RuggedSwitch™ M2200

MIL-STD 9-Port Modular Managed
Gigabit Ethernet Switch

Installation Guide

www.RuggedCom.com

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Federal Communications Commission
Radio Frequency Interference Statement

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his expense.

CAUTION
This product contains a laser system and is classified as a **"CLASS 1 LASER PRODUCT"**

CAUTION
Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. This product contains no user serviceable parts. Attempted service by unauthorized personnel shall render all warranties null and void.

Changes or modifications not expressly approved by RuggedCom Inc. could void the user's authority to operate the equipment.

Should this device require service see the "Warranty and Service" section of this guide.

IMPORTANT

The RX1000 family of products should be installed in a <u>restricted access location</u> where access can only be gained by service personnel or users who have been instructed about the reasons for the restrictions applied to the location and about any precautions that shall be taken; and access is through the use of a tool or lock and key, or other means of security, and is controlled by the authority responsible for the location.

Trademarks:
Ethernet is a trademark of Xerox Corporation
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3 Product Overview

3.1 Functional Overview & Feature Highlights

The RuggedSwitch M2200 is a MIL-STD hardened, fully managed, modular Gigabit Ethernet switch specifically designed to operate reliably in harsh environments. The M2200's superior ruggedized hardware design coupled with the embedded Rugged Operating System (ROS™) provides improved system reliability, and advanced cyber security and networking features making it ideal for creating secure mission critical real-time control applications, and for aggregating Ethernet switches onto a Gigabit backbone.

The M2200's modular flexibility offers 1000BaseX fiber (LC connectors) and 10/100/1000BaseTX copper port (Micro-D connectors) combinations. The M2200 is packaged in a rugged galvanized steel enclosure and provides MIL-901D shock and vibration immunity. The M2200 is highly versatile and suitable for many applications within a "harsh" environment.

Ethernet Ports
- Up to 9-Gigabit Ethernet ports - copper and/or fiber
- 2 port modules for tremendous flexibility
- Supports multimode and singlemode fiber
- Non-blocking, store and forward switching
- Supports LC connectors for fiber, Mirco-D connectors for copper

RuggedRated™ for Reliability in Harsh Environments
- Immunity to EMI and heavy electrical surges
- Zero-Packet-Loss™ Technology
- -40 to +85°C operating temperature (no fans)
- Conformal coated printed circuit boards
- 18 AWG galvanized steel enclosure

MIL-STD Ratings
- MIL-STD 901D – Shock (Hard Mounted)
- MIL-STD 167 – Vibration
- MIL-STD 461 – EMI
- MIL-STD 1399 – Magnetic Field (DC Magnetic Exposure)
- MIL-STD 810 – Temperature and Humidity

Universal Power Supply Options

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- Fully integrated, dual-redundant (optional) power supplies
- Universal high-voltage range: 88-300VDC or 85-264VAC
- Popular low voltage DC ranges: 12, 24 or 48 VDC
- Terminal blocks for reliable maintenance free connections
- CSA/UL 60950 safety approved to +85°C

Simple Plug and Play Operation
- Automatic learning of up to 8192 MAC addresses
- Auto-negotiation on all 10/100/1000BaseTX ports
- Auto-MDI/MDIX (crossover) on all 10/100BaseTX ports
- LED indicators for link, activity and speed

Rugged Operating System (ROS™) Advanced Network Management
- Enhanced Rapid Spanning Tree (eRSTP™)
- Quality of Service (802.1p) for real-time traffic
- Port rate limiting: 128kbps - 8Mbps
- VLAN (802.1q) with double tagging
- IGMP Snooping for multicast filtering
- Port configuration, status, statistics, mirroring, security
- Loss of link management on fiber ports
- Web-based, Telnet, CLI management interfaces
- SNMP v2 and RMON
- Rich set of diagnostics with logging and alarms

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3.2 Ethernet Panel Description

Each Ethernet module is equipped with two LEDs that indicate link/activity status information. The LED will be solid for ports with link, and will blink for activity. The diagram in Figure 1 highlights the port and the associated link/activity LED.
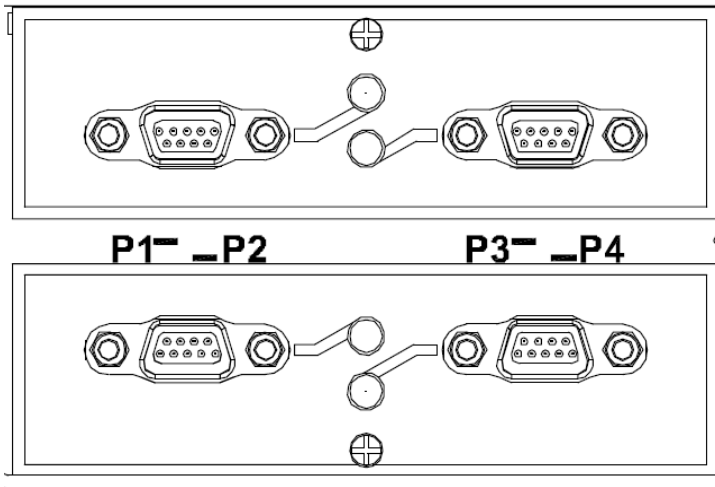
Figure 1: Ethernet panel LED description

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3.2.1 Fiber Optical Transceiver Orientation and Connection

Depending on the order code of the product, the M2000 series products can be equipped with different types of fiber optic ports. The Transmit (TX) and Receive (RX) connections of each port must be properly connected and matched for proper link and operation. Modules populated on the top row of the device typically have locking mechanisms or tabs towards the top of the unit. Modules located on the bottom row of the device have locking mechanisms or tabs towards the bottom of the device.

The drawings in the following figures show each fiber optical connector style with a side and top view to allow the user to identify the proper cable connection orientation. If modules are populated on the bottom row of the device, the transceiver orientation will be reversed (i.e. RX and TX will be reversed).
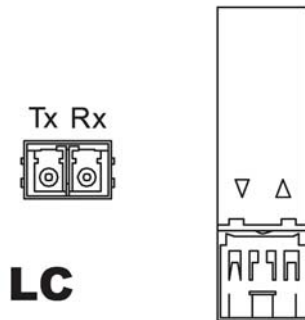
Figure 2: 1000BaseX LC connector

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3.3 Display Panel Description

The M2000 series products are equipped with a versatile display panel, shown in Figure 3, which is designed to provide quick status information for each port, as well as the entire device to allow for simple diagnostics and troubleshooting. It features:

- RS232 console port for 'out of band' console access and configuration
- Power supply and Alarm status indicators
- Convenient port status indicators conveying Link-Activity, Duplex, or Speed via push-button control.
- System reset via push-button if held for 5 seconds
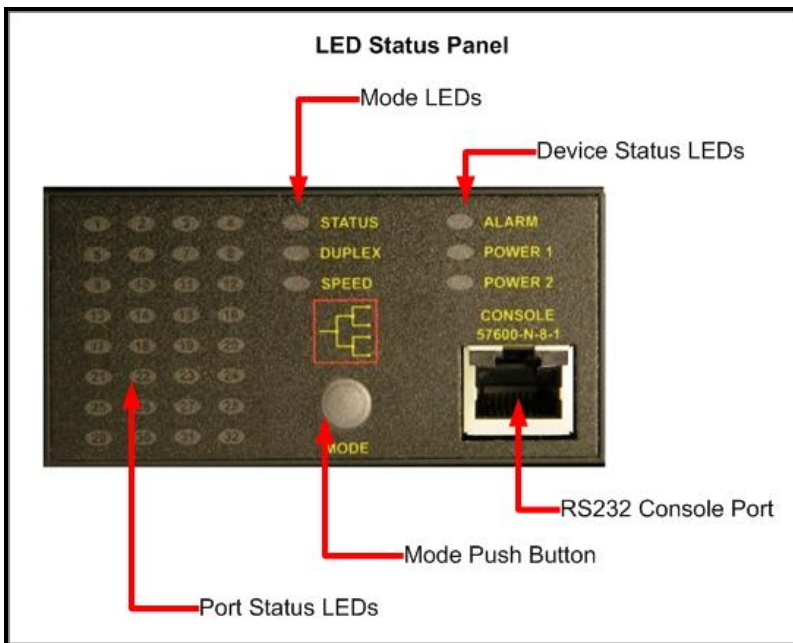
Figure 3: M2000 Series LED Display Panel

Device status LEDs exist to provide a quick visual indicator to operators for operational status of the unit. Table 1 defines the possible LED colours and the corresponding description.

LED	Colour	Description
PS1 / PS2	Green	Power supply operating normal
	Red	Power supply failure
	Off	No power supply installed
Alarm	Red	Alarm exist – login to web management interface to determine alarm code
	Off	No alarms exist

Table 1: LED Display – Device status LED behavior definition

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The port-based LEDs can be cycled between three display modes: Status, Duplex, and Speed.
Pushing the mode button causes the display mode to be cycled.

Mode	Colour	Description
Status	Green (Solid)	Link
	Green (Blinking)	Activity
	Off	No link
Duplex	Green (Solid)	Full-Duplex operation
	Orange (Solid)	Half-Duplex operation
	Off	No link
Speed	Green (Blinking)	1000Mb/s
	Green (Solid)	100Mb/s
	Orange (Solid)	10Mb/s
	Off	No link

Table 2: LED Display Description

4 Installation

4.1 Panel Mounting

The M2000 series products can be ordered with Panel mount chassis. This option involves the use of the panel adapters to be mounted on each side of the chassis enclosure. See Figure 4 for a Panel mount diagram.
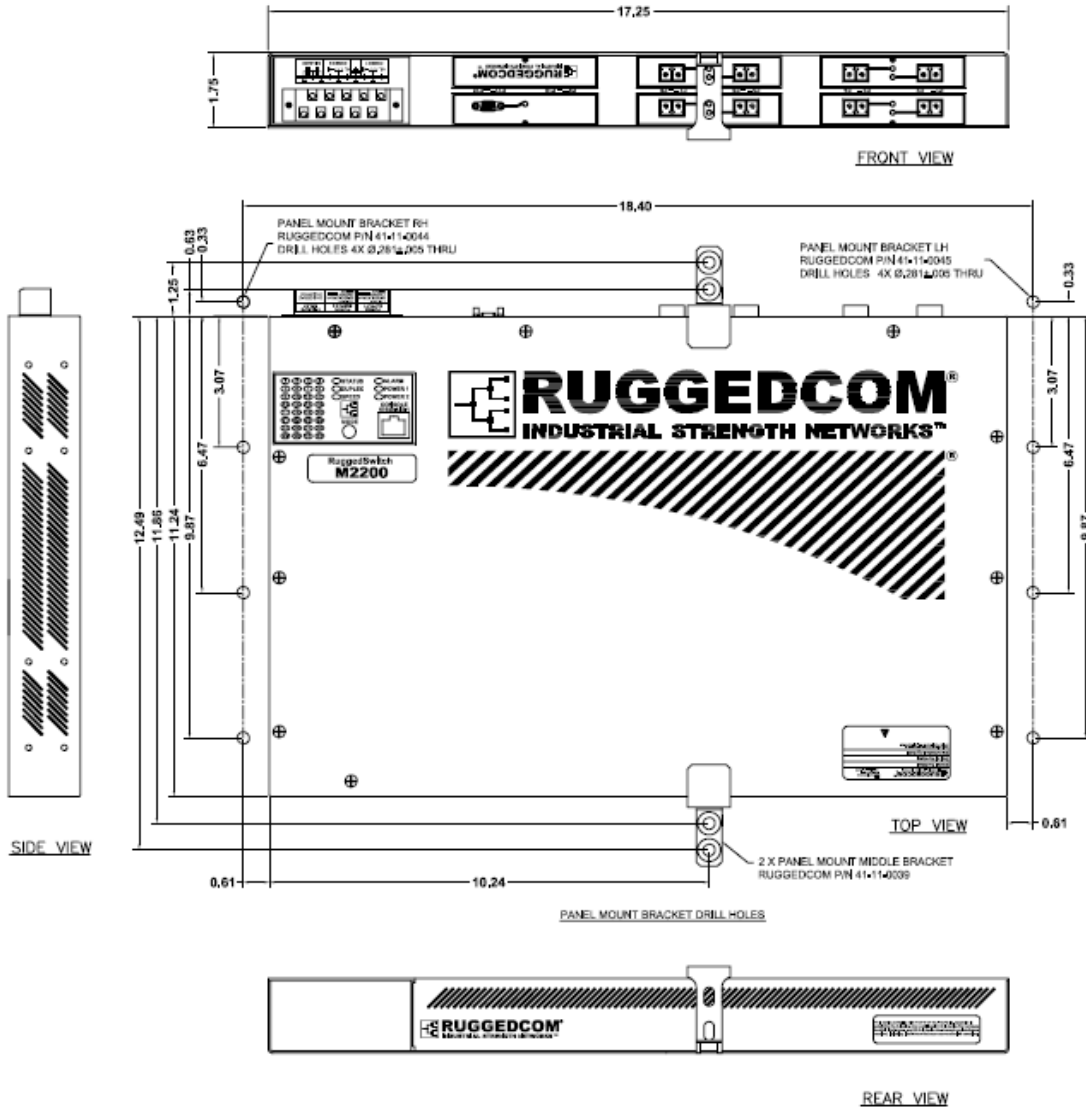
Figure 4: M2200 Panel Mounting Diagram

4.2 Power Supply Wiring and Grounding
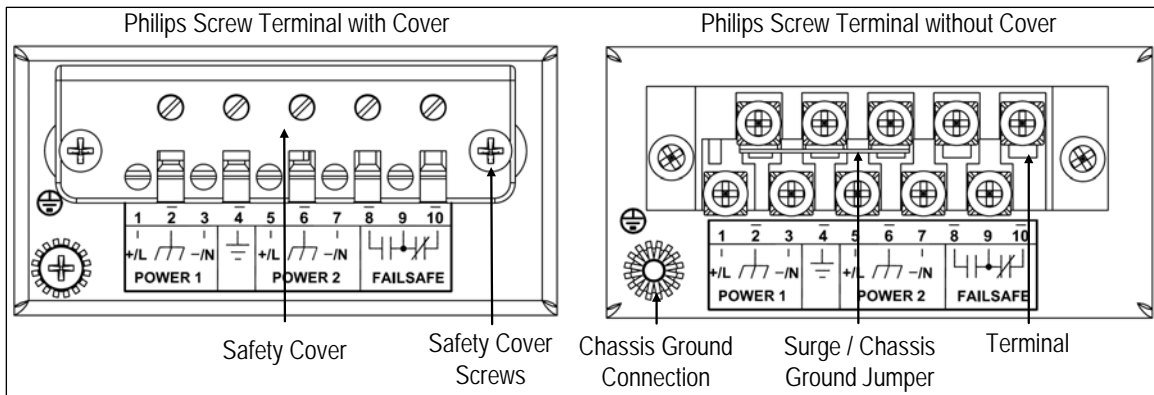
Figure 5: M2000 Series Philips Screw Terminal Block

The M2000 Family supports dual redundant power supplies – "Power Supply 1 (PS1)" and "Power Supply 2 (PS2)". The connections for PS1, PS2 and the fail-safe relay are located on the terminal block as shown in Figure 5.

The M2000 Family is equipped with a Philips Screw Terminal Block. The Philips Screw Terminal Block has Philips screws with a compression plate allowing either bare wire connections or crimped terminal lugs. RuggedCom recommend the use of #6 size ring lugs to ensure secure, reliable connections under severe shock or vibration. The terminal block has a safety cover which must be removed via two Phillips screws before connecting any wires. The safety cover must be re-attached after wiring to ensure personnel safety. Refer to Table 3 below for a description of each terminal as well as sections 4.2.1 through 4.2.3 for wiring examples.

Terminal #	Description	Usage
1	PS1 Live / +	**PS1 Live / +** is connected to the positive (+) terminal if the power source is DC or to the (Live) terminal if the power source is AC.
2	PS1 Surge Ground	**PS1 Surge Ground** is connected to the Chassis Ground via a jumper on the terminal block. Surge Ground is used as the ground conductor for all surge and transient suppression circuitry. **NOTE:** Surge Ground must be disconnected from Chassis Ground during HIPOT (dielectric strength) testing.
3	PS1 Neutral / -	**PS1 Neutral / -** is connected to the negative (-) terminal if the power source is DC or to the (Neutral) terminal if the power source is AC.
4	Chassis Ground	**Chassis Ground** is connected to the Safety Ground terminal for AC inputs or the equipment ground bus for DC inputs. Chassis ground connects to both power supply surge grounds via a removable jumper.
5	PS2 Live / +	**PS2 Live / +** is connected to the positive (+) terminal if the power source is DC or to the (Live) terminal if the power source is AC.
6	PS2 Surge Ground	**PS2 Surge Ground** is connected to the Chassis Ground via a jumper on the terminal block. Surge Ground is used as the ground conductor for all surge and transient suppression circuitry. **NOTE:** Surge Ground must be disconnected from Chassis Ground during HIPOT (dielectric strength) testing.
7	PS2 Neutral / -	**PS2 Neutral / -** is connected to the negative (-) terminal if the power source is DC or to the (Neutral) terminal if the power source is AC.
8	Relay NO Contact	Normally open, failsafe relay contact.
9	Relay Common	Failsafe relay common contact.
10	Relay NC Contact	Normally closed, failsafe relay contact.

Table 3: M2200 Power terminal block connection description

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4.2.1 AC Power Supply Wiring Examples
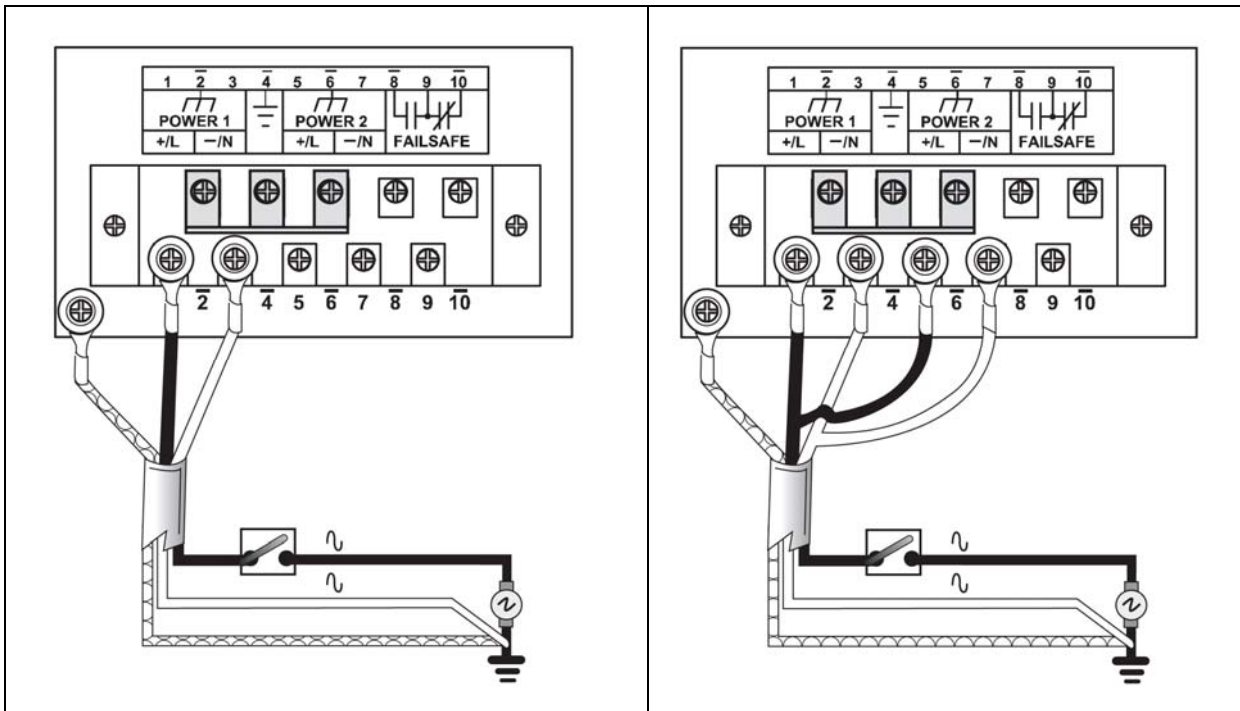
Figure 6: AC Power supply wiring examples

NOTES:
1. 100-240VAC rated equipment: A 250VAC appropriately rated circuit breaker must be installed within 3m of unit.
2. Equipment must be installed according to the applicable country wiring codes.
3. When equipped with two HI voltage power supplies, independent AC sources can be used to power the product for greater redundancy.

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4.2.2 DC Power Supply Wiring Examples
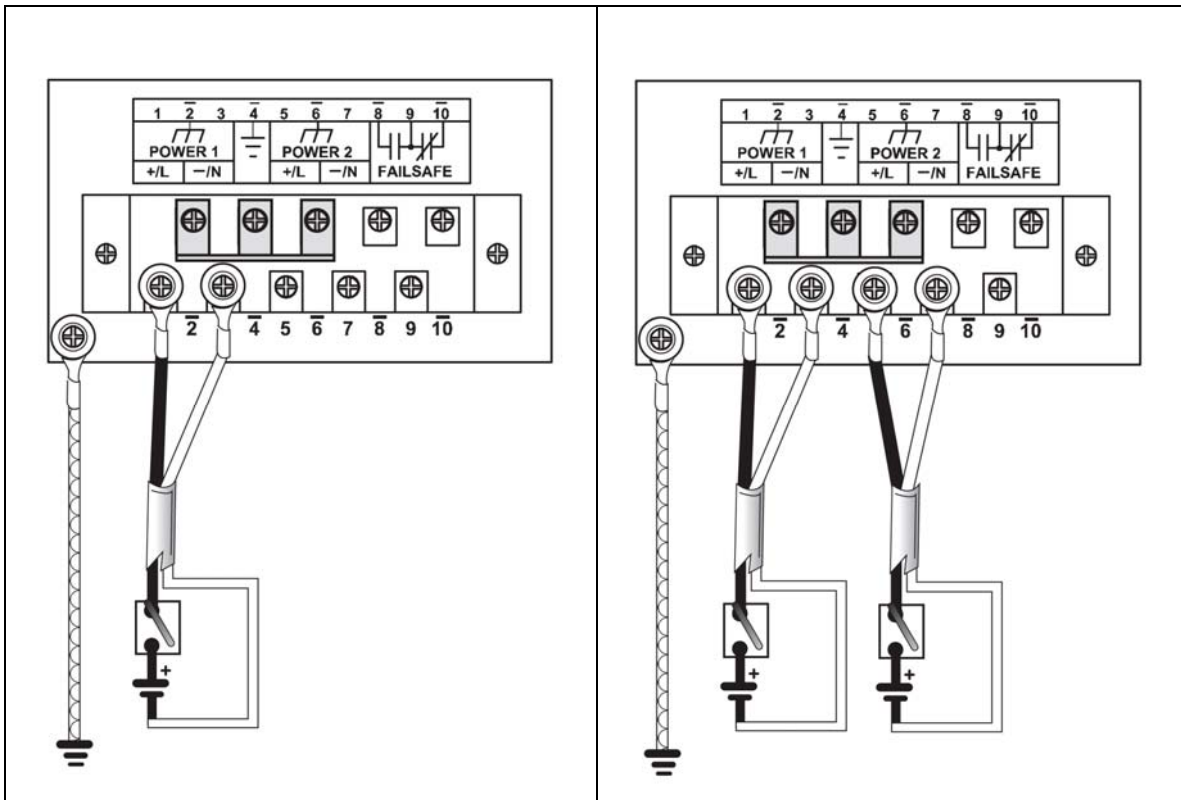
Figure 7: DC Power supply wiring examples

NOTES:
1. 88-300VDC rated equipment: A 300VDC appropriately rated circuit breaker must be installed within 3m of unit.
2. A circuit breaker is not required for 12, 24 or 48 VDC rated power supplies.
3. For dual DC power supplies, Separate circuit breakers must be installed and separately identified.
4. Equipment must be installed according to the applicable country wiring codes.

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4.2.3 Dual Power Supplies – DC and AC Inputs
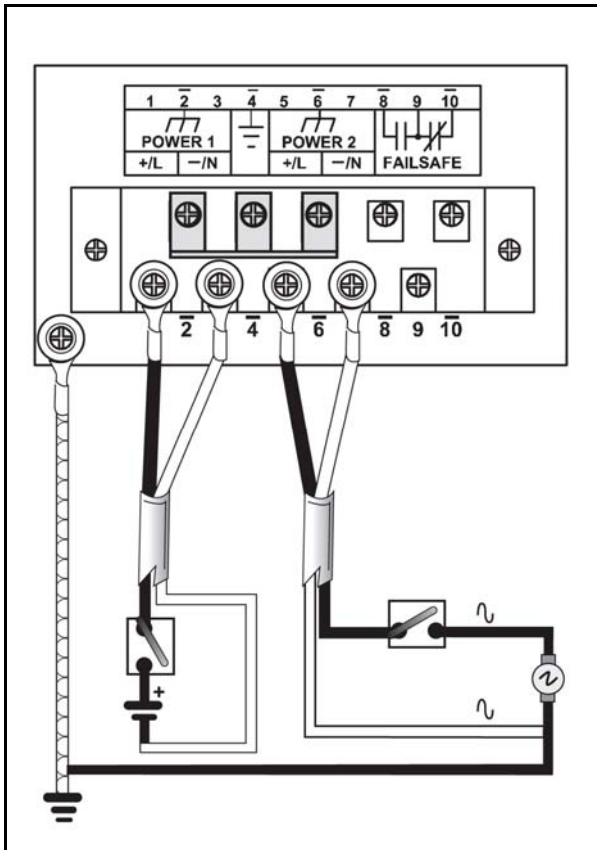
Figure 8: DC And AC power supply wiring examples

NOTES:
1. 88-300VDC rated equipment: A 300VDC appropriately rated circuit breaker must be installed within 3m of unit.
2. 100-240VAC rated equipment: A 250VAC appropriately rated circuit breaker must be installed within 3m of unit.
3. A circuit breaker is not required for 48 or 24VDC rated power supplies.
4. Separate circuit breakers must be installed and separately identified.
5. Equipment must be installed according to the applicable country wiring codes.

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4.3 Dielectric Strength (HIPOT) Testing

For dielectric strength (HIPOT) testing in the field, users must remove the metal jumper located on terminal 2, 4, and 6 of the power supply terminal block. This metal jumper connects transient suppression circuitry to chassis ground and must be removed in order to avoid damage to transient suppression circuitry during HIPOT testing. Figure 9 shows the proper HIPOT test connections and should be followed to avoid damage to the device.
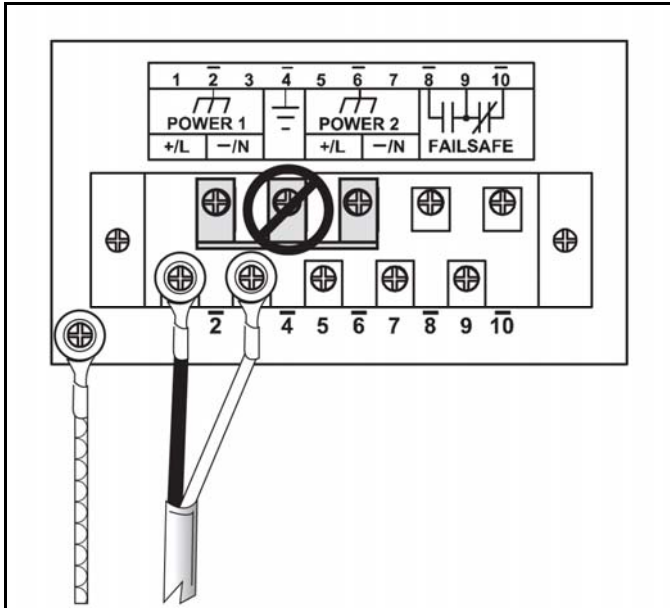
Figure 9: Dielectric Strength (HIPOT) Testing

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4.4 Failsafe Alarm Relay Wiring and Specifications

The "Failsafe" output relay is provided to signal critical error conditions that may occur on the M2000 series products. The contacts are energized upon power up of the unit and remain energized until a critical error occurs. The proper relay connections are shown in Figure 10. One common application for this output is to signal an alarm if a power failure or removal of control power occurs.

Figure 10: Failsafe Alarm Relay Wiring

Common

Normally   N

Open

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4.5 Console Port Wiring

A RS232 console port for configuration and management of the device is located on the LED display module shown in Figure 11. This port is intended to be a temporary connection during initial configuration or troubleshooting and allows for direct access to the serial-based management console. The connection is made using the DB9-Female to RJ45 console cable included in the device packaging shown in Figure 12. Console connection settings are: 57600 baud, no parity bits, 8 data bits, and 1 stop bit.
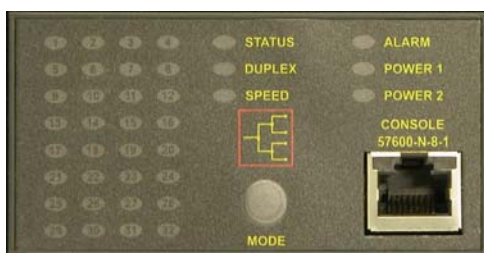
Figure 11: Console port location on display board

Figure 12: M2200 Console cable

For user reference, the console cable pin-out is show in Table 5.

RuggedCom RS232 over RJ45 pin-out specification		
Signal Name (PC is DTE)	DB9- Female	RJ45 Male
DCD – Carrier detect	1	2
RxD – Receive data (to DTE)	2	5
TxD – Transmit data (from DTE)	3	6
DTR – Data terminal ready	4	3
Signal GND	5	4
DSR – Data set ready	6	1*
RTS – Ready to send	7	8
CTS – Clear to send	8	7
RI – Ring Indicator	9	1*

Table 4: RS232 over RJ45 console cable pin-out

After initial configuration, the RuggedSwitch device can be configured via a number of new mechanisms such as Telnet, and the built-in web server. Consult the RuggedSwitch ROS User Guide for further details.

NOTE: This port is not intended to be a permanent connection and the cable shall be less than 2m (6.5 ft) in length.

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4.6 Twisted-Pair Data Ports

4.6.1 Micro-D Twisted-Pair Data Ports

The M2100 may have several 10/100/1000BaseTX ports that allow connection to standard CAT-5 UTP cable with Micro-D connectors. Figure 13 shows the Micro-D port pin configuration.

Pin	Signal
1	TX+
2	No Connection
3	No Connection
4	No Connection
5	RX+
6	TX-
7	No Connection
8	No Connection
9	RX-

Micro-D 10/100BaseTX port pin-out

Pin	Signal
1	TP1+ (B+)
2	TP3+ (D+)
3	No Connection
4	TP2+ (C+)
5	TP0+ (A+)
6	TP1- (B-)
7	TP3- (D-)
8	TP2- (C-)
9	TP0- (A-)

Micro-D 10/100/1000BaseTX port pin-out

Pin 1

Pin 6
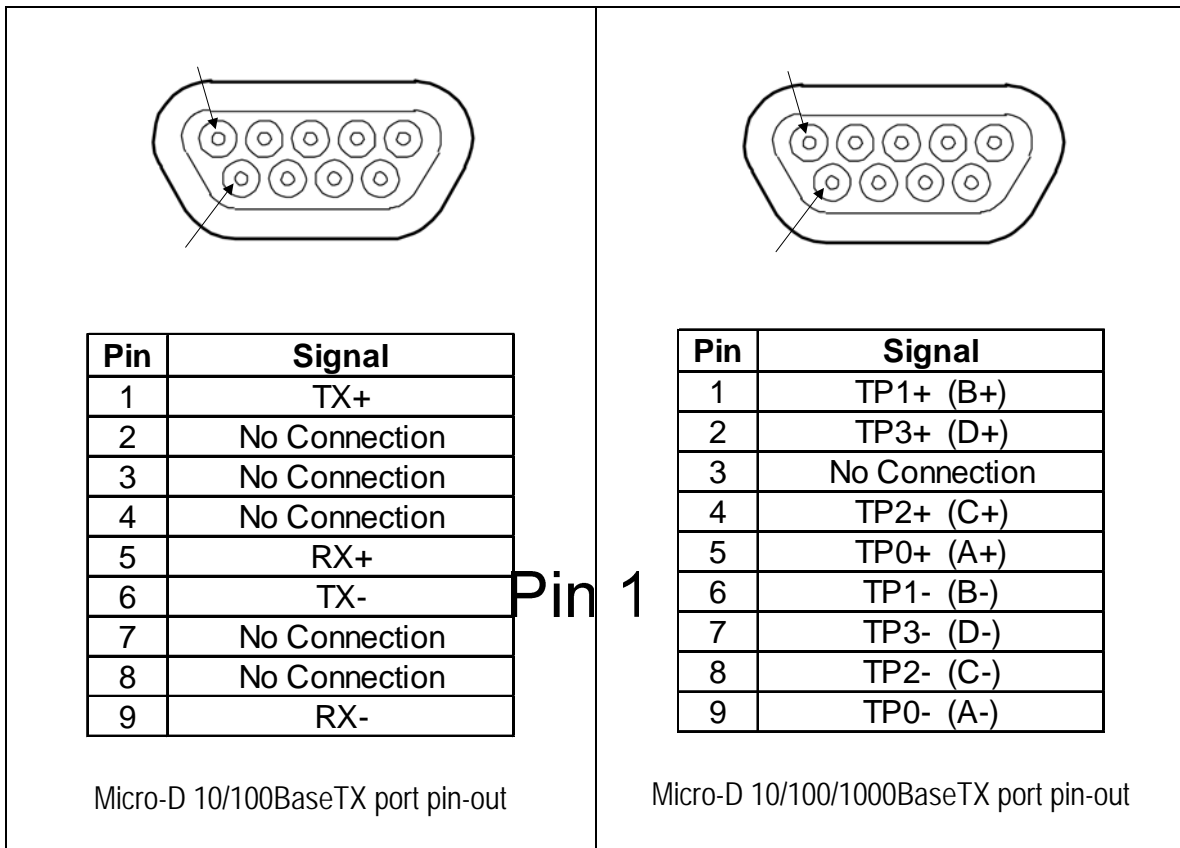
Figure 13: Micro-D port pin configuration

NOTES:
1. For 10/100Base-TX ports: pin2 and pin7 are internally connected, pin4 and pin8 are internally connected on PCB board.
2. For 10/100/1000Base-TX ports: pin3 and pin8 are internally connected on PCB board.

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4.6.2 Protection on Twisted-Pair Data Ports

RuggedCom does not recommend the use of CAT-5 cabling of any length for critical real-time substation automation applications. However, transient suppression circuitry is present on all copper ports to protect against damage from electrical transients and to ensure IEC 61850-3 and IEEE 1613 Class 1 conformance. This means that during the transient event communications errors or interruptions may occur but recovery is automatic.

RuggedCom also does not recommended to use these ports to interface to field devices across distances which could produce high levels of ground potential rise, (i.e. greater than 2500V) during line to ground fault conditions.

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4.7 Gigabit Ethernet 1000Base-Tx Cabling Recommendations

The IEEE 802.3ab Gigabit Ethernet standard defines 1000Mbit/s Ethernet communications over distances of up to 100 meters using 4 pairs of category 5 (or higher) balanced unshielded twisted-pair cabling. For wiring guidelines, system designers and integrators should refer to the Telecommunications Industry Association (TIA) TIA/EIA-568-A wiring standard that characterizes minimum cabling performance specifications required for proper Gigabit Ethernet operation. To ensure reliable, error-free data communications, new and pre-existing communication paths should be verified for TIA/EIA-568-A compliance. Table 5 summarizes cabling standards available today.

Cabling Category	1000BaseTx Compliant	Required action
< 5	No	New wire infrastructure required
5	Yes	Verify TIA/EIA-568-A compliance
5e	Yes	No action required. New installations should be designed with Category 5e components or higher
6	Yes	No action required
> 6	Yes	Connector and cabling standards to be determined.

Table 5: Cabling categories and 1000BaseTx compliance defined.

In general the following recommendations should be followed for copper data cabling in high electrical noise environments:

- Data cable lengths should be as short as possible, ideally limited to 3m (10ft) in length. Copper data cables should not be used for inter-building communications.
- Power and data cables should not be run in parallel for long distances, and ideally should be installed in separate conduits. Power and data cables should intersect at 90° angles when necessary to reduce inductive coupling.
- Shielded/screened cabling can optionally be used. The cable shield should be grounded at one single point to avoid the generation of ground loops.

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5 Technical Specifications

5.1 Power Supply Specifications

Power Supply Type	Input Range		Fuse Rating	Max. Power Consumption[3]
	Min	Max		
12 – 24 VDC	10 VDC	36 VDC	6.3A(F) [2]	
24 VDC	18 VDC	36 VDC	5A(F) [2]	
48 VDC	36 VDC	59 VDC	2A(T) [2]	22W
HI (125/250 VDC) [1] HI (110/230 VAC) [1]	88 VDC 85 VAC	300 VDC 265 VAC	2A(T) [1,2]	

NOTES:
1. This is the same power supply for both AC and DC.
2. (F) Denotes fast-acting fuse, (T) denotes time-delay fuse
3. Power consumption varies based on configuration. 10/100Tx ports consume roughly 1W less than fiber optic ports.
4. For continued protection against risk of fire, replace only with same type and rating of fuse.

5.2 Failsafe Relay Specifications

Parameter	Value (Resistive Load)
Max Switching Voltage	240VAC, 125VDC
Rated Switching Current	2A @ 240VAC 0.15A @ 125VDC, 2A @ 30VDC
Max Switching Capacity	150W, 500VA

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5.3 Networking Standards Supported

Parameter	10Mbps Ports	100Mbps Ports	1000Mbps Ports	Notes
IEEE 802.3				10BaseT / 10BaseFL
IEEE 802.3u				100BaseTX / 100BaseFX
IEEE 802.3z			✓	1000BaseSX/LX
IEEE 802.3ab			✓	1000BaseTx
IEEE 802.3x	✓	✓	✓	Full Duplex Operation
IEEE 802.1D	✓	✓	✓	MAC Bridges
IEEE 802.1Q	✓	✓	✓	VLAN (Virtual LAN)
IEEE 802.1p	✓	✓	✓	Priority Levels

5.4 Twisted-Pair Port Specifications

Parameter	Specification	Notes
Speed	10/100 Mbps	Auto-negotiating
Duplex	FDX / HDX	Auto-negotiating
Cable-Type	> Category 5	Shielded/Unshielded
Wiring Standard	TIA/EIA T568A/B	Auto-Crossover, Auto-polarity
Max Distance	100m	
Connector	RJ45	
Isolation	1.5kV	RMS 1-minute

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5.5 Fiber Optical Specifications

The following sections detail fiber optical specifications on ports that can be ordered with the M2200 series Ethernet switch. The user determines the type of optics at time of ordering, and can determine the modules installed on a particular unit by reading the factory data file via the RuggedSwitch ROS™ user interface. The following sections detail specifications of fiber optic modules in Gigabit Ethernet (1000Mbps).

5.5.1 Gigabit Ethernet (1000Mbps) Modules

For maximum flexibility RuggedCom Inc. offers a number of different transceiver choices for Gigabit fiber optical communications. The following table details fiber optic specifications based on the 2-port modules or pluggable transceivers selected at time of ordering.

Optics Order Code	Mode / Connector	Tx λ (nm)	Cable Type[2]	Tx Pwr (dBm)[3] (Min/Max)	Rx Sensitivity (dBm)[3]	Rx Saturation (dBm)[3]	Typical Distance (km)[1]	Power Budget (dB)
12-11-0036	MM / LC	850	50μ/125	-9.5 / -4	-20	0	0.5	13
12-11-0027	SM / LC	1310	9μ/125	-9.5 / -3	-22	-3	10	18.5
12-11-0028	SM / LC	1310	9μ/125	-5 / 0	-22	-3	25	19.5

NOTES:
1. Maximum segment length is greatly dependent on factors such as fiber quality, and number of patches and splices. Please consult RuggedCom sales associates when determining maximum segment distances.
2. All cabling is duplex type unless otherwise specified.
3. All optical power numbers are listed as dBm averages.
4. These transceivers utilize a distributed feedback (DFB) type laser and are rated for -20°C to +85°C operation only.

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5.6 Type Test Specifications

Electrical Safety	Levels	Comments
Dielectric Withstand	2 kV RMS for 1 minute	ANSI/IEEE C37.90 (1989) IEC 60255-5 (Section 6)
High Voltage Impulse	5 kV peak	IEC 60255-5 (Section 8)
Insulation Resistance	500 VDC for 1 minute	IEC 60255-5 (Section 6

Electrical Environment	Levels	Comments
High Frequency Disturbance (Oscillatory)	2.5 kV @ 1MHz for 2s	ANSI/IEEE C37.90.1 IEC 60255-22-1
IEC Surge	4 kV / 2 kV	IEC 61000-4-5 (Level 4)
IEC Fast Transient	2 kV / 1 kV	IEC 61000-4-4 (Level 4)
ANSI/IEEE Fast Transient	4 kV	ANSI/IEEE C37.90.1
IEC Radiated RFI Immunity	10 V/m	IEC 61000-4-3
ANSI/IEEE Radiated RFI Immunity	20 V/m	ANSI/IEEE C37.90.2
ESD (Electrostatic Discharge)	15 kV (air discharge) 8 kV (contact)	IEC 61000-4-2 (Level 4)

Atmospheric Environment	Levels	Comments
Temperature (Dry Cold)	-40°C	IEC 60068-2-1 Test Ad: 16 hrs @ -40°C
Temperature (Dry Heat)	85°C	IEC 60068-2-2 Test Bd: 16 hrs @ 85°C
Humidity	95% non-condensing	IEC 60068-2-30 Test Db: 6 cycles, 55°C, 95% Humidity

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5.7 Operating Environment

Parameter	Range	Comments
Ambient Operating Temperature	-40 to 85°C	Ambient Temperature as measured from a 30cm radius surrounding the center of the enclosure.
Ambient Relative Humidity	5% to 95%	Non-condensing
Ambient Storage Temperature	-40 to 85°C	

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5.8 Mechanical Specifications

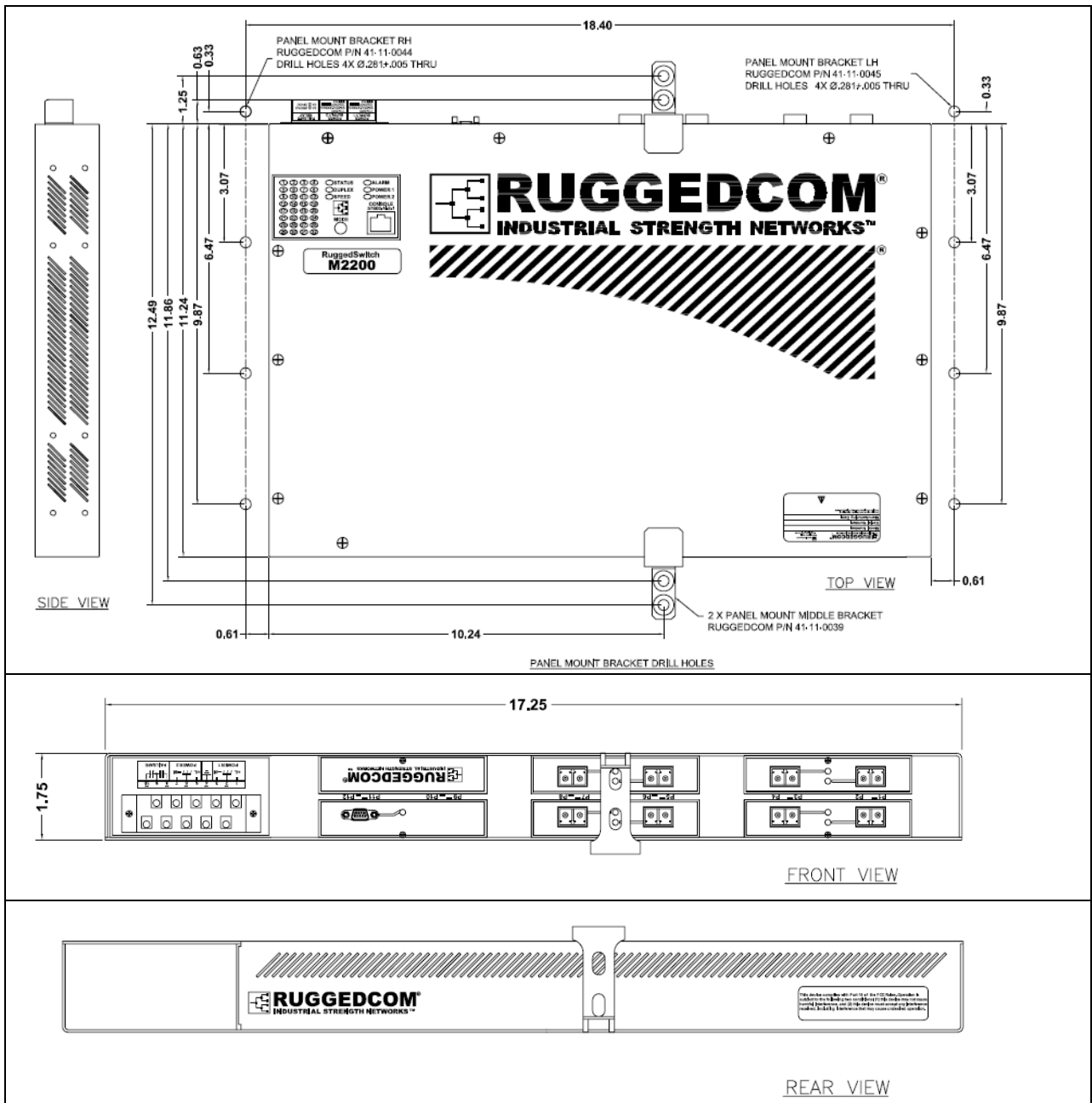| Parameter	Value	Comments
Dimensions	19.00 x 14.50 x 2.02 inches (482.6) x (368.3) x (51.3) mm	(Length x Width x Height) with mounting brackets installed
Weight	11.2 lb (5 Kg)	with mounting brackets installed
Enclosure	18awg galvanized steel	

Figure 14: Mechanical Dimensions

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6 Agency Approvals

Agency	Standards	Comments
CE	EN 60950, EN 61000-6-2	CE Compliance is claimed via Declaration of Self Conformity Route
FCC	FCC Part 15, Class A	Passed
CISPR	EN55022, Class A	Passed
FDA/CDRH	21 CFR Chapter 1, Subchapter J	Passed
IEC/EN	EN60825-1:1994 + A11:1996 + A2:2001	Passed

7 Warranty

RuggedCom warrants this product for a period of five (5) years from date of purchase. For warranty details, visit http://www.ruggedcom.com/ or contact your customer service representative.

Should this product require warranty or service contact the factory at:

RuggedCom Inc.
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Woodbridge, Ontario
Canada L4L 7Z4

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