateway, then click the **Next** button.

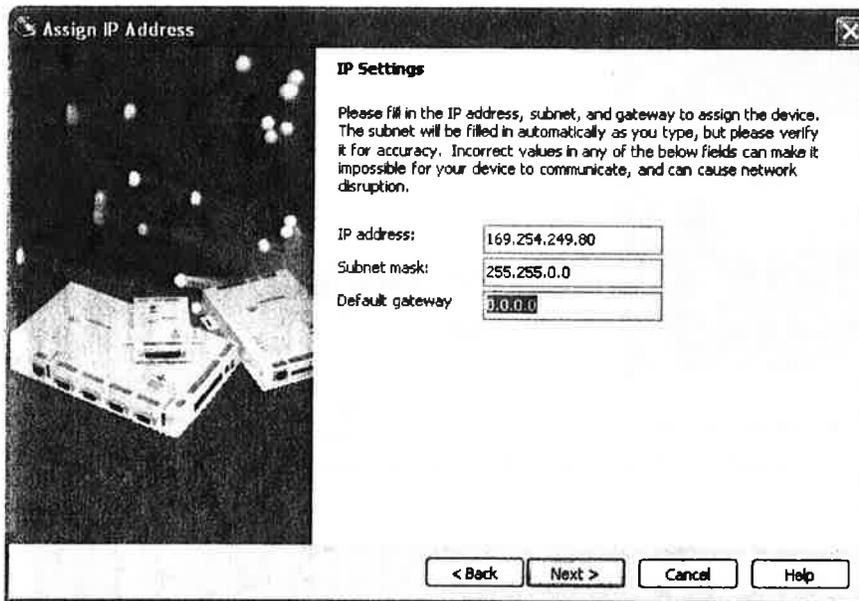


Figure 4. IP Settings dialog box

6. When the **Assignment** dialog box appears, click the **Assign** button (shown in Figure 5). A progress indicator will display the progress of the assignment. When it is complete, click the Finish button (shown in Figure 6).

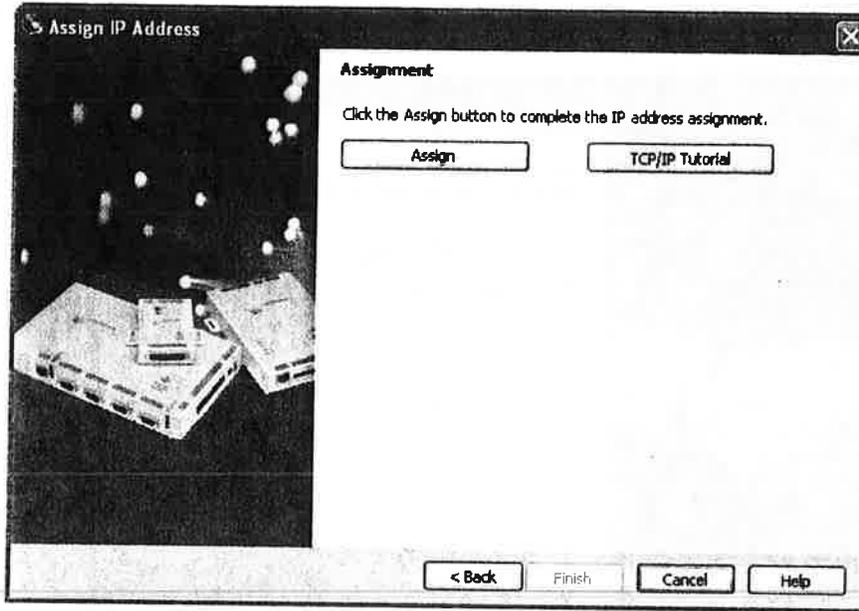


Figure 5. Assignment dialog box

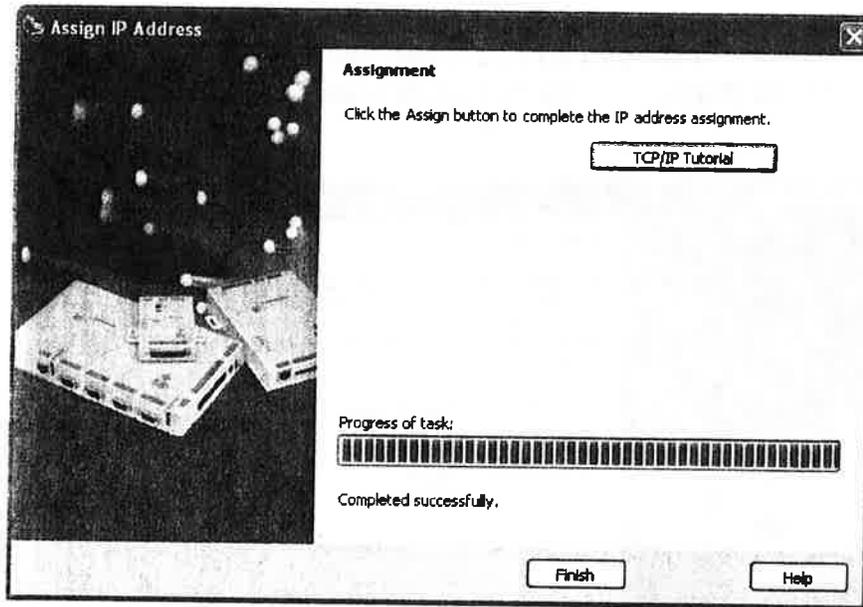


Figure 6. Assignment dialog box with progress indicator

7. Click the  button on the main toolbar of DeviceInstaller (as shown in Figure 7).

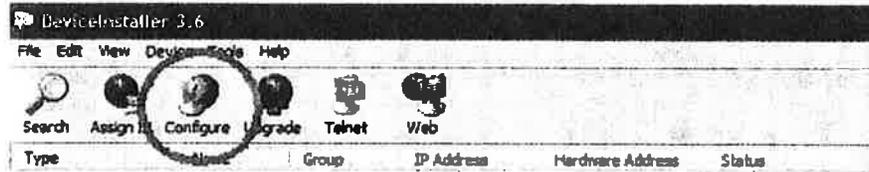


Figure 7. The Configure button on the DeviceInstaller Main Toolbar

8. When the **Configure Device** dialog box appears (see Figure 8), click on the **Ports** tab. The device should appear in the box list. Select the device and click the **Edit Settings** button.

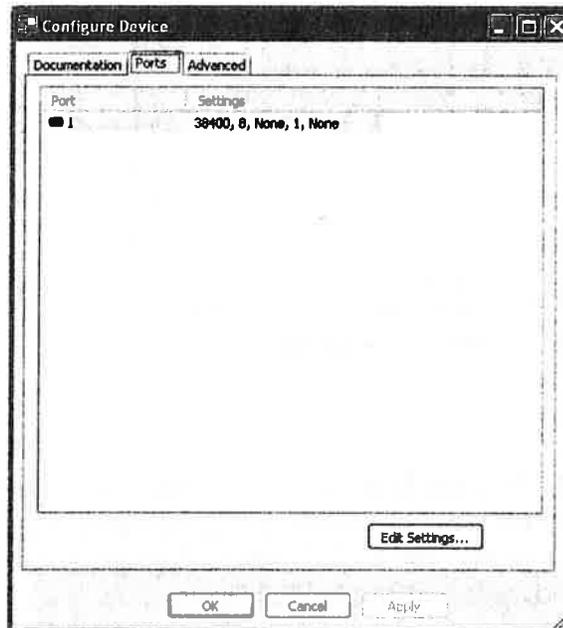


Figure 8. Configure Device dialog box, Ports tab

9. When the **Port Properties** dialogue box appears, click on the **Port Settings** tab and select the settings from the dropdown menus as shown in Figure 9.

Baud Rate: <connection speed>
 Data Bits: 8
 Parity: Even
 Stop Bits: 1
 Flow Control: None

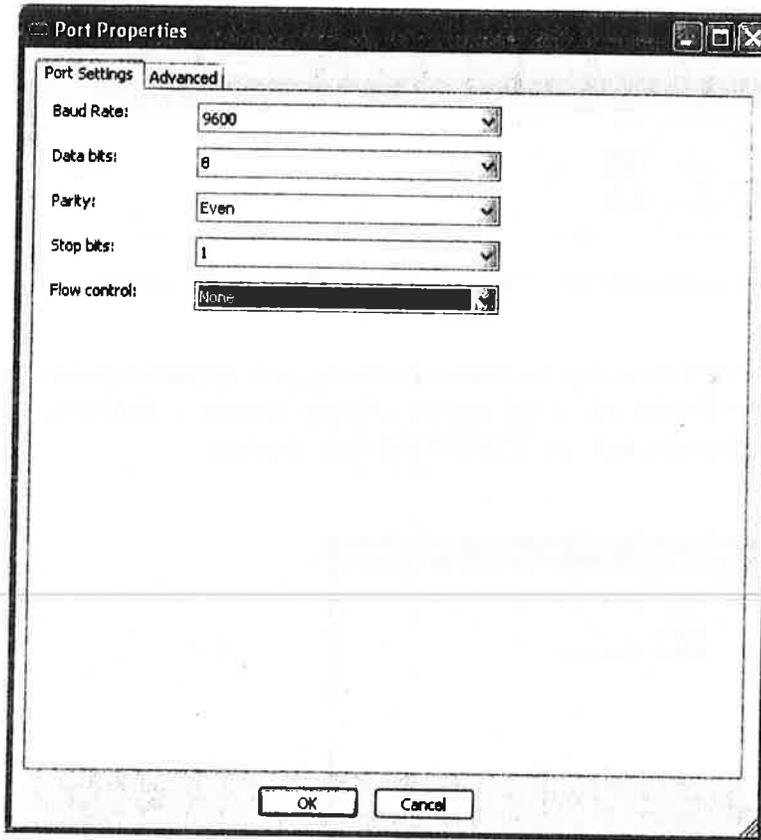


Figure 9. Port Properties dialogue box, Port Settings tab

10. While still in the **Port Properties** dialog box, select the **Advanced** tab. (See all the sections by scrolling down.) The selections made in the previous step will be displayed in Section 1. Type the information that follows into the listed sections of the dialog box.

Port Properties/Advanced dialog box section 2: UDP Datagram Mode

Datagram Mode: True

Datagram Type: 01

Port Properties/Advanced dialog box section 3: Passive Connection

Accept Passive Connection: Yes

Local Port: <port number assigned in QuicNet/4 commproc.ini>

Auto Increment Source Port: False

Port Properties/Advanced dialog box section 4: Active Connection

Remote Port: <port number assigned in Quicnet/4 commproc.ini>

Remote Host: <IP number of computer running QuicNet/4 FEP>

Port Properties/Advanced dialog box section 8: Packing

Enable Packing: True

Send Trailing Bytes: None

Send Frame Only: False

Match Two Byte Sequence: False
Idle Time: Force Transmit 12 ms
Match Byte 2: 00
Match Byte 1: 00

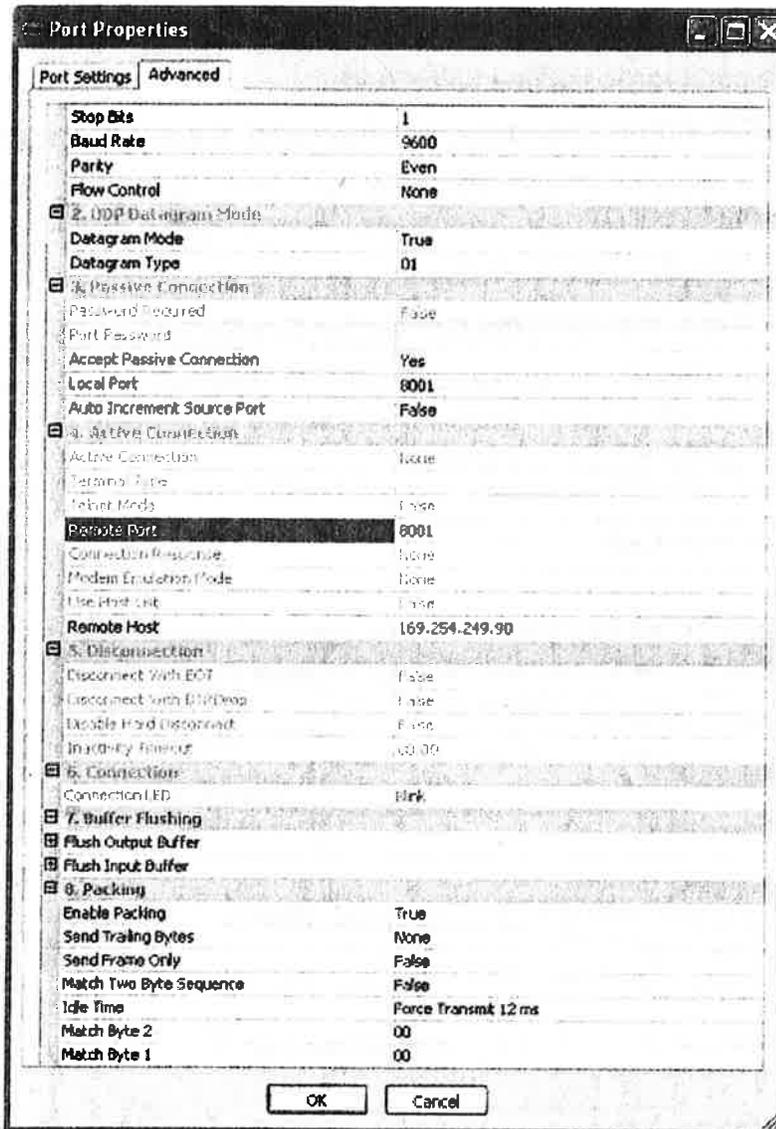


Figure 10. Port Properties dialog box, Advanced tab

11. Click the OK button and the card setup is complete.

3 QUICNET/4 SETUP

Complete the following steps to configure QuicNet/4 to recognize the controller with the Ethernet-to-Serial card (see Figure 11).

1. Make sure QuicNet is not running.
2. Open the commproc.ini file in Notepad.
3. Add an UDP Virtual Channel to commproc.ini, if it is not present, as follows:
 - a) Under **[Comm]** section, add an entry following the convention: CommPort=UDP:<portnum> (ex. CommPort=UDP:8001)
 - b) Save the file and exit Notepad.
4. Start QuicNet/4 and open the **Controller Configuration** dialog box.
5. In the **Controller Configuration** dialog box, look for the **Channel** drop down list and select UDP:<portnum> from the drop down combo. Add text per the following the convention: UDP:<portnum>:<IP Address> (ex. UDP:8001:169.254.249.80)
6. Click **Save** then **Exit**.

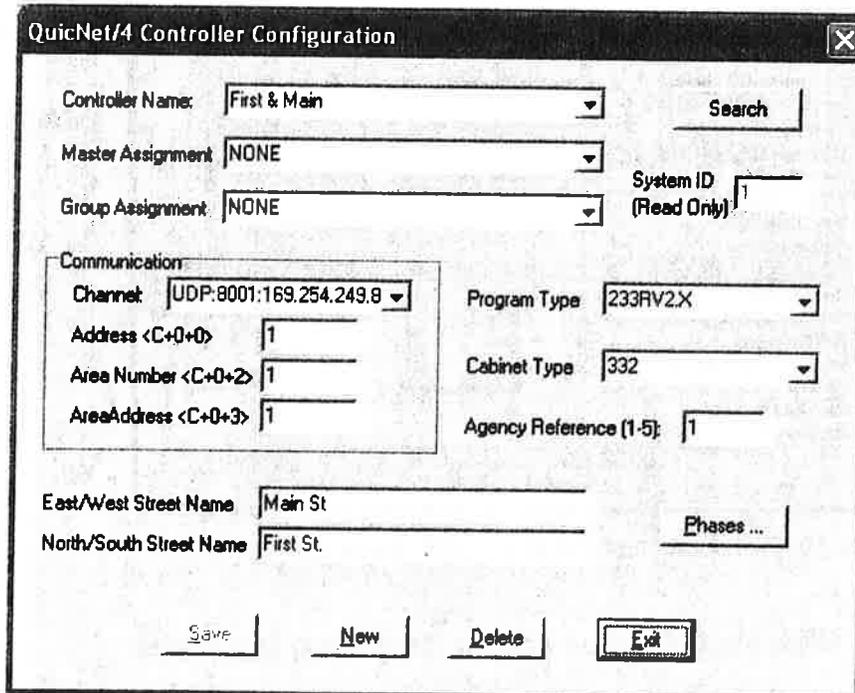


Figure 11. QuicNet/4 Controller Configuration dialog box

4 OPTIONAL CONFIGURATION USING INTERNET EXPLORER

1. Once the Ethernet-to-Serial Card has been assigned an IP address using DeviceInstaller as described previously, the Lantronix Web-Manager may be used to configure the card instead of using the DeviceInstaller. If DeviceInstaller is already running, the Web-Manager may be run by

selecting the device and clicking the **Web** button (Figure 12) on the main toolbar. Otherwise, follow the instructions in Step 2 below.

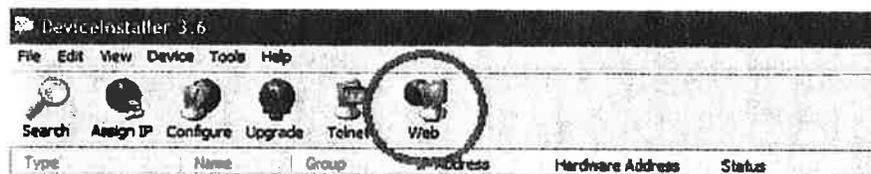


Figure 12. The Web button on the DeviceInstaller Main Toolbar

2. Make sure the computer is assigned a static IP address with the same network address as the card. Connect to the Ethernet-to-Serial Card using a hub, a switch, or a crossover cable. Open Internet Explorer and enter the IP address of the card in the web browser (ex: <http://169.254.249.80>). The following screen should appear (see Figure 13).

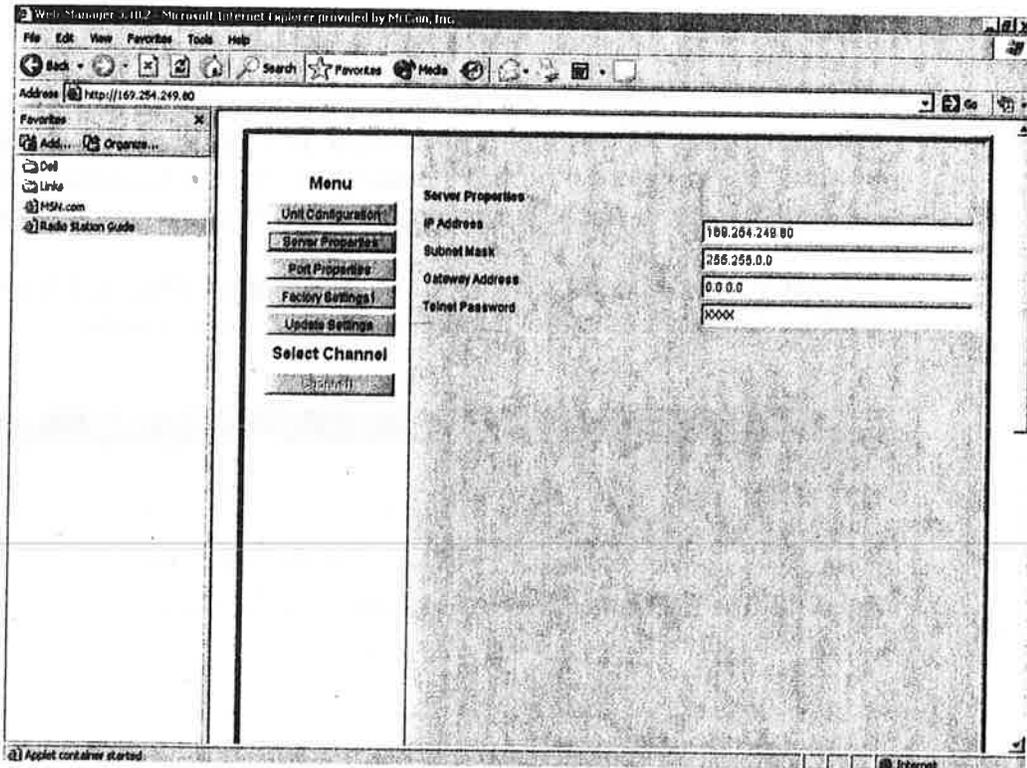


Figure 13. Server Properties Menu

3. Click the **Server Properties** button and verify the following settings:

IP Address = Desired IP address of card
 Subnet Mask = Desired Subnet Mask of card
 Gateway Address = (If present)

If any changes are made, be sure to click the **Update Settings** button to save them to the flash memory in the Ethernet card.

4. Click the Port Properties button and view the following screen (see Figure 15).

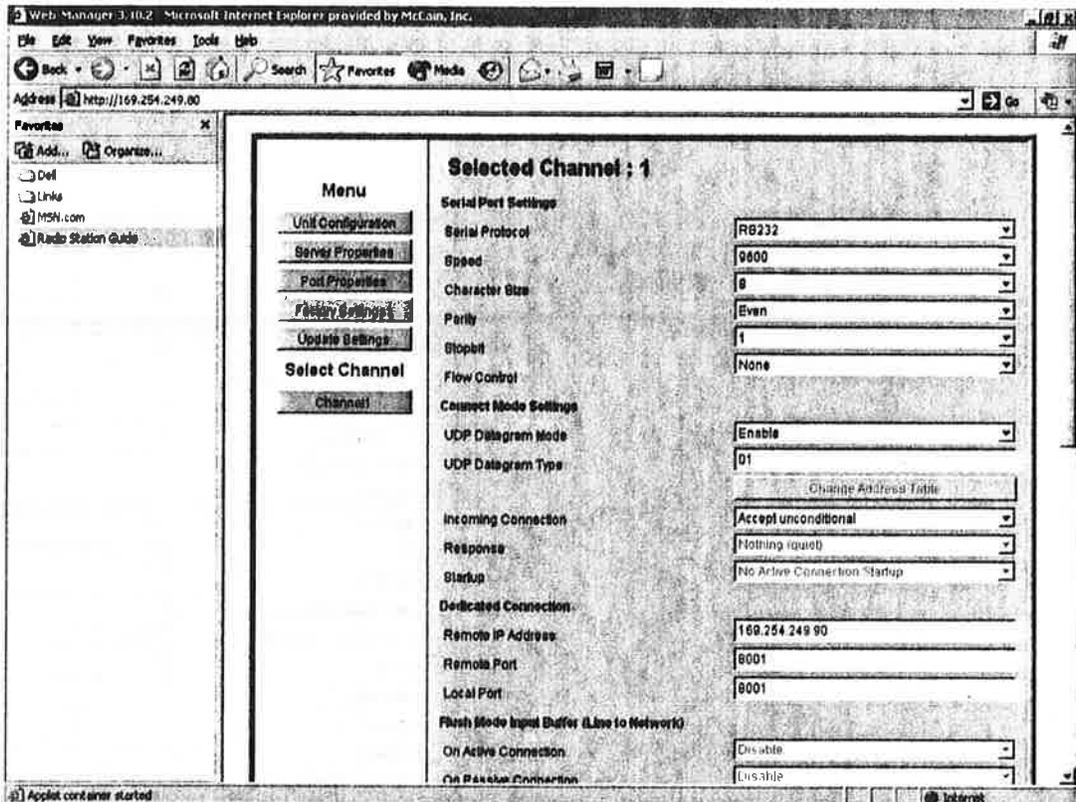


Figure 14. Menu for Selected Channel: 1

5. Verify the following settings on this upper portion of the window:

Serial Port Settings -

Serial Protocol = RS232
 Speed = (same as configured on 170 CPU card)
 Character Size = 8
 Parity = Even
 Stopbit = 1
 Flow Control = None

Connect Mode Settings -

UDP Datagram Mode = Enable
 UDP Datagram Type = 01
 Incoming Connection = Accept Unconditional

Dedicated Connection -

Remote IP Address = IP Address of QuicNet/4 FEP
 Remote Port = (same as <portnum> defined in commproc.ini)
 Local Port = (same as <portnum> defined in commproc.ini)

6. Scroll down and verify the remaining settings as shown in the following screen (see Figure 15).

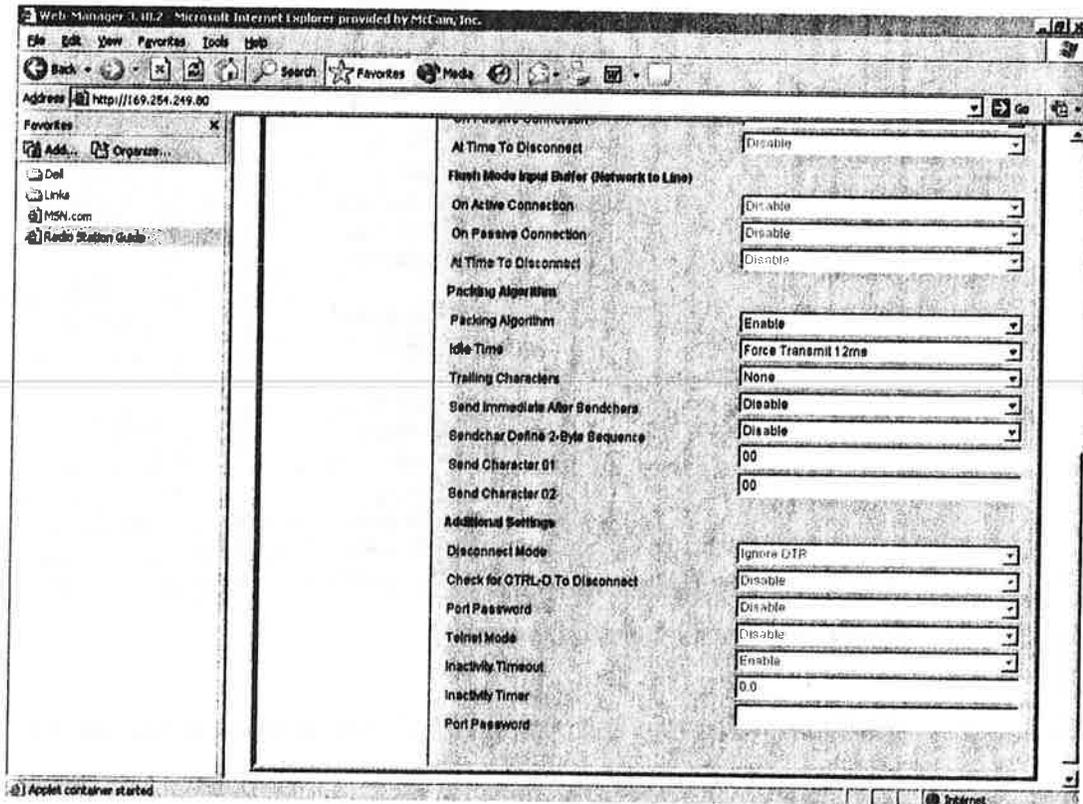


Figure 15. Port Properties Remaining Settings

Packing Algorithm -

Packing Algorithm	=	Enable
Idle Time	=	Force Transmit 12 ms
Trailing Characters	=	None
Send Immediate After Sendchars	=	Disable
Sendchar Define 2-Byte Sequence	=	Disable
Send Character 01	=	00
Send Character 02	=	00

If any changes are made, be sure to click the **Update Settings** button to save to flash memory in the Ethernet card.

The configuration of the Ethernet-to-Serial Card is complete.

5 OPTIONAL CONFIGURATION USING TELNET

Use the following instructions when the IP address is unknown.

1. "Point" the computer to card via MAC address and temporary IP address. Accomplish this by adding an entry for the card to the ARP table.
2. From the command prompt:

```
arp -s <temporary IP Address> <MAC address>  
(arp -s 192.168.0.1 00-20-4A-80-31-A2)
```

The MAC address is printed on a label on the Lantronix jack.
The IP address is arbitrary. For ease, select something in the subnet.

3. Access telnet-based configuration. From the command prompt:

```
telnet <temporary IP address> 1  
(telnet 192.168.0.1.1)  
It is normal for this to fail.  
  
telnet <temporary IP address> 9999  
(telnet 192.168.0.1 9999)
```
4. Edit the **Server Configuration** (change IP address desired value and save. This will allow you to access the web-based configuration utility and make further changes).

GLOSSARY

algorithm	A finite sequence of steps for solving a logical or mathematical problem or performing a task.
baud	Most commonly refers to the data transmission speed of a modem.
bits	Short for binary digit . The smallest unit of information handled by a computer. One bit expresses a 1 or a 0 in a binary numeral, or a true or false logical condition, and is represented physically by an element such as a high or low voltage at one point in a circuit or a small spot on a disk magnetized one way or the other.
controller	A device that other devices rely on for access to a computer subsystem. A disk controller, for example, controls access to one or more disk drives, managing physical and logical access to the drive or drives.
downloads	To transfer a copy of a file from a remote computer to the requesting computer by means of a modem or network.
ethernet	The IEEE 802.3 standard for contention networks.
Internet	The worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another.
Internet protocol	The protocol within TCP/IP that governs the breakup of data messages into packets, the routing of the packets from sender to destination network and station, and the reassembly of the packets into the original data messages at the destination. IP runs at the internetwork layer in the TCP/IP model—equivalent to the network layer in the ISO/OSI reference model.
IP	Acronym for Internet Protocol.
IP address	A 32-bit (4-byte) binary number that uniquely identifies a host (computer) connected to the Internet to other Internet hosts, for the purposes of communication through the transfer of packets. An IP address is expressed in “dotted quad” format, consisting of the decimal values of its 4 bytes, separated with periods; for example, 127.0.0.1. The first 1, 2, or 3 bytes of the IP address identify the network the host is connected to; the remaining bits identify the host itself. The 32 bits of all 4 bytes together can signify almost 2^{32} , or roughly 4 billion, hosts. (A few small ranges within that set of numbers are not used.) Also called: Internet Protocol number, IP number.
modem	Short for modulator/demodulator . A communications device that converts between digital data from a computer or terminal and analog audio signals that can pass through a standard telephone line. Because the telephone system was designed to handle voice and other audio signals and a computer processes signals as discrete units of digital information, a modem is necessary at both ends of the telephone line to exchange data between computers.

network	A group of computers and associated devices that are connected by communications facilities. A network can involve permanent connections, such as cables, or temporary connections made through telephone or other communication links. A network can be as small as a LAN (local area network) consisting of a few computers, printers, and other devices, or it can consist of many small and large computers distributed over a vast geographic area (WAN, or wide area network).
parity	The quality of sameness or equivalence, in the case of computers usually referring to an error-checking procedure in which the number of 1s must always be the same—either even or odd—for each group of bits transmitted without error. If parity is checked on a per-character basis, the method is called vertical redundancy checking, or VRC; if checked on a block-by-block basis, the method is called longitudinal redundancy checking, or LRC. In typical modem-to-modem communications, parity is one of the parameters that must be agreed upon by sending and receiving parties before transmission can take place.
port	An interface through which data is transferred between a computer and other devices (such as a printer, mouse, keyboard, or monitor), a network, or a direct connection to another computer. The port appears to the CPU as one or more memory addresses that it can use to send or receive data. Specialized hardware, such as in an add-on circuit board, places data from the device in the memory addresses and sends data from the memory addresses to the device. Ports may also be dedicated solely to input or to output. Ports typically accept a particular type of plug used for a specific purpose. For example, a serial data port, a keyboard, and a high-speed network port all use different connectors, so it's not possible to plug a cable into the wrong port.
properties	In Windows 9x, the characteristics or parameters of an object or device. Properties of a file, for example, include type, size, and creation date and can be identified by accessing the file's property sheet.
serial	One by one. For example, in serial transmission, information is transferred one bit at a time; a serial computer has only one arithmetic logic unit, which must execute the whole program one step at a time.
static	In information processing, fixed or predetermined. For example, a static memory buffer remains invariant in size throughout program execution. The opposite condition is dynamic, or ever-changing.
telnet	<ol style="list-style-type: none"> 1. A client program that implements the Telnet protocol. 2. A protocol in the TCP/IP suite that enables individuals to log on to and use a remote computer as if they were sitting at a terminal directly connected to the machine.
Virtual channel	In Asynchronous Transfer Mode (ATM), the path taken by data sent from one sender to one receiver. See also ATM (definition 1), virtual path (definition 2).

Loose Tube Double Jacket Single Armor

Loose Tube Double Jacket Single Armor

OSP 1A

PRODUCT DESCRIPTION

Loose tube cables are the product of choice as the backbone in Outside Plant (OSP) environments. The rugged loose tube design offers reliable transmission performance over a broad temperature range. Optical fibers are placed inside filled buffer tubes containing PFM™ gel. The core is constructed by stranding the buffer tubes around a central member using a reverse oscillating lay (ROL). The core is wrapped with flexible strength members covered with a water-blocking tape then encased with a black inner jacket. Water-blocking yarns and a corrugated steel armor are applied and a black outer jacket completes the cable construction. Rip cords are included under the inner jacket and armor for ease of entry.

APPLICATIONS

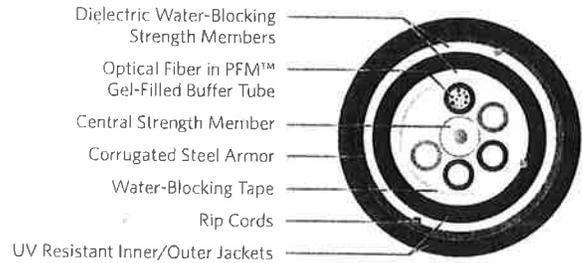
- Direct bury, underground duct and lashed aerial
- Trunk, distribution and feeder cables
- Local loop, metro, long-haul and broadband network

FEATURES

- Available with up to 288-fiber
- Multiple fiber types including hybrids
- Dry (SAP) core standard
- Standard tube size for all fiber counts
- Corrugated steel armor
- PFM gel

BENEFITS

- High fiber density
- Multiple network applications
- Reduces cable prep and installation time
- Reduces the number of tools required
- Improves compressive strength and rodent protection
- Non-sticky gel speeds fiber access and clean-up



OSP FIBER

SPECIFICATIONS

Fiber Count	Available in 6-fiber up to 288-fiber
Standards Compliance	Telcordia GR-20-CORE RDUP PE-90 Designation MLT ICEA S-87-640-2006 RoHS-compliant

ENVIRONMENTAL SPECIFICATIONS

Operation/Storage	-40°C to +70°C
Installation	-30°C to +75°C

PART NUMBERS AND PHYSICAL CHARACTERISTICS

Part Number ¹	Fiber Count	Nominal Diameter in (mm)	Approx. Weight lbs/kft (kg/km)	Maximum Tensile Loading		Minimum Bend Radius	
				Install lbs (N)	Long Term lbs (N)	Install in (mm)	Long Term in (mm)
1A006xx01	6	0.56 (14.1)	127 (188)	600 (2,700)	200 (890)	11.4 (290)	5.7 (145)
1A012xx01	12	0.56 (14.1)	127 (188)	600 (2,700)	200 (890)	11.4 (290)	5.7 (145)
1A024xx01	24	0.56 (14.1)	127 (188)	600 (2,700)	200 (890)	11.4 (290)	5.7 (145)
1A036xx01	36	0.56 (14.1)	127 (188)	600 (2,700)	200 (890)	11.4 (290)	5.7 (145)
1A048xx01	48	0.56 (14.1)	127 (188)	600 (2,700)	200 (890)	11.4 (290)	5.7 (145)
1A072xx01	72	0.58 (14.9)	161 (240)	600 (2,700)	200 (890)	13.2 (335)	6.6 (168)
1A096xx01	96	0.65 (16.6)	192 (285)	600 (2,700)	200 (890)	14.4 (365)	7.2 (183)
1A144xx01	144	0.78 (19.9)	269 (400)	600 (2,700)	200 (890)	17.4 (442)	8.7 (221)
1A216xx01	216	0.81 (20.7)	269 (400)	600 (2,700)	200 (890)	17.4 (442)	8.7 (221)
1A288xx01	288	0.90 (22.9)	327 (487)	600 (2,700)	200 (890)	19.6 (498)	9.8 (249)

PART NUMBER KEY

1	A	-	-	-	x	x	0	-
1	2	3	4	5	6	7	8	9
product family	fiber count (006-288)	fiber type	internal designator	water block/ marking (1-8)				

¹Contact Customer Service for availability of non-standard offerings.
See "Optical Fiber Cable" options in the "Technical Info" section for flooding and jacket marking options.

SINGLE MODE AND PL FIBER TYPES

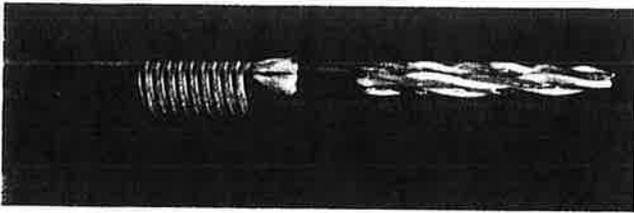
	Conventional	Reduced Water Peak	Zero Water Peak	TeraFlex® Bend Resistant			
				G.657.A1	G.657.A2	G.657.B3	NZDS
¹ For ≤ 36 fibers replace "xx" with:	9T	3T	2T	KT	JT	LT	8T
² For > 36 fibers replace "xx" with:	91	31	21	K1	J1	L1	81

MULTI-MODE OM3/OM4 FIBER TYPES

	TeraGain Laser Optimized 50/125			
	TeraGain® 62.5/125	10G/150	10G/300	10G/550
¹ Replace "xx" with:	6G	AG	BG	FG



Outdoor Cable



LAN-Trak OSP Category 5E

4 Pair #24 AWG ScTP Category 5E Outdoor Cable

PART # M57562

DESCRIPTION

ENHANCED OVERALL SHIELDED TWISTED PAIR (ScTP) CATEGORY 5E CABLE FOR USE IN HORIZONTAL CABLING SYSTEMS PER TIA/EIA 568-B. THE CABLE EXCEEDS TIA 568-B.2 CATEGORY 5e AND ISO/IEC 11801 CATEGORY 5 ELECTRICAL CHARACTERISTICS. THE CABLE CONSISTS OF #24 AWG SOLID BARE COPPER INSULATED CONDUCTORS, ASSEMBLED INTO FOUR TIGHTLY TWISTED PAIRS, FLOODED TO PREVENT MOISTURE INGRESS, UNDER AN INNER JACKET, CORRUGATED ALUMINUM SHIELD AND OUTER JACKET. THIS PRODUCT AND/OR ITS MANUFACTURE IS COVERED BY US PATENT NO. 5424491.

THE CABLE IS SUITABLE FOR OUTDOOR USE IN DUCT, FOR AERIAL LASHING, AND FOR DIRECT BURIAL. IT IS WATER BLOCKED AND HAS A BLACK SUNLIGHT RESISTANT JACKET. THE CABLE IS NOT UL OR CSA LISTED, SINCE IT IS NOT FLAME RETARDANT. CONSULT THE NATIONAL ELECTRICAL CODE (NEC) ARTICLE 800 FOR USE IN BUILDINGS.

THIS CABLE COMPLIES WITH THE EU-ROHS DIRECTIVE 2002/95/EC (RESTRICTIONS ON HAZARDOUS SUBSTANCES) REGULATIONS.

SUPPORTED APPLICATIONS

IEEE 802.3 10BASE-T (ETHERNET), 100BASE-T (FAST ETHERNET), AND 1000BASE-T (GIGABIT ETHERNET), ANSI.X3.263 FDDI TP-PMD, IEEE 802.5 4 AND 16 Mbps TOKEN RING, ATM UP TO 155 Mbps, 550 MHz BROADBAND VIDEO AND STANDARDS UNDER DEVELOPMENT SUCH AS ATM AT 622 Mbps & 1.2 Gbps.

CONSTRUCTION

PRIMARIES: CONDUCTOR: 24 AWG (.5 mm) SOLID BARE COPPER
INSULATION: THERMOPLASTIC POLYOLEFIN

PAIR ASSEMBLY: 2 PRIMARIES TWISTED IN VARIOUS LAYS

COLOR CODE: SEE TABLE 1 (WHITE CONDS HAVE INTEGRAL STRIPE TO MATCH THEIR MATE)

CABLE ASSEMBLY: 4 PAIRS CABLED TOGETHER

INNER JACKET: MATERIAL: BLACK POLYETHYLENE
NOMINAL WALL: .030" (.76 mm)
NOMINAL DIAMETER: .231" (5.87 mm)

SHIELD: CORRUGATED COATED ALUMINUM TAPE

OUTER JACKET: MATERIAL: BLACK POLYETHYLENE
NOMINAL WALL: .045" (1.14 mm)
NOMINAL DIAMETER: .380" (9.65 mm)

PRINT: MOHAWK LAN-TRAK (TM) OSP CAT.5E+ 4PR 24
AWG --- ROHS M57562 (DATE CODE)
(SEQUENTIAL FOOTAGE MARKERS)

NOTE: CABLE FLOODED FOR MOISTURE PROTECTION

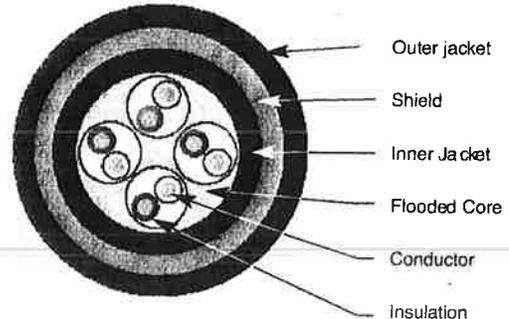


TABLE 1

PAIR NUMBER	PAIR COLOR CODE	
	1	WHITE-BLUE
2	WHITE-ORANGE	ORANGE
3	WHITE-GREEN	GREEN
4	WHITE-BROWN	BROWN

PHYSICAL CHARACTERISTICS

CABLE WEIGHT: 88 lbs/1000ft (131 kg/km)

BEND RADIUS: 5.7" (145 mm) MIN (15 x CABLE OD)

OPERATING TEMP.: -40°C to +60°C (-40°F to +140°F)

STORAGE TEMP.: -40°C to +75°C (-40°F to +167°F)

INSTALLATION TEMP.*: -20°C to +60°C (-4°F to +140°F)

*THE INSTALLATION TEMPERATURE REFERS TO THE TEMPERATURE OF THE CABLE WHILE BEING INSTALLED OR PULLED.

LAN-Trak OSP Category 5E

4 Pair #24 AWG ScTP Category 5E Outdoor Cable

ELECTRICAL CHARACTERISTICS (REF TABLE 2)

STANDARDS:	EXCEEDS TIA/EIA 568-B.2 CAT 5e AND ISO/IEC 11801 CAT 5 HORIZONTAL CABLE	INSERTION LOSS:	$1.97 \sqrt{f} + .013 f + \frac{.050}{\sqrt{f}}$ dB/100m MAX
VOLTAGE RATING:	300 VOLTS	NEAR END CROSSTALK (NEXT):	$40.3 - 15 \log_{10}(f/100)$ dB/100m MIN
CONDUCTOR DCR:	8.9 Ω /100m (27.1 Ω /Mft) MAX	POWER SUM NEAR END CROSSTALK (PS-NEXT):	$38.3 - 15 \log_{10}(f/100)$ dB/100m MIN
DCR UNBALANCE:	3% MAX	EQUAL LEVEL FAR END CROSSTALK (ELFEXT):	$27.8 - 20 \log_{10}(f/100)$ dB/100m MIN
MUTUAL CAPACITANCE:	51.5 pF/m (15.7 pF/ft) NOM	POWER SUM EQUAL LEVEL FAR END CROSSTALK (PS-ELFEXT):	$24.8 - 20 \log_{10}(f/100)$ dB/100m MIN
CAPACITANCE UNBALANCE PAIR/GROUND:	66 pF/100m (200 pF/Mft) MAX	PROPAGATION DELAY:	$534 + 36 / \sqrt{f}$ ns/100m MAX
CHARACTERISTIC IMPEDANCE:	100 $\Omega \pm 15\%$ (1-400 MHz)	DELTA DELAY (SKEW):	25 ns/100m MAX
INPUT IMPEDANCE:	100 $\Omega \pm 15\%$ (1-100 MHz) 100 $\Omega \pm 22\%$ (>100-200 MHz)	NOMINAL VELOCITY OF PROPAGATION (NVP):	65%
RETURN LOSS (RL):	20 + 5 $\log_{10}(f)$ dB MIN (1-10 MHz) 25 dB MIN (>10-20 MHz) 25 - 7 $\log_{10}(f/20)$ dB MIN (>20 MHz)	WHERE f = FREQUENCY IN MHz from .772 to 250 MHz, except for ELFEXT and PS-ELFEXT from 1 to 250 MHz.	

TABLE 2

REFERENCE ELECTRICAL CHARACTERISTICS

FREQ (MHz)	INSERTION LOSS			NEXT		ACR	PS-NEXT		PS-ACR	ELFEXT	PS-ELFEXT	RL
	(dB/100m)	(dB/mft)	(dB/mft)	(dB/100m)	(dB)							
1.0	avg	max	max	avg	min	min	avg	min	min	min	min	min
4.0	1.8	2.0	6.2	80	70.3	70.3	73	68.3	66.3	67.8	64.8	20.0
8.0	3.6	4.0	12.2	70	61.3	59.3	63	59.3	55.3	55.8	52.8	23.0
10.0	5.2	5.7	17.4	66	56.8	53.1	59	54.8	49.1	49.7	46.7	24.5
16.0	5.8	6.4	19.4	64	55.3	50.9	58	53.3	46.9	47.8	44.8	25.0
20.0	7.3	8.1	24.7	62	52.2	46.1	56	50.2	42.1	43.7	40.7	25.0
25.0	8.3	9.1	27.7	60	50.8	43.7	54	48.8	39.7	41.8	38.8	25.0
31.25	9.3	10.2	31.0	59	49.3	41.1	52	47.3	37.1	39.8	36.8	24.3
62.5	10.4	11.4	34.8	58	47.9	38.5	51	45.9	34.5	37.9	34.9	23.6
100.0	15.1	16.4	50	54	43.4	29.0	47	41.4	25.0	31.9	28.9	21.5
155.0	19.6	21.0	64	50	40.3	21.3	43	38.3	17.3	27.8	24.8	20.1
200.0	25.0	26.6	81	48	37.4	12.9	41	35.4	8.9	24.0	21.0	18.8
250.0	28.8	30.5	93	46	35.8	7.3	40	33.8	3.3	21.8	18.8	18.0
300.0	32.8	34.4	105	45	34.3	1.9	38	32.3	-	19.8	16.8	17.3
350.0	36.5	38.0	116	44	33.1	-	37	31.1	-	-	-	16.8
400.0	40.0	41.4	126	43	32.1	-	36	30.1	-	-	-	16.3
400.0	43.2	44.6	136	42	31.3	-	35	29.3	-	-	-	15.9

VALUES ABOVE 250 MHz ARE FOR ENGINEERING INFORMATION ONLY.

Mohawk reserves the right to change specification in the interest of product enhancement.

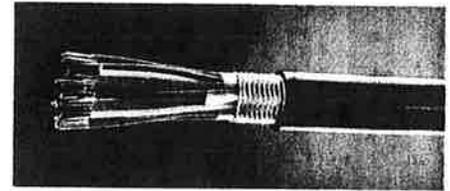


9 Mohawk Drive, Leominster, MA 01453
 (978) 537-9961 • 1-800-422-9961 • FAX (978) 537-4358
 info@mohawk-cable.com www.mohawk-cable.com
 ©Mohawk 11/2007

Cable

ALP Air Core, Aerial and Duct RUS/RDUP Spec PE-22

For primarily aerial installation by attachment to a support strand. The cable must be pressurized if it is placed in a duct.



Core Construction

Conductors	Solid, annealed bare copper in 19, 22, 24 and 26 AWG.
Insulation	Solid, color-coded polyolefin.
Twisted Pairs	Individual insulated conductors are twisted into pairs with varying lay lengths.
Core Assembly	Cables of 25 pairs or less are assembled into a cylindrical core. Cables larger than 25 pairs are assembled into units, which are then used to assemble the core. Units are individually identifiable by color coded unit binders.
Core Wrap	Non-hygroscopic, dielectric tape.
Shielding	Corrugated, copolymer coated, .008" aluminum tape applied longitudinally with an overlap.
Outer Jacket	Black, linear low-density PE designed to withstand exposure to direct sunlight, atmospheric temperature changes and stresses expected in standard installations.
Footage Marking	Printed sequentially every 2' along the outer jacket.

RUS/RDUP Designation: CA

Electrical Characteristics

See Table A on page 21 in this section.

Note: T-Screen® Type ALP cables may be available with a core separated design for use with PCM-type carrier equipment.

See referenced pages in the Hardware & Supplies section:

Installation Hardware

- Ready Access Closures - B-1
- Better Buried Closures - B-6
- Cable Rings - A-4

Suggested Prep Tools

- Armored Cable Slitter - I-10
- MK01A Multi-wire Stripper/Cutter - I-11
- MK04 Cable Jacket Stripper - I-11

Cable

GOPIC®-F

RDUP PE-39



SPECIFICATIONS

Conductor	Solid annealed copper
Insulation	Solid polyolefin; color coded in accordance with industry standards
Twisted Pairs	Individual insulated conductors; twisted into pairs with varying lay lengths; specific color combinations provide pair identification
≤ 25-Pair Core	Pairs are assembled into a cylindrical core
> 25-Pair Core	Cables larger than 25-pair are assembled into units, which are then used to assemble the core; units are identifiable using color-coded binders
Filling Compound	80°C ETPR compound, completely filling the interstices between the pairs and under the core wrap
Core Wrap	Non-hygroscopic, dielectric tape applied over the core
Shield	Corrugated, rodent resistant, copper bearing armor applied longitudinally with an overlap; flooded shield interfaces
Jacket	Black, polyethylene
Jacket Marking	Identifying information includes a telephone handset, cable code, pair count, AWG, date of manufacture and sequential length markings at 2 foot intervals
Standards Compliance	ANSI/ICEA S-84-608-2007 RDUP 7 CFR 1755.390 (PE-39) RoHS-compliant

PRODUCT DESCRIPTION

GOPIC®-F Cables are designed for use in direct burial applications where additional mechanical or rodent protection is required. GOPIC-F may be used aerially, but must be attached to a support strand.

APPLICATIONS

- Direct burial where additional mechanical protection is required or desired
- Lashed aerial where additional mechanical protection is required or desired

FEATURES

- Twisted into pairs with varying lay lengths
- Core wrap
- Filled core
- Corrugated, copper bearing armor
- Fully flooded shield interfaces
- Black, polyethylene jacket

BENEFITS

- Minimizes crosstalk
- Provides thermal protection
- Moisture resistant
- Rodent resistant
- Inhibits corrosion and water migration
- Provides a tough, protective covering designed to withstand exposure to direct sunlight, atmospheric temperature changes and stresses expected in standard installations

ELECTRICAL SPECIFICATIONS

Number of Pairs	Average Mutual Capacitance @ 1000 Hz nF/mile (nF/km)	Capacitance Unbalance Pair to Pair @ 1 kHz		Capacitance Unbalance Pair to Ground @ 1 kHz	
		Maximum Individual pF @ 1 kft (pF @ 1 km)	Maximum RMS pF @ 1 kft (pF @ 1 km)	Maximum Individual pF @ 1 kft (pF @ 1 km)	Maximum Average pF @ 1 kft (pF @ 1 km)
12 or less	83 ± 7 (52 ± 4)	80 (145)	-	800 (2,625)	-
Over 12	83 ± 4 (52 ± 2)	80 (145)	25 (45)	800 (2,625)	175 (574)

Conductor Size AWG (mm)	Minimum Insulation Resistance @ 68°F (20°C) gigohm-mile (gigohm-km)	Maximum Average Attenuation* 772 kHz @ 68°F (20°C) dB/kft (dB/km)	Maximum Conductor Resistance @ 68°F (20°C) Ohms/sheath mile (km)	DC Resistance Unbalance Maximum %		Dielectric Strength DC Potential – Volts	
				Average	Individual Pair	Conductor to Conductor	Conductor to Shield
19 (0.90)	1.0 (1.6)	2.8 (9.2)	45.0 (28.0)	1.5	5.0	7,000	15,000
22 (0.64)	1.0 (1.6)	4.0 (13.1)	91.0 (56.5)	1.5	5.0	5,000	15,000
24 (0.51)	1.0 (1.6)	5.0 (16.4)	144.0 (89.5)	1.5	5.0	4,000	15,000

*For cables of 12-pair or less, the maximum average attenuation may be increased by 10% over the values shown.

Minimum Near End Crosstalk (NEXT) @ 772 kHz

PSWUNEXT Mean (dB)	47
PSWUNEXT Worst Pair (dB)	42

Minimum Far End Crosstalk (FEXT) @ 772 kHz

Conductor Size (AWG)	19	22	24
PSELFEXT Mean (dB/kft)	51	49	49
PSELFEXT Worst Pair (dB/kft)	45	43	43

RDUP/RUS OSP COPPER

PART NUMBERS AND PHYSICAL CHARACTERISTICS

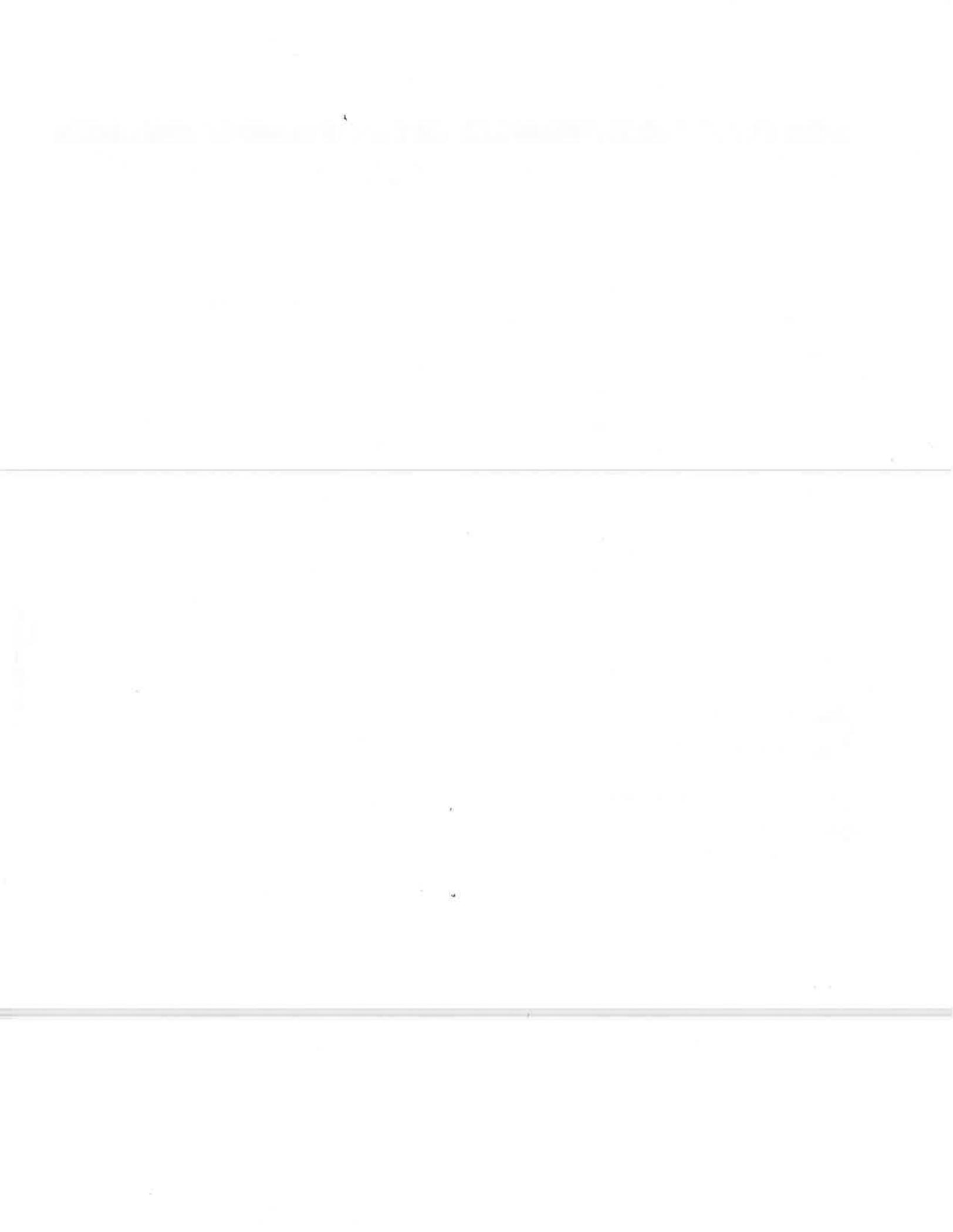
Part Number	Pair Count	AWG (mm)	Nominal Diameter in (mm)	Approx. Weight lbs/kft (kg/km)	Standard Length ft (m)	Approx. Shipping Weight lbs (kg)	Reel Size F x T x D in
04-026-27	6	19 (0.90)	0.54 (14)	155 (230)	5,000 (1,524)	885 (400)	44 x 18 x 20
04-028-27	12	19 (0.90)	0.69 (18)	255 (380)	5,000 (1,524)	1,440 (655)	46 x 25 x 20
04-031-27	25	19 (0.90)	0.92 (23)	470 (700)	5,000 (1,524)	2,720 (1,235)	65 x 30 x 32
04-034-27	50	19 (0.90)	1.22 (31)	850 (1,265)	5,000 (1,524)	4,950 (2,245)	78 x 40 x 39
04-038-27	100	19 (0.90)	1.69 (43)	1,620 (2,410)	2,500 (762)	4,665 (2,115)	72 x 35 x 36
04-057-27	6	22 (0.64)	0.43 (11)	95 (140)	5,000 (1,524)	540 (245)	36 x 18 x 14
04-059-27	12	22 (0.64)	0.53 (14)	150 (225)	5,000 (1,524)	860 (390)	44 x 18 x 20
04-062-27	25	22 (0.64)	0.68 (17)	260 (385)	5,000 (1,524)	1,465 (665)	46 x 25 x 20
04-065-27	50	22 (0.64)	0.89 (23)	450 (670)	5,000 (1,524)	2,495 (1,130)	58 x 25 x 20
04-069-27	100	22 (0.64)	1.19 (30)	820 (1,220)	5,000 (1,524)	4,715 (2,140)	72 x 35 x 36
04-073-27	200	22 (0.64)	1.63 (41)	1,555 (2,315)	2,500 (762)	4,500 (2,040)	72 x 35 x 36
04-075-27	300	22 (0.64)	1.96 (50)	2,275 (3,385)	2,500 (762)	6,385 (2,895)	78 x 40 x 39
04-077-27	400	22 (0.64)	2.23 (57)	2,965 (4,415)	1,250 (381)	4,320 (1,960)	72 x 35 x 36
04-081-27	600	22 (0.64)	2.72 (69)	4,395 (6,540)	1,250 (381)	6,290 (2,855)	84 x 40 x 42
04-083-27	900	22 (0.64)	3.30 (84)	6,505 (9,680)	1,250 (381)	8,130 (3,690)	96 x 40 x 48
04-092-27	6	24 (0.51)	0.38 (9.7)	70 (105)	5,000 (1,524)	415 (190)	36 x 18 x 14
04-094-27	12	24 (0.51)	0.46 (12)	110 (165)	5,000 (1,524)	660 (300)	44 x 18 x 20
04-097-27	25	24 (0.51)	0.58 (15)	180 (270)	5,000 (1,524)	1,065 (485)	46 x 25 x 20
04-100-27	50	24 (0.51)	0.74 (19)	310 (460)	5,000 (1,524)	1,755 (795)	52 x 25 x 20
04-104-27	100	24 (0.51)	0.98 (25)	550 (820)	5,000 (1,524)	3,120 (1,415)	65 x 30 x 32
04-108-27	200	24 (0.51)	1.32 (34)	1,020 (1,520)	5,000 (1,524)	5,800 (2,630)	78 x 40 x 39
04-110-27	300	24 (0.51)	1.58 (40)	1,475 (2,195)	2,500 (762)	4,300 (1,950)	72 x 35 x 36
04-112-27	400	24 (0.51)	1.79 (46)	1,910 (2,845)	2,500 (762)	5,475 (2,485)	78 x 40 x 39
04-116-27	600	24 (0.51)	2.18 (55)	2,825 (4,205)	1,250 (381)	4,145 (1,880)	72 x 35 x 36
04-118-27	900	24 (0.51)	2.63 (67)	4,145 (6,170)	1,250 (381)	5,880 (2,665)	78 x 40 x 39
04-120-27	1,200	24 (0.51)	3.00 (76)	5,435 (8,090)	1,000 (305)	6,135 (2,780)	78 x 40 x 39
04-121-27	1,500	24 (0.51)	3.35 (85)	6,745 (10,040)	1,000 (305)	7,920 (3,590)	96 x 40 x 48
04-124-27	1,800	24 (0.51)	3.63 (92)	8,005 (11,915)	1,000 (305)	9,180 (4,165)	96 x 40 x 48

FREQUENTLY ASKED QUESTIONS

Product FAQs for OSP copper cables are available online:
SuperiorEssex.com/Comm/productFAQs.aspx

FOR EXTREME RISK ENVIRONMENTS

For extreme direct burial or lashed aerial installations, this cable is available with the +M feature. See the "Mechanical Protection (+M) for Extreme Risk Environments" in the "Technical Info" section for more information.



Router/Switch



The RuggedWireless™ RS900W is an industrially hardened Ethernet switch which integrates an IEEE 802.11b/g Wireless Access Point, with a fully managed wired 8-Port Ethernet switch providing six Fast Ethernet copper only ports and two optional copper or fiber ports. With the installation of the RS900W wireless access point, a network designer will achieve the integration of wired and wireless networks. The RS900W can be configured as an access, client, or bridge device.

Designed to operate reliably in harsh industrial environments the RS900W provides a high level of immunity to electromagnetic interference and heavy electrical surges typical of environments found in electric utility substations, factory floors or in curb side traffic control cabinets. An operating temperature range of -40°C to +85°C coupled with hazardous location certification, optional conformal coating and a galvanized steel enclosure allows the RS900W to be placed in almost any location.

The RS900W functions as a standalone IEEE 802.11b/g access point for wireless clients providing wireless data rates of up to 54Mbps. All wireless communications are protected by the very latest "robust security networks" features including strong encryption protocols using WPA with TKIP and even WPA2/802.11i with AES support. Static authentication support is provided by WPA-PSK. For additional centralized control, the RS900W also supports IEEE 802.1X/RADIUS for wireless user traffic and distributing dynamic encryption keys.

The embedded Rugged Operating System (ROS®) provides advanced networking features such as Enhanced Rapid Spanning Tree (eRSTP™), VLAN, Quality of Service, and a full array of intelligent functionality and advanced cyber security features for high network availability and manageability.

The RS900W is backed by a five year warranty and unsurpassed technical support.

Features and Benefits

Ethernet Ports

- 6 - Fast Ethernet ports (10/100BaseTX)
- Optional 2 - Fast Ethernet ports (10/100BaseTX or 100BaseFX)
- Multiple fiber connector types

Cyber Security

- WPA (Wi-Fi Protected Access) with TKIP for enhanced security and encryption
- WPA2/802.11i with CCMP for robust security and 128-bit AES encryption
- IEEE 802.1X/RADIUS using EAP-PEAP for secure "enterprise class" authentication configuration
- Pre-shared Key Mode (PSK) for "personal" mode authentication configuration
- Multi-level user passwords
- SSH/SSL (128-bit encryption)
- Enable/disable ports, MAC based port security
- Port based network access control (802.1x)
- VLAN (802.1Q) to segregate and secure network traffic
- RADIUS centralized password management
- SNMPv3 authentication and 56-bit encryption

Rugged Operating System (ROS®) Features

- Simple plug and play operation - automatic learning, negotiation, and crossover detection
- MSTP (802.1Q-2005, formerly 802.1s)
- RSTP (802.1D-2004) and Enhanced Rapid Spanning Tree

(eRSTP™) network fault recovery (<5ms)

- Quality of Service (802.1p) for real-time traffic
- VLAN (802.1Q) with double tagging and GVRP support
- Link aggregation (802.3ad)
- IGMP Snooping for multicast filtering
- Port Rate Limiting and Broadcast Storm Limiting
- Port configuration, status, statistics, mirroring, security
- SNTP time synchronization (client and server)

RuggedRated™ for Reliability in Harsh Environments

- Immunity to EMI and heavy electrical surges
 - Meets IEEE 1613 (electric utility substations)
 - Exceeds IEC 61850-3 (electric utility substations)
 - Exceeds IEC 61800-3 (variable speed drive systems)
 - Exceeds IEC 61000-6-2 (generic industrial)
 - Exceeds NEMA TS-2 (traffic control equipment)
- -40°C to +85°C operating temperature (no fans)
- 20 AWG galvanized steel enclosure
- DIN or panel mounting options provide secure mechanical reliability
- Hazardous Locations: Class 1, Division 2

Universal Power Supply Options

- Fully integrated power supply (no external adaptors)
- Universal high-voltage range: 88-300VDC or 85-264VAC
- Dual low-voltage DC inputs: 24VDC (10-36VDC) or 48VDC (36-72VDC)
- Terminal blocks for reliable maintenance free connections
- CSA/UL 60950 safety approved to +85°C



RuggedWIRELESS™ RS900W

Optional Ports

- ▶ Up to 2 Additional Ports
- ▶ Fast 10/100BaseTX or 10/100BaseFX
- ▶ Fiber Optical (MMF/SMF)
- ▶ Multiple Fiber Connector Types

Rugged Construction

- ▶ 20 AWG. galvanized steel enclosure
- ▶ Conformal coating (optional)

Hazardous Location Certification

- ▶ Class1, Division2

Integrated Power Supply

- ▶ Universal high-voltage range: 88-300VDC or 85 - 264VAC
- ▶ Popular low voltage DC ranges: 24VDC (10-36VDC) 48VDC (36-59VDC)
- ▶ Dual Isolated DC power inputs

Mounting Options

- ▶ DIN Rail
- ▶ Panel Mount

Antenna

- ▶ Standard 3dBi
- ▶ Various antenna option packages available

Operating Temperature

- ▶ -40°C to +85°C
- ▶ No Fans

Fast Ethernet Ports:

- ▶ 6 - Fast Ethernet Ports (10/100BaseTX)

Critical Alarm Relay

- ▶ Form-C failsafe contact relay: 1A@30VDC



Wireless Specifications

- IEEE 802.11b/g compliant provides simultaneous support for both IEEE802.11b and IEEE802.11g wireless clients.
- Can be configured as an access, client or bridge device
- Antenna type: Removable, upgradeable 3dBi Antenna with R-SMA (male) connector
- Operating channels/frequency-range:
 - 11 channels, 2.400 - 2.4720 Ghz (US, Canada)
 - 13 channels, 2.400 - 2.4835 Ghz (ETSI)
 - 14 channels, 2.400 - 2.4970 Ghz (Japan)
- Data rates:
 - IEEE 802.11b: 11/5.5/2/1 Mbps with automatic failback
 - IEEE 802.11g: 54/48/36/24/18/12/9/6 Mbps with automatic failback
- Modulation technology:
 - IEEE 802.11b: DSSS over CCK (11/5 Mbps), DQPSK (2 Mbps), DBPSK (1 Mbps)
 - IEEE 802.11g: OFDM over 64QAM, 16QAM, QPSK, BPSK
- Transmit power:
 - IEEE 802.11b: 20dBm nominal @ 11 Mbps
 - IEEE 802.11g: 16dBm nominal @ 54 Mbps
- Receiver sensitivity:
 - IEEE 802.11b: -88dBm @ 11 Mbps with 8% FER
 - IEEE 802.11g: -74dBm @ 54 Mbps with 10% FER

ROS® Features



Cyber Security

Cyber security is an urgent issue in many industries where advanced automation and communications networks play a crucial role in mission critical applications and where high reliability is of paramount importance. Key ROS® features that address security issues at the local area network level include:

- **Passwords** - Multi-level user passwords secures switch against unauthorized configuration
- **SSH / SSL** - Extends capability of password protection to add 128-bit encryption of passwords and data as they cross the network
- **Enable/Disable Ports** - Capability to disable ports so that traffic can not pass
- **802.1Q VLAN** - Provides the ability to logically segregate traffic between predefined ports on switches
- **MAC Based Port Security** - The ability to secure ports on a switch so only specific Devices / MAC addresses can communicate via that port
- **802.1x Port Based Network Access Control** - The ability to lock down ports on a switch so that only authorized clients can communicate via this port
- **RADIUS** - authentication service using MD5 hash and providing centralized password management
- **SNMPv3** - encrypted authentication access security and data encryption (CBC-DES with 56-bit encryption key)
- **Secure Socket Layer** - Web-based management using SSL with data encryption (128-bit encryption key)
- **RSA** - 1024 bit key for key management and key exchange
- **TACACS+** - Terminal Access Control and Accounting Services Client provides encrypted authentication and authorization
- **Point to Point (PPP)** - using CHAP (MD5 Hash) authentication service
- **SFTP** - Secure File Transfer Protocol using SSH encryption

The ROS® cyber security features are included to help address the various industry specific security standards such as NERC CIP, ISA S99, AGA 12, IEC 62443, ISO 17799:2005 and PCSRF SPP-ICS.

Enhanced Rapid Spanning Tree Protocol (eRSTP™)

RuggedCom eRSTP™ allows the creation of fault-tolerant ring and mesh Ethernet networks that incorporate redundant links that are 'pruned' to prevent loops. eRSTP™ yields worst-case fault recovery¹ of 5ms times the 'bridge diameter' and allows rings of up to 160 switches. For example, a ring of ten switches will have fault recovery times under 50ms. eRSTP™ implements both STP and RSTP to ensure interoperability with commercial switches unlike other proprietary 'ring' solutions.

Quality of Service (IEEE 802.1p)

Some networking applications such as real-time control or VoIP (voice over IP) require predictable arrival times for Ethernet frames. Switches can introduce latency in times of heavy

network traffic due to the internal queues that buffer frames and then transmit on a first come first serve basis. ROS® supports 'Class of Service' in accordance with IEEE 802.1p that allows time critical traffic to jump ahead to the front of the queue thus minimizing latency and reducing jitter to allow such demanding applications to operate correctly. ROS® allows priority classification by port, tags, MAC address, and IP type of service (ToS). A configurable "weighted fair queuing" algorithm controls how frames are emptied from the queues.

VLAN (IEEE 802.1Q)

Virtual local area networks (VLAN) allow the segregation of a physical network into separate logical networks with independent broadcast domains. A measure of security is provided since hosts can only access other hosts on the same VLAN and traffic storms are isolated. ROS® supports 802.1Q tagged Ethernet frames and VLAN trunks. Port based classification allows legacy devices to be assigned to the correct VLAN. GVRP support is also provided to simplify the configuration of the switches on the VLAN.

Link Aggregation (802.3ad)

The link aggregation feature provides the ability to aggregate several Ethernet ports into one logical link (port trunk) with higher bandwidth. This provides an inexpensive way to set up a high speed backbone to improve network bandwidth. This feature is also known as "port trunking", "port bundling", "port teaming", and "Ethernet trunk".

IGMP Snooping

ROS® uses IGMP snooping (Internet Group Management Protocol v1&v2) to intelligently forward or filter multicast traffic streams (e.g. MPEG video) to or from hosts on the network. This reduces the load on network trunks and prevents packets from being received on hosts that are not involved. ROS® has a very powerful implementation of IGMP snooping that:

- Can be enabled on a per VLAN basis.
- Detects and filters all multicast streams regardless of whether subscribers exist.
- Supports "router-less" operation by supporting an "active" mode.
- Restores traffic streams immediately after an RSTP topology change.

SNMP (Simple Network Management Protocol)

SNMP provides a standardized method for network management stations the ability to interrogate devices from different vendors. SNMP versions supported by ROS® are v1, v2c, and v3. SNMPv3 in particular provides security features such as authentication, privacy with data encryption (CBC-DES with 56-bit encryption key) and access control not present in earlier SNMP versions. ROS® also supports numerous standard MIBs (Management Information Base) allowing for easy integration with any network management system (NMS).

ROS® Features

ROS
Rugged Operating
System™

A feature of SNMP supported by ROS® is the ability to generate "traps" upon system events. RuggedNMS™, the RuggedCom management solution, can record traps from multiple devices providing a powerful network troubleshooting tool. It also provides a graphical visualization of the network and is fully integrated with all RuggedCom products.

SNTP (Simple Network Time Protocol)

SNTP automatically synchronizes the internal clock of all ROS® devices on the network. This allows for correlation of time stamped events for troubleshooting.

SCADA and Industrial Automation

ROS® contains features that optimize network performance and simplify switch management based on the unique requirements found in SCADA and industrial automation applications. Features such as Modbus TCP management for retrieval of switch data using the ubiquitous Modbus protocol and DHCP Option 82, a Rockwell Automation ODVA requirement for IP address assignment based on the location of the end device, provide capabilities not found in typical "commercial" or "office grade" Ethernet switches.

Port Based Network Access Control (802.1x)

ROS® supports the IEEE 802.1x standard that defines a mechanism for port-based network access control which provides a means of authenticating and authorizing devices attached to LAN ports.

Port Rate Limiting

ROS® supports configurable rate limiting per port to limit unicast and multicast traffic. This can be essential to managing precious network bandwidth for service providers. It also provides edge security for denial of service (DoS) attacks.

Broadcast Storm Filtering

Broadcast storms wreak havoc on a network and can cause attached devices to malfunction. This could be disastrous on a network with mission critical equipment. ROS® limits this by filtering broadcast frames with a user-defined threshold.

Link Fault Indication™

Some intelligent electronic devices (IEDs) have dual fiber optic ports with automatic failover to a backup port should the primary fail. ROS® ensures this mechanism works reliably under all failure modes by appropriately disabling link signals when required. ROS® also flushes learned MAC addresses to ensure the failover occurs quickly.

Port Mirroring

ROS® can be configured to duplicate all traffic on one port to a designated mirror port. When combined with a network analyzer, this can be a powerful troubleshooting tool.

Port Configuration and Status

ROS® allows individual ports to be 'hard' configured for speed, duplex, auto-negotiation, flow control and more. This allows proper connection with devices that do not negotiate or have unusual settings. Detailed status of ports with alarm and SNMP trap on link problems aid greatly in system troubleshooting.

Port Statistics and RMON (Remote Monitoring)

ROS® provides continuously updating statistics per port that provide both ingress and egress packet and byte counters as well as detailed error figures. Also provided is full support for the RMON statistics, history, alarms, and event groups. RMON allows for very sophisticated data collection, analysis and detection of traffic patterns.

Event Logging and Alarms

ROS® records all significant events to a non-volatile system log allowing forensic troubleshooting. Events include link failure and recovery, unauthorized access, broadcast storm detection, and self-test diagnostics among others. Alarms provide a snapshot of recent events that have yet to be acknowledged by the network administrator. An external hardware relay is de-energized during the presence of critical alarms allowing an external controller to react if desired.

HTML Web Browser and Telnet User Interfaces

ROS® provides a simple, intuitive user interface for configuration and monitoring via a standard graphical web browser or via Telnet. All system parameters include detailed on-line help to make setup a breeze. ROS®, presents a common look and feel and standardized configuration process allowing easy migration to other RuggedCom managed products.

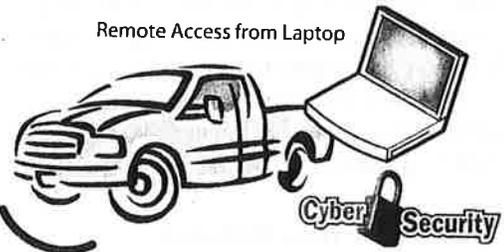
Configuration via ASCII Text File

All configuration parameters are stored in an ASCII formatted text file that can easily be transferred via TFTP or Xmodem. The configuration file can be saved for backup purposes and easily manipulated by a text editor. The same text file can be downloaded to the switch at a later date in order to re-configure or restore a previous configuration.

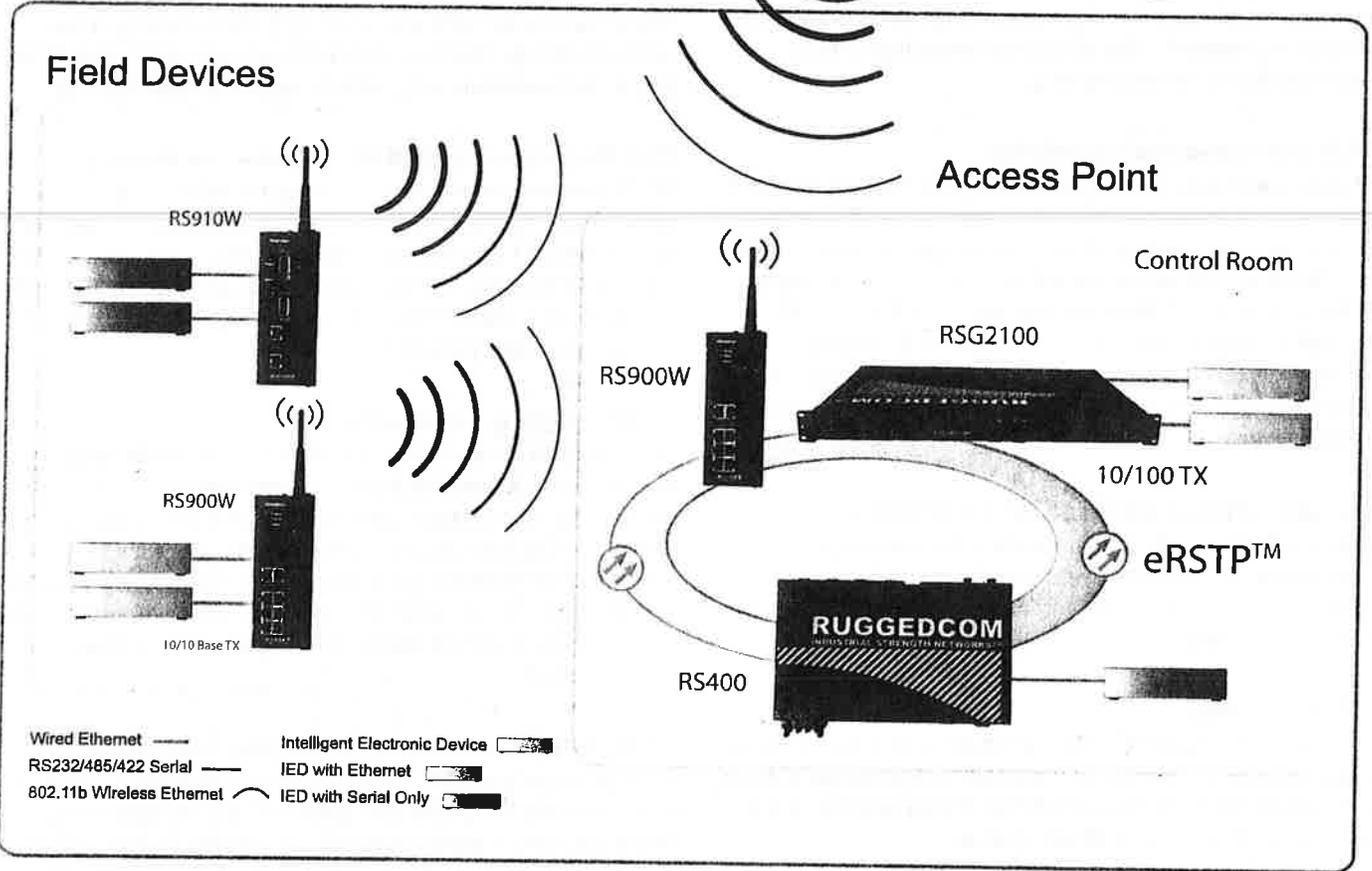
Command Line Interface (CLI)

A command line interface can be used in conjunction with remote shell to automate data retrieval, configuration updates, and firmware upgrades. A powerful SQL-like capability allows expert users the ability to selectively retrieve or manipulate any parameters the device has to offer.

Network Architecture



"Security Perimeter"



EMI and Environmental Type Tests

IEC 61850-3 EMI TYPE TESTS					
TEST	Description		Test Levels	Severity Levels	
IEC 61000-4-2	ESD	Enclosure Contact	+/- 8kV	4	
		Enclosure Air	+/- 15kV	4	
IEC 61000-4-3	Radiated RFI		Enclosure ports	20 V/m	Note 1
IEC 61000-4-4	Burst (Fast Transient)	Signal ports	+/- 4kV @ 2.5kHz	Note 1	
		D.C. Power ports	+/- 4kV	4	
		A.C. Power ports	+/- 4kV	4	
		Earth ground ports	+/- 4kV	4	
IEC 61000-4-5	Surge	Signal ports	+/- 4kV line-to-earth, +/- 2kV line-to-line	4	
		D.C. Power ports	+/- 2kV line-to-earth, +/- 1kV line-to-line	3	
		A.C. Power ports	+/- 4kV line-to-earth, +/- 2kV line-to-line	4	
IEC 61000-4-6	Induced (Conducted) RFI	Signal ports	10V	3	
		D.C Power ports	10V	3	
		A.C. Power ports	10V	3	
		Earth ground ports	10V	3	
IEC 61000-4-8	8 Magnetic Field		Enclosure ports	40 A/m continuous, 1000 A/m for 1 s 1000 A/m for 1 s	Note 1 5
IEC 61000-4-29	Voltage Dips & Interrupts	D.C. Power ports	30% for 0.1s, 60% for 0.1s, 100% for 0.05s	N/A	
IEC 61000-4-11		A.C. Power ports	30% for 1 period, 60% for 50 periods	N/A	
			100% for 5 periods, 100% for 50 periods	N/A	
IEC 61000-4-12	Damped Oscillatory	Signal ports	2.5kV common, 1kV diff. mode@1MHz	3	
		D.C. Power ports	2.5kV common, 1kV diff. mode@1MHz	3	
		A.C. Power ports	2.5kV common, 1kV diff. mode@1MHz	3	
IEC 61000-4-16	Mains Frequency Voltage	Signal ports	30V Continuous, 300V for 1s	4	
		D.C. Power ports	30V Continuous, 300V for 1s	4	
IEC 61000-4-17	Ripple on D.C. Power Supply	D.C. Power ports	10%	3	
IEC 60255-5	Dielectric Strength	Signal ports	2kVac (Fail-Safe Relay output)	N/A	
		D.C. Power ports	1.5kV DC	N/A	
		A.C. Power ports	2kVac	N/A	
IEC 60255-5	H.V. Impulse	Signal ports	5kV (Fail-Safe Relay output)	N/A	
		D.C. Power ports	5kV	N/A	
		A.C. Power ports	5kV	N/A	

IEEE 1613 (C37.90.x) EMI IMMUNITY TYPE TESTS ²				
Test	Description		Test Levels	
IEEE C37.90.3	ESD	Enclosure Contact	+/-2kV, +/-4kV, +/- 8kV	
		Enclosure Air	+/-4kV, +/-8kV, +/-15kV	
IEEE C37.90.2	Radiated RFI		Enclosure ports	35 V/m
IEEE C37.90.1	Fast Transient	Signal ports	+/- 4kV @ 2.5kHz	
		D.C. Power ports	+/- 4kV	
		A.C. Power ports	+/- 4kV	
		Earth ground ports ³	+/- 4kV	
IEEE C37.90.1	Oscillatory	Signal ports	2.5kV common mode @1MHz	
		D.C. Power ports	2.5kV common, 1kV diff. mode@1MHz	
		A.C. Power ports	2.5kV common, 1kV diff. mode@1MHz	
IEEE C37.90	H.V. Impulse	Signal ports	5kV (Fail-Safe Relay output)	
		D.C. Power ports	5kV	
		A.C. Power ports	5kV	
IEEE C37.90	Dielectric Strength	Signal ports	2kVac	
		D.C. Power ports	1.5kV DC	
		A.C. Power ports	2kVac	

Environmental Type Tests				
Test	Description		Test Levels	
IEC 60068-2-1	Cold Temperature	Test Ad	-40°C, 16 Hours	
IEC 60068-2-2	Dry Heat	Test Bd	+85°C, 16 Hours	
IEC 60068-2-30	Humidity (Damp Heat, Cyclic)	Test Db	95% (non-condensing), 55°C, 6 cycles	
IEC 60255-21-1	Vibration		2g @ (10 - 150) Hz	
IEC 60255-21-2	Shock		30g @ 11ms	

Technical Specifications

Power Supply

- Power Consumption: 10W Max
- 24VDC: 10-36VDC, 0.4A
- 48VDC: 36-72VDC, 0.2A
- HI Voltage AC/DC: 88-300VDC, 85-264VAC, 0.1A

Critical Alarm Relay

- Form-C failsafe contact relay: 1A@30VDC
- Physical
- Height: 7.4"
- Width: 2.6"
- Depth: 5.0"
- Weight: 2.7lbs
- Ingress Protection: IP40 (1mm objects)
- Enclosure: 20 AWG galvanized steel enclosure
- Mounting: DIN rail or panel mounted

Switch Properties

- Switching method: Store & Forward
- Switching latency: 8 us (100Mbps)
- Switching bandwidth: 1.8Gbps
- MAC address table size: 16kbytes
- Priority Queues: 4
- Frame buffer memory: 1 Mbit
- Simultaneous VLANs: 255
- VLAN ID Range: 1 to 4094
- IGMP and static multicast groups: 256
- Port rate limiting: 128kbps, 256, 512, 4, 8Mbps
- No head of line blocking

Approvals

- Hazardous Locations: Class 1, Division 2
- ISO: Designed and manufactured using a ISO9001: 2000 certified quality program
- CE Marking
- Emissions: FCC Part 15 (Class A), EN55022 (CISPR22 Class A)
- Safety: cCSAus (Compliant with CSA C22.2 No. 60950, UL 60950, EN60950)
- Laser Eye Safety (FDA/CDRH): Complies with 21 CFR Chapter1, Subchapter J.

EMI Immunity and Environmental Compliance

- IEC 61000-6-2 Industrial (Generic)
- IEC 61800-3 Industrial (Variable Speed Drive Systems)
- IEC 61850-3 Electric Utility Substations
- IEEE 1613 Electric Utility Substations
- NEMA TS 2 Traffic Control Equipment

Network Management

- HTTP graphical web-based, SSL (128-bit encryption)
- SNMP v1, v2c, v3 (56-bit encryption)
- Telnet, VT100, SSH/SFTP (128-bit encryption)
- Command Line Interface (CLI)
- RSA Key Management (1024 bit key)
- Authentication and Accounting - TACACS+ (encrypted), RADIUS client, PPP

Warranty

- 5 Years - Applicable to design or manufacturing related product defects.

IEEE Compliance

- 802.3-10BaseT
- 802.3u-100BaseTX, 100BaseFX
- 802.3x-Flow Control
- 802.3z-1000BaseLX
- 802.3ab-1000BaseTX
- 802.3ad-Link Aggregation
- 802.1D-MAC Bridges
- 802.1D-Spanning Tree Protocol
- 802.1p-Class of Service
- 802.1Q-VLAN Tagging
- 802.1D-2004-Rapid Spanning Tree Protocol
- 802.1x-Port Based Network Access Control
- 802.11 b/g WLAN
- 802.11i Security 128-bit AES encryption
- 802.1Q-2005 (formerly 802.1s) MSTP

IETF RFC Compliance

- RFC768-UDP
- RFC783-TFTP
- RFC791-IP
- RFC792-ICMP
- RFC793-TCP
- RFC826-ARP
- RFC854-Telnet
- RFC894-IP over Ethernet
- RFC1112-IGMP v1
- RFC1519-CIDR
- RFC1541-DHCP (client)
- RFC2030-SNTP
- RFC2068-HTTP
- RFC2236-IGMP v2
- RFC2284-EAP
- RFC2475-Differentiated Services
- RFC2865-RADIUS
- RFC3414-SNMPv3-USM
- RFC3415-SNMPv3-VACM

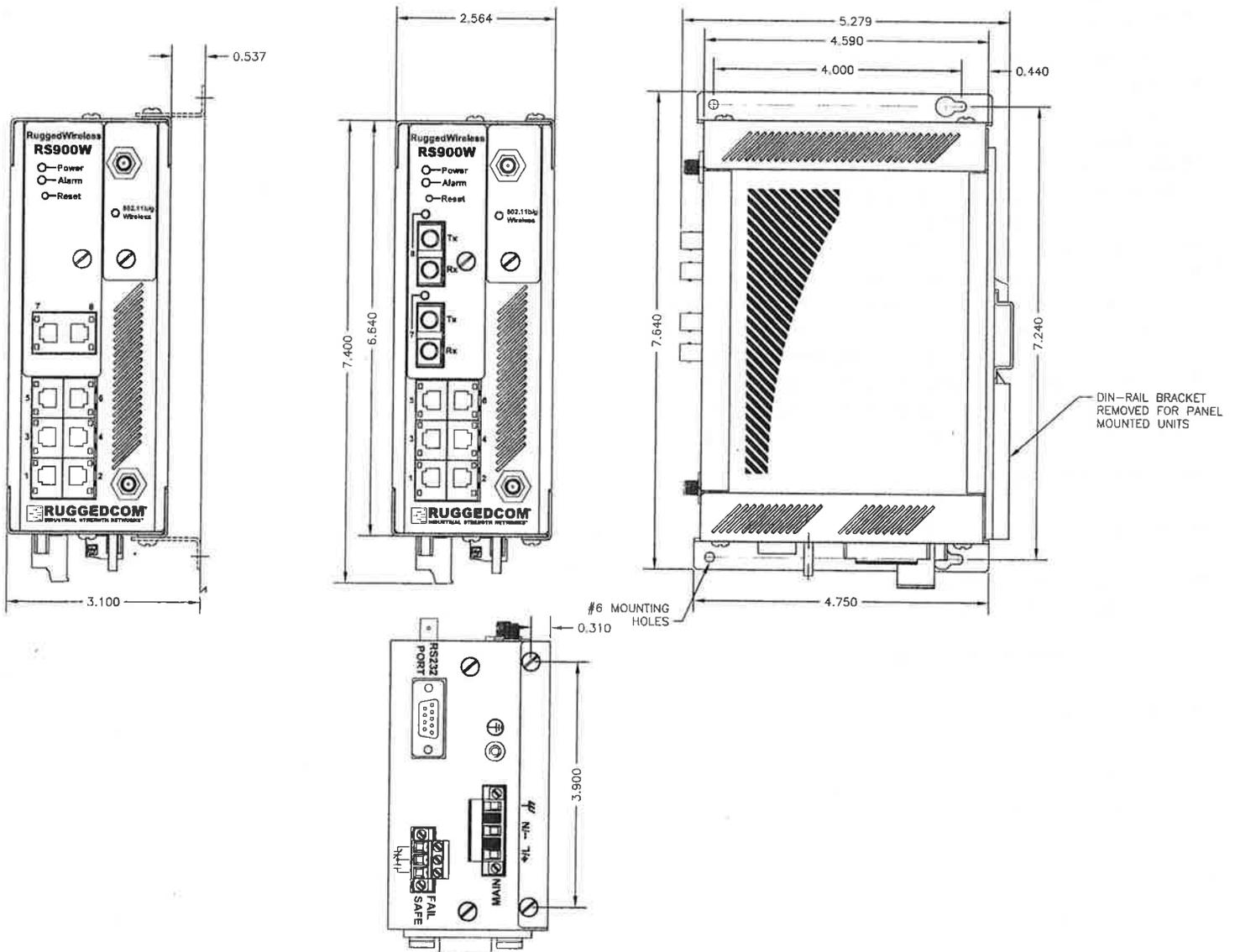
IETF SNMP MIBS

- RFC1493-BRIDGE-MIB
- RFC1907-SNMPv2-MIB
- RFC2012-TCP-MIB
- RFC2013-UDP-MIB
- RFC2578-SNMPv2-SMI
- RFC2579-SNMPv2-TC
- RFC2819-RMON-MIB
- RFC2863-IF-MIB
- Draft-ietf-bridge-rstpmib-03-BRIDGE-MIB
- Draft-ietf-bridge-bridgemib-smiv2-03-RSTP-MIB
- IANAifType-MIB

Fiber Specifications and Mechanical Drawing

Parameter	Fiber Optical Specifications			
	Multimode		Singlemode	
Mode	Multimode		Singlemode	
Connectors	MTRJ / ST / SC / LC		LC / SC / ST	
Typical Dist. (km)	2		20	90
Optical Wavelength (nm)	1310		1310	
Cable Size Core/Cladding (um)	50 or 62.5/125		8 or 9/125	
Tx Power (dBm)	-15.7	-15.5	-2.5	2.5
Rx Sensitivity (dBm)	-33.5	-32	-37	-39
Typical Budget (dB)	17	16.5	34.5	41.5

Longer segment lengths dependent on fiber specifications. Consult factory for further details.



Order Code

RS900W - - - - - -
 PS M P7 P8 WW MOD

Base Unit includes 802.11i wireless interface and 6 10/100BaseTx Ethernet ports.

PS: Power Supply

- 24 = 24VDC (10-36VDC)
- 48 = 48VDC (36-72VDC)
- HI = 85-264VAC or 88-300VDC
- M: Mounting Option
- D = DIN Rail
- P = Panel Mount
- N = None

P7, P8: Additional Ethernet Ports

- XX = None
- TX = 1 x 10/100BaseTX
(if selected, P7 & P8 must both be TX)
- MJ = 1 x 100BaseFX – Multimode, MTRJ connector
- MC = 1 x 100BaseFX – Multimode, SC connector
- MT = 1 x 100BaseFX – Multimode, ST connector
- ML = 1 x 100BaseFX – Multimode, LC connector
- T2 = 1 x 100BaseFX – Singlemode, ST connector, 20km
- L2 = 1 x 100BaseFX – Singlemode, LC connector, 20km
- L5 = 1 x 100BaseFX – Singlemode LC connector, 50km
- L9 = 1 x 100BaseFX – Singlemode LC connector, 90km
- C2 = 1 x 100BaseFX – Singlemode SC connector, 20km
- C5 = 1 x 100BaseFX – Singlemode SC connector, 50km
- C9 = 1 x 100BaseFX – Singlemode SC connector, 90km

WW: Wireless Options

- W1 = 802.11 – US (North America)
- W2 = 802.11 – EU (European Union)
- W3 = 802.11 – CH (China) (coming soon)
- W4 = 802.11 – AU (Australia)
- W6 = 802.11 – IN (India)

MOD: Manufacturing Modifications

- XX = None
- C01 = Conformal Coating

Power Cables

- 43-10-0008 - Bare-wire
- 43-10-0007 - with lugs

RuggedCom Inc.

300 Applewood Crescent, Unit 1,
Concord, Ontario, Canada L4K 5C7

Tel: +1 (905) 856-5288 **Fax:** +1 (905) 856-1995
Toll Free: 1 (888) 264-0006

Technical Support Center

Toll Free (USA & Canada): 1 (866) 922-7975

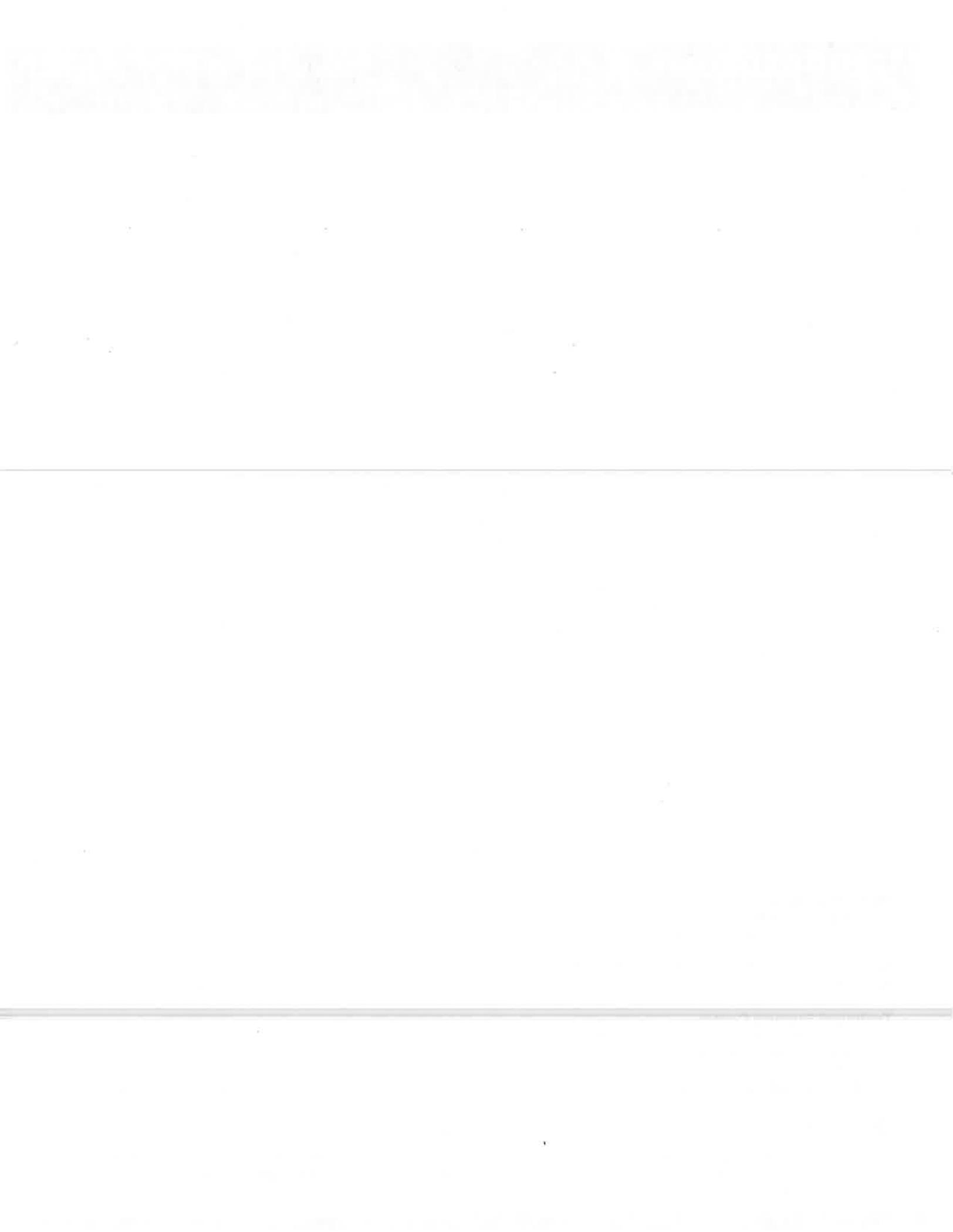
International: +1 (905) 856-5288

USA: +1 (954) 922-7975

E-mail: Support@RuggedCom.com

© 2010 RuggedCom Inc.
RuggedSwitch is a registered trademark of RuggedCom Inc.
Ethernet is a trademark of the Xerox Corporation.
Patent Pending
All specifications in this document are subject to change without notice.
Rev 1r — 04/27/10

For additional information on our products and services, please
visit our web site at: www.RuggedCom.com



Switch

**EoVDSL**
Ethernet over VDSL**eRSTP™****ROS**
Rugged Operating System™**128 bit**

The RuggedVDSL RS930L is a 6 port industrially hardened, fully managed Ethernet switch supporting Ethernet over VDSL (EoVDSL) allowing up to 5km LAN segments over telephone grade cable (or other legacy serial cabling) at up to 35Mbps. The RS930L allows for aggregation of Ethernet enabled devices at a remote location back to the central control room with EoVDSL using existing telephone grade cable (or other legacy serial cabling). The RS930L can be configured with dual EoVDSL interfaces and is ideal for ring or loop network architecture and is the perfect solution for bringing Ethernet networking to applications where existing telephone wiring is already present, thus saving the considerable cost of installing new network cabling.

Designed to operate reliably in harsh industrial environments the RS930L provides a high level of immunity to electromagnetic interference and heavy electrical surges typical of environments found in electric utility substations, factory floors or in curb side traffic control cabinets. An operating temperature range of -40°C to +85°C coupled with hazardous location certification, optional conformal coating and a galvanized steel enclosure allows the RS930L to be placed in almost any location.

The RS930L is packaged in a compact, galvanized steel enclosure that allows either DIN or panel mounting for efficient use of cabinet space. The RS930L provides an integrated power supply with a wide range of voltages (88-300VDC or 85-264VAC) for worldwide operability or dual-input, reversible polarity, 12VDC, 24VDC and 48VDC power supply inputs for high availability applications requiring backup power inputs.

The RS930L's superior ruggedized design coupled with the embedded Rugged Operating System (ROS®) provides improved system reliability and advanced networking features making it ideally suited for creating Ethernet networks for mission-critical, real-time, control applications.

All RuggedCom products are backed by a five year warranty and unsurpassed technical support.

Features and Benefits

Ethernet Ports

- Up to two Ethernet over VDSL (EoVDSL) interfaces
- 6 fast Ethernet ports (10/100BaseTX)

Ethernet Over VDSL Port Characteristics:

- Up to 5km LAN segments
- Symmetric data rates up to 35Mbps
- Asymmetric data rates up to 40Mbps
- Automatically selects fastest data rate based on distance and quality of cable
- Software selectable to be master or slave
- Frequency Division Multiplexing (FDM)

Cyber Security Features

- Multi-level user passwords
- SSH/SSL (128-bit encryption)
- Enable/disable ports, MAC based port security
- Port based network access control (802.1x)
- VLAN (802.1Q) to segregate and secure network traffic
- RADIUS centralized password management
- SNMPv3 authentication and 56-bit encryption

RuggedRated™ for Reliability in Harsh Environments

- Immunity to EMI and heavy electrical surges
 - Meets IEEE 1613 (electrical utility substations)
 - Exceeds IEEE 61850-3 (electrical utility substations)
 - Exceeds IEC 61800-3 (variable speed drive systems)
 - Exceeds IEC 61000-6-2 (generic industrial)
 - Exceeds NEMA TS-2 (traffic control equipment)
- -40 to +85°C operating temperature (no fans)
- 20 AWG galvanized steel enclosure
- DIN or panel mounting options provide secure mechanical reliability
- Hazardous Locations: Class 1, Division 2

Rugged Operating System (ROS®) Features

- Simple plug and play operation - automatic learning, negotiation, and crossover detection
- MSTP (802.1Q-2005, formerly 802.1s)
- RSTP (802.1D-2004) and Enhanced Rapid Spanning Tree (eRSTP™) network fault recovery (<5ms)
- Quality of Service (802.1p) for real-time traffic
- VLAN (802.1Q) with double tagging and GVRP support
- Link aggregation (802.3ad)
- IGMP Snooping for multicast filtering
- Port Rate Limiting and Broadcast Storm Limiting
- Port configuration, status, statistics, mirroring, security
- SNTP time synchronization (client and server)

Universal Power Supply Options

- Fully integrated power supply (no external adaptors)
- Universal high-voltage range: 88-300VDC or 85-264VAC
- Dual low-voltage DC inputs: 24VDC (10-36VDC) or 48VDC (36-72VDC)
- Terminal blocks for reliable maintenance free connections
- CSA/UL 60950 safety approved to +85°C

RUGGEDCOM
ISO 9001
REGISTERED

RuggedSwitch® RS930L

Rugged Construction:

- ▶ 20 AWG. galvanized steel enclosure
- ▶ Conformal coating (optional)

Operating Temperature

- ▶ -40°C to +85°C
- ▶ No Fans

Integrated Power Supply

- ▶ Universal high-voltage range: 88-300VDC or 85 - 264VAC
- ▶ Popular low voltage DC ranges: 24VDC, 48VDC
- ▶ Dual Isolated DC power inputs

Mounting Options

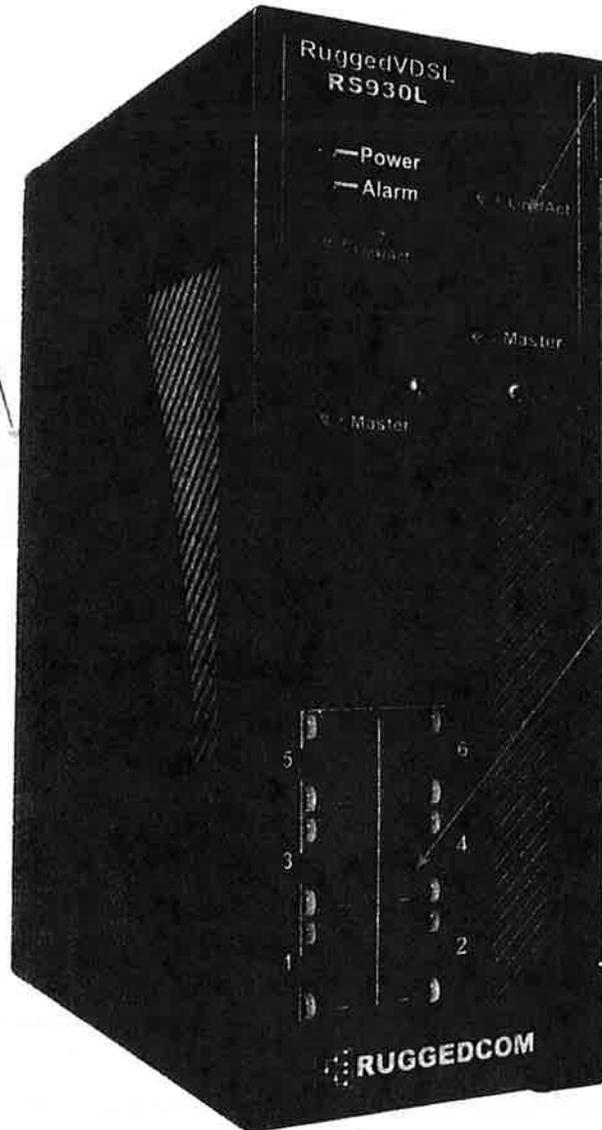
- ▶ Din Rail
- ▶ Panel Mount

EoVDSL Port

- ▶ Two EoVDSL ports
- ▶ RJ11 connector
- ▶ Symmetrics data rates up to 35Mbps

Fast Ethernet Ports:

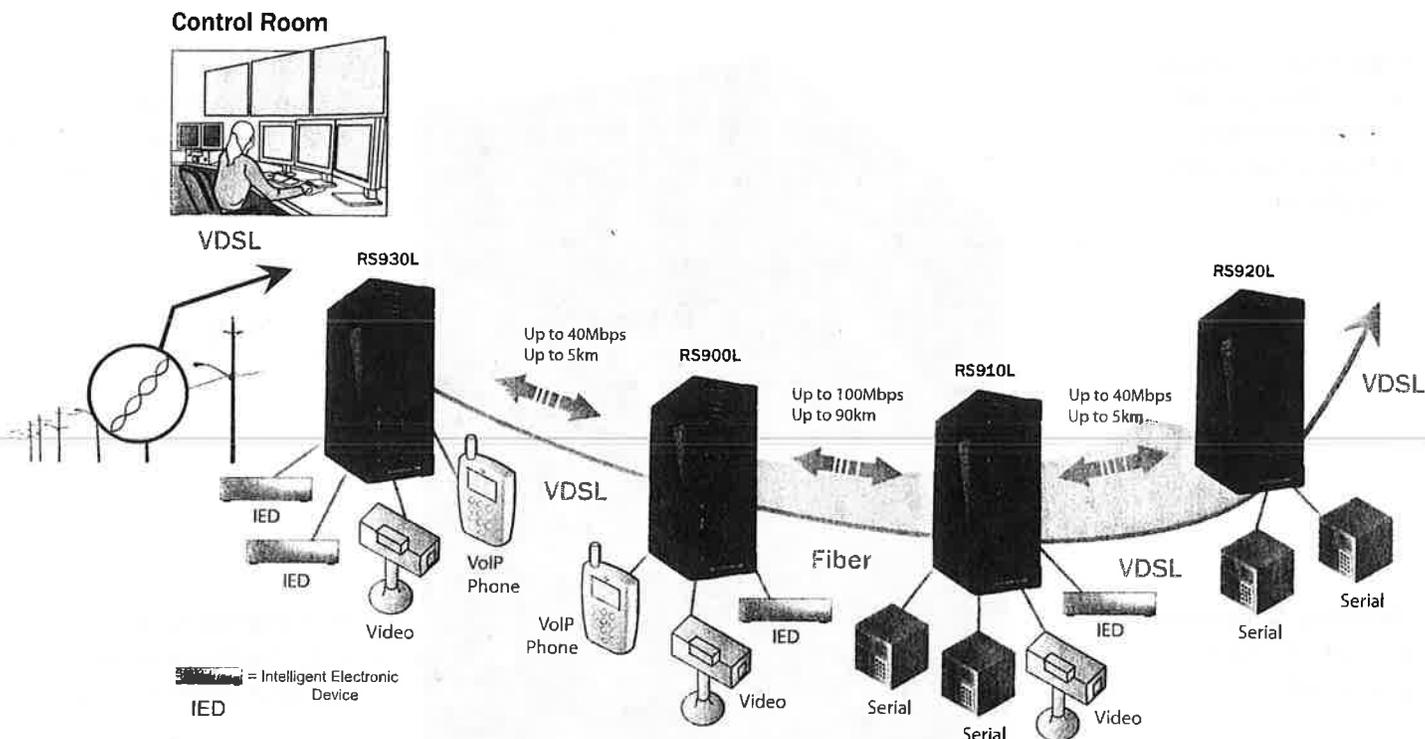
- ▶ 6 - Fast Ethernet Ports (10/100BaseTX)



Critical Alarm Relay

- ▶ Form-C failsafe contact relay: 1A@30VDC

Network Architecture



NOTE: Call for availability for the RS910L, RS920L and RS930L products.

RS900L

8 Port Managed Switch with Ethernet over VDSL Uplink

- 1 Ethernet over VDSL interface
- Up to 8 fast Ethernet ports
- Copper and fiber options
- Use to aggregate Ethernet enabled devices at remote locations back to a central point

RS910L

Serial and Ethernet Device Server with Ethernet over VDSL Uplink

- 1 Ethernet over VDSL interface
- 2 RS485/RS422/RS232 Serial ports (DB9 or RJ45)
- Optional 2 Ethernet ports – copper or fiber
- Use to network enable legacy serial devices at remote locations

RS920L

Dual Port Ethernet over VDSL with Integrated Dual Port Serial Server

- 2 Ethernet over VDSL interfaces
- 2 RS485/RS422/RS232 Serial ports (DB9 or RJ45)
- Use as a serial drop point for a ring or busnetwork topology

RS930L

6 Port Managed Switch with Dual Port Ethernet over VDSL Uplink

- 2 Ethernet over VDSL interfaces
- 6 Port Managed Ethernet Switch - copper interfaces
- Use as an Ethernet drop point for a ring or bus network topology
- Span over hundreds of kilometers using existing telephone grade cables

ROS® Features



Serial IP Encapsulation

Many 'legacy' devices (RTU, PLC, IED, etc.) only support serial communications via RS232, RS422 or RS485. ROS® encapsulates the serial data within a TCP connection allowing these devices to be reached via an IP network. A wide range of baud rates, frame packetization options, and diagnostics allows any serial protocol to function. The RS930L has specific support for the following serial protocols:

- Raw Socket serial encapsulation
- Modbus TCP (client and server)
- DNP 3
- WIN and TIN
- Microlok

MODBUS TCP

The Modbus protocol is ubiquitous in the industrial control and automation world. ROS® converts Modbus RTU master/slave serial data packets to Modbus TCP client/server packets for transmission over an IP network. This allows communications to Modbus RTU slaves via Ethernet and allows multiple masters to poll the same slave device.

Cyber Security

Cyber security is an urgent issue in many industries where advanced automation and communications networks play a crucial role in mission critical applications and where high reliability is of paramount importance. Key ROS® features that address security issues at the local area network level include:

- **Passwords** - Multi-level user passwords secures switch against unauthorized configuration
- **SSH / SSL** - Extends capability of password protection to add 128-bit encryption of passwords and data as they cross the network
- **Enable/Disable Ports** - Capability to disable ports so that traffic can not pass
- **802.1Q VLAN** - Provides the ability to logically segregate traffic between predefined ports on switches
- **MAC Based Port Security** - The ability to secure ports on a switch so only specific Devices / MAC addresses can communicate via that port
- **802.1x Port Based Network Access Control** - The ability to lock down ports on a switch so that only authorized clients can communicate via this port
- **RADIUS** - authentication service using MD5 hash and providing centralized password management
- **SNMPv3** - encrypted authentication access security and data encryption (CBC-DES with 56-bit encryption key)
- **Secure Socket Layer** - Web-based management using SSL with data encryption (128-bit encryption key)
- **RSA** - 1024 bit key for key management and key exchange
- **TACACS+** - Terminal Access Control and Accounting Services Client provides encrypted authentication and authorization

- **Point to Point (PPP)** - using CHAP (MD5 Hash) authentication service
- **SFTP** - Secure File Transfer Protocol using SSH encryption

The ROS® cyber security features are included to help address the various industry specific security standards such as NERC CIP, ISA S99, AGA 12, IEC 62443, ISO 17799:2005 and PCSRF SPP-ICS.

Enhanced Rapid Spanning Tree Protocol (eRSTP™)

RuggedCom eRSTP™ allows the creation of fault-tolerant ring and mesh Ethernet networks that incorporate redundant links that are 'pruned' to prevent loops. eRSTP™ yields worst-case fault recovery¹ of 5ms times the 'bridge diameter' and allows rings of up to 160 switches. For example, a ring of ten switches will have fault recovery times under 50ms. eRSTP™ implements both STP and RSTP to ensure interoperability with commercial switches unlike other proprietary 'ring' solutions.

Quality of Service (IEEE 802.1p)

Some networking applications such as real-time control or VoIP (voice over IP) require predictable arrival times for Ethernet frames. Switches can introduce latency in times of heavy network traffic due to the internal queues that buffer frames and then transmit on a first come first serve basis. ROS® supports 'Class of Service' in accordance with IEEE 802.1p that allows time critical traffic to jump ahead to the front of the queue thus minimizing latency and reducing jitter to allow such demanding applications to operate correctly. ROS® allows priority classification by port, tags, MAC address, and IP type of service (ToS).

A configurable "weighted fair queuing" algorithm controls how frames are emptied from the queues.

VLAN (IEEE 802.1Q)

Virtual local area networks (VLAN) allow the segregation of a physical network into separate logical networks with independent broadcast domains. A measure of security is provided since hosts can only access other hosts on the same VLAN and traffic storms are isolated. ROS® supports 802.1Q tagged Ethernet frames and VLAN trunks. Port based classification allows legacy devices to be assigned to the correct VLAN. GVRP support is also provided to simplify the configuration of the switches on the VLAN.

Link Aggregation (802.3ad)

The link aggregation feature provides the ability to aggregate several Ethernet ports into one logical link (port trunk) with higher bandwidth. This provides an inexpensive way to set up a high speed backbone to improve network bandwidth. This feature is also known as "port trunking", "port bundling", "port teaming", and "Ethernet trunk".

ROS® Features



IGMP Snooping

ROS® uses IGMP snooping (Internet Group Management Protocol v1&v2) to intelligently forward or filter multicast traffic streams (e.g. MPEG video) to or from hosts on the network. This reduces the load on network trunks and prevents packets from being received on hosts that are not involved. ROS® has a very powerful implementation of IGMP snooping that:

- Can be enabled on a per VLAN basis.
- Detects and filters all multicast streams regardless of whether subscribers exist.
- Supports "router-less" operation by supporting an "active" mode.
- Restores traffic streams immediately after an RSTP topology change.

SNMP (Simple Network Management Protocol)

SNMP provides a standardized method for network management stations the ability to interrogate devices from different vendors. SNMP versions supported by ROS® are v1, v2c, and v3. SNMPv3 in particular provides security features such as authentication, privacy with data encryption (CBC-DES with 56-bit encryption key) and access control not present in earlier SNMP versions. ROS® also supports numerous standard MIBs (Management Information Base) allowing for easy integration with any network management system (NMS). A feature of SNMP supported by ROS® is the ability to generate "traps" upon system events. RuggedNMS™, the RuggedCom management solution, can record traps from multiple devices providing a powerful network troubleshooting tool. It also provides a graphical visualization of the network and is fully integrated with all RuggedCom products.

SCADA and Industrial Automation

ROS® contains features that optimize network performance and simplify switch management based on the unique requirements found in SCADA and industrial automation applications. Features such as Modbus TCP management for retrieval of switch data using the ubiquitous Modbus protocol and DHCP Option 82, a Rockwell Automation ODVA requirement for IP address assignment based on the location of the end device, provide capabilities not found in typical "commercial" or "office grade" Ethernet switches.

Port Based Network Access Control (802.1x)

ROS® supports the IEEE 802.1x standard that defines a mechanism for port-based network access control which provides a means of authenticating and authorizing devices attached to LAN ports.

Port Rate Limiting

ROS® supports configurable rate limiting per port to limit unicast and multicast traffic. This can be essential to managing precious network bandwidth for service providers. It also provides edge security for denial of service (DoS) attacks.

Broadcast Storm Filtering

Broadcast storms wreak havoc on a network and can cause attached devices to malfunction. This could be disastrous on a network with mission critical equipment. ROS® limits this by filtering broadcast frames with a user-defined threshold.

Port Mirroring

ROS® can be configured to duplicate all traffic on one port to a designated mirror port. When combined with a network analyzer, this can be a powerful troubleshooting tool. Port Configuration and Status ROS® allows individual ports to be 'hard' configured for speed, duplex, auto-negotiation, flow control and more. This allows proper connection with devices that do not negotiate or have unusual settings. Detailed status of ports with alarm and SNMP trap on link problems aid greatly in system troubleshooting.

Port Statistics and RMON (Remote Monitoring)

ROS® provides continuously updating statistics per port that provide both ingress and egress packet and byte counters as well as detailed error figures. Also provided is full support for the RMON statistics, history, alarms, and event groups. RMON allows for very sophisticated data collection, analysis and detection of traffic patterns.

Event Logging and Alarms

ROS® records all significant events to a non-volatile system log allowing forensic troubleshooting. Events include link failure and recovery, unauthorized access, broadcast storm detection, and self-test diagnostics among others. Alarms provide a snapshot of recent events that have yet to be acknowledged by the network administrator. An external hardware relay is de-energized during the presence of critical alarms allowing an external controller to react if desired.

HTML Web Browser and Telwexpert users the ability to selectively retrieve or manipulate any parameters the device has to offer.

¹ eRSTP fault recovery times may be approximated as follows:

For 100 Mbps, fault recovery performance is <5ms/hop

For 1,000 Mbps, fault recovery performance is <5ms/hop + 20ms

EMI and Environmental Type Tests

IEC 61850-3 EMI TYPE TESTS				
TEST	Description	Test Levels	Severity Levels	
IEC 61000-4-2	ESD	Enclosure Contact	+/- 8kV	4
		Enclosure Air	+/- 15kV	4
IEC 61000-4-3	Radiated RFI	Enclosure ports	20 V/m	Note 1
IEC 61000-4-4	Burst (Fast Transient)	Signal ports	+/- 4kV @ 2.5kHz	Note 1
		D.C. Power ports	+/- 4kV	4
		A.C. Power ports	+/- 4kV	4
		Earth ground ports	+/- 4kV	4
IEC 61000-4-5	Surge	Signal ports	+/- 4kV line-to-earth, +/- 2kV line-to-line	4
		D.C. Power ports	+/- 2kV line-to-earth, +/- 1kV line-to-line	3
		A.C. Power ports	+/- 4kV line-to-earth, +/- 2kV line-to-line	4
IEC 61000-4-6	Induced (Conducted) RFI	Signal ports	10V	3
		D.C Power ports	10V	3
		A.C. Power ports	10V	3
		Earth ground ports	10V	3
IEC 61000-4-8	8 Magnetic Field	Enclosure ports	40 A/m continuous, 1000 A/m for 1 s 1000 A/m for 1 s	Note 1 5
IEC 61000-4-29	Voltage Dips & Interrupts	D.C. Power ports	30% for 0.1s, 60% for 0.1s, 100% for 0.05s	N/A
IEC 61000-4-11		A.C. Power ports	30% for 1 period, 60% for 50 periods	N/A
			100% for 5 periods, 100% for 50 periods	N/A
IEC 61000-4-12	Damped Oscillatory	Signal ports	2.5kV common, 1kV diff. mode@1MHz	3
		D.C. Power ports	2.5kV common, 1kV diff. mode@1MHz	3
		A.C. Power ports	2.5kV common, 1kV diff. mode@1MHz	3
IEC 61000-4-16	Mains Frequency Voltage	Signal ports	30V Continuous, 300V for 1s	4
		D.C. Power ports	30V Continuous, 300V for 1s	4
IEC 61000-4-17	Ripple on D.C. Power Supply	D.C. Power ports	10%	3
IEC 60255-5	Dielectric Strength	Signal ports	2kVac (Fail-Safe Relay output)	N/A
		D.C. Power ports	1.5kV DC	N/A
		A.C. Power ports	2kVac	N/A
IEC 60255-5	H.V. Impulse	Signal ports	5kV (Fail-Safe Relay output)	N/A
		D.C. Power ports	5kV	N/A
		A.C. Power ports	5kV	N/A

IEEE 1613 (C37.90.x) EMI IMMUNITY TYPE TESTS ²			
Test	Description	Test Levels	
IEEE C37.90.3	ESD	Enclosure Contact	+/-2kV, +/-4kV, +/- 8kV
		Enclosure Air	+/-4kV, +/-8kV, +/-15kV
IEEE C37.90.2	Radiated RFI	Enclosure ports	35 V/m
IEEE C37.90.1	Fast Transient	Signal ports	+/- 4kV @ 2.5kHz
		D.C. Power ports	+/- 4kV
		A.C. Power ports	+/- 4kV
		Earth ground ports ³	+/- 4kV
IEEE C37.90.1	Oscillatory	Signal ports	2.5kV common mode @1MHz
		D.C. Power ports	2.5kV common, 1kV diff. mode@1MHz
		A.C. Power ports	2.5kV common, 1kV diff. mode@1MHz
IEEE C37.90	H.V. Impulse	Signal ports	5kV (Fail-Safe Relay output)
		D.C. Power ports	5kV
		A.C. Power ports	5kV
IEEE C37.90	Dielectric Strength	Signal ports	2kVac
		D.C. Power ports	1.5kV DC
		A.C. Power ports	2kVac

Environmental Type Tests			
Test	Description	Test Levels	
IEC 60068-2-1	Cold Temperature	Test Ad	-40°C, 16 Hours
IEC 60068-2-2	Dry Heat	Test Bd	+85°C, 16 Hours
IEC 60068-2-30	Humidity (Damp Heat, Cyclic)	Test Db	95% (non-condensing), 55°C, 6 cycles
IEC 60255-21-1	Vibration		2g @ (10 - 150) Hz
IEC 60255-21-2	Shock		30g @ 11mS

Notes:
 1. Ruggedcom specified severity levels
 2. Meets Class 2 requirements for an all fiber configuration. Class 1 for copper ports.

Technical Specifications

Power Supply

- Power Consumption: 10W Max
- 24VDC: 10-36VDC, 0.4A
- 48VDC: 36-72VDC, 0.2A
- HI Voltage AC/DC: 88-300VDC, 85-264VAC, 0.1A

Critical Alarm Relay

- Form-C failsafe contact relay: 1A@30VDC

Physical

- Height: 7.4" / 18.8cm
- Width: 2.6" / 6.6cm
- Depth: 5.0" / 12.7cm
- Weight: 2.7lbs / 1.22kg
- Ingress Protection: IP40 (1mm objects)
- Enclosure: 20 AWG galvanized steel enclosure
- Mounting: DIN rail or panel mounted

Switch Properties

- Switching method: Store & Forward
- Switching latency: 8 us (100Mbps)
- Switching bandwidth: 1.8Gbps
- MAC address table size: 16kbytes
- Priority Queues: 4
- Frame buffer memory: 1 Mbit
- Simultaneous VLANs: 255
- VLAN ID Range: 1 to 4094
- IGMP and static multicast groups: 256
- Port rate limiting: 128kbps, 256, 512, 4, 8Mbps
- No head of line blocking

Approvals

- ISO: Designed and manufactured using a ISO9001: 2000 certified quality program
- CE Marking
- Emissions: FCC Part 15 (Class A), EN55022 (CISPR22 Class A)
- Safety: cCSAus (Compliant with CSA C22.2 No. 60950, UL 60950, EN60950)
- Laser Eye Safety (FDA/CDRH): Complies with 21 CFR Chapter1, Subchapter J.
- Hazardous Locations: Class 1, Division 2

EMI Immunity and Environmental Compliance

- IEC 61000-6-2 Industrial (Generic)
- IEC 61800-3 Industrial (Variable Speed Drive Systems)
- IEC 61850-3 Electric Utility Substations
- IEEE 1613 Electric Utility Substations
- NEMA TS 2 Traffic Control Equipment

Network Management

- HTTP graphical web-based, SSL (128-bit encryption)
- SNMP v1, v2c, v3 (56-bit encryption)
- Telnet, VT100, SSH/SFTP (128-bit encryption)
- Command Line Interface (CLI)
- RSA Key Management (1024 bit key)
- Authentication and Accounting - TACACS+ (encrypted), RADIUS client, PPP

Warranty

- 5 Years-Applicable to design or manufacturing related product defects.

IEEE Compliance

- 802.3-10BaseT
- 802.3u-100BaseTX, 100BaseFX
- 802.3x-Flow Control
- 802.3z-1000BaseLX
- 802.3ab-1000BaseTX
- 802.3ad-Link Aggregation
- 802.1D-MAC Bridges
- 802.1D-Spanning Tree Protocol
- 802.1p-Class of Service
- 802.1Q-VLAN Tagging
- 802.1D-2004 -Rapid Spanning Tree Protocol
- 802.1x-Port Based Network Access Control
- 802.1Q-2005 (formerly 802.1s) MSTP

IETF RFC Compliance

- RFC768-UDP
- RFC783-TFTP
- RFC791-IP
- RFC792-ICMP
- RFC793-TCP
- RFC826-ARP
- RFC854-Telnet
- RFC894-IP over Ethernet
- RFC1112-IGMP v1
- RFC1519-CIDR
- RFC1541-DHCP (client)
- RFC2030-SNTP
- RFC2068-HTTP
- RFC2236-IGMP v2
- RFC2284-EAP
- RFC2475-Differentiated Services
- RFC2865-RADIUS
- RFC3414-SNMPv3-USM
- RFC3415-SNMPv3-VACM

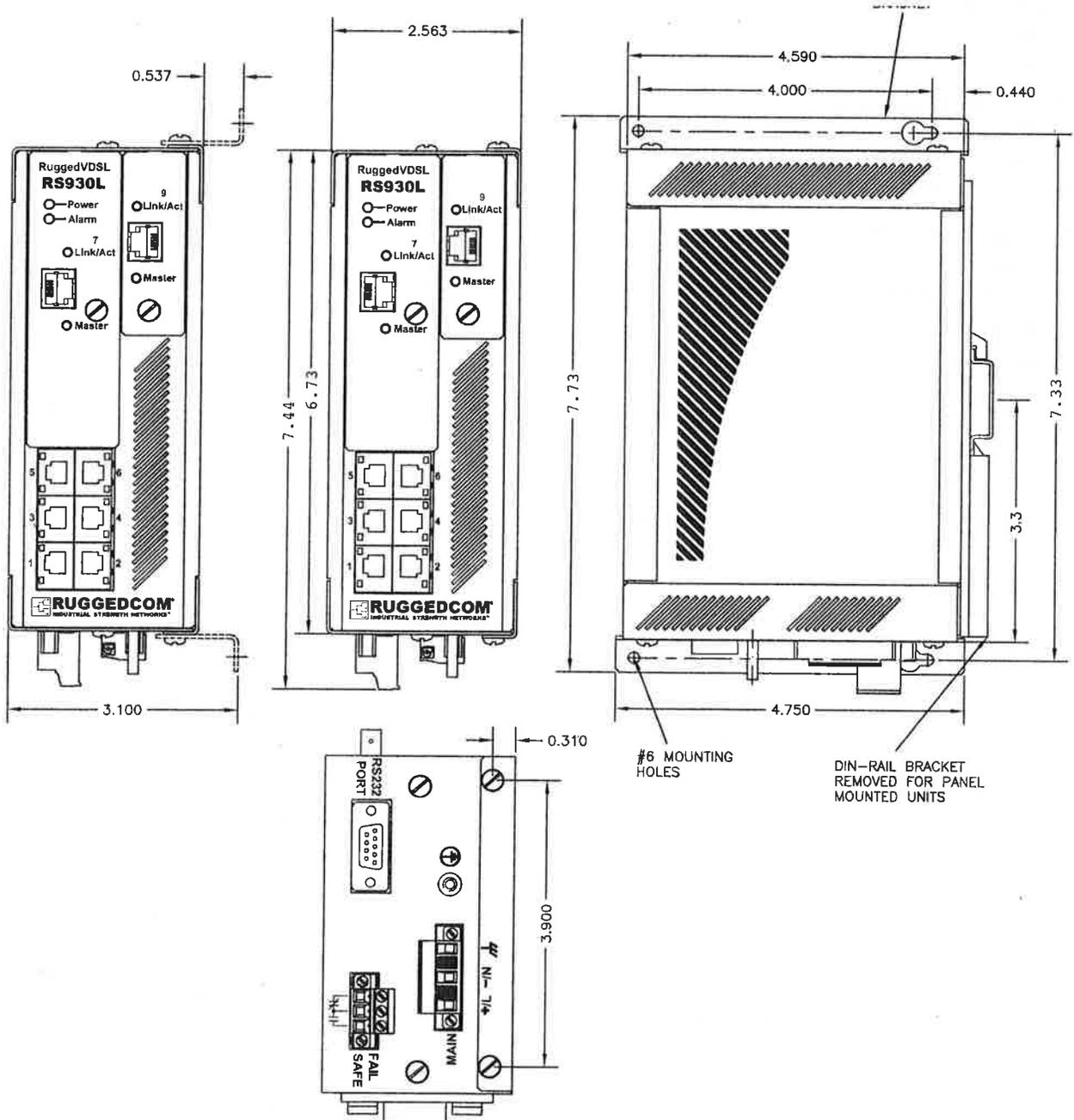
IETF SNMP MIBS

- RFC1493-BRIDGE-MIB
- RFC1907-SNMPv2-MIB
- RFC2012-TCP-MIB
- RFC2013-UDP-MIB
- RFC2578-SNMPv2-SMI
- RFC2579-SNMPv2-TC
- RFC2819-RMON-MIB
- RFC2863-IF-MIB
- draft-ietf-bridge-rstpmib-03-BRIDGE-MIB
- draft-ietf-bridge-bridgemib-smiv2-03-RSTP-MIB
- IANAifType-MIB

Fiber Specifications and Mechanical Drawing

Parameter	Fiber Optical Specifications			
	Multimode		Singlemode	
Mode	Multimode		Singlemode	
Connectors	MTRJ / ST / SC		LC / SC / ST	
Typical Dist. (km)	2	20	50	90
Optical Wavelength (nm)	1310		1310	
Cable Size Core/Cladding (um)	50 or 62.5/125		8 or 9/125	
Tx Power (dBm)	-15.7	-15.5	-2.5	2.5
Rx Sensitivity (dBm)	-33.5	-32	-37	-39
Typical Budget (dB)	17	16.5	34.5	41.5

Longer segment lengths dependent on fiber specifications. Consult factory for further details.



Order Codes

RS930L - - - - -
 PS M VV1 VV2 MOD

Base Unit includes 6 10/100 BaseTX Ethernet Ports

PS: Power Supply

- 24 = 24VDC (10-36VDC)
- 48 = 48VDC (36-72VDC)
- HI = 87-264VAC OR 88-300VDC

M: Mounting Option

- D = DIN Rail
- P = Panel Mount
- N = None

VV1, VV2: VDSL Interface

- V1 = Standard reach (<2.5km)
- V2 = Long Reach (5km) Master / CO
- V3 = Long Reach (5km) / CPE

MOD: Manufacturing Modifications

- XX = None
- C01 = Conformal Coating

Power Cables

- 43-10-0008 - Bare-wire
- 43-10-0007 - with lugs

RuggedCom Inc.

300 Applewood Crescent, Unit 1,
Concord, Ontario, Canada L4K 5C7

Tel: +1 (905) 856-5288 **Fax:** +1 (905) 856-1995

Toll Free: 1 (888) 264-0006

Technical Support Center

Toll Free (USA & Canada): 1 (866) 922-7975

International: +1 (905) 856-5288

USA: +1 (954) 922-7975

E-mail: Support@RuggedCom.com

© 2010 RuggedCom Inc.

RuggedSwitch is a registered trademark of RuggedCom Inc.

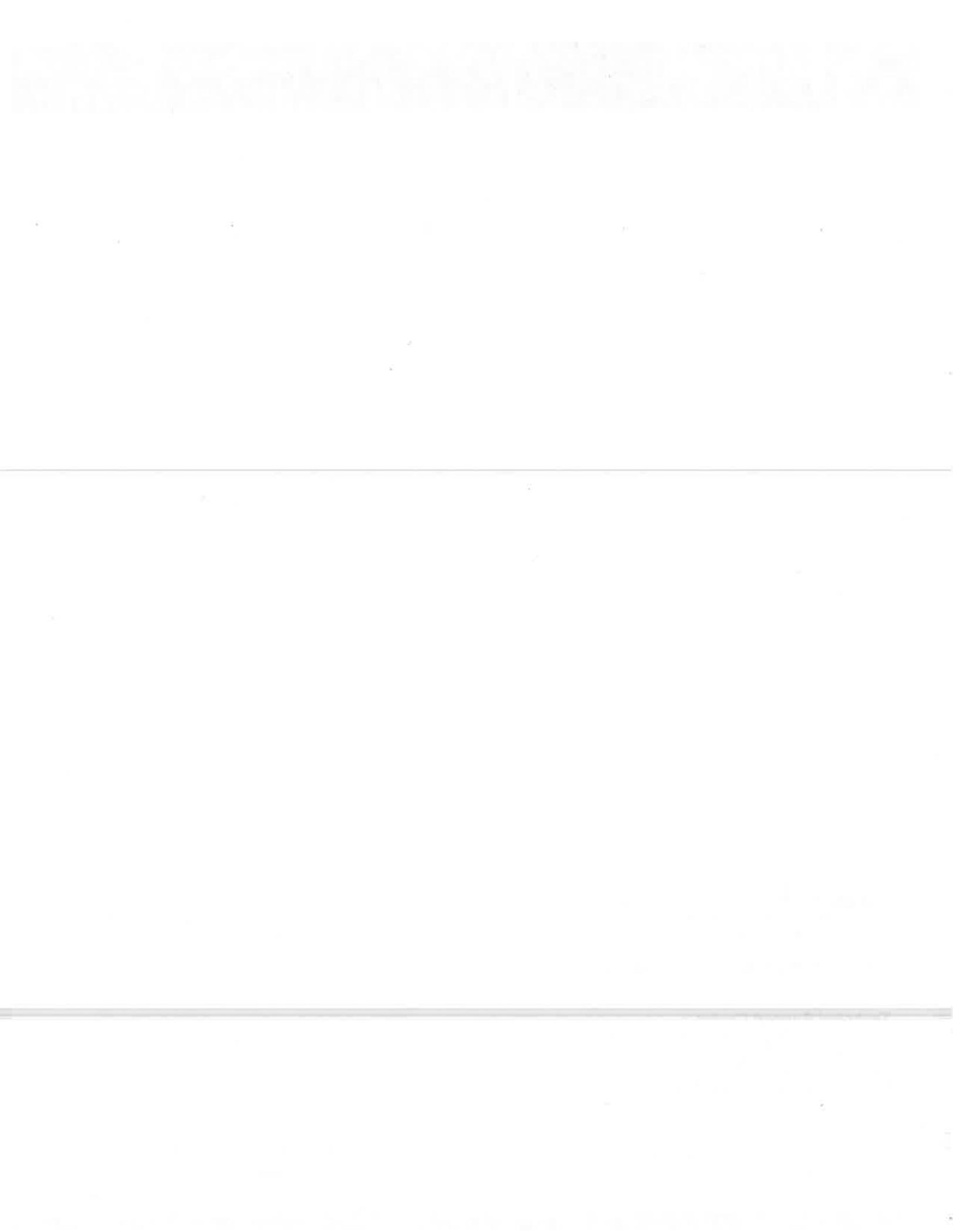
Ethernet is a trademark of the Xerox Corporation.

Patent Pending

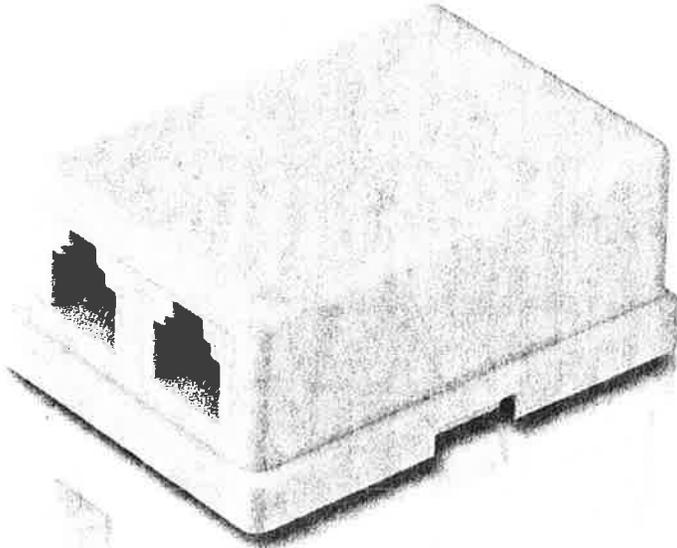
All specifications in this document are subject to change without notice.

Rev 1a — 04/27/10

For additional information on our products and services, please
visit our web site at: www.RuggedCom.com



Duplex Jack



Philips
Duplex jack

Surface mount

Almond

SDJ6913

Mount a modular duplex jack

Place a modular duplex jack anywhere you need it. This convenient design mounts on any surface.

Mounts on any surface

- Mountable back tray

Superior technology

- Six conductor construction
- Crafted with quality construction

Hook up two devices

- Splits one phone line into two

Environmentally friendly

- Environmentally friendly lead-free construction

PHILIPS

sense and simplicity

Specifications

Packaging

- EAN/UPC/GTIN: 609585130258
- Quantity: 1
- Gross Weight: 0.045 kg
- Tare Weight: 0.023 kg
- Net Weight: 0.022 kg
- Length: 7 cm
- Width: 3.2 cm
- Height: 14.6 cm

Inner Carton

- EAN/UPC/GTIN: 10609585130255
- Quantity: 6
- Gross weight: 0.272 kg
- Tare weight: 0.136 kg

- Net weight: 0.136 kg
- Length (cm): 17.8 cm
- Width (cm): 7.6 cm
- Height (cm): 10.2 cm

Outer Carton

- EAN/UPC/GTIN: 20609585130252
- Quantity: 36
- Gross weight: 1.882 kg
- Tare weight: 1.202 kg
- Net weight: 0.680 kg
- Length (cm): 24.8 cm
- Width (cm): 19.1 cm
- Height (cm): 23.5 cm

Highlights

Mountable back tray

Easily remove the back tray to install the unit directly onto any surface.

Six conductor construction

Allows for up to three different phone lines.

Quality construction

Quality construction uses only top grade materials to create products of extended durability.

Splits one phone line into two

Easily create two phone lines from one existing line.



Issue date 2009-11-06

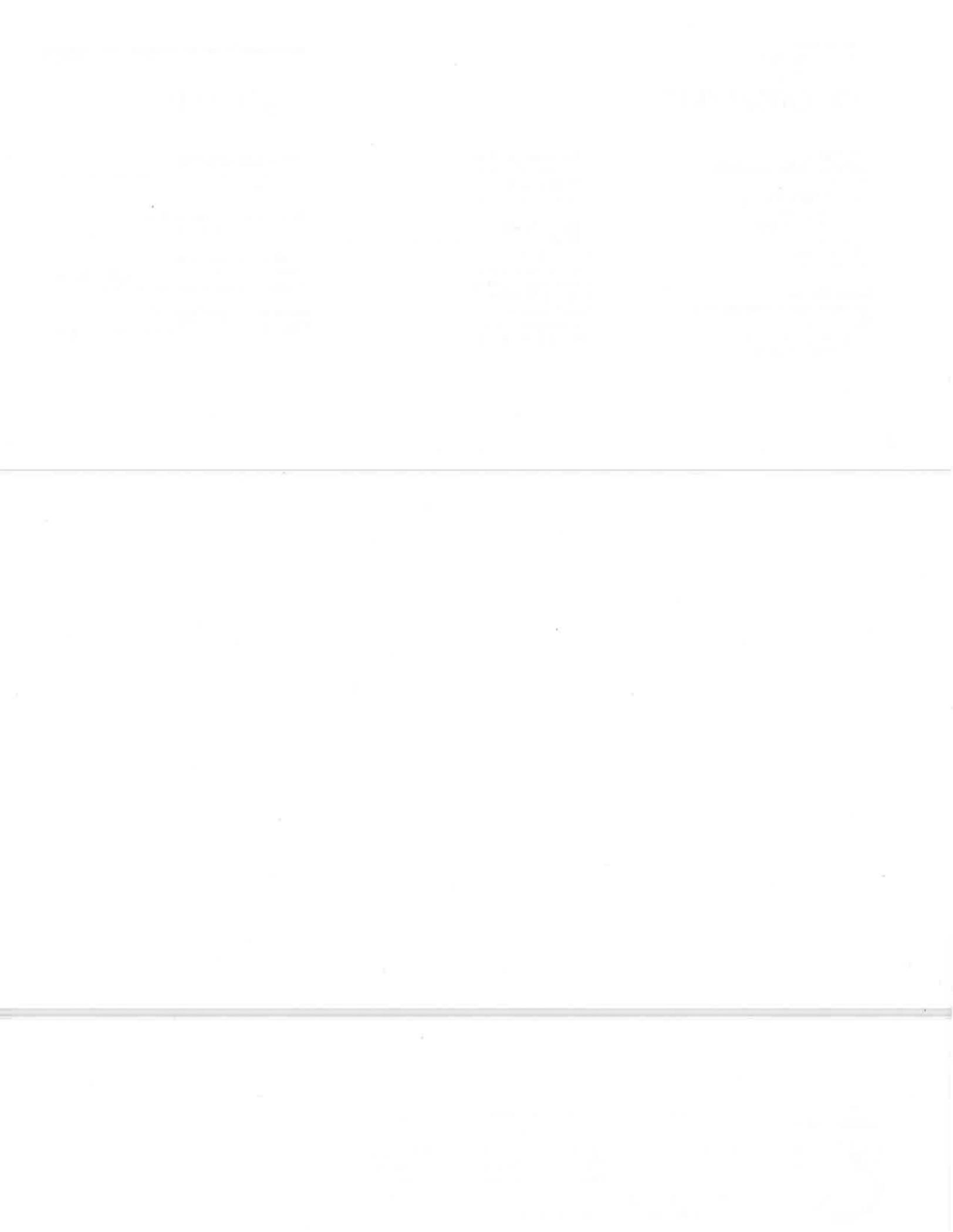
Version: 1.2.11

12 NC: 8670 000 29069
UPC: 6 09585 13025 8

© 2009 Koninklijke Philips Electronics N.V.
All Rights reserved.

Specifications are subject to change without notice.
Trademarks are the property of Koninklijke Philips
Electronics N.V. or their respective owners.

www.philips.com



CCTV System Specification

DDOT CCTV System Specifications

1. IP Camera Specifications

- 1.1 IP CCTV Camera shall allow video compression in Mpeg4/H.264 format.
- 1.2 CCTV Camera shall provide compatible control protocol with CCTV system.
- 1.3 CCTV Camera shall have preset positions.
- 1.4 CCTV Camera shall have privacy mask zones.
- 1.5 CCTV Camera shall have Auto Iris function.
- 1.6 CCTV Camera shall have Auto Focus function.
- 1.7 CCTV Camera shall have pan, tilt and zoom in-out functionality.
- 1.8 CCTV Camera shall have in NTSC format.
- 1.9 CCTV Camera shall allow up to 30 frames per second (fps).
- 1.10 CCTV Camera shall have controllable frame rate.
- 1.11 CCTV Camera shall have controllable bandwidth.
- 1.12 CCTV Camera shall have text overlay.
- 1.13 CCTV Camera shall have User Authentication and password protection.
- 1.14 CCTV Camera shall support the following protocols: IPv4/v6, HTTP.
- 1.15 CCTV Camera shall have automatic day/night viewing mode.
- 1.16 CCTV Camera shall allow access/control from the local site.
- 1.17 CCTV Camera shall allow access/control from a central location.
- 1.18 CCTV Camera shall have standard TCP/IP network capabilities.

2. Joy Stick

- 2.1 Joystick shall control camera view position (left, right, up, down).
- 2.2 Joystick shall control camera zoom in and zoom out function.

- 2.3 Joystick shall facilitate setting the address range of the camera and controlling the selected camera to monitor.
- 2.4 Joystick shall interface with workstations using a USB port.
- 2.5 Joystick shall set or call the preset points.

3. Encoder

- 3.1 Encoder shall allow transport of the pan/tilt/zoom communications protocol via network.
- 3.2 Encoders shall allow video compression in Mpeg4/H.264 formats.
- 3.3 Encoder shall allow up to 30 frames per second (fps) in Mpeg4/H.264 format.
- 3.4 Encoder shall have controllable frame rate.
- 3.5 Encoder shall have controllable bandwidth.
- 3.6 Encoder shall allow multicasting.
- 3.7 Encoder shall have password protection.
- 3.8 Encoder shall accept IP addressing and support the following protocols: IPv4/v6, HTTP.
- 3.9 Encoders shall allow access/control from both the local site and a central location.
- 3.10 Encoder shall be shelf mountable.
- 3.11 Encoder shall have standard TCP/IP network capabilities.

4. Decoder

- 4.1 Decoders shall allow transport of the pan/tilt/zoom communications protocol via network.
- 4.2 Decoders shall allow video compression in multicasting—unicasting Mpeg4/H.264 format.
- 4.3 Decoder shall allow up to 30 frames per second (fps) adjustable in Mpeg4/H.264 format.
- 4.4 Decoder shall have password protection.
- 4.5 Decoder shall accept IP addressing and support the following protocols: HTTP, UDP, SNMP and standard others.
- 4.6 Decoder shall allow access/control both from the local/remote site
- 4.7 Decoder shall be rack/chassis mountable.
- 4.8 Decoders Decoder shall have standard TCP/IP network capabilities.

5. CCTV Server

- 5.1 CCTV Server shall have the capability to record video.
- 5.2 CCTV Server shall interface with analog to digital video Encoders and/or IP cameras in format of MPEG2, MPEG4 or H.264.
- 5.3 CCTV Server shall be scalable for additional cameras on a unit-by-unit basis.
- 5.4 CCTV Server shall be configured for concurrent user accesses.
- 5.5 CCTV Server shall have a CCTV system software application that provides full network management operations and switching for DDOT's camera infrastructure.
- 5.6 CCTV Server shall have the ability to accept a multicasting video source.
- 5.7 CCTV Server shall, in the case of a camera signal loss, detect the video loss and have the capability to provide on-screen alert to the operator.
- 5.8 CCTV Server shall create a log of events and user activities.
- 5.9 CCTV Server shall authenticate users and give access to the CCTV System based on predefined user access rights.
- 5.10 CCTV Server shall limit the maximum number of simultaneous connections to the CCTV System for any given user.
- 5.11 CCTV Server shall support the following Advanced Management capabilities:
 - 5.11.1 CCTV Server shall have the ability to assign specific Managers, Supervisors, Users or User groups.
 - 5.11.2 CCTV Server shall allow a user to view, collect and display alarm history/log.
- 5.12 CCTV Server shall include a video virtual matrix (Switching) application.
- 5.13 CCTV Server shall allow assigning of PTZ priority to each operator. This allows a prioritization among operators of who has control over a camera.
- 5.14 CCTV Server shall have a configuration tool that allows administrator or users with appropriate privileges to change system configuration.
- 5.15 CCTV Server shall provide decentralized administration of the entire system from anywhere on the network.
- 5.16 CCTV Server shall allow camera layouts. Camera layouts shall be available to all users in the CCTV System with appropriate authorization.

- 5.17 CCTV Server shall have the capability to define access and privileges by user group as well as by individual users.
- 5.18 CCTV Server shall provide the capability to regroup specific cameras together and restrict or enable access rights to this group on a per user basis.
- 5.19 CCTV Server shall allow mixing of CCTV cameras of various manufacturers within the system.
- 5.20 CCTV Server shall allow text and image overlay (DDOT Logo) on the video images.
- 5.21 CCTV Server shall have the ability to configure a return to home function after a predefined time of inactivity for PTZ cameras. The inactivity time shall be configurable.
- 5.22 CCTV Server Event logs shall have the following functions: Live view, Sort by date and camera or locations, Search video feeds, List by date durations, Export to Excel.
- 5.23 CCTV GUI shall have the capability to execute any of the following actions:
 - 5.23.1 CCTV GUI shall block a camera.
 - 5.23.2 CCTV GUI shall unblock a camera.
 - 5.23.3 CCTV GUI shall view a camera in the CCTV System.
 - 5.23.4 CCTV GUI shall assign camera position presets.
 - 5.23.5 CCTV GUI shall send an alert to a user (sound, email and optional phone call).
- 5.24 CCTV GUI shall have software modules and applications that run on Windows operating system.
- 5.25 CCTV GUI database shall be Structured Query Language (SQL database).
- 5.26 CCTV GUI shall have ability to add functions via a SDK from manufacture.
- 5.27 CCTV GUI shall allow users to use CCTV joystick to operate the entire set of cameras throughout the system including their PTZ functionalities.
- 5.28 CCTV GUI shall allow users to activate all live viewing controls using a standard PC keyboard and mouse.
- 5.29 CCTV GUI shall allow all standard camera matrix switching and automation functions including PTZ and control of video being displayed in any number of monitors.
- 5.30 CCTV System shall enable the video in MPEG4/H.264 format from the CCTV System to an external web server, allowing for broadcasting of video.

- 5.31 CCTV GUI Virtual Matrix shall have the capability of creating camera sequences with the following functionality: (1) Each entry in a sequence shall have the capacity to trigger camera presets, patterns or auxiliaries; (2) Multiple users shall be able to view the same camera sequence simultaneously.
- 5.32 CCTV GUI Virtual matrix shall have the capability to interface with existing monitors.
- 5.33 CCTV GUI shall support GIS mapping functionality with videos displayed as video shaped icons in the GUI map at the location where cameras are installed.
- 5.34 CCTV GUI shall display the video on a map next to the icon with its window/size scalable.
- 5.35 CCTV GUI shall display multiple video images on the map at locations chosen by the user.
- 5.36 CCTV Client/Workstation GUI shall have a viewer application with graphic user interface (GUI) that has the following minimum capabilities:
 - 5.36.1 Shall provide live monitoring of simultaneous video images.
 - 5.36.2 Shall allow the operator to choose from a number of possible camera display patterns.
 - 5.36.3 Shall allow the operators to view all cameras attached to the CCTV System.
 - 5.36.4 Shall display video on monitors attached to the system.
 - 5.36.5 Shall display all cameras, sequences and monitors in a logical tree.
 - 5.36.6 Shall allow the operator to drag and drop a camera sequence from a tree of cameras into a window or an analog monitor icon for live viewing.
 - 5.36.7 Shall allow the operator to choose any of the video images associated with a camera for viewing.
 - 5.36.8 Shall have the capability to view all system events in logs as they occur and export event logs to Excel or .csv format that Excel can read.
 - 5.36.9 Shall view the same video image multiple times in different workstation locations.
- 5.37 CCTV Client/Workstation shall have the following ability for client application to: Pan, Tilt, Zoom, Iris, Focus and Presets.
- 5.38 CCTV Client/Workstation shall decode Mpeg2, Mpeg4 and H.264 format.
- 5.39 CCTV Client/Workstation shall display video images by virtual switching on multiple monitor locations including local or remote workstation and existing video wall.
- 5.40 CCTV Client/Workstation shall control camera from local or remote workstation.

5.41 CCTV Workstation shall be compatible and fully functional with workstations operating an Internet Browser.

6. CCTV System Ethernet Switch

6.1 Ethernet switch shall be stackable.

6.2 Ethernet switch shall provide multicast routing.

6.3 Ethernet switch shall provide both IPV4 and IPv6 routing.

6.4 Ethernet switch shall have standard TCP/IP and UDP network capabilities.

6.5 Ethernet switch shall have out-of-band Ethernet management port along with RS232 console port.

6.6 Ethernet switch shall have the ability to migrate uplinks from Gigabit Ethernet to 10 Gigabit Ethernet.

6.7 Ethernet switch shall have multiple Ethernet ports.

6.8 Ethernet switch shall be compatible with existing switches.

6.9 Ethernet switch shall be capable of mirroring any port to any other port within the switch.

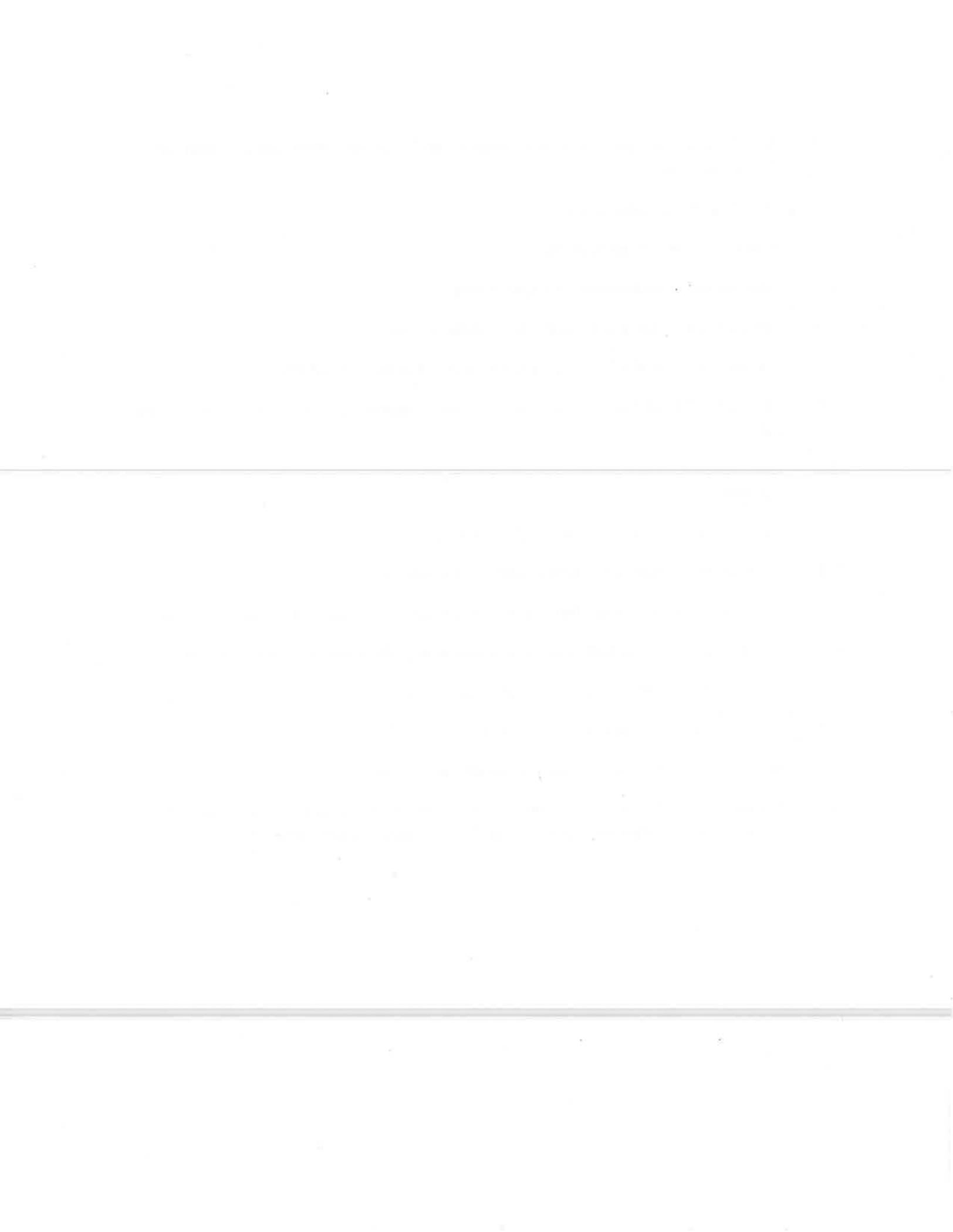
6.10 Ethernet switch shall provide password/control management through SNMP and HTTP.

6.11 Ethernet switch shall provide VLAN capability per port.

6.12 Ethernet switch shall have fiber connections.

6.13 Ethernet switch shall have per port bandwidth management.

6.14 Ethernet switch shall be managed remotely or locally utilizing multiple industry standard interfaces, specifically a web-based user interface, Telnet, Console and SNMP.



Dynamic Message Signs

I. DYNAMIC MESSAGE SIGNS

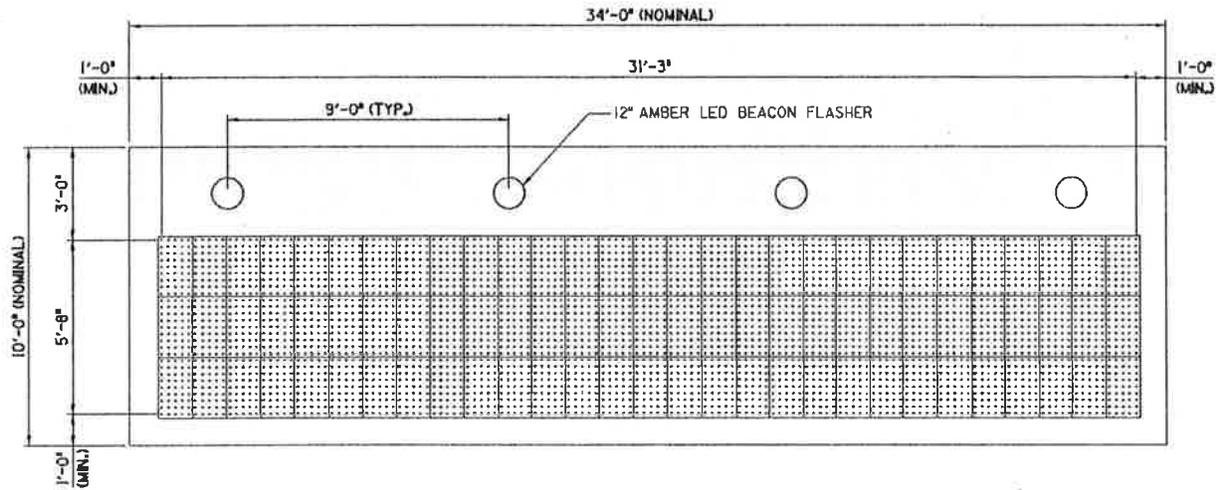
(A)

GENERAL

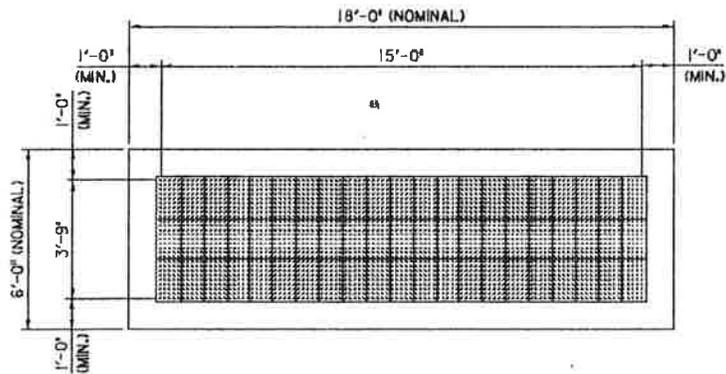
Dynamic Message Sign (DMS) equipment to be furnished at each field site shall include, but not be limited to LED DMS, sign controller, and other systems such as DMS Controller Cabinet and Communications Equipment specified elsewhere. The DMS message display, including character and interline spacing, shall be in conformance with the Manual on Uniform Traffic Control Devices (MUTCD) 2009. To ensure overall system compatibility, all DMS signs shall be from the same manufacturer.

1. **DMS Type – The DMS to be supplied under this contract shall be of the following types:**
 - a. **Type I** shall be LED Full-Matrix DMS (27 x 145 pixels, 66 mm pitch), 30-degree viewing cone, capable of displaying at least 3 lines, each with 21 18-inch characters per line, flashing beacons where applicable, and walk-in housing for installation on major freeways and arterials. [ADDENDUM NO. 3 REVISED] Nominal dimensions for cabinet shall be 10ft H x 34ft W x 4ft D and 4,500 lbs.
 - b. **Type II** shall be LED Full-Matrix DMS (27 x 105 pixels, 44 mm pitch), 30-degree viewing angle, capable of displaying 1, 2, or 3 lines, with 15 12-inch characters per line, cantilever or pedestal mounted, and front access for installation on city streets. Nominal dimensions for cabinet shall be 6ft H x 18ft W x 2ft D and 2,000 lbs.
 - c. **Type III** shall be LED Full-Matrix DMS (27 x 125 pixels, 66 mm pitch), 30-degree viewing cone, capable of displaying at least 3 lines, each with 18 18-inch characters per line, flashing beacons where applicable, and walk-in housing for installation on major freeways and arterials. Nominal dimensions for cabinet shall be 10ft x 30ft x 4ft and 4,500 lbs.

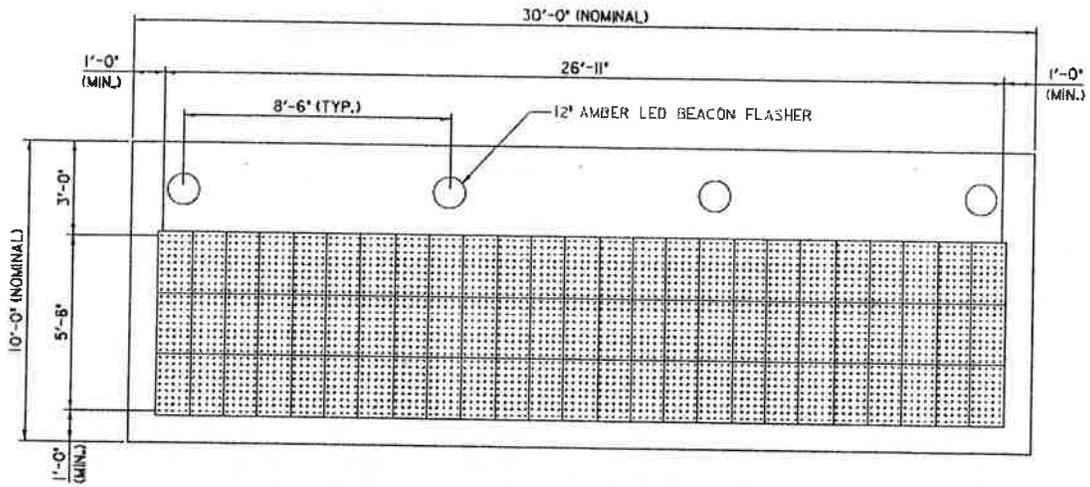
DMS CABINET LAYOUT DIAGRAMS



LED Full-Matrix DMS Type I



LED Full-Matrix DMS Type II



LED Full-Matrix DMS Type III

DMS 6007

2. **Definition** – Full-Matrix is defined as a type of DMS without fixed lines, columns or characters and the entire display area contains equally spaced pixels. The DMS and controller shall have the ability to display characters using proportional spacing on the full-matrix configuration. Any graphic, symbol, character or font can be placed in any location within the display area of the DMS without regard to lines or columns.
3. **Test Certificate** – The DMS manufacturer shall submit a test certificate from an independent laboratory to certify compliance with the cone-of-vision requirement. The cone of vision shall be measured at the front of the sign in its final position with any component that could impede or otherwise affect the light output (such as the front face, mask, and polycarbonate) in place. An LED component manufacturer certificate shall not satisfy this requirement, since the test shall consider the mounting of display boards within the sign and the front face.
4. **DMS Manufacturer Pre-qualification** –
 - a. The DMS manufacturer shall have been in the successful business of the DMS design and manufacture of multi-unit, multi-line State or Interstate Highway overhead, permanently-mounted DMS systems; installation and maintenance of State or Interstate Highway, permanently-mounted, overhead DMS electronics and control systems for highway use at least 10 years prior to the advertisement date. The DMS manufacturer shall provide documentation and references of manufacturing history.
 - b. The DMS manufacturer shall have supplied and/or installed DMS systems similar to that required by the Project Specifications on a project of similar size and scope in the past three (3) years. Untried or prototype units shall not be considered for acceptance. The DMS manufacturer shall submit three (3) references for work similar in size and scope to the work specified in the Scope of Work that it has completed successfully in the past three (3) years, including a walk-in housing highway LED full-matrix NTCIP-compliant DMS system, supplied by this manufacturer under the current corporate name, which otherwise meets this specification, and that has been operational for a period of no less than one year. At least one of these references shall be from a U.S. State Department of Transportation.
 - c. The DMS manufacturer shall design, manufacture, and test its LED module boards and controller. These may not be sub-contracted or 3rd-party products. The manufacturer shall have its own lab environment on the North American continent for continual sample testing of production line products, including temperature, humidity, corrosion, and accelerated life testing programs.
 - d. The DMS manufacturer shall have a USA-based sales and distribution point of operation. This operation shall have been present for at least 5 years and the manufacturer shall keep such operation present for the life of the contract. At no time shall shipments to or from the manufacturer be subject to customs processing, delays, or other international shipping issues. Any parts or pieces that are fabricated from outside the country shall be stocked in ample supply at the USA-based operation such that no delays in the shipment or delivery of such parts are experienced by the customer.

- e. The DMS manufacturer shall have USA-based technical staff with minimum 5 year experience available to assist with the project for duration of the contract.
 - f. The DMS manufacturer shall be ISO 9001 or equivalent, formally-documented Quality System certified.
5. **Terminology** – Due to the varying definitions used in Dynamic Message Sign technology, this section defines specific terms as they apply to this specification.
- a. **Sign:** The sign housing and its contents.
 - b. **Sign Controller:** Located in a cabinet (as detailed in this specification), the sign controller manages all aspects of the sign operation including: specifying the message to be displayed, diagnostics, and remote communications. Messages can be selected either remotely from the central controller, locally from a laptop computer or from the front panel of the sign controller.
 - c. **Central Controller:** The Microsoft Windows Server computer system and related software, which operates the system from a remote control site.
 - d. **Workstation:** The Microsoft Windows workstation computer and related software that operates as a remote client over a computer network to the central controller. A workstation operator can access the central controller and gain access to the functions of the central by using the appropriate access codes.
 - e. **LED (Light Emitting Diode):** The DMS display lighting technology.
 - f. **Pixel:** Any of the small discrete elements that, when arranged in a pixel matrix, create a character. A pixel contains a cluster of LEDs.
 - g. **Pitch:** Distance measured from center to center of adjacent pixels within a matrix. This distance is measured both horizontally and vertically.
 - h. **Poll:** The central controller and laptop computer are said to “poll” a sign when they request the sign’s status information. The term is derived from the periodic status polling, which a central controller can perform, but is loosely used to refer to any status request.
 - i. **Message:** Text; the information displayed on the sign.
 - j. **Display:** The message seen by the motorist. A display may include more than one page of text (an alternating display). Any character or set of characters of a display may be flashed (a flashing display).
 - k. **Neutral State:** Sign is blank, or displaying a predefined message that is displayed regularly.
6. The Contractor shall register with the manufacturer(s) all equipment in the name of the Department. Photocopies of the registration forms shall be forwarded to the District Engineer.
7. The Contractor shall store and handle all materials and equipment in a clean, dry location; free from construction dust, precipitation and excess moisture, so as not to degrade quality, serviceability or appearance.

8. The Contractor shall contact the DMS manufacturer for information on proper storing and installation of the DMS equipment.

(B)

MATERIAL

1. General –

- a. All materials furnished, assembled, fabricated or installed under this item shall be new and of the latest design and recent manufacture, corrosion resistant, and in strict accordance with this specification. No used or refurbished hardware is permitted. Furthermore, firmware and software shall be tested and in working order. Neither prototype firmware, nor prototype software is permitted. Failure to meet all details and functionality detailed in this specification shall be grounds for rejection of the equipment.
- b. All parts shall be of high-quality workmanship, and no part or attachment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.
- c. All external screws, nuts, and locking washers shall be stainless steel. Self-tapping screws shall not be used on the exterior of the sign. All nuts shall be nyloc nuts or similar. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, aluminum or brass. All materials used in construction shall be resistant to fungal growth and moisture deterioration. All dissimilar metals shall be separated by an inert dielectric material.

2. Physical Characteristics –

- a. The latest available techniques shall be utilized in equipment design and construction of the LED DMS with a minimum number of different parts, subassemblies, circuits, cards and modules to maximize standardization and commonality.
- b. The equipment shall be designed for ease of maintenance with all component parts readily accessible for inspection and maintenance. Test points for checking essential voltages shall be provided.
- c. All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician.
- d. Solid-state display elements and modules shall be provided. Mechanical or electromechanical elements or shutters shall not be used.
- e. The DMS, including the sign housing and all modules and assemblies, shall be designed and manufactured by company certified by ISO 9001 or equivalent formal Quality Systems, and shall comply with the provisions of NEMA Standard TS 4-2005, latest revision.
- f. The LED DMS shall be designed for a minimum life of 10 years.

- g. The signs shall be designed and constructed to present a clean and neat appearance. Poor workmanship will be cause for rejection of the sign.
- h. If cable attachments are used in the sign housing, the cables shall be securely clamped in a manner as approved by DDOT. No adhesive attachments shall be allowed.
- i. The complete sign housing of the LED DMS shall be designed and manufactured in-house by the LED DMS Sign Manufacturer.
- j. The presence of power transients or electromagnetic fields, including those created by any components of the system, shall have no deleterious effect on the performance of the system. The system shall not conduct or radiate signals which will adversely affect other electrical or electronic equipment including, but not limited to, other control systems, data processing equipment, audio, radio, and industrial equipment.

3. Electrical Components –

- a. All electronic equipment shall be of solid-state design and modular construction. Individual electronic modules shall provide easy service access and shall be field replaceable. The design shall be such as to prevent incorrect assembly or installation of connectors, fasteners, etc., where possible malfunction or personnel hazards might occur. Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
- b. All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods. All electronic assemblies shall meet or exceed IPC 610A workmanship standards.
- c. The sign and its sign controller shall be capable of operating with 240/120 VAC, 40 amp per leg, 60 hertz, single-phase power.
- d. The system shall be protected by transient voltage suppression devices, including MOVs, RIS and spark gap arrestor. Resettable surge protection shall be provided. Tripping of the surge protection shall prevent power from reaching any components of the sign until the surge protection has been reset. Tripping of the surge protection shall cause the sign controller to call the TMC and report the error condition.
- e. Each DMS provided shall consist of internal wirings, terminal strips for interconnecting wire, duplex outlets for maintenance equipment, photosensors, and heating strips.

4. Sign Housing –

- a. The equipment within the sign housing shall be protected from moisture, dust, dirt and corrosion.
- b. The sign housing shall be constructed of .125" (3 mm) high-quality aluminum alloy 5052-H32 or 3003-H14 (AlMg3) and capable of withstanding a wind

loading of 120 mph at a minimum, without permanent deformation or other damages. At a minimum, the DMS housing, structural frame, face covering, and mounting members shall be capable of withstanding the environmental loadings specified in AASHTO's Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition.

- c. Framing structural members shall be constructed from aluminum alloy 6061-T6 or 6063-T5.
- d. All welding shall be by an inert gas process in accordance with the American Welding Society (AWS) Standards, ANSI/AWS D1.2-97. The LED DMS manufacturer's welders and welding procedures shall be certified by an ANSI/AWS Certified Welding Inspector to the 1997 ANSI/AWS D1.2-97 Structural Welding Code for Aluminum. Proof of certification of all the LED DMS manufacturer's welders and applicable welding procedures shall be supplied with the submittals. The name, phone number and address of the ANSI/AWS Certified Welding Inspector that certified the LED DMS manufacturer's welders and procedures shall also be provided with the submittals.
- e. The number of seams shall be minimized and all exterior seams and joints shall be sealed to form a rain-tight enclosure.
- f. The skin material shall be stitch-welded to the internal structural members to form a unitized structure.
- g. The performance of the LED DMS, including the visibility and legibility of the display, shall not be impaired due to continuous vibration caused by wind, traffic or other factors.
- h. The housing shall be designed to accommodate mounting on the rear vertical plane only.
- i. The sign housing shall be designed so that the angular alignment is adjustable in the vertical direction from zero (0) degrees to ten degrees down in one-degree increments to optimize the viewing angle.
- j. The serial number and model number shall be etched, stamped, or molded on the housing.
- k. The sign housing shall be designed to protect all inside equipment from dust, water, and any other environmental exposure.
- l. A minimum of 3 photocells shall be installed on each sign. These devices shall permit automatic light intensity measurement of light conditions at each sign location. These photocells shall be of sufficient quantity and mounted in a manner to fully measure ambient light conditions to set the sign brightness levels.
- m. Mounting devices shall be provided for the photoelectric cells, allowing full adjustment of the cell orientation.

- n. Photocells shall be mounted so that they may be serviced from inside the sign enclosure or from the front face and/or catwalk.
- o. Automatic adjustment of the LED brightness shall occur in small enough increments so that the brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. Provision shall be made to prevent perceivable brightening of the sign due to stray headlights shining upon the photo sensors at night.

5. Housing Face –

- a. The housing face shall be of three-piece construction, consisting of internal structural members, external face panels and lens panel assemblies.
- b. The interior structural members shall be fabricated from 6061-T6 or 6063-T6 aluminum alloy extrusions and shall:
 - (1) Accommodate both display module mounting and air distribution.
 - (2) Retain the display modules in a manner to facilitate easy and rapid removal of each display module without disturbing adjacent display modules.
- c. There shall be no exposed fasteners or welds on the housing face.
- d. The external face panels shall be designed to minimize heat conduction between the exterior surfaces and the interior components.
- e. The external face panels shall be made of UV stabilized high-impact resistant polycarbonate material with a UV silk-screened mask that provides a high level of contrast and readability. The Panel shall absorb greater than 80% of UVA and UVB.
- f. The border and therefore, the external fascia perimeter panels shall be a minimum of 12 inches wide.
- g. The external face panels shall be thermally isolated from the rest of the sign housing.
- h. The housing face shall be finished with a matte black, licensed factory-applied KYNAR 500 Resin, fluopolymer based coating system. Certification shall be provided from the licensed factory KYNAR 500 coater for all aluminum face materials. All other exterior and interior surfaces shall be a natural aluminum mill finish. Surfaces shall not be painted.
- i. The Lens Panel Assembly shall consist of a KYNAR 500 coated aluminum mask over a clear glazing and shall be modular in design, interchangeable with no misalignment with the LED pixels and sealed with a closed-cell resilient gasket.
- j. The lens panel shall be heated to prevent fogging and condensation.
- k. No manufacturer and/or vendor logos shall be allowed on the housing face. Logos, preapproved by the District Engineer, may be allowed on the sides and/or rear of the sign housing.

6. Walk-in Access DMS –

- a. The DMS housing shall be walk-in access containing two (2) access doors, one on each side of the enclosure. Each door shall be mounted to the housing using a stainless-steel, continuous piano-style hinge so that it opens towards the outside front of the sign to shield maintenance personnel visibility from traffic.
- b. The walk-in housing access shall be from the side via a door with a minimum internal height of 6'-6".
- c. The access door, when open at a 90-degree angle from the DMS housing front wall, shall not extend more than 38-inches from the housing. All doors shall contain a stop that retains the door in a 90-degree open position. When a door is open, the door and its stop shall not be damaged by an 80 mph wind.
- d. A document holder on the inside of door shall be provided for schematics, line diagrams, etc.
- e. The DMS housing doors shall be furnished with a door lock that is keyed to DDOT standard lock. The latching/locking mechanism shall include a handle on the interior of the housing such that a person with no key and no tools cannot become entrapped inside the housing.
- f. Doors shall be provided with door switch(s) and control wiring connected to the sign controller for reporting door open/closed status.
- g. A closed-cell neoprene gasket shall be used to seal out moisture and other contaminants when the door is closed.
- h. A level interior walkway manufactured of anti-skid aluminum with a minimum width of 18 inches running the entire length of the sign shall be installed in the bottom of the sign housing.
- i. The sign floor shall be designed to be slip resistant and to avoid water retention. The bottom panel of the housing shall be provided with a minimum of four drain holes, with snap-in, replaceable drain filter plug inserts, in each section formed by internal structural members.
- j. The housing shall contain a floor system capable of safely supporting a weight of 1,000 pounds. Signs indicating the maximum weight shall be conspicuously displayed inside the housing.
- k. The interior sign housing shall be a minimum of 2' 10" wide to allow adequate room inside the sign housing for maintenance personnel. There shall be 18 inches of clear area between all equipment along the entire length of the sign housing from the 18-inch walkway up to 6 feet above the 18-inch walkway.
- l. The sign housing shall provide easy access to all internal components for maintenance and repair purposes.
- m. A shelf or workbench shall be provided inside the enclosure for a notebook computer and related equipment.
- n. The sign interior shall be equipped with fluorescent lights fitted with clear protective covers running the length of the housing. A 60-minute mechanical

rotary timer switch shall be easily accessible upon entering the housing. The light timer shall be clearly labeled "LIGHTS".

- o. The DMS housing shall include a minimum of two 15 AMP, 120 VAC duplex electrical outlets, with ground fault circuit interrupters (GFI), for use by maintenance personnel. The two duplex outlets, one at each end, shall be located within the DMS housing.
- p. A humidistat shall be provided that shall monitor the humidity from 0% to 100%. The humidistat shall be sensed by the sign controller and shall provide continuous, automatic control to sense humidity rise exceeding a selected level with an adjustable range of 20-80%.
- q. Provisions shall be made for natural ventilation inside the sign enclosure by means of screened and filtered air outlets at the top, rear of the enclosure. These outlets shall be suitably baffled or louvered to prevent the entry of wind-blown moisture and dust. The filters shall be of the permanent, washable type, and shall be easily removable for servicing.
- r. A positive-pressure, filtered, forced-air ventilation system that cools both the display modules and the sign interior shall be provided. The forced-air ventilation system shall provide a minimum of one sign enclosure volume change per minute.
- s. The ventilation system shall have two methods of control; an industrial-style thermostat, and a 60-minute mechanical rotary timer switch. The thermostat shall operate with one internal temperature sensor and an additional temperature sensor to measure the ambient temperature outside the sign housing. Temperature sensors shall have an accuracy of ± 1.5 degrees F. and a range from -30° F to $+140^{\circ}$ F. The set point of the thermostat shall be adjustable from 90° F to 130° F. The blower timer shall be clearly labeled "BLOWER", in the same manner as the light switch, and shall be mounted directly adjacent to the light switch.
- t. Enough baseboard heaters shall be provided to warm the interior of the walk-in housing to 30 degrees F above ambient. A 60-minute mechanical rotary timer switch in the sign and remotely from the laptop and central computers shall control these heaters. The heater timer shall be clearly labeled "HEATER" in the same manner as the blower switch, and shall be mounted directly adjacent to the blower switch.
- u. The LED modules and electronic equipment shall be protected by a fail-safe, back-up fan control system in the event of an electronic fan control failure or shutdown of the sign controller.
- v. Each DMS shall be equipped with the secured fiberglass ladder of sufficient height to permit servicing all modules and components within the enclosure.
- w. Each DMS shall have a set of tools necessary for performing preventive maintenance service on the walk-in enclosure. Tools shall be placed in the tool box and secured inside the sign.

- x. Fall arrest anchor points shall be provided at the doors at both ends of the walk-in housing for workers to attach to when the door is opened.

7. Sign Display –

- a. The signs shall be capable of displaying ASCII characters 32 through 126 (including all upper and lower case letters and digits from 0 to 9), up to 32 user-defined graphic characters, and all standard Manual on Uniform Traffic Control Devices (MUTCD) traffic symbols or icons at any size and location on the display.
- b. The signs shall be capable of supporting customized fonts using variable-width or proportional spacing, modifying the ASCII space character to achieve 3 pixels width, modifying the inter-character spacing to achieve 2 pixels between characters and the interline spacing to achieve 3 pixels between lines within the fonts.
- c. The sign shall be capable of displaying alphanumeric text only, graphics only, or a combination of both.
- d. The sign shall be capable of displaying from one to six messages in sequence.
- e. The LED DMS shall enable the display of text, consisting of a string of alphanumeric and other characters and programmed and customized graphics. Each character shall be formed by a matrix of luminous pixels. The matrix of a standard character shall consist of 35 pixels over 5 columns and 7 rows.
- f. The rectangular display modules shall have an identical horizontal and vertical pitch between pixels.
- g. The separation between the last column and row of one module and the first column and row of the next shall be equal to the horizontal distance between the columns and rows of a single display module.
- h. The characters shall be legible under all light and normally-encountered weather conditions up to the rated distance within a 30-degree cone of vision centered on the optical axis of the pixel. It shall be bright enough to have a good target value, but not to the point where the pixels bloom, especially in low ambient light level conditions. Its 50% intensity points shall define the cone perimeter.
- i. The brightness and color of each pixel shall be uniform over the entire face of the sign within the 30-degree cone of vision up to the rated distance in all lighting conditions. Non-uniformity of brightness or color over the face of the sign under these conditions shall be cause for rejection of the sign.
- j. Each display shall have the necessary light output intensity to meet or exceed the legibility requirements. Each pixel shall have an initial luminous intensity of 35 candelas or greater on the optical axis when the sign is operating in the overbright mode. Light output shall be measured at a distance of 100 ft. from a test character in a fully instrumented optical testing chamber.
- k. The DMS shall be capable of changing from one message to another without visual disturbance or high-speed scrolling of messages.

- l. DMS messages shall be legible within a distance range of 200 ft to 1100 ft from the DMS display face under the following conditions:
 - (1) When the DMS is displaying alphanumeric text that is 18-inches high.
 - (2) 24 hours per day and in most normally encountered weather conditions.
 - (3) During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DMS.
 - (4) When viewed by motorists that have 20/20 corrected vision.
 - (5) When the motorist eye level is 3 to 12 feet above the roadway surface.
- m. Replacement of a complete display module shall be possible without the use of any tools.
- n. The DMS shall have a power distribution system connecting each display module to all power supplies and minimizing the voltage drop over the face of the sign. The voltage measured at the display modules shall not vary more than 50 millivolts over all the display modules in the sign with 17 pixels on at 100% intensity in each and every display module.
- o. The time required to clear any display and post any new display shall not exceed 500 milliseconds.

8. LED and Pixel Characteristics --

- a. The LEDs will be AlInGaP technology. The diodes will have a 30-degree viewing angle, amber color of dominant wavelength between 585 and 595 nm, with all LED pixels in a sign having the same dominant wavelength.
- b. All pixels in all signs in this project, including the spare parts, will have equal color and on-axis intensity.
- c. The LEDs shall be mounted directly to a printed circuit board and be easily replaceable and individually removable using conventional electronics repair methods.
- d. The sign display using LED shall consist of a continuous full-matrix format consisting of smaller matrices of pixels. Each pixel shall consist of a high-intensity LED cluster. The LED lamps shall run at a minimum voltage to provide extended life. Each pixel shall be either square in shape with a minimum of two-inch (2") sides or round in shape with a minimum two-inch (2") diameter.
- e. LED boards and daughter boards that are fully interchangeable and do not require any address switches or adjustment when interchanged or placed in service shall be provided.
- f. All LEDs shall be mounted so that their mechanical axes are normal ± 1.00 degree to the face of the sign to ensure brightness uniformity over the face of the sign.
- g. The LEDs shall be protected from the outside environmental conditions, including moisture, snow, ice, wind, dust, dirt and UV rays.

- h. Pixel brightness shall be controlled by pulse-width modulation of the DC current. Brightness shall be manually settable from the front panel of the sign controller and remotely from the central controller in 1% increments. Brightness control shall be able to be returned to automatic from the sign controller front panel and the central computer.
- i. Dimming circuitry that does not reduce the LED rated life shall be used.
- j. The operational status of the LEDs in each pixel string shall be tested and then transmitted to the central controller or laptop computer.
- k. The state of the LEDs (full on, half on or off) in each pixel of the sign shall be read by the sign controller to allow the central controller or laptop computer to show the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign in a WYSIWYG format, including any half-out, full-out, half stuck-on or fully stuck-on pixels. This pixel status reading will take place while a message is displayed on the sign without disturbing the message in any way. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel status reading will be cause for rejection of the sign. A list of defective pixels, listing pixel status, line number, module number, column number and row number shall be provided for each defective pixel.
- l. All printed circuit boards, except the LED circuit board, shall be conformal coated. The LED board shall be conformal coated except at the pixels.
- m. All printed circuit boards shall be provided with a solder mask and a component identifier silk screen.
- n. The voltage to the LED modules and associated electronics shall not exceed 25 VDC. The power supplies shall be paralleled in a diode OR configuration such that if one supply completely fails, the sign will still be supplied with enough power to run 50% of all pixels at 100% duty cycle. Functioning supplies shall current share to within 10%. The combined effect of line (95 to 135 VAC) and load (10% to 100%) on the power supplies shall not exceed 1.0%. The efficiency of the power supplies shall be 80% or greater at 120 VAC 50% to 100% of maximum load. Power supplies having a power factor of 0.95 or greater at 120 VAC from 50% to 100% of maximum load shall be provided.
- o. The LED shall be rated for 100,000 hours continuous operation, at 30 mA drive current, with less than 30% lumen depreciation.

9. Beacon Flasher System –

- a. The enclosure shall contain four 12", Amber LED signal heads and 8 inch tunnel visors, arranged as shown in the plans. The signals installed shall have Fresnel-style, or "ball" diffusers.
- b. LED signal modules shall comply with all requirements of the most recent, formally-ratified version of the ITE Interim Purchase Specification – Vehicle Traffic Signal Control Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules, with the exception of luminous intensity.

- (1) The on-axis (2.5 degree) luminous intensity shall be a minimum of 675 candelas, not to exceed 1,000 candelas.
 - (2) The manufacturer of LED signal heads supplied shall provide written certification of compliance with the ITE Specification, and the luminous intensity stated in item (1) above, in their catalog cut submittals.
 - (3) The manufacturer of LED signal heads supplied shall provide written certification that their LED signals are approved for use in flashing mode.
- c. The signal heads shall be wired to a two-circuit NEMA flasher so that the flasher will activate alternate pairs of bulbs simultaneously. One cycle will light bulbs 1 and 3, and the next will light bulbs 2 and 4.
 - d. Current sensing circuitry shall be provided to monitor operation of the signal modules, and log and remotely alert the system operator of signal failure.
 - e. The entire flasher and signal head system shall be installed and pre-wired to the main sign connection terminal block by the sign manufacturer.
 - f. The operation of the beacon flasher system shall be controlled by software command, at the discretion of the system operator. Upon issuing the command, the controller shall activate the NEMA flasher, which will then activate the signal heads as described above.
 - g. Shop drawings for the complete beacon flasher system shall be submitted to the District Engineer for approval along with the shop drawings for the walk-in enclosures before beginning fabrication of either system.

10. Environmental –

- a. The sign shall operate without malfunction and without any decrease in performance over an ambient temperature range of -30° F to +140° F and with a relative humidity of up to 95% non-condensing.
- b. The DMS sign controller shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a 140° F threshold temperature.

11. DMS Sign Controller –

- a. The controller shall meet NTCIP requirements and shall be provided with resident software stored in non-volatile memory. The sign controller shall be programmed to receive sign control commands from the central controller or laptop computer, transmit responses as requested to the central controller or laptop computer via the communication system, monitor sign and message status and control sign operation and message displays.
- b. The controller shall be a software-driven microprocessor-type DMS controller with printed circuit boards and front panel indicators.
- c. The controller shall continuously monitor the display of the sign independent of any external commands, and cause the signs to display all the appropriate characters

- d. The controller shall incorporate an audible tone that sounds about every 15 minutes when messages are displayed to alert the operators that a message or messages is/are running during an incident clearing activity, a stationary or roving work crew, etc. The sound will alert the operators to check on the message status so that they may update the message or blank out as needed.
- e. The controller shall accumulate data about the sign status (to be transmitted upon request), and receive commands from the central computer, maintenance laptop computer, and a local panel.
- f. The controller shall have the ability to control the brightness level, using the photosensor controls in the DMS cabinet. The controller shall have the ability to achieve an "overbrightness" mode operation in fog or intense sunlight.
- g. The operator shall be able to select independent display times for alternating, flashing messages and blank-out time between messages in one-tenth (0.1) second increments. Upon terminating the display time for a message, the controller shall either blank the sign or place the sign in a neutral condition.
- h. A fail-safe mechanism shall be provided to automatically blank the sign upon encountering an error, or improper information display in the case of malfunction, or communication and/or power failure.
- i. The controller shall have power-up and auto-restart capabilities with automatic sign blanking when recovering from a power off condition. A watchdog circuit shall be utilized to provide automatic reset to the controller. The central controller shall be capable of remotely commanding a sign controller reset.
- j. The controller shall be 19-inch rack mounted in the DMS Controller Cabinet.
- k. The controller will communicate with the display modules via fiber-optic cable.
- l. The controller shall include a local/remote control switch and LED indicator, allowing a local operator to override central operations and take over local control of the sign. A timeout feature will force the controller to revert to central operations after a configurable timeout or inactivity period.
- m. A controller shall be provided that is able to read the internal temperature sensors, external ambient temperature sensor and the humidistat. The controller shall use these readings in an algorithm that turns on the heat at the appropriate times to reduce both frost on the face of the sign and condensation on the display modules and other display system circuitry.
- n. A temperature reading greater than a user selectable critical temperature shall cause the sign to go to blank and the sign controller shall report this error message to the central computer.
- o. The controller shall continuously measure all LED module power supply voltages. The controller will provide these voltage readings to the central controller or laptop computer when the central controller or laptop computer polls the sign controller.
- p. The controller shall be easily replaceable/interchangeable in case of any failures.

- q. The controller shall provide a library with a minimum of 50 permanent messages, consisting of 30 or fewer characters per line, stored in PROM. The controller shall also be able to accept a downloaded library from the central or laptop computer containing at least 25 changeable messages stored in non-volatile RAM. These messages may be displayed on the sign from the keypad on the front panel of the controller. The RAM shall be backed up by a long life battery allowing power outages of a minimum of 12 months without loss of data.
- r. The controller shall also be capable of displaying messages on the sign that are downloaded from the central controller or laptop computer, but are not located in the library stored in non-volatile memory of the sign controller.
- s. The full matrix display shall also be capable of displaying other sized characters and other number of lines depending on the height of the character utilized. The interline spacing shall be variable.
- t. Central Communications

(1) Exchanges between the DMS sign controller and central controller shall be made only upon the central controller request inviting the DMS sign controller to send (select) or receive (poll) data. The three modes of operation shall be:

(a) Central Mode: The central controller controls and monitors the sign.

(b) Local Mode: The sign controller LCD panel and keypad are used for direct sign operations and diagnostics.

(c) Remote Mode: A local laptop computer is used to control and monitor the sign.

(2) The communications between the sign controller and the central controller or laptop computer shall comply with the NEMA National Transportation Communication for ITS Protocol (NTCIP) as detailed in this specification. Unless otherwise stated, the software shall comply with the versions of the relevant NTCIP standards that are current at the date of this document.

u. Communications Interfaces

(1) The controller will include separate RS-232/422/485 serial interface and an RJ45 Ethernet 10/100 Base T interface for communication with the central controller.

(2) The controller will include a separate RS-232 serial interface for communication with the laptop computer. A minimum 6-foot long serial cable will be supplied to connect the laptop computer to the sign controller.

(3) The controller will include an RJ-11 jack for connecting to a dial-up phone line.

(4) The controller will contain 8 digital inputs, 4 analog inputs, and 4 digital outputs to support external alarm and contact closure monitoring

12. DMS Controller Wiring –

- a. The communication and control cables between DMS controller and sign housing shall be fiber optic. The cables shall terminate in a fiber patch panel at both ends. Fiber patch cords, meeting the same specifications of the fiber cable and 3 ft length, shall be used to connect local equipment to the patch panel.
- b. The fiber optic cable shall meet the following requirements.
 - (1) A 6-fiber optic 62.5/125 cable shall meet the specifications of Corning OM1 fiber type multimode, or equal, at a minimum. The duplex fiber optic cable shall have a nominal fiber OD of 2 x 4 mm and shall be orange in color. The fiber optic cable shall have a maximum attenuation of 3.75dB/km @ 850 nm and 1.5 dB/km @ 1300 nm. The fiber optic cable shall have a minimum gigabit Ethernet capability of 220 meters @ 850 nm and 550 meters @ 1300 nm. The fiber shall have a maximum tensile load capability of 48 lb-ft short term and 15 lb-ft long term with a minimum installed bend radius of 2.5 cm (1 inch). Maximum insertion loss shall be less than 0.4 dB with a maximum back reflection of less than -25 dB.
 - (2) The fiber optic cable shall be terminated with “ST” connectors on all ends within the fiber patch panel. The “ST” connectors shall be Corning Glass Insert Connectors (GIC) Anaerobic (95-101-52 SP multimode 62.5/125 um) or equal.

13. DMS Sign Controller Software – Sign Controller software and firmware shall be NTCIP 1203 v.2 compliant and support the following minimum functions:

- a. Report errors and failures, including, but not limited to:
 - (1) Power recovery
 - (2) Power Failure
 - (3) Pixel string failure
 - (4) Fan failure
 - (5) Over user selectable critical temperature
 - (6) Power supply failure
- b. Message and status monitoring – The sign controller will respond to the central controller whenever it receives a request for status. The return message will be capable of providing the following information:
 - (1) Actual message that is visibly displayed on the sign on an individual pixel basis
 - (2) Current sign illumination level
 - (3) Local Control Panel switch position (central or local)
 - (4) Error and failure reports
 - (5) Temperature readings

- (6) Power supply voltage levels
 - (7) Origin of display message transmission (laptop or central)
 - (8) Heater status
 - (9) Uninterruptible power supply status
- c. Severe error condition response:
- (1) In dial-up mode, the sign controller will initiate a call to the central controller and report any severe error conditions. In multi-drop mode, the sign controller will report severe error conditions to the central controller during the next polling. In network communication mode (UDP/IP), the sign controller will automatically send the diagnostic information to the Traffic Management Center (TMC) to notify the technicians of any reported errors. Also email notification alarm can be setup to notify the Supervisor if the sign controller reported any severe error conditions.
 - (2) The severe error conditions are:
 - (a) AC power failure
 - (b) AC power recovery
 - (c) Surge protection has tripped
 - (d) Temperature reading over a user selectable critical temperature
 - (e) The sign housing and controller cabinet door is open
- d. Display Control:
- (1) Display static, flashing, and alternating messages
 - (2) Supports amber monochrome alphanumeric characters and graphics messages
 - (3) Has the ability to control any size character, line, or full matrix DMS
 - (4) Scheduling is based on to-the-minute time-of-day, day-of-week, holiday or special days, one-time or recurring scenarios
 - (5) Photo sensor override and manual brightness control
- e. DMS Messaging:
- (1) Includes message-creating editing tool with preview
 - (2) Manages DMS font database
 - (3) Has the ability to create, save, and adjust message duration and priority settings
 - (4) Configures flash rates, scrolling and other message attributes
 - (5) Can create and save banned words list (white and black lists)
 - (6) Spell checks messages before display and can edit one line (or word) of text without having to retype the entire message

- (7) Supports multi-phase (3-phase minimum) messages
- (8) Supports beacon activation by message
- (9) Has the ability to create and save default messages for each DMS
- f. Utilities and Diagnostics:
 - (1) Has the ability to view status, errors, and any error codes of all DMS subsystems in real time and historical date/time stamped logs.
 - (2) Has the ability to locate pixel failures and verify the error
 - (3) Has a built-in pre-programmed common pixel test patterns and diagnostics
 - (4) Has the ability to monitor the DMS environmental conditions based on DMS sensors
 - (5) Has the ability to accept remote firmware upgrades
- g. Security:
 - (1) Has the ability to restrict each user's functional areas (read/write restrictions) with user accounts containing unique user names and passwords.

II. DMS TEST FIXTURE

(A)

GENERAL

The DMS Test Fixture includes an appropriate quantity and type of all modules and electronics components from each DMS sign type necessary for bench testing and troubleshooting DMS system operation.

(B)

MATERIAL

As a minimum the following types of subassembly modules should be provided. The contractor should follow recommendations of the DMS sign manufacturers as to the exact mix, type and quantity of components.

1. DMS Sign Controller with software/firmware
2. Display modules
3. Single board computers and electronic driver boards to control display modules
4. Power supplies, wiring harnesses, test stands and other miscellaneous items necessary to support a suitable test bench environment

III. DMS CONTROLLER CABINET

(A)

GENERAL

The DMS Controller Cabinet includes the physical cabinet housing and associated internal cabinet support subassemblies. Specific equipment necessary to support the DMS operation and communications are specified elsewhere.

(B)

MATERIAL

1. **Cabinet Enclosure** – A NEMA 3R single-door enclosure sign control cabinet containing all equipment required for controlling the DMS shall be provided as follows:
 - a. The cabinet shall be constructed using stainless steel with a minimum thickness of 0.125 inch. Material used in the cabinet shall meet NEMA standards.
 - b. The cabinet shall be completely weatherproofed to prevent water intrusion. All exterior seams for cabinets and doors shall be continuously welded. All exterior welds shall be smooth.
 - c. The cabinet shall have one full-size door for accessing the cabinet. The door shall have a full-length stainless steel piano hinge, with a stainless steel pin spot welded at the top. The hinge shall be mounted so that it is not possible to remove it from the door or cabinet without first opening the door.
 - d. The door and hinges shall be braced to withstand a 100 pound per vertical foot of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed.
 - e. A door stop to retain the door at three-quarter open and full-open positions shall be included.
 - f. The cabinet door shall be fitted with a three-point latching mechanism and number 3 Corbin lock. Two keys shall be provided for each cabinet.
 - g. The door opening shall be double flanged on all four sides.
 - h. A gasket shall be provided to act as a permanent dust and weather-resistant seal at the cabinet door facing. The gasket material shall be closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket shall show no sign of rolling or sagging and shall ensure a uniform dust and weather-resistant seal around the entire door facing.
 - i. The cabinet shall contain a self-standing, 4-post EIA standard 19” equipment rack. All equipment shall be rack mounted.

- j. The controller cabinet and its sub-assemblies, except the modem and UPS, will be designed for continuous operation over an ambient temperature range of -40° F to +158° F without requiring fans or heaters.
 - k. The cabinet shall be a normally vented design with thermostatically-controlled fan and filtered louvered vent
 - l. A work tray, mounted on ball bearing slides, with a document compartment shall be provided for the laptop computer.
 - m. Each cable within the cabinet shall be individually and clearly labeled with permanent markings
 - n. A cabinet lamp to illuminate the internal controller cabinet when the cabinet door is opened shall be activated by the door switch, turning on the lamp when the cabinet door is opened and extinguishing it when the cabinet door is closed.
 - o. The cabinet door shall be provided with a door switch and control wiring connected to the sign controller for reporting door open/closed status.
 - p. All markings and identification shall be silk screened on the panel and sealed with a clear sealer or as approved by the District Engineer.
 - q. The Contractor shall be responsible for all phone, data, control and confirmation connections between the sign and ground control box and for any required wiring harnesses and connectors.
 - r. Cables between the sign and the DMS controller cabinet shall be provided for the operation of the sign.
 - s. A document holder on the inside of door shall be provided for schematics, line diagrams, etc.
2. **Power Distribution Panel** – Each cabinet shall be equipped with a fully enclosed, pre-wired power distribution / panelboard enclosure for utility power distribution. The power panel breaker box enclosure shall be comprised of and adhere to the following:
- a. The design shall be such as to prevent incorrect assembly or installation of connectors, fasteners, etc., where possible malfunction or personnel hazards might occur. Each item of equipment shall be designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.
 - b. Service Feed: service power from utility meter shall consist of 240/120V, three-wire split-phase neutral.
 - c. Site grounding electrode conductor shall terminate at the enclosure ground bar.
 - d. Service Feed neutral shall be bonded to the ground bar.
 - e. Power filtering and surge suppression on the main service feed shall be provided.
 - f. Lightning protection shall be provided.

- g. Panelboard shall have a main 2-pole breaker to protect the breaker box assembly and conductors, and provide main feed to the branch circuit breakers.
- h. Panelboard shall accommodate the following branch circuit breakers:
 - (1) Two-pole 50A for DMS sign power
 - (2) Single-pole 15A for cabinet fan, heater, and light
 - (3) Single-pole 15A for two (2) duplex outlets for cabinet electronic equipment
 - (4) Single-pole 10A for duplex GFCI utility outlet
 - (5) Spare 15A branch circuit breakers: provide (2) 1-pole breakers.
- i. Complete panelboard shall be UL Listed for outdoor operation.
- j. Conduit fittings into enclosure (knockouts) shall be UL Listed rain tight.
- k. Panelboard compartment front access shall accommodate a padlock
- l. Wall mounted power enclosures- secure to new wall-fastened 1-5/8" Unistrut (stainless steel) using new SS hardware. Do not mount enclosure directly to cabinet wall.
- m. Stainless steel cabinet/enclosure construction shall be a minimum 304SS grade, maintaining the rated NEMA 3R rain tight protection.
- n. Power Distribution Panel shall be Acme Electric Panel-Tran® or District Engineer approved equivalent.

3. Uninterruptible power supply (UPS) –

- a. A UPS unit shall be provided to allow the sign controller to notify the central controller when an improper power condition exists at the DMS.
- b. The UPS unit shall be rack mounted as shown on the plans.
- c. The UPS provided shall meet the following minimum specifications:
 - (1) Lightning and surge protection: Passes ANSI/IEEE C62.41 Categories A and B. UL 1449 listed, and shall provide protection to all connected equipment against all forms of surges and lightning.
 - (2) Noise (RF) Isolation: 33dB common-mode; 47dB normal-mode. Full-time, advanced, multistage filter.
 - (3) Input: 97 - 136V, 55 - 63Hz.
 - (4) Output Waveform: Sine-wave on line. Regulated, stepped waveform on inverter.
 - (5) Output Protection: Automatic (over current, short circuit, and over voltage).
 - (6) Alarms: Battery backup operation, battery runtime remaining, overload.
 - (7) Communications Ports: DB-9 alarm/status contact closures, RS-232/422/485 serial interface, and RJ45 Ethernet 10/100 Base T central system communications

- (8) Safety: UL listed, CSA certified.
 - (9) Operating Environment: -40°F to +158°F, 0 to 95% relative humidity (non-condensing).
 - (10) 250 VA minimum to allow the sign controller and communications to operate for a minimum of 10 minutes during power-out conditions.
- d. The UPS shall be provided with central management software with the following capabilities:
- (1) Application software compatible with Microsoft Windows XP/7 workstation operation system.
 - (2) SNMP support to allow central communications remotely through a web-based interface. Supported SNMP MIBs shall be supplied in electronic file format.
 - (3) Remotely monitor, control and set various parameters for the UPS systems via the Ethernet system communications port.
 - (4) Email notifications that are configurable based on selectable severity levels and triggered by events, faults and/or alarms.
 - (5) Read and display UPS events, warnings, date, time and relay configurations.

(C) CONSTRUCTION AND INSTALLATION

Installation of the DMS cabinet and all utility and DMS sign connections shall be in accordance with the approved final design plans and all applicable DDOT standards.

1. DMS Controller Cabinet –

- a. The Contractor shall install at each site the DMS Controller Cabinet and all standard hardware items in the cabinet in accordance with the approved design plans. Additional equipment shall be installed in the cabinet as specified elsewhere.
- b. The Controller Cabinet shall be installed on the DMS support in accordance with the attached installation drawings. The Contractor shall submit attachment details for the Controller Cabinet for review and approval by the District Engineer prior to the installation of the Controller Cabinet.
- c. The Contractor shall plug all conduit entrances in the cabinet with duct seal to prevent rodent entries.

2. Conduit –

- a. The Contractor shall install new conduit from the DMS Controller Cabinet to the Dynamic Message Sign (DMS) and from the DMS Controller Cabinet to the utility service pedestal and meter.

- b. New electrical and fiber optic wire or cable shall be installed in new conduit or raceway by the Contractor as shown on plans. Electrical cable and communications cable shall be installed in separate conduit or raceway.
- c. All conduit wire/cable pulls shall have a pull rope installed beside installed conductors.
- d. Construction and materials – refer to DDOT Standard Specification Sections 618.13 and 621.09.

3. Wire & Cable –

- a. DMS Controller Cabinet to Service Pedestal: The Contractor shall install the power cables from the service pedestal to the cabinet in conduit buried below grade entering the foundation and up through the vertical support to a handhole in accordance with the approved design plans. The power and fiber communication cables supporting the DSM sign shall exit the cabinet through the same access hole and routed up the vertical sign support. Power and communications cables shall be routed in separate conduits where conduits are required as shown on the plans.
- b. DMS Controller Cabinet to Sign: The Contractor shall install cables from the DMS to the Controller Cabinet through the vertical support as indicated on the approved design plans.
- c. The Contractor shall install waterproof connectors where the cables enter into the cabinet. All cables shall be clearly marked or tagged. A minimum of 3 ft of cable shall be left coiled in the cabinet.
- d. Panelboard (Breaker Box) enclosure:
 - (1) Tag conductors with new sleeve tag using the sign number as the conductor label identification. Affix wire tag at panelboard and sign ends for each conductor.
 - (2) Refer to the Plans as a basis for specific sign / circuit assignment (wire tag) labels.
 - (3) New sign power wiring from panelboard circuit breaker shall be 12AWG.
- e. Wire insulation class shall be THHW minimum.
- f. UPS: The UPS discrete contact closure outputs shall be wired to the sign controller alarm inputs and appropriately configured to provide this capability.

4. Electrical Power –

- a. The Contractor shall connect installed equipment to the Power Distribution Panel within the cabinet as indicated in the approved design plans. Prime operating power to each site shall be supplied from nominal 240/120 VAC power.
- b. All conductors entering and leaving the cabinet shall be protected by surge protectors and lightning arrestors to protect against damage resulting from voltage surges.

5. **Grounding** – The Contractor shall install #10 copper ground wire from the electrical panel in the cabinet to nearest ground rod as indicated on the design plans. The ground wire shall be connected to the ground rod with 3/4" acorn ground rod clamps.

(D)

TESTING

1. **System Integration Test** – The system integration test shall demonstrate that all equipment is fully integrated and operational. This test shall verify that all equipment installed at each location is installed properly and that all functions are in conformance with the Contract Documents.
2. **30-Day Field Operational Test** – All equipment shall be subject to the same 30-day field operation test requirements as described in the S.P. entitled FURNISH AND INSTALL LED FULL-MATRIX DMS.
3. **Test Documentation** – The Contractor shall submit to DDOT for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

(E)

DOCUMENTATION

The following shall accompany all electrical and mechanical components supplied:

1. **Operator Manuals** – Operator Manuals shall be provided for all equipment and components supplied as part of the cabinet. The manuals shall be comprehensive, easy to use and understand, and completely descriptive of the product.
2. **Maintenance Procedures Manuals** –
 - a. A service manual containing detailed preventive and corrective maintenance procedures shall be provided for each different type or model of equipment. The manual shall cover as a minimum the proper method of adjusting and otherwise maintaining each item, a concise statement of the necessary operating functions in proper sequence, and a detailed description of the component function in relation to the various operation steps.
 - b. Systematic field and bench trouble shooting procedures shall be included, as shall normative waveforms and test voltages as applicable.
 - c. A detailed parts list shall be included. For each part, its circuit or pictorial identifications shall be shown, as shall all necessary rating information and a manufacturer and associated model or part number. The list shall also include cross-references to parts numbers of other manufacturers who make the same replacement part.

3. **As-Built Drawings –**

- a. A complete set of as-built shop drawings including equipment layout, assembly drawings, electrical schematic, wiring diagram and a logic diagram shall be provided for each cabinet. All connections, conduits, wiring, function and I/O information shall be detailed. A stage-by-stage explanation of the circuit theory shall be provided with the circuit wiring diagrams. All drawings shall be identified by cabinet location.
- b. Schematics shall include a list of tests points detailing the nominal operating voltage, wave form and all pertinent information regarding the wave form at each test point.
- c. The as-built drawings shall provide a complete record of the final installation by location. The Contractor shall incorporate all design modifications, change orders and field installation changes.

4. **Media –**

- a. The Contractor shall provide one (1) complete set of all Manuals, Drawings and other documentation in bounded paper format to be stored in the equipment cabinet documentation holder.
- b. Three (3) additional complete sets of all documentation, bound, loose-leaf copies of a booklet, 8-1/2 inches x 11 inches in size, and One (1) reproducible electronic copy in .pdf format shall be delivered to the District Engineer prior to DMS System Integration Testing.

IV. DMS CENTRAL CONTROLLER

(A)

GENERAL

A single central server computer installed in the DDOT Traffic Management Center, and as directed by the District Engineer, will be used to provide remote management, monitoring, and control of all DMS signs. The server will be used to host the DMS Central Controller Software specified elsewhere.

(B)

MATERIAL

A rack-mounted server computer CPU of a brand that is fully compliant with District IT computing standards and meeting the following minimum specifications:

1. The hardware, operating system, and any other commercial off-the-shelf components of the DMS Central Controller shall be fully compatible with the DMS Control Software specified elsewhere, and with existing District field communications,

shall be in a method consistent with Distract standards and as directed by the District Engineer.

(D)

TESTING

1. **System Integration Test** – The system integration test shall demonstrate that all equipment is fully integrated and operational. Testing of the DMS Central Controller shall be performed after installation and configuration of the DMS Central Controller Software and shall include:
 - a. Verification of user account logon profiles
 - b. Verification of IP address, name resolution, and reachability of host devices, such as DMS signs and client workstations
 - c. Verification of Central Controller redundant component operation, such as power supply, hard disks, and network interface
2. **30-Day Field Operational Test** – All equipment shall be subject to the same 30-day field operation test requirements as described in the S.P. entitled FURNISH AND INSTALL LED FULL-MATRIX DMS.
3. **Test Documentation** – The Contractor shall submit to DDOT for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

V. DMS CENTRAL CONTROLLER SOFTWARE

(A)

GENERAL

The central controller software server will be used to support remote management, monitoring, and control of all DMS signs. The software will be hosted in the DDOT Traffic Management Center on the Central Server Computer specified elsewhere.

(B)

MATERIAL

DMS Central Controller Software that complies with the latest version of NTCIP standards publications for communications with DMS sign field equipment, and meeting the following minimum specifications:

1. **General Architecture** –

- a. Have the ability to provide client-server architecture that any computer connected to the District network and equipped with the client version is able to connect to the central controller. Support a minimum of four (4) simultaneous users.
- b. Have the ability to support unlimited signs at once from traffic management centers.
- c. Support Ethernet, serial connections, and modem pools.
- d. Have the ability to enable/disable ping, telnet, http on field controller.
- e. Have the ability to push firmware upgrades onto all field controllers.
- f. Support event logging and email alerts.
- g. The hardware, operating system, and any other commercial off-the-shelf components of the DMS Central Controller shall be fully compatible with the DMS Control Controller Software specified elsewhere, and with existing field communications, networking components, and equipment rack mounting and KVM systems.

2. NTCIP Compliant –

- a. The software shall be able to be universally interface with all NTCIP-compliant DMS.
- b. The software shall be able to support NTCIP 1203 v.2.

3. Display Control –

- a. Have the ability to display DMS network in list or map view.
- b. Have the ability to view, group, and monitor multiple DMS in real time.
- c. Have the ability to control any size character, line, or full matrix DMS.
- d. Enable scheduling based on to-the-minute time-of-day, day-of-week, holiday or special days, one-time or recurring scenarios.
- e. Have a photosensor override and manual brightness control.

4. DMS Messaging –

- a. Include WYSIWYG graphical message creating editing tool with preview.
- b. Manage font database for each DMS.
- c. Have the ability to create, save, and adjust message duration and priority setting.
- d. Configure flash rates, scrolling and other message attributes.
- e. Have the ability to create and save banned words list (white and black lists).
- f. Spell check messages before display and have the ability to edit one line (or word) of text without having to retype the entire message.
- g. Support multi-phase (3-phase minimum) messages.
- h. Support beacon activation by message.

- i. Support amber monochrome alphanumeric characters and graphics messages.
- j. Have the ability to create and save default messages for each DMS.

5. Utilities and Diagnostics –

- a. Have the ability to view status, errors, and any error codes of all DMS subsystems in real time and historical date/time stamped logs.
- b. Have the ability to locate pixel failures and verify the error.
- c. Have built-in pre-programmed common pixel test patterns and diagnostics.
- d. Have the ability to monitor the DMS environmental conditions based on DMS sensors.
- e. Verify NTCIP conformance parameters for each DMS.

6. Security –

- a. Have the ability to restrict each user's functional areas (read/write restrictions) with user accounts containing unique user names and passwords.
- b. Have the ability to centrally manage field controller user accounts and passwords.

7. Operating System and Software Compatibility –

- a. Client workstation – Microsoft Windows XP/7
- b. Server – Microsoft Server 2008 R2 or later
- c. Browser – Microsoft Internet Explorer 8.0 or later

(C) INSTALLATION AND INTEGRATION

Installation of the DMS Central Controller Software shall take place on the DMS Central Controller, installed and accepted under separate bid item, and up to four (4) other non-project workstations as directed by the District Engineer.

All necessary information to provide a fully-functional system shall be programmed into the DMS Central Controller Software, including but not limited to: user account information, DMS sign controller device configuration information, maps and lists of field devices, communication parameters, and other application settings. This will also include any client software installation and configuration for up to four (4) workstation computers as directed by the District Engineer.

(D) TESTING

- 1. System Integration Test –** The system integration test shall demonstrate that all equipment is fully integrated, operational, and meets all of the functionality as stated herein.

2. **30-Day Field Operational Test** – All equipment shall be subject to the same 30-day field operation test requirements as described in the S.P. entitled FURNISH AND INSTALL LED FULL-MATRIX DMS.
3. **Test Documentation** – The Contractor shall submit to DDOT for approval appropriate documentation related to each phase of testing. No testing shall commence without appropriate documentation approval. Test procedures and test data forms shall be submitted. The Contractor shall submit Test Reports for all testing levels. The Test Reports shall verify that the approved test procedures were conducted. All Test Reports shall be presented and organized in logical groups of equipment and shall be signed by the Contractor.

VI. NTCIP COMPLIANCE

(A)

GENERAL

1. The sign controller and central computer software shall comply with the National Transportation Communications for ITS Protocol (NTCIP) Standards when installed. The Contractor shall be responsible for furnishing DMS equipment that is compliant with NTCIP standards as defined below. The Department reserves the right to define conformance groups to be supported. The Contractor shall provide a detailed description of how the system shall conform to the following minimum NTCIP requirements at the time of bid.
2. **NTCIP References** – The DMS shall comply with all applicable NTCIP standards that are current at the date of this document, including all Recommended or Approved Amendments. Under this contract, the Contractor shall ensure that each NTCIP component covered by these technical specifications implements the most recent version of the standard at the development stage of “Recommended” or higher, including any and all Approved or Recommended Amendments to these standards. It is the responsibility of the Contractor to monitor NTCIP activities to discover any recent additional documents. The following is a list of these Standards:
 - a. NTCIP 1101:1996 (V01.12) Simple Transportation Management Framework, December, 2001 with Amendment 1 v08
 - b. NTCIP 2104:2003 (V01.11) Ethernet Sub network Profile, September, 2005
 - c. NTCIP 2202:2001 (V01.05) Internet (TCP/IP and UDP/IP) Transport Profile, December, 2001
 - d. NTCIP 2301:2001 (V01.08) Simple Transportation Management Framework Application Profile
 - e. NTCIP1203 (V2.35a): Object Definitions for Dynamic Message Signs (DMS) Information Profile, March 2007

f. NTCIP 1201:2005 (V02.32) Global Object (GO) Definitions - Version 02, Information Profile October 2005

3. **NTCIP Framework** – The software shall comply with NTCIP 1101 (NEMA TS 3.2, Amendment #1) the Simple Transportation Management Framework, and shall meet the requirements for Conformance Level 1 as clarified by amendment 1.
4. **NTCIP Communications, Subnet Level** –
 - a. Each NTCIP Component that communicates remotely shall conform to all mandatory NTCIP 2104 (Ethernet) subnet profile requirements. Each NTCIP component shall support the receipt of application data packets at any time.
 - b. NTCIP Components may support additional Subnet Profiles at the vendor's option. At any one time, only one Subnet Profile shall be active on a given serial port of the NTCIP Component. If the NTCIP Component has a serial port that supports multiple Subnet Profiles, the NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.
5. **Transport Level** – Each NTCIP Component shall comply with NTCIP 2202 (TCP/IP and UDP/IP). Each NTCIP component shall support the receipts of datagrams conforming to the DMS configured TCP/IP and UDP/IP Transport profiles. NTCIP Components may support additional Transport Profiles at the manufacturer's option. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.
6. **Application Level** – Each DMS controller shall comply with NTCIP 2301, (NEMA TS 3.AP-STMF), as a Managed Agent and shall meet the requirements for Conformance Level 1. SNMP shall be required and STMP shall not be required. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the sample Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

**Maintenance Service
for Citywide Dynamic
Message Signs**

Maintenance Services for Citywide Dynamic Message Signs (Scope of Work)

GENERAL

DDOT is seeking to hire a contractor to provide maintenance services for all 13 Dynamic Message Signs (DMS) in the District. The scope of services includes:

- (1) Perform routine maintenance to achieve uninterrupted operations of all DMS;
- (2) Perform emergency repairs to the DMS and communication in case of critical failure of the DMS system;
- (3) Perform replacement of DMS components if necessary.

DEFINITIONS

DMS Equipment: all necessary DMS components that make DMS fully functioning in accordance with the established Standard Operating Procedures (SOP). DMS equipment includes DMS sign board, DMS cabinet, DMS server(s), central software, communication links and electrical wirings.

Critical Failure: any failure causing communications loss or failure of DMS components such that DMS operations are degraded or mal-functional, as determined by the Owner.

Emergency Repairs: any activity required to bring the DMS to full functionality in accordance with the specifications other than Routine Maintenance activities. Any trouble shooting efforts required to restore/repair the communications with the DMS are considered as "Emergency Repairs".

Maintenance Equipment: all electrical or mechanical devices and vehicles used or reasonably required for use in Emergency Repairs or Routine Maintenance of the DMS Components.

Routine Maintenance: routine preventive maintenance activities in accordance with the manufacturer's recommendations and in accordance with the DMS System Components Maintenance and Service Manuals. Routine Maintenance includes the periodic adjustment of System components to correct deviations from System specifications resulting from normal operation of the System.

SCOPE

The Contractor shall develop routine maintenance plan and submit to DDOT for approval. The maintenance plan should specify the schedules and procedures of the routine maintenance.

The Contractor shall perform routine maintenance to all DMS components according to the developed maintenance plan to keep DMS in good working condition in accordance with DDOT DMS specifications;

The routine maintenance activities shall include, but not limited to, inspection of sign pixels, inspection of the ventilation system and cleaning photo sensor bubble of the sign.

The Contractor shall visually inspect the sign (with a test pattern) every week to locate any non-functional pixels. The Contractor shall test the pixels for failure at frequency as recommended by manufacturer and replace any non-functional pixels boards.

The Contractor shall identify any issues in DMS operations, report all findings to DDOT project manager and recommend solutions;

During routine maintenance, the contractor shall comply with the manufacturer's recommendations and be in accordance with the manufacturer Operations and Maintenance Manual.

In case lane closure or shoulder closure is needed to perform routine maintenance, the contractor shall develop a Traffic Control Plan and submit to DDOT 10 days ahead for review and approval. The traffic control plan should comply with DDOT specifications and rules.

The contractor shall log all maintenance activities. The logbook shall be available to DDOT project manager upon request. The logbook shall contain the following information: (1) Date and time; (2) DMS ID; (3) DMS Location; (4) Type of maintenance; (5) Findings; and (6) Suggestions.

The contractor shall utilize its own maintenance equipment for the work.

The contractor shall provide shall provide 24-hour/7 days a week on-call emergency repair service phone number and contact person who shall be available for emergency repairs. The Contractor shall respond to Emergency Repair calls by DDOT project manager or his/her representative.

Any work in the DDOT server room shall be done in presence of DDOT technical staff.

The Contractor shall complete the maintenance report form for any emergency maintenance work and email it to DDOT project manager the same day as the date of repair. The completed maintenance report form shall also be attached to the invoice for the work.

For Non-Critical Failures the Contractor shall have 24 hours from the time of receipt of notification of a defect to restore the subsystems to a full functional condition meeting all requirements of the DDOT Special Provisions.

For Critical Failures, the time for the Contractor to respond on site shall not exceed two (2) hours. The Contractor shall restore full functionality within four (4) hours of responding on site.

Critical Failures shall be restored to a full functional condition meeting all requirements of the DDOT specifications and to the satisfaction of DDOT project manager within twelve (12) hours of notification of the failure.

The contractor shall discuss the issues in DMS operations and feasible solutions with DDOT technical representative before any major repairs are performed.

In case that replacement of components is needed, the contractor shall submit a request of procurement to DDOT project manager for review and approval. The contractor shall procure same type and same model of component to replace the defect component(s). Acceptance testing shall be done according to the specifications after component replacement is done.

QUALIFICATIONS

DDOT requires that the Contractor shall have staff with minimum 3 years of experience in DMS Maintenance or having DMS vendor training certification completed within one year. Only qualified Contractor personnel shall be allowed to perform maintenance activities on DDOT DMS.

DURATION

The contract duration is one base year plus four option years.