CRS-280L

1:N Redundancy Switch

Installation and Operation Manual

Part Number MN/CRS280L.IOM

Revision 0

Errata A

Comtech EF Data Documentation Update

Subject:	Deletion of CRS-400 Switch Reference
Date:	February 2, 2005
Document:	CRS-280L 1:N Redundancy Switch Installation and Operation Manual, Rev. 0, dated October 24, 2003
Part Number:	MN/CRS280L.EA0
Collating Instructions:	Attach this page to page 1

Comments:

This information will be incorporated into the next revision.

Change Specifics:

Delete the CRS-400 Switch reference throughout the manual.

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Errata B

Comtech EF Data Documentation Update

Subject:	Updated Table 1
Date:	February 2, 2005
Document:	CRS-280L 1:N Redundancy Switch Installation and Operation Manual, Rev. 0, dated October 24, 2003
Part Number:	MN/CRS280L.EB0
Collating Instructions:	Attach this page to page 4

Comments:

This information will be incorporated into the next revision.

Change Specifics:

Table 1. CRS-280L Specifications

Characteristic	Definition
TX/RX Operating Frequency	950 to 1950 MHz
Impedance	50 Ω
TX Return Loss	15 dB at 50 Ω
TX to TX Channel Isolation	>70 dB
RX to RX Channel Isolation	>70 dB
TX to RX Channel Isolation	>90 dB
Maximum Number of Uplinks	10
Transmit IF Loss / Flatness TX (in) to Associated Uplink (out) BU (in) to Any Uplink (out)	 < 0.8 dB / 0.5 dB over operating frequency < 2.5 dB / 1.0 dB over operating frequency
Receive IF Loss / Flatness DL (in) to associated RX (out) Any DL (in) to BU RX (out)	 < 4.0 dB / 0.5 dB over operating frequency < 5.5 dB / 1.0 dB over operating frequency
RX Return Loss	15 dB into 50 Ω
Maximum Number of Downlinks	10
TX/RX Connectors	N-Type female (50 Ω)
Input Power	Redundant 25 W, AC, Universal Input Switch Mode Power Supplies Input voltage: 90 - 264 VAC Input frequency: 47 - 440 Hz Input current: 0.75 A rms max. @ 90 VAC 0.35 A rms @ 230 VAC
Power Loss Failsafe	All uplinks/downlinks revert to associated L-Band inputs/outputs
Dimensions	19 (W) x 7(H) x 14 (D) inches, 4 RU 48.26 (W) x 17.78(H) x 35.6(D) cm
Weight	< 25 lbs (<11.35kg)
Environmental Operating Temperature Storage Temperature Humidity	 0° to +50° C (32° to +122° F) -50° to +100° C (-58° to +212° F) 95% at +50° C (+122° F), Non-condensing
Control Interface	25-pin sub-D female, compatible with CRS-300 controller. 15-pin sub-D female, compatible with SMS-7000
EMC And Safety	EN 55022 Class B emissions EN 50082-1 immunity EN 60950 Safety FCC Part 15 Class B

Errata C

Comtech EF Data Documentation Update

Subject: Revised Overview Description

Date: February 2, 2005
Document: CRS-280L 1:N Redundancy Switch Installation and Operation Manual, Rev. 0, dated October 24, 2003
Part Number: MN/CRS280L.EC0
Collating Instructions: Attach this page to page 1

Comments:

This information will be incorporated into the next revision.

Change Specifics:

1.1 Overview

The CRS-280L M:N L-Band Redundancy Switch supports systems with one backup and up to 10 prime channels. Operation of the CRS-280L is controlled by the switching system to which it is connected. It is designed for use with:

Modem	Remarks	Notes
CDM-570L	Used with CRS-300	1:10
CDM-600L	Used with CRS-300 and CRS-350 (ESC only)	1:10
CLM-9600L	Used with CRS-300 and CRS-350 (ESC only)	1:10
SDM-300L3	Used with SMS-7000	1:8
SDM-2020D (L-Band)	Used with CRS-400 (HSSI)	1:10

The CRS-280L replaces:

- CRS-280 IF switch for L-Band applications (CRS-300/CRS-400)
- IFU for SMS-7000 L-Band applications.

The CRS-280L features redundant power supplies with status LEDs on the front panel and can be configured for 4 to 10 channel applications (SMS-7000 supports 8 channels

max). Each channel has a transmit section with TX input/uplink output and a receive section with downlink input / RX output.

CRS-280L

1:N Redundancy Switch
Installation and Operation Manual

Part Number MN/CRS280L.IOM
Revision 0
October 24, 2003

Comtech EF Data is an ISO 9001
Registered Company.

Comtech EF Data, 2114 West 7th Street, Tempe, Arizona 85281 USA, (480) 333-2200, FAX: (480) 333-2161

CUSTOMER SUPPORT

Contact the Comtech EF Data Customer Support Department for:

- Product support or training
- Information on upgrading or returning a product
- Reporting comments or suggestions concerning manuals

Contact Customer Support using any of the following methods:

Mail: Comtech EF Data
Customer Support Department
2114 West 7th Street
Tempe, Arizona 85281 USA

Email: service@comtechefdata.com

Internet: www.comtechefdata.com

Phone: (480) 333-2200 (Main Comtech EF Data Number)
(480) 333-4357 (Customer Support Desk)

Fax: (480) 333-2161

To return a Comtech EF Data product (in-warranty and out-of-warranty) for repair or replacement:

1. Request a Return Material Authorization (RMA) number from the Comtech EF Data Customer Support Department.

2. Be prepared to supply the Customer Support representative with the model number, serial number, and a description of the problem.

3. To ensure that the product is not damaged during shipping, pack the product in its original shipping carton/packaging.

4. Ship the product back to Comtech EF Data. (Shipping charges should be prepaid.)

For more information regarding the warranty policies, see Warranty Policy, p. xi.

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Figures

Tables

ABOUT THIS MANUAL

This manual provides installation and operation information for the Comtech EF Data CRS-280L 1:N L-Band Redundancy Switch. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the 1:N L-Band Redundancy Switch.

RELATED DOCUMENTS

The following documents are related:

- CRS-300 1:10 Redundancy Switch Installation and Operation Manual
- CRS-400 1:8 Redundancy Switch Installation and Operation Manual
- SMS-7000 1:8 Modem Protection Switch Installation and Operation Manual

CONVENTIONS AND REFERENCES

CAUTIONS AND WARNINGS

Indicates information critical for proper equipment function.

Indicates a hazardous situation that, if not avoided, may result in minor or moderate injury. CAUTION may also be used to indicate other unsafe practices or risks of property damage.

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

METRIC CONVERSION

Metric conversion information is located on the inside back cover of this manual. This information is provided to assist the operator in cross-referencing English to Metric conversions.

TRADEMARKS

All product names mentioned in this manual may be trademarks or registered trademarks of their respective companies and are hereby acknowledged.

REPORTING COMMENTS OR SUGGESTIONS CONCERNING THIS MANUAL

Comments and suggestions regarding the content and design of this manual will be appreciated. To submit comments, please contact the Comtech EF Data Customer Support Department.

EMC COMPLIANCE

This is a Class A product. In a domestic environment, it may cause radio interference that requires the user to take adequate protection measures.

EN55022 - 1997 COMPLIANCE

This equipment meets the radio disturbance characteristic specifications for information technology equipment as defined in EN55022.

EN55024 - 1998 COMPLIANCE

This equipment meets the electromagnetic compatibility/Information technology equipment – Immunity characteristics – Limits and methods of measurement per EN55024:998.

FEDERAL COMMUNICATIONS COMMISSION (FCC)

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. If not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference; in which case, users are required to correct the interference at their own expense.

Note: To ensure compliance, properly shielded cables for DATA I/O shall be used. More specifically, these cables shall be shielded from end to end, ensuring a continuous shield.

SAFETY COMPLIANCE

EN 60950

Applicable testing is routinely performed as a condition of manufacturing on all units to ensure compliance with safety requirements of EN60950.This equipment meets the Safety of Information Technology Equipment specification as defined in EN60950.

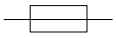
LOW VOLTAGE DIRECTIVE (LVD)

The following information is applicable for the European Low Voltage Directive (EN60950):

<HAR>	Type of power cord required for use in the European Community.
	CAUTION: Double-pole/Neutral Fusing. ACHTUNG: Zweipolige bzw. Neutralleiter-Sicherung.

.

International Symbols:

Symbol	Definition
	Alternating Current.
	Fuse.

Symbol	Definition
	Protective Earth.
	Chassis Ground.

Note: For additional symbols, refer to "Cautions" listed earlier in this preface.

WARRANTY POLICY

This Comtech EF Data product is warranted against defects in material and workmanship for a period of two years from the date of shipment. During the warranty period, Comtech EF Data will, at its option, repair or replace products that prove to be defective.

For equipment under warranty, the customer is responsible for freight to Comtech EF Data and all related custom, taxes, tariffs, insurance, etc. Comtech EF Data is responsible for the freight charges only for return of the equipment from the factory to the customer.

Comtech EF Data will return the equipment by the same method (i.e., Air, Express, Surface) as the equipment was sent to Comtech EF Data.

LIMITATIONS OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper installation or maintenance, abuse, unauthorized modification, or operation outside of environmental specifications for the product, or, for damages that occur due to improper repackaging of equipment for return to Comtech EF Data.

No other warranty is expressed or implied. Comtech EF Data specifically disclaims the implied warranties of merchantability and fitness for particular purpose.

EXCLUSIVE REMEDIES

The remedies provided herein are the buyer's sole and exclusive remedies. Comtech EF Data shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

DISCLAIMER

Comtech EF Data has reviewed this manual thoroughly in order that it will be an easy-to-use guide to your equipment. All statements, technical information, and recommendations in this manual and in any guides or related documents are believed reliable, but the accuracy and completeness thereof are not guaranteed or warranted, and they are not intended to be, nor should they be understood to be, representations or warranties concerning the products described. Further, Comtech EF Data reserves the right to make changes in the specifications of the products described in this manual at any time without notice and without obligation to notify any person of such changes.

If you have any questions regarding the equipment or the information in this manual, please contact the Comtech EF Data Customer Support Department.

Chapter 1. Introduction

CRS-280L
1:10 Redundancy Switch

1.1 OVERVIEW

The CRS-280L 1:N L-Band Redundancy Switch supports systems with one backup and up to 10 prime channels. Operation of the CRS-280L is controlled by the switching system to which it is connected. It is designed for use with:

- CRS-300 1:10 Redundancy Switch
- CRS-400 1:8 Redundancy Switch
- SMS-7000 1:8 Modem Protection Switch

The CRS-280L replaces:

- CRS-280 IF switch for L-Band applications (CRS-300/CRS-400)
- IFU for SMS-7000 L-Band applications.

The CRS-280L features redundant power supplies with status LEDs on the front panel and can be configured for 4 to 10 channel applications (SMS-7000 supports 8 channels max). Each channel has a transmit section with TX input/uplink output and a receive section with downlink input / RX output.

The CRS-280L is not designed to convey DC power to external equipment such as LNBs or BUCs. Do not apply DC power to the L-Band input and output (N-type) ports of the switch. In addition, the CRS-280L is not designed to pass to 10 MHz reference or FSK signaling.

FRONT PANEL - Figure 1 is an illustration of the front panel. The CRS-280L is constructed as a 4U high rack-mounting chassis that can be freestanding, if desired. It is provided with rack handles at the front for easy removal from and placement into a rack.

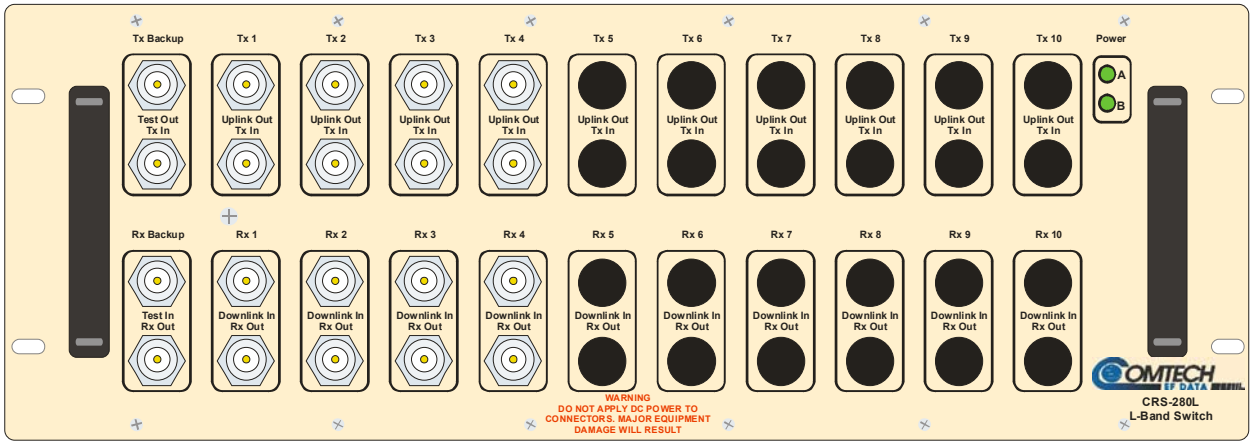


Figure 1. CRS-280L Front Panel (Configuration 1:4)

REAR PANEL – Figure 2

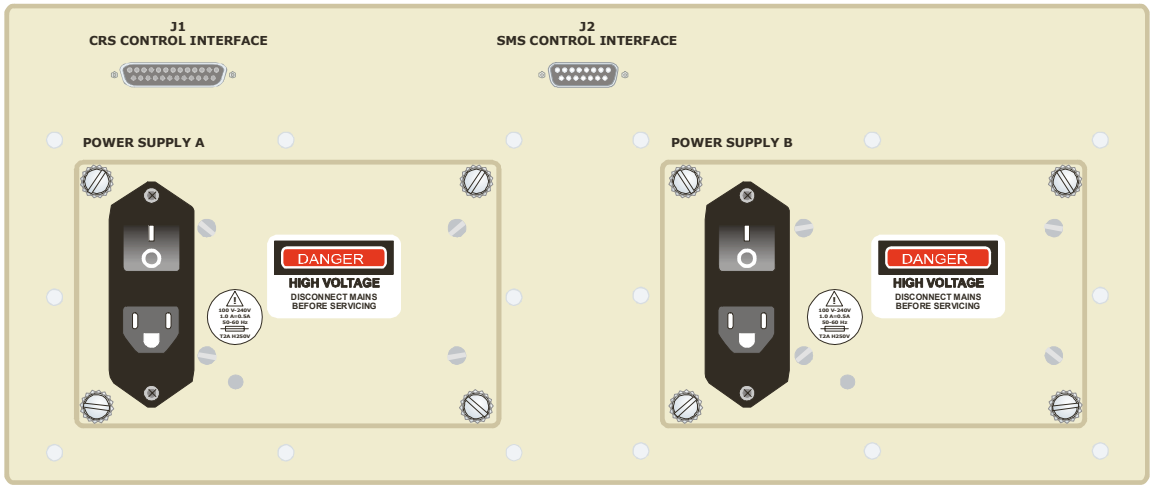


Figure 2. CRS-300 Rear Panel

1.1.1 COMPATIBILITY

CRS-300/400, use CRS control interface. SMS-7000, uses SMS control interface. Unused interface should remain unconnected. The CRS-280L senses the interface in use.

The Comtech EF Data CRS-280L 1:N Redundancy Switch is designed specifically as an accessory product for Comtech EF Data equipment

It is not designed to operate with any other manufacturer's equipment.

1.1.2 REDUNDANCY SYSTEM-LEVEL BLOCK

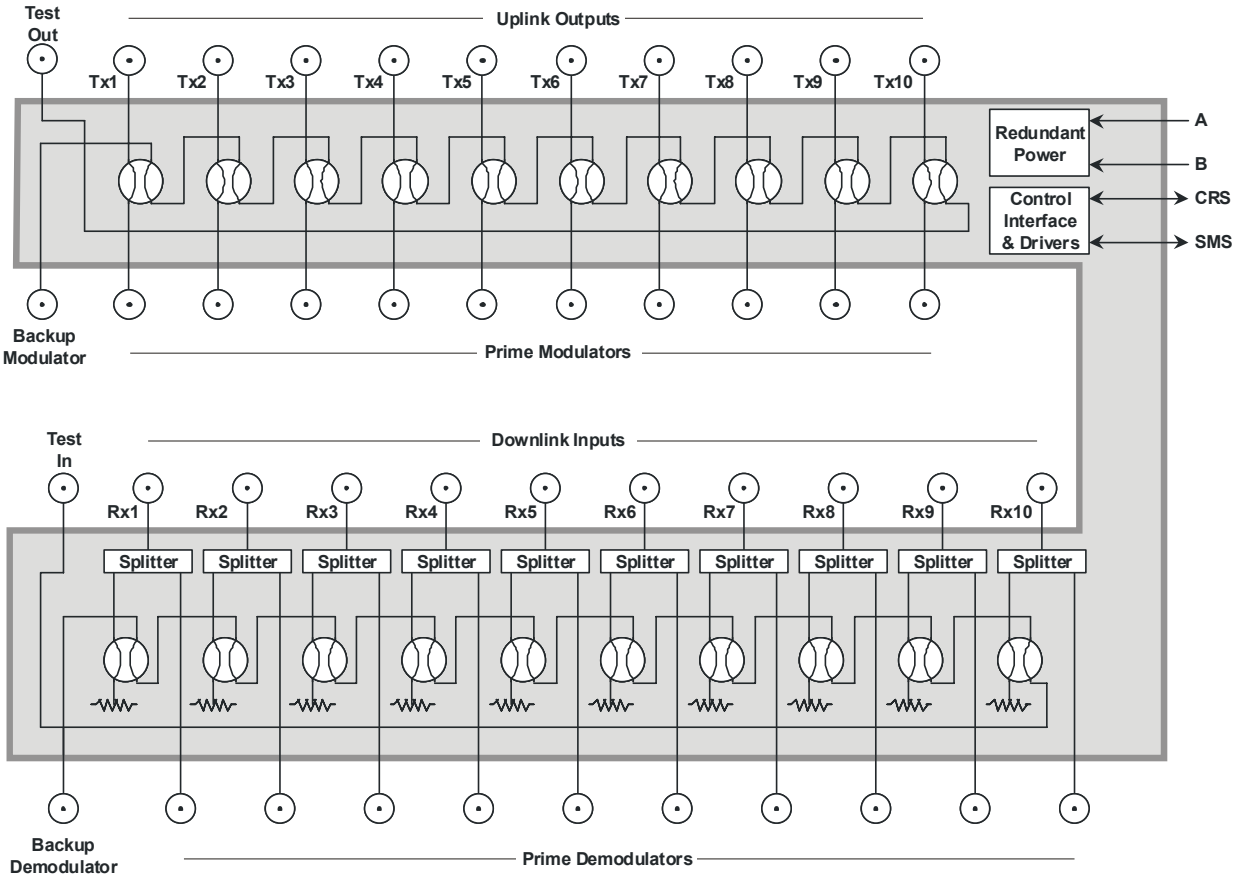


Figure 3. CRS-280L System Level Block

1.1.2.1 CRS-280L SPECIFICATIONS

Table 1. CRS-280L Specifications

Characteristic	Definition
TX/RX Operating Frequency	950 to 1950 MHz
Impedance	50 Ω
TX Return Loss	15 dB into 50 Ω
TX to TX Channel Isolation	>70 dB
RX to RX Channel Isolation	>70 dB
TX to RX Channel Isolation	>90 dB
Maximum Number of Uplinks	10
Transmit IF Loss / Flatness TX (in) to Associated Uplink (out) BU (in) to Any Uplink (out)	 < 0.8 dB / 0.5 dB over operating frequency < 2.5 dB / 1.0 dB over operating frequency
Receive IF Loss / Flatness DL (in) to associated RX (out) Any DL (in) to BU RX (out)	 < 4.0 dB / 0.5 dB over operating frequency < 5.5 dB / 1.0 dB over operating frequency
RX Return Loss	15 dB into 50 Ω
Maximum Number of Downlinks	10
TX/RX Connectors	N-Type female (50 Ω)
Input Power	Redundant 25 W, AC, Universal Input Switch Mode Power Supplies Input voltage: 90 - 264 VAC Input frequency: 47 - 440 Hz Input current: 0.75 A rms max. @ 90 VAC 0.35 A rms @ 230 VAC
Power Loss Failsafe	All uplinks/downlinks revert to associated L-Band inputs/outputs
Dimensions	19 (W) x 7(H) x 14 (D) inches, 4 RU 48.26 (W) x 17.78(H) x 10.16(D) cm
Weight	< 25 lbs (<11.35kg)
Environmental Operating Temperature Storage Temperature Humidity	 0° to +50° C (32° to +122° F) -50° to +100° C (-58° to +212° F) 95% at +50° C (+122° F), Non-condensing
Control Interface	25-pin sub-D female, compatible with CRS-300 and CRS-400 controller. 15-pin sub-D female, compatible with SMS-7000
EMC And Safety	EN 55022 Class B emissions EN 50082-1 immunity EN 60950 Safety FCC Part 15 Class B

1.1.2.2 INSERTION LOSS GRAPHS

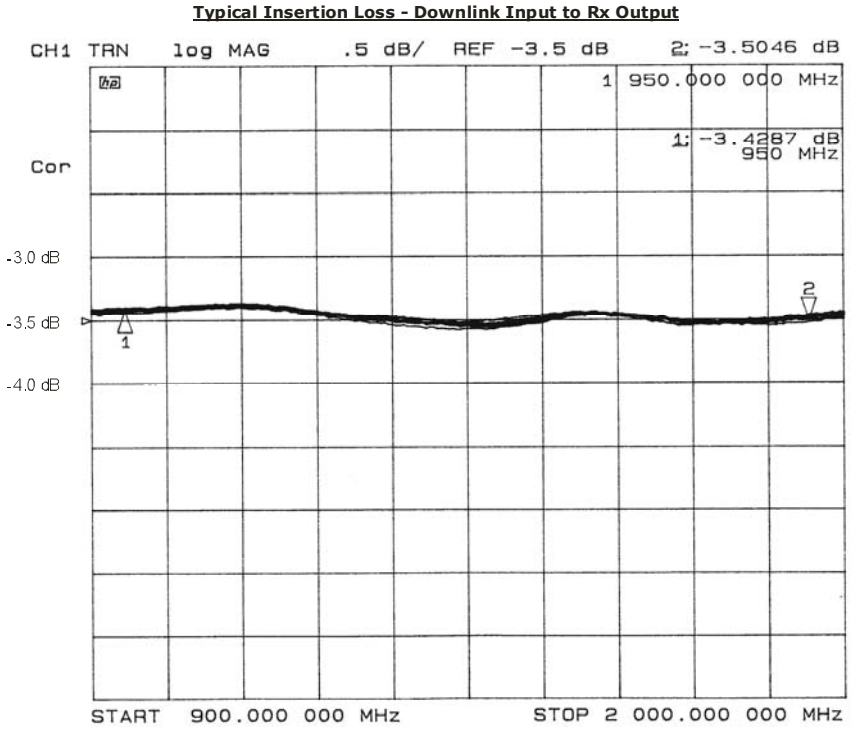


Figure 4. Insertion Loss Graph 1

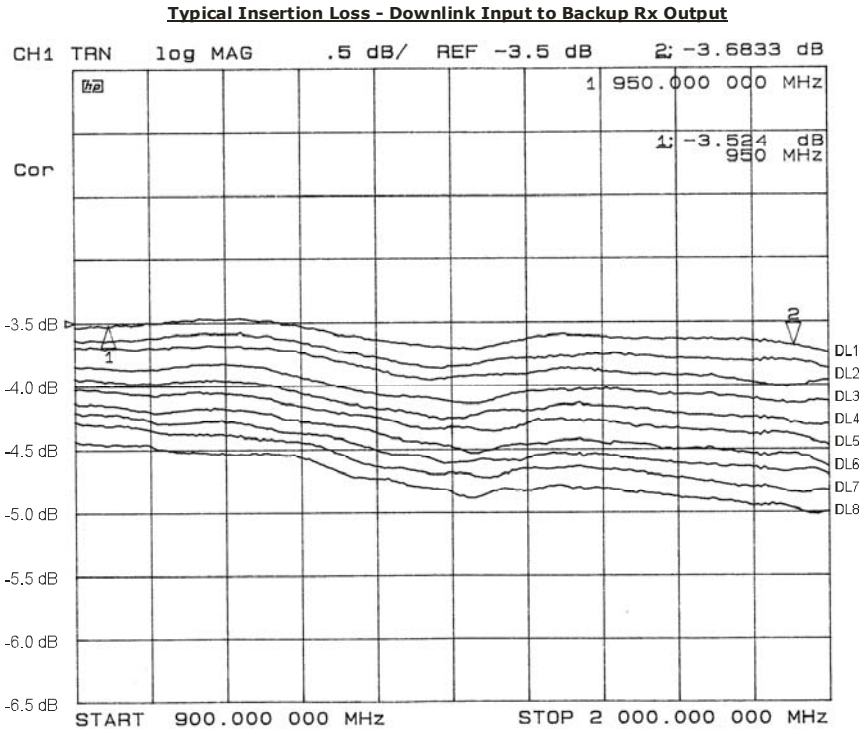


Figure 5. Insertion Loss Graph 2

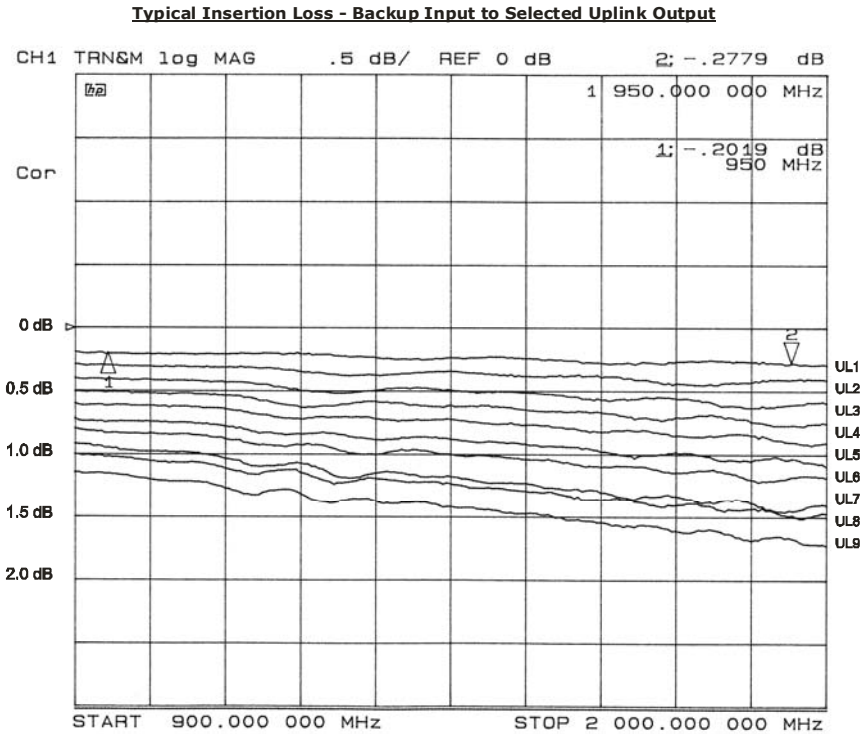


Figure 6. Insertion Loss Graph 3

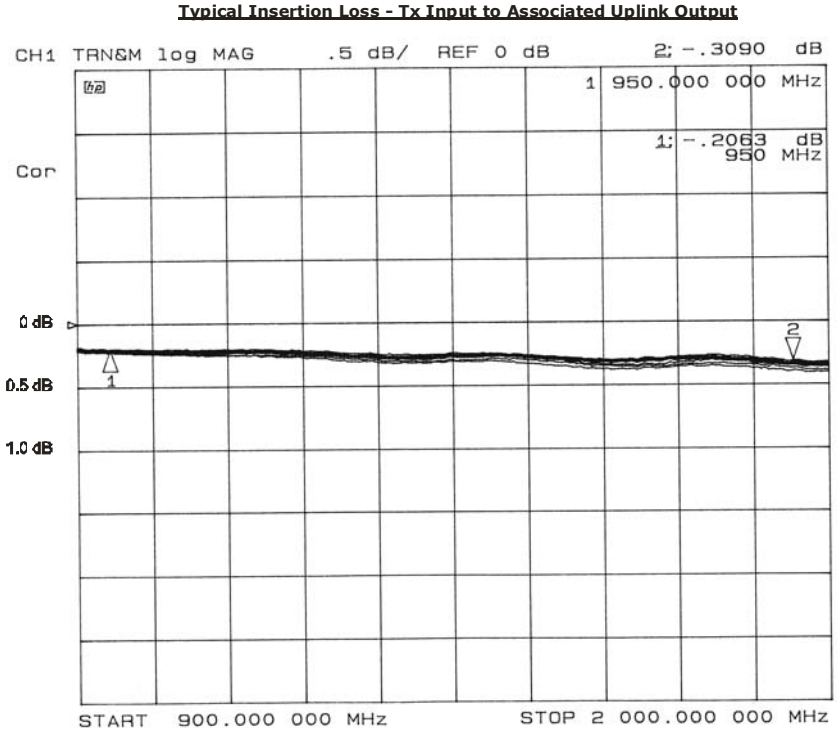


Figure 7. Insertion Loss Graph 4

1.1.2.3 DIMENSIONS

Dimensions are shown in both inches and centimeters.

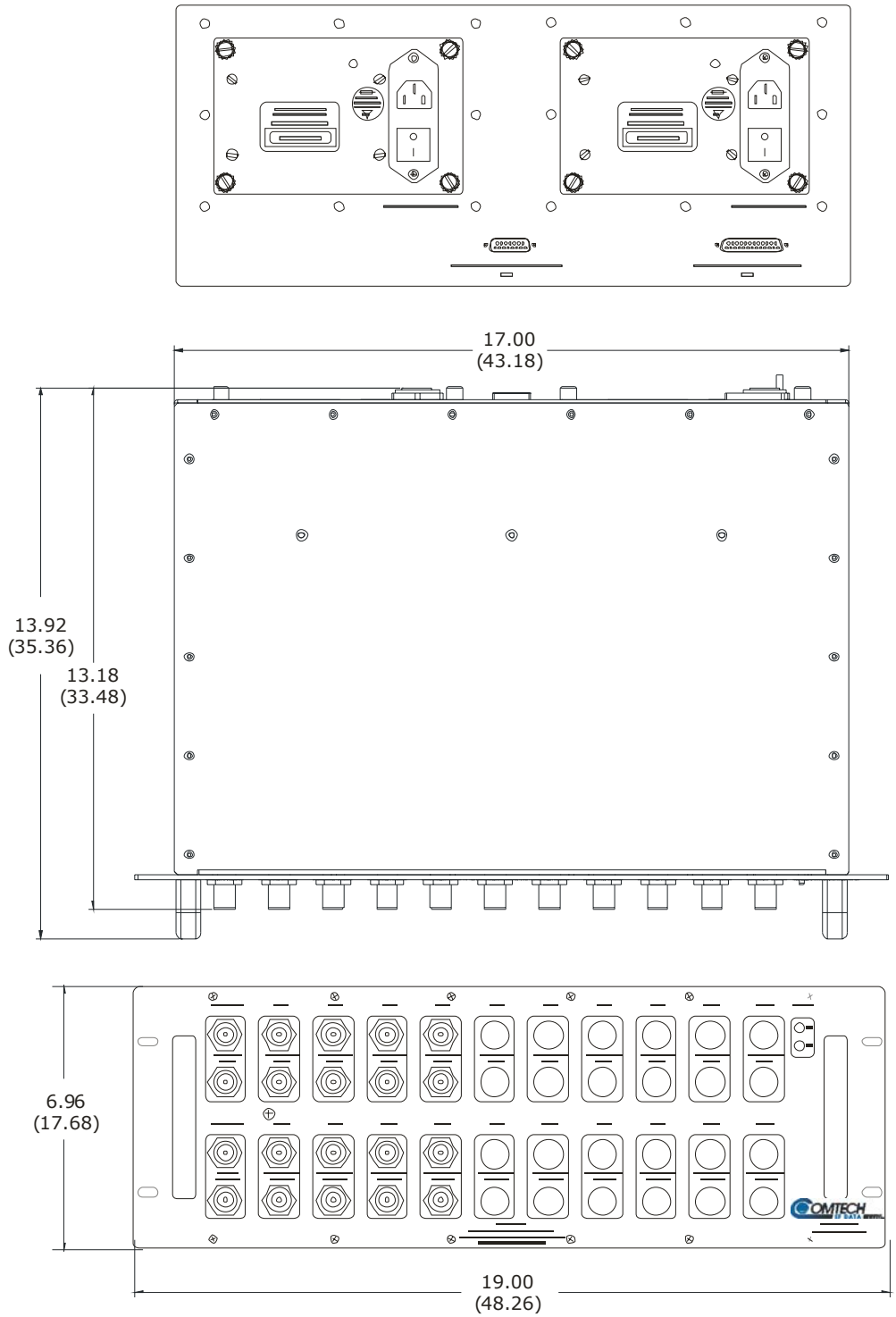


Figure 8. CRS-280L Dimensional Envelope

NOTES

Chapter 2.
Installation and Initial Setup

2.1 UNPACKING AND INSPECTION

1 Inspect shipping containers for damage.

If shipping containers are damaged, keep them until the contents of the shipment have been carefully inspected and checked for normal operation.

2 Remove the packing list from the outside of the shipping carton.

3 Open the carton and remove the contents.

4 Check the contents against the packing list to verify completeness of the shipment.

5 If damage is evident, contact the carrier and Comtech EF Data immediately and submit a damage report.

6 If the unit needs to be returned to Comtech EF Data, please use the original shipping container.

Note: Be sure to keep all shipping materials for the carrier's inspection.

2.2 MOUNTING INSTRUCTIONS

2.2.1 PROVIDE AIRFLOW

Typically, the CRS-280L is mounted in a rack along with all the Modems with which it is to operate, so it is important to ensure that there is adequate clearance for ventilation. Since the switch itself is relatively passive, no additional clearance is needed between it and the nearest Modem.

In rack, systems where there is high heat dissipation, provide forced-air cooling by installing top or bottom-mounted fans or blowers.

DO NOT ALLOW THE INTERNAL RACK TEMPERATURE TO EXCEED 50^{O} C (122^{O} F).

2.2.2 ABOUT RACK SUPPORT

Mount the switch using front panel screws only. Do not install rack slides to the side of the CRS-280L chassis. Contact the factory if there are questions about rack supports.

Since the switch itself is relatively passive, no additional clearance is needed between it and the nearest Modem.

In rack, systems where there is high heat dissipation, provide forced-air cooling by installing top or bottom-mounted fans or blowers.

2.3 INSTALLATION DETAILS

The CRS-280L is constructed as a 4U high rack-mounting chassis. Rack-handles at the front of the unit facilitate removal from and placement into a rack. Mount the switch in the rack using the mounting holes on the front panel. Figure 9 is a side “cut-away” view of a typical rack configuration. The CRS-280L is compatible with mounting at the top, back, or front of the rack. Refer to the associated controller documentation for additional details. The CRS-280L replaces the CRS-280 (CRS-300/CRS-400) and IFU (SMS7000) for L-Band applications.

Mount all modems in the rack.

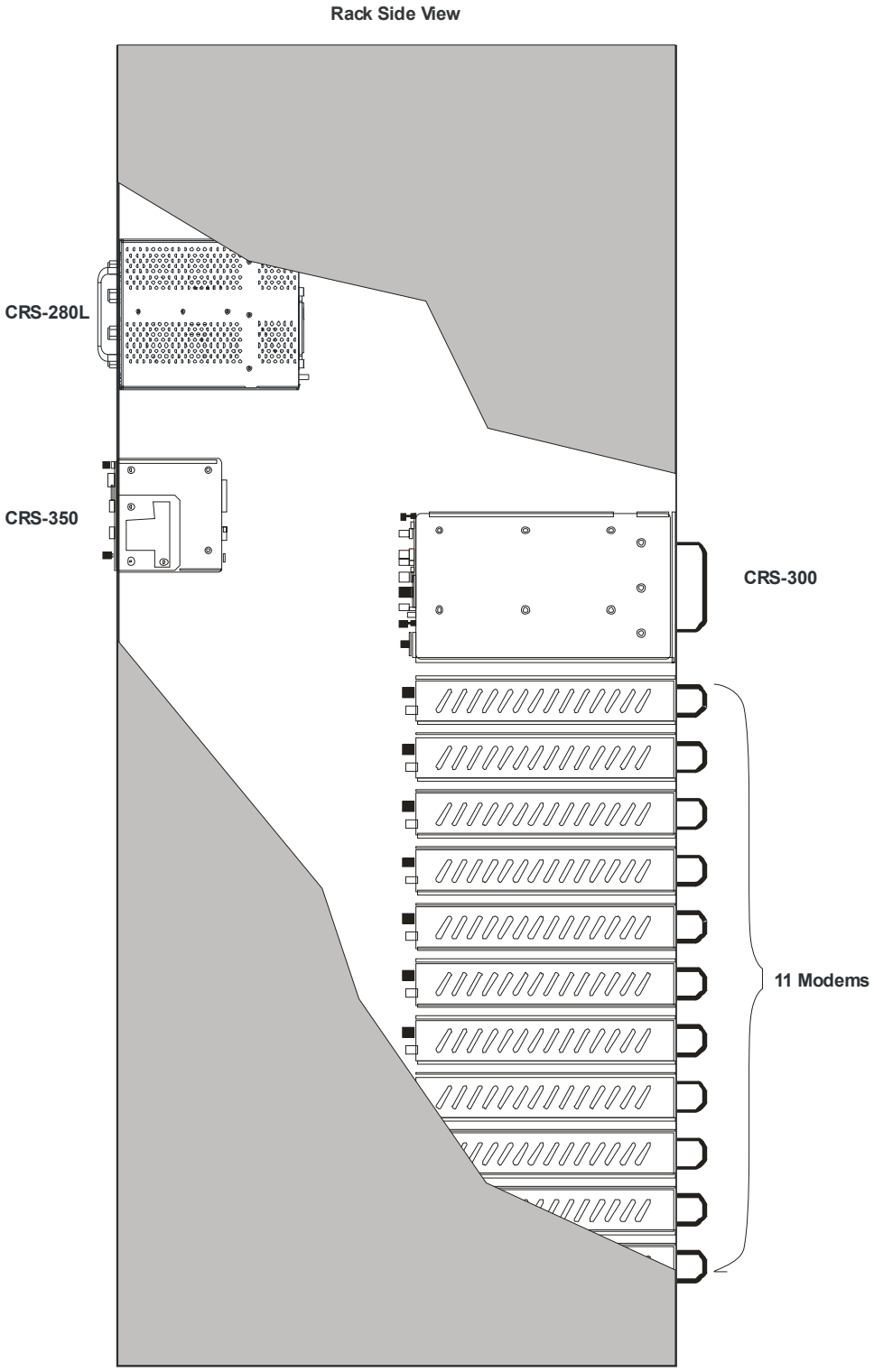


Figure 9. Typical Rack Mounting Configuration

2.4 CONNECTING THE CABLES

Once the switch and all the modems have been mounted, the user must properly attach all required cabling and configure the system for correct operation. Refer to the associated switch controlled documentation for additional information.

IMPORTANT

Leave the switch and all modems powered off until all connections are ready.

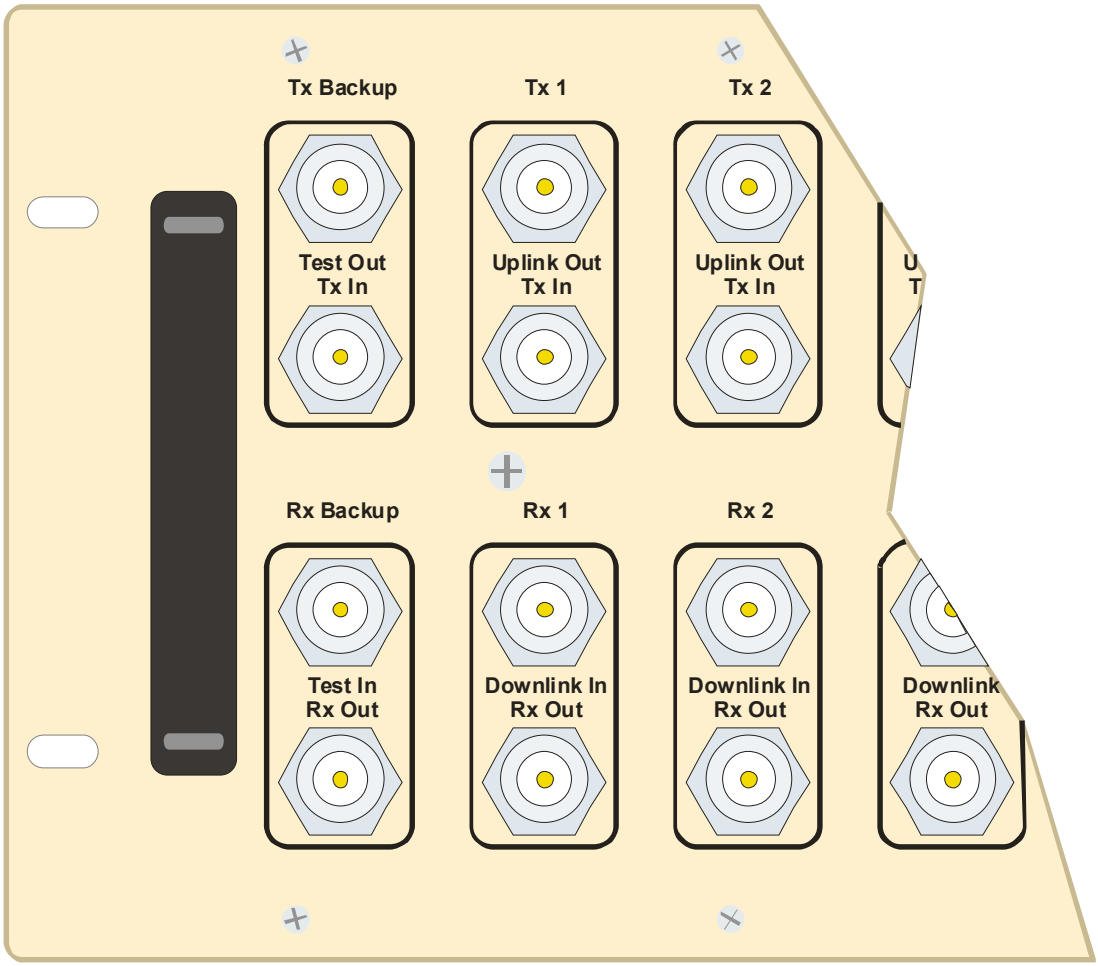


Figure 10. Front Panel Connector Details

2.4.1 Input Power Cord Connections

Connect the Power Cord as follows:

1. Ensure that both power supply switches are in the off position before connecting the power supply power cords.

2. Each CRS-280L is supplied with two power cords. Connect the female end of the supplied power cords: one to each power supply power input.

3. Plug both power cords into the AC power source.

Do not put the CRS-280L power supply switches in the on position until all system connections are in place.

2.4.2 Control Cable Connection

Each CRS-280L is supplied with a controller cable for connection to the associated switch control unit. The control cable must be specified at time of order.

Switch Controller	Cable Number	Description
CRS-300	CA/WR0066	25-pin sub-D, 6 ft
CRS-400	CA/WR0066	25-pin sub-D, 6 ft
SMS-7000	PL/5343-1	15-pin sub-D, 8 ft

Connect the supplied cable between the controller and the CRS-280L. Refer to the associated switch controller documentation for additional information.

Connect CRS-300 and CRS-400 Control Cables as follows:

1. Connect the control cable (CA/WR0066) to the CRS Control Interface Connector, J1 (25-pin sub-D female) on the rear panel of the CRS-280L.
2. Connect the other end of the control cable to the IF Switch Control Connector of the CRS-300 or CRS-400 control unit.
3. Secure the cable by tightening the screw locks on both ends of the control cable.

Connect SMS-7000 Control Cable as follows:

1. Connect the control cable (PL/5343-1) to the SMS Control Interface Connector, J2 (15-pin sub-D male) on the rear panel of the CRS-280L.
2. Connect the other end of the control cable to the IF Control Port Connector of the SMS-7000 control unit.
3. Secure the cable by tightening the screw locks on both ends of the control cable.

Note: Only one control interface must be used. Do not make connections to both control interfaces on the CRS-280L. The CRS-280L automatically detects the control interface in use and cannot function with both control cables connected.

2.4.3 MODEM TO CRS-280L L-BAND CABLE CONNECTIONS

L-Band cables for connecting the CRS-280L to the L-Band modems within the system are available from CEFD. The L-Band cables can be ordered at the same time the order is placed for the CRS-280L. The number of cables required depends on the switch system configuration. Each modem connected to the switch requires two L-Band cables:

- One cable for the RX L-Band connection
- One cable for the TX L-Band connection

Table 2. CEFD L-Band Cable Descriptions

Cable Number	Description
CA/RF10453-2	2 ft, L-Band 50 Ω N-type male connectors
CA/RF10453-4	4 ft, L-Band 50 Ω N-type male connectors
CA/RF10453-6	6 ft, L-Band 50 Ω N-type male connectors
CA/RF10453-8	8 ft, L-Band 50 Ω N-type male connectors

Table 3. CEFD L-Band Cable Characteristics

Cable Type	Loss at 1GHz	Loss at 2GHz
Semflex BPE200 (or equivalent)	0.11 dB/ft	0.15 dB/ft

If L-Band cables are not purchases from CEFD use of a suitable equivalent is recommended.

Each cable must be connected and secured (at both ends) using the N-type screw connectors between the L-Band modems and the CRS-280L. Cable connections are defined in the table below.

Table 4. L-Band Cable Connections

L-Band Modem Connection		CRS-280L Connection	Comments
Redundant Modem	TX Output ↔	TX Backup (TX In)	
	RX Input ↔	RX Backup (RX Out)	
Prime Modem #1	TX Output ↔	TX 1 (TX In)	
	RX Input ↔	RX 1 (RX Out)	
Prime Modem #2	TX Output ↔	TX 2 (TX In)	
	RX Input ↔	RX 2 (RX Out)	
Prime Modem #3	TX Output ↔	TX 3 (TX In)	
	RX Input ↔	RX 3 (RX Out)	
Prime Modem #4	TX Output ↔	TX 4 (TX In)	
	RX Input ↔	RX 4 (RX Out)	
Prime Modem #5	TX Output ↔	TX 5 (TX In)	
	RX Input ↔	RX 5 (RX Out)	
Prime Modem #6	TX Output ↔	TX 6 (TX In)	
	RX Input ↔	RX 6 (RX Out)	
Prime Modem #7	TX Output ↔	TX 7 (TX In)	
	RX Input ↔	RX 7 (RX Out)	
Prime Modem #8	TX Output ↔	TX 8 (TX In)	
	RX Input ↔	RX 8 (RX Out)	
Prime Modem #9	TX Output ↔	TX 9 (TX In)	
	RX Input ↔	RX 9 (RX Out)	
Prime Modem #10	TX Output ↔	TX 10 (TX In)	
	RX Input ↔	RX 10 (RX Out)	

2.4.4 UPLINK/DOWNLINK L-BAND CABLE CONNECTIONS

CEFD recommends that connections to uplink and downlink equipment be made after all other system cabling and configuration is complete. Cabling to and from the CRS-280L uplink and downlink ports is dependant on the system configuration and the uplink/downlink equipment used. For additional information, refer to the uplink/downlink equipment documentation.

The CRS-280L is not designed to convey DCpower to external equipment such as LNBs or BUCs. Do not apply DC power to the L-Band input and output (N-type) ports of the switch.

2.5 POWERING THE CRS-280L

After the redundant system cabling is complete and the switch controller and modems have been initially configured the CRS-280L may be powered.

The typical equipment power-up sequence is as follows:

1. Power the redundant system L-Band modems.
2. Power the CRS-280L L-Band switch.
3. Power the System controller and data switch (CRS-300, CRS-400, or SMS-7000).

To power the CRS-280L turn both power supply switches located on the back panel of switch to the on position. After the power supplies are turned on both power status LEDs (A and B) on the front panel should illuminate (green).

The CRS-280L is designed to operate with only one power supply energized. However, it is recommended to continually operate the system with both supplies energized for redundancy.

Chapter 3. Maintenance

The only field replaceable components in the CRS-280L 1:N Redundancy switch are the power supplies.

3.1 Power Supply Replacement

Replacement of Power Supply A is shown as an example. Refer to Figure 11 through 15 and use the following procedure. Procedures are reversed for installation of a new power supply.

1 Set power switches on both power supplies to OFF.

2 Disconnect AC Power Cables.

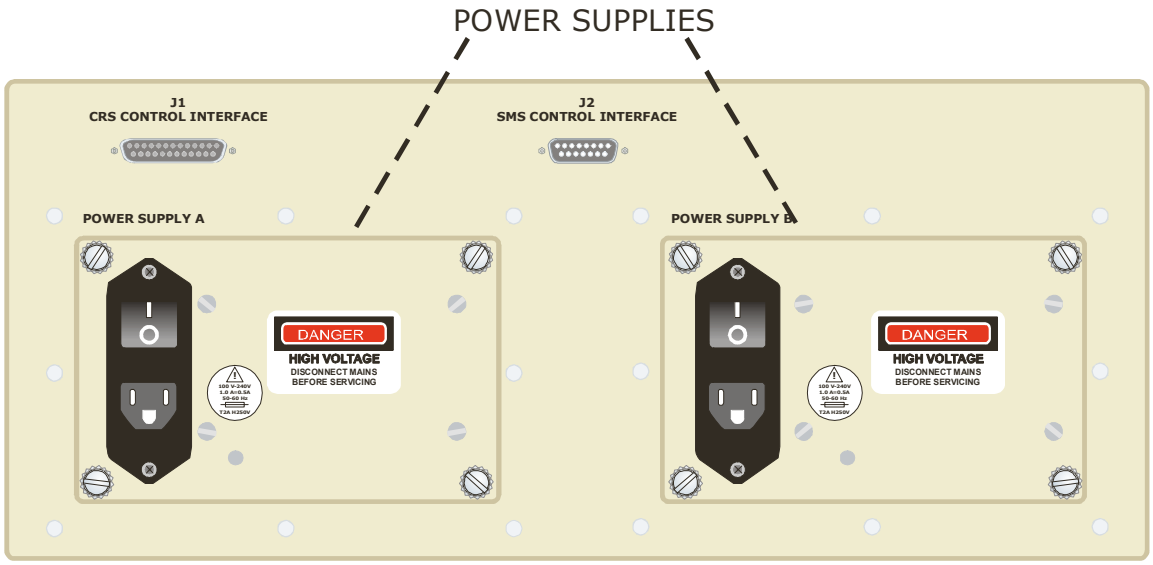


Figure 11. CRS-280L Power Suppplies

3 Loosen captive mounting screws at Power Supply A (4 places). Carefully pull plate away from the unit.

4 Carefully unplug cable at the power supply. Place power supply on bench. (See Figure 13.)

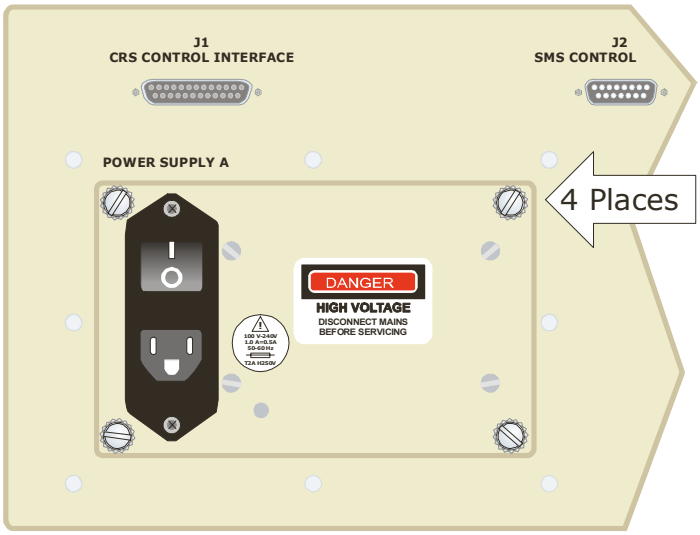


Figure 12. Captive Mounting Screws

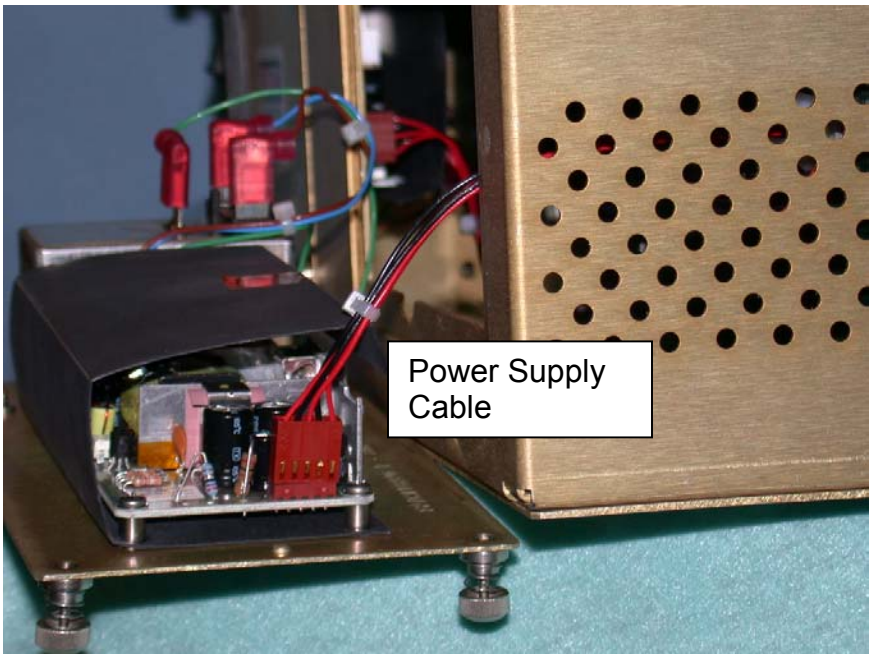


Figure 13. Unplug Power Supply A

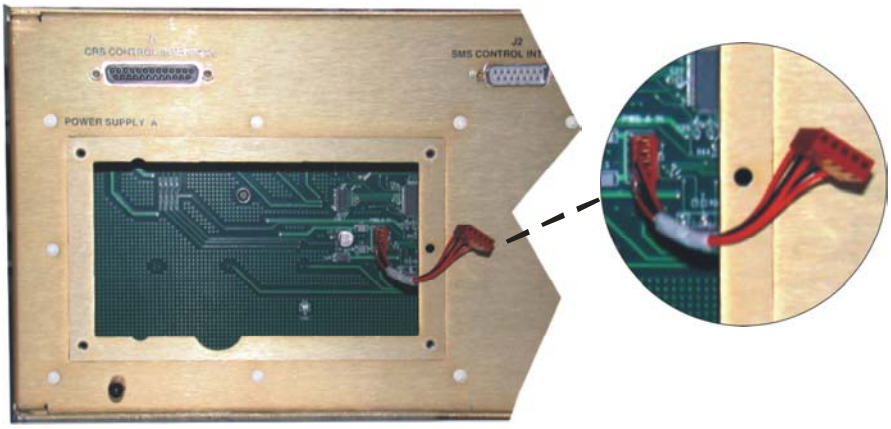


Figure 14. Power Supply Cable Removed From Power Supply

4 Carefully pull power Supply A out of the chassis and place on the bench.

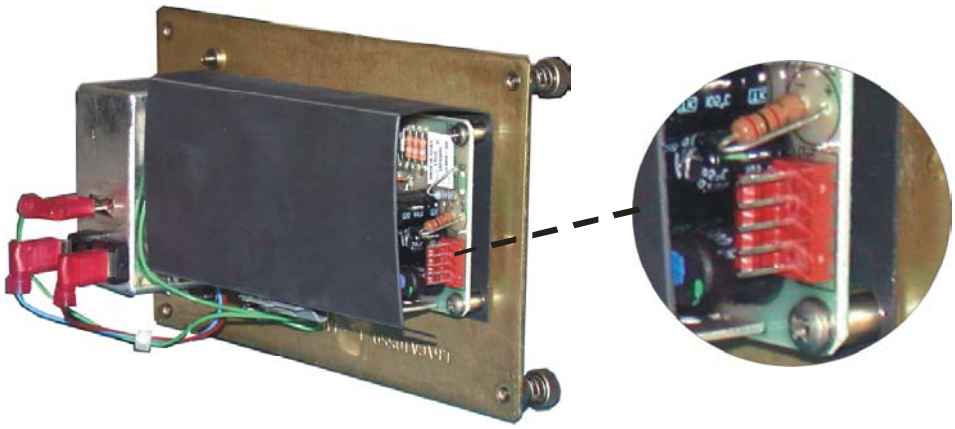


Figure 15. Power Supply Power Cable Connector

METRIC CONVERSIONS

Units of Length

Unit	Centimeter	Inch	Foot	Yard	Mile	Meter	Kilometer	Millimeter
1 centimeter	—	0.3937	0.03281	0.01094	6.214×10^{-6}	0.01	—	—
1 inch	2.540	—	0.08333	0.2778	1.578×10^{-5}	0.254	—	25.4
1 foot	30.480	12.0	—	0.3333	1.893×10^{-4}	0.3048	—	—
1 yard	91.44	36.0	3.0	—	5.679×10^{-4}	0.9144	—	—
1 meter	100.0	39.37	3.281	1.094	6.214×10^{-4}	—	—	—
1 mile	1.609×10^{5}	6.336×10^{4}	5.280×10^{3}	1.760×10^{3}	—	1.609×10^{3}	1.609	—
1 mm	—	0.03937	—	—	—	—	—	—
1 kilometer	—	—	—	—	0.621	—	—	—

Temperature Conversions

Unit	° Fahrenheit	° Centigrade
32° Fahrenheit	—	0 (water freezes)
212° Fahrenheit	—	100 (water boils)
-459.6° Fahrenheit	—	273.1 (absolute 0)

Formulas
C = (F - 32) * 0.555
F = (C * 1.8) + 32

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoir.	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoir.	28.35	—	0.9115	0.0625	0.07595	0.02835
1 oz. troy	31.10	1.097	—	0.06857	0.08333	0.03110
1 lb. avoir.	453.6	16.0	14.58	—	1.215	0.4536
1 lb. Troy	373.2	13.17	12.0	0.8229	—	0.3732
1 kilogram	1.0×10^{3}	35.27	32.15	2.205	2.679	—

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