



**MOTOROLA**

**MTR2000™**

**Base Station, Repeater  
and Receiver**

**For Analog Conventional,  
and Trunking Systems**

**132 - 174 MHz**



**Instruction / Field Service Manual**

**68P81096E30-F**

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NOTE: The equipment has been tested and found to comply with the limits for a Class B 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 or residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with its instruction manual, may cause harmful interference to radio communication.

## ELECTROMAGNETIC COMPATIBILITY

This product conforms with the protection requirements of Council Directive 89/336/EEC of 3rd May 1989 (EMC) on the approximation of the laws of the Member States relating to electromagnetic compatibility.

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## ENVIRONMENTAL INFORMATION

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### Material Content

The material content of the MTR2000 is 16% of the product it replaces.

The following table provides a rough estimate of the material content of the station. The actual percentages vary in relation to the station configuration. The power supply is not included in the percentage of weights since the end-of-life value is dependent on the model of supply used in the station.

Most of the Material categories are self explanatory. Copper bearing materials:

- include any material that contains copper.
- primarily consist of circuit boards.
- exclude cables (separate Material category).

| Material       | % by weight |
|----------------|-------------|
| Aluminum       | 92%         |
| Steel          | 2%          |
| Copper Bearing | 4%          |
| Cable          | 1%          |
| Polycarbonate  | 1%          |

Beryllium Oxide has been used in the power amplifier. Beryllium Oxide should not be subjected to any process which will generate dust.

---

### Features

Over 92% of the station is made of aluminum, one of the most recycled materials commonly available today. In addition, the aluminum used in the station consists of 90-95% recycled content.

Plastic use has been minimized since the market for recycled engineering plastics is limited. The plastic which has been used for the front panel is a relatively clean and pure resin.

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## Disposal of your Electronic and Electric Equipment

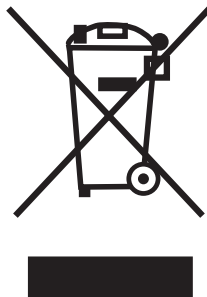
Please do not dispose of Electronic and Electric Equipment or Electronic and Electric Accessories with your household waste. In some countries or regions, collection systems have been set up to handle waste of electrical and electronic equipment.

In European Union countries, please contact your local equipment supplier representative or service center for information about the waste collection system in your country.

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## Disposal Guideline

The following symbol on a Motorola product indicates that the product should not be disposed of with household waste.






**MTR2000™**  
**Base Station, Repeater  
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**For Analog Conventional,  
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**132 - 174 MHz**

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### INSTALLATION

**68P81096E37**

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## STATION MODULES

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68P81096E22

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**Model CLN1203** **68P81096E29**

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**Model CLN1205** **68P81096E31**

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#### Model DLN6624

68P81011Y29

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## ANCILLARY EQUIPMENT

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#### Model CLN6680

68P81096E41

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## POWER SUPPLIES

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#### Models DLN6622

68P81011Y31

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#### Model CLN1221

68P81096E34

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#### Model DLN6624

68P81011Y29

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#### Model CLN1222

68P81096E51

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#### Model CLN1223

68P81096E52

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ANCILLARY EQUIPMENT

**ANTENNA RELAY MODULE**

**Model CLN6680** **68P81096E41**

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**VHF EXTERNAL PRESELECTOR MODULE**

**Models CLN1216 and CLN1217** **68P81096E43**

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**Models CLN1207, CLN1208 and CLN1209** **68P81096E49**

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**VHF DUPLEXER MODULE**

**Models TYD4031, TYD4032, and TYD4033** **68P81085E16**

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## MODEL AND OPTION SELECTION PROCEDURE (INCLUDES MODEL/OPTION COMPLEMENTS)

The following equipment ordering process is used by the sales representative to equip a VHF station with the proper hardware and firmware for specific system types and customer-defined options and features. This process is described here, showing the structure and contents of the various models and options.

**1**

The Factory ID Model numbers are:

| MTR2000...                 | Factory ID Model No. | Station Description |
|----------------------------|----------------------|---------------------|
| Base Stations or Repeaters | T5544, T5766         | MTR2000 Station     |
| Receivers                  | T5731, T5769         | MTR2000 Receiver    |



Option numbers are used to determine the configuration of an MTR2000 station. The suffixes of these option numbers (i.e., the last 2 characters) may change.

The sales model includes the following items which are **common to all stations**:

- Station Control Module.
- Backplane Interconnect Board.
- Backplane hardware.
- Station chassis hardware.
- Front panel.
- Cables.

**For Receivers**, the sales model determines that the:

- 250W Power Supply module is included in the station, Option X30AM.

2

If the station is a **Base Station** or a **Repeater**, the power/frequency option is now selected. The power/frequency option is determined based on the power specified by the customer. The following table shows the available power/frequency options:

| Frequency Range – VHF | Output Power  |               |               |
|-----------------------|---------------|---------------|---------------|
|                       | 30 W          | 40 W          | 100 W         |
| 132 to 154 MHz        | –             | –             | Option X530AC |
| 132 to 174 MHz        | Option X345AA | Option X330AD | –             |
| 150 to 174 MHz        | –             | –             | Option X530AD |

**For Base Stations and Repeaters**, the power/frequency option determines which:

- Power Supply module (based on power level) is included in the station; either Option X30AM for the 250 W power supply, or X30AL for the 500 W power supply.
- Power Amplifier module (based on frequency band and power level) is included in the station.
- Exciter module (based on frequency band) is included in the station.
- Receiver module (based on frequency band) is included in the station; Option X333AE.

**OR**

If the station is a **Receiver**, the frequency option is now selected. The frequency option is determined based on the frequency specified by the customer. The following table shows the available frequency options:

| Frequency Range – VHF | Receiver Option |
|-----------------------|-----------------|
| 132 to 174 MHz        | Option X319AC   |

The frequency option determines which:

- Receiver module (based on frequency band) is included in the station; Option X333AE.

3

A System Software Option must be selected **for Base Stations, Repeaters and Receivers** as follows:

| System Type                    | Software Option |
|--------------------------------|-----------------|
| Conventional Analog Operation  | X597AF          |
| Conventional Analog RECEIVER   | X597AG          |
| 6809 Trunking Analog Operation | X997AE          |
| 6809 Trunking Analog Receiver  | X997AF          |

If the station is a Receiver, go to step 5.

**For Trunking Analog Operation** the software option determines that the Auxiliary I.O Board is included in the station; Option X151AH.

4

A Station Operation Option must be selected as follows:

| Operation Type         | Operation Option |
|------------------------|------------------|
| Repeater Operation     | X580AC           |
| Base Station Operation | X622AC           |

5

The following lists available options that may be selected in addition to the standard model and options (described in steps 1 through 4).

#### AVAILABLE OPTIONS FOR VHF STATIONS

| Option Category                      | Option and Complement |   |
|--------------------------------------|-----------------------|---|
| DC-Only Power Supplies               | <b>X121AC</b>         | <b>500W DC-Only power supply.</b><br>When this option is ordered, it automatically replaces Option X30AL. |
|                                      | CPN6059A              | 500W DC Power Supply  |
|                                      | CPN6060A              | DC Power Input Cable  |
|                                      | <b>X121AB</b>         | <b>250W DC-Only power supply.</b><br>When this option is ordered, it automatically replaces Option X30AM. |
| Mounting Racks                       | CPN6058A              | 250W DC Power Supply  |
|                                      | CPN6060A              | DC Power Input Cable  |
|                                      | <b>X741AF</b>         | <b>76.2cm (30 in) Modular Rack</b>  |
|                                      | THN6752A              | Modular Rack, 16-Rack Unit  |
|                                      | CLN6679A              | Rack Mounting Hardware  |
|                                      | <b>X742AF</b>         | <b>1.143m (45 in) Modular Rack</b>  |
| Slide Rail (for rackmounted station) | THN6753A              | Modular Rack, 24-Rack Unit  |
|                                      | CLN6679A              | Rack Mounting Hardware  |
|                                      | <b>X743AF</b>         | <b>1.32m (52 in) Modular Rack</b>   |
|                                      | THN6754A              | Modular Rack, 27-Rack Unit  |
|                                      | CLN6679A              | Rack Mounting Hardware  |
|                                      | <b>X968AA</b>         | <b>Slides, Motorola Cabinet</b>   |
| Indoor Cabinets                      | THN6788A              | Slide rails for mounting station  |
|                                      | <b>X346AB</b>         | <b>Slides, Non-Motorola Cabinet</b>   |
| Indoor Cabinets                      | CLN6833A              | Universal slide rails for mounting station  |
|                                      | <b>X52AF</b>          | <b>76.2cm (30 in) Indoor Cabinet</b>  |
|                                      | THN6701A              | 30" Indoor Cabinet, 2 Rails   |
|                                      | TTN5040A              | Grommet Channel Kit   |
|                                      | <b>X308AD</b>         | <b>1.168m (46 in) Indoor Cabinet</b>  |
|                                      | THN6702A              | 46" Indoor Cabinet, 2 Rails   |
|                                      | TTN5040A              | Grommet Channel Kit   |
|                                      | <b>X180AC</b>         | <b>1.524m (60 in) Indoor Cabinet</b>  |
|                                      | THN6703A              | 60" Indoor Cabinet, 2 Rails   |
|                                      | TTN5040A              | Grommet Channel Kit   |

## AVAILABLE OPTIONS FOR VHF STATIONS

| Option Category                | Option and Complement  |   |
|--------------------------------|--|---|
| Duplexer Module                | TYD4031A   | RF Duplexer (132 to 146MHz)   |
|                                | TYD4032A   | RF Duplexer (144 to 160MHz)   |
|                                | TYD4033A   | RF Duplexer (158 to 174MHz)   |
| External Preselector           | <b>X265AA</b><br>TRN7799A  | <b>External Preselector Module (132 to 154 MHz)</b><br>VHF/UHF Tuning Kit   |
|                                | <b>X265AB</b><br>TRN7799A  | <b>External Preselector Module (150 to 174 MHz)</b><br>VHF/UHF Tuning Kit   |
|                                | When either of the above options is ordered, Receiver Option X333AE is automatically replaced by Option X333AF |   |
| Wireline Interface Board (WIB) | <b>X216AC</b><br>TTN5066A  | <b>Add 4-Wire Euro Wireline Interface Board (WIB)</b><br>4-Wire Euro Wireline Interface Board   |
|                                | <b>X264AA</b><br>TTN5067A  | <b>Add 4-Wire Wireline Interface Board (WIB)</b><br>This WIB is the factory default, unless X216AC is ordered.<br>4-Wire Wireline Interface Board   |
| External Double Circulator     | <b>X676AS</b><br>TYD4001A<br>TYD4010A<br>TRN7751A<br>TKN9133A<br>TLN3391A                                      | <b>External Double Circulator Module (132 to 146 MHz)</b><br>Double Circulator (132 to 146 MHz)<br>Low Pass Filter<br>Peripheral Tray<br>Cables, Peripheral Tray<br>Circulator Load (heat sink) |
|                                | <b>X676AT</b><br>TYD4002A<br>TYD4010A<br>TRN7751A<br>TKN9133A<br>TLN3391A                                      | <b>External Double Circulator Module (144 to 160 MHz)</b><br>Double Circulator (144 to 160 MHz)<br>Low Pass Filter<br>Peripheral Tray<br>Cables, Peripheral Tray<br>Circulator Load (heat sink) |
|                                | <b>X676AU</b><br>TYD4003A<br>TYD4010A<br>TRN7751A<br>TKN9133A<br>TLN3391A                                      | <b>External Double Circulator Module (158 to 174 MHz)</b><br>Double Circulator (158 to 174 MHz)<br>Low Pass Filter<br>Peripheral Tray<br>Cables, Peripheral Tray<br>Circulator Load (heat sink) |
| Antenna Relay                  | <b>X371AG</b><br>CLN6680A  | <b>Antenna Relay</b><br>Antenna Relay   |
| External Reference             | <b>X747AB</b><br>CKN6682A  | <b>Add External Reference</b><br>External Reference Cable   |
| Trunking Cables                | 3083765X04<br>3083765X05<br>3083765X06<br>3083765X07   | 7.62m (25 ft) Trunk Cable<br>15.24m (50 ft) Trunk Cable<br>22.86m (75 ft) Trunk Cable<br>30.48m (100 ft) Trunk Cable  |
| Miscellaneous                  | HSN1000<br>0185180U01<br>GMN6147   | External Speaker<br>External Speaker Cable<br>Service Microphone  |

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## FOREWORD

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### Product Maintenance Philosophy

Due to the high percentage of surface-mount components and multi-layer circuit boards, the maintenance philosophy for this product is one of Field Replaceable Unit (FRU) substitution. The station is comprised of self-contained modules (FRUs) which, when determined to be faulty, may be quickly and easily replaced with a known good module to bring the equipment back to normal operation. The faulty module must then be shipped to the Motorola System Support Center for further troubleshooting and repair to the component level.

The System Support Center can be contacted at:

| Address  | Phone No.      | FAX No.        |
|--|----------------|----------------|
| Motorola Systems Support Center<br>1311 East Algonquin Rd.<br>Schaumburg IL,<br>60196, USA | (800) 925-0911 | (847) 576-2172 |

For other issues call:

(800) 448-3245

or

(847) 576-7300

---

### Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. In keeping with the maintenance philosophy of Field Replaceable Units (FRU), this manual contains functional information sufficient to give service personnel an operational understanding of all FRU modules, allowing faulty FRU modules to be identified and replaced with known good FRU replacements.

The information in this manual is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revisions (SMR). These SMRs are added to the manuals as the engineering changes are incorporated into the equipment.

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## Documentation Conventions

Documentation conventions are used in this manual to highlight certain information.

The area to the left of the text column contains key words and graphic symbols which allow the reader to quickly identify desired information.

The following text highlight symbols are used:



A note symbol indicates important information that helps improve the described function.



**CAUTION**

A caution symbol indicates a potential problem, unless the proper actions are taken. A caution also explains how to avoid the problem.



**WARNING**

A WARNING symbol indicates the potential for personal injury or serious system degradation unless the proper actions are taken. A WARNING also explains how to avoid the problem.



**IMPORTANT**

An IMPORTANT symbol indicates the potential for damaging the station unless the proper actions are taken. An IMPORTANT note also explains how to avoid the problem.



This graphic symbol appears in this manual and on the station front panel (and other station surfaces) as a reminder that the station can become extremely hot during normal station operation. Turn off all power to the station, and wait until sufficiently cool before touching the station.

---

## Service and Replacement Modules

For complete information on ordering FRU replacement modules, or instructions on how to return faulty modules for repair, contact the appropriate facility:

|  | Address  | Phone No.        | FAX No.          |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
|--|--|------------------|------------------|----------|-------------|--------|--------------|----------|--------------|------------|-------------|----------|-------------|--------------|-------------|-----------|----------------|---------|-------------|---------|----------------|-----------|----------------|----------|----------------|--------|--------------|---------|--------------------|---------|--------------|-----|----------------|--------------|----------------|----------|----------------|----------|-----------|
| <b>United States</b>   | Motorola Inc.<br>Radio Products Services Division<br>2200 Galvin Dr.<br>Elgin, IL,<br>60123, USA                 | (800) 422-4210   | (800) 622-6210   |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>Canada</b>  |  |                  |                  |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>International</b>   |  | (847) 538-8023   | (847) 576-3023   |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>Mexico</b>  | Motorola de Mexico<br>Huatabampo No. 50<br>APDO Postal 71064<br>Mexico DF 06700                                  | (525) 584-4560   | (525) 584-6843   |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>Asia</b>  | Motorola Singapore Parts<br>Centre<br>1302 Lor 1 Toa Payoh Siong<br>Hoe Ind Bldg.<br>#01-03/04<br>Singapore 1231 | (65) 353-0311    | (65) 353-9152    |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>Australia &amp;<br/>New Zealand</b>   | Motorola Australia Ltd.<br>666 Wellington Rd.<br>Victoria 3170<br>Melbourne<br>Australia                         | (61) 3 566-7766  | (61) 3 566-7910  |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>Japan</b>   | Nippon Motorola Ltd.<br>3-20-1 Ninomi Azabu<br>Minato-Ku Tokyo 106<br>Japan                                      | (81) 3 3440 3311 | (81) 3 3440 3505 |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| <b>Europe,<br/>Mideast &amp;<br/>Africa</b>  | Motorola GmbH<br>Heinrich - Hertz Strasse 1<br>D-65232 Taunusstein 4<br>Germany                                  | 0049-6128-702164 | 0049-6128-704903 |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
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| Austria:   | 06 60 75 41  | Italy:           | 16 78 77 387     |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| Belgium:   | 08 00 72 471   | Luxemburg:       | 08 00 23 27      |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| Denmark:   | 80 01 55 72  | Netherlands:     | 60 22 45 13      |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| Finnland:  | 08 00 11 49 10   | Norway:          | 80 01 11 15      |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| France:  | 08 00 90 30 90   | Portugal:        | 05 05 49 35 70   |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| Germany:   | 01 30 18 75 24   | Spain:           | 90 09 84 902     |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| Greece:  | 00 80 04 91 29 020   | Sweden:          | 02 07 94 307     |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| UK:  | 08 00 96 90 95   | Switzerland:     | 08 00 55 30 82   |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |
| Ireland:   | 18 00 55 50 21   | Iceland:         | 80 08 147        |          |             |        |              |          |              |            |             |          |             |              |             |           |                |         |             |         |                |           |                |          |                |        |              |         |                    |         |              |     |                |              |                |          |                |          |           |

## Station FRU Components

The following Field Replacement Units (FRUs) can be ordered for an MTR2000 VHF station::

| Module Description  | FRU Kit # |
|---|-----------|
| Receiver Module (132 to 174 MHz)<br>- with varactor preselector   | CLN1211   |
| Receiver Module (132 to 174 MHz)<br>- without varactor preselector  | CLN1212   |
| Exciter Module (132 to 174 MHz)   | CLN1233   |
| Station Control Module  | CLN1465   |
| Power Amplifier (30 W, 132 to 174 MHz)  | CLN1227   |
| Power Amplifier (40 W, 132 to 174 MHz)  | CLN1226   |
| Power Amplifier (100 W, 132 to 154 MHz)   | CLN1224   |
| Power Amplifier (100 W, 150 to 174 MHz)   | CLN1225   |
| Station Backplane Board   | CLN1202   |
| Power Supply (250 W), AC with DC Battery Connect<br>- provided with all low power stations using AC input.  | CLN1221   |
| Power Supply (500 W), AC with DC Battery Connect<br>- provided with high power stations installed outside of the European Union (EU) countries and installed in EU countries prior to January 1, 2001.      | CLN1220   |
| Power Supply (500 W), AC with DC Battery Connect<br>- provided with high power stations installed in EU countries after January 1, 2001.<br>- operates in conjunction with a Power Factor Correction choke. | DLN6458   |
| Power Supply (250 W), DC-Only   | CLN1223   |
| Power Supply (500 W), DC-Only   | CLN1222   |
| 4-Wire Wireline Interface Board   | CLN1203   |
| 4-Wire Euro Wireline Interface Board  | CLN1204   |
| 8-Wire Wireline Interface Board   | CLN1205   |
| Auxiliary I/O Board   | CLN1206   |
| Antenna Relay   | CLN6680   |
| External (metal) Preselector (132 to 154 MHz)   | CLN1216   |
| External (metal) Preselector (150 to 174 MHz)   | CLN1217   |
| External Double Circulator (132 to 146 MHz)   | CLN1207   |
| External Double Circulator (144 to 160 MHz)   | CLN1208   |
| External Double Circulator (158 to 174 MHz)   | CLN1209   |
| Duplexer Module (132 to 146 MHz)  | TYD4031   |
| Duplexer Module (144 to 160 MHz)  | TYD4032   |
| Duplexer Module (158 to 174 MHz)  | TYD4033   |
| Zetron Repeater Panel   | TDN9946   |

If help is required to identify a part number, call

**(847) 538-0021**



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## GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

- DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.
- DO NOT operate the transmitter of a fixed radio (base station, microwave and rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.
- DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition:

- DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.
- All equipment must be properly grounded according to Motorola installation instructions for safe operation.
- All equipment should be serviced only by a qualified technician.
- An operating license may be required to operate this station.

Refer to the appropriate section of the product service manual for additional pertinent safety information.



**Some station components can become extremely hot during station operation. Turn off all power to the station, and wait until sufficiently cool before touching the station.**

## PERFORMANCE SPECIFICATIONS

### General

| Frequency Range:               | 132 to 174 MHz  |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
|--------------------------------|---|----------------|----------------|--------|--|-----------|----------------|----------------|-------------------|---------|-------|-------|-------|----------|-------|-------|--------|--------------------|---------|--------|-------|-------|----------|--------|--------|--------|
| Number of Channels:            | 32  |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Frequency Generation:          | Synthesized   |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Power Supply Type:             | Switching   |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Power Supply Input Voltage:    | 85 to 264 Vac (for Models CLN1220 and CLN1221)<br>180 to 264 Vac (for Model DLN6458; used in conjunction with a PFC choke)  |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Power Supply Input Frequency:  | 47 to 63 Hz   |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Current Consumption (typical): | <table><thead><tr><th></th><th><u>DC</u></th><th><u>120 Vac</u></th><th><u>240 Vac</u></th></tr></thead><tbody><tr><td rowspan="2">Low Power station</td><td>Standby</td><td>1.5 A</td><td>0.5 A</td><td>0.3 A</td></tr><tr><td>Transmit</td><td>9.5 A</td><td>2.3 A</td><td>1.25 A</td></tr><tr><td rowspan="2">High Power station</td><td>Standby</td><td>0.85 A</td><td>0.6 A</td><td>0.4 A</td></tr><tr><td>Transmit</td><td>10.0 A</td><td>4.45 A</td><td>2.45 A</td></tr></tbody></table> <p>Note: DC voltage is 14Vdc for low power stations and 28Vdc for high power stations.<br/>Current consumption values during transmit are at full rated output.</p> |                |                |        |  | <u>DC</u> | <u>120 Vac</u> | <u>240 Vac</u> | Low Power station | Standby | 1.5 A | 0.5 A | 0.3 A | Transmit | 9.5 A | 2.3 A | 1.25 A | High Power station | Standby | 0.85 A | 0.6 A | 0.4 A | Transmit | 10.0 A | 4.45 A | 2.45 A |
|                                | <u>DC</u>   | <u>120 Vac</u> | <u>240 Vac</u> |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Low Power station              | Standby   | 1.5 A          | 0.5 A          | 0.3 A  |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
|                                | Transmit  | 9.5 A          | 2.3 A          | 1.25 A |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| High Power station             | Standby   | 0.85 A         | 0.6 A          | 0.4 A  |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
|                                | Transmit  | 10.0 A         | 4.45 A         | 2.45 A |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Temperature Range (ambient):   | −30°C (−22°F) to +60°C (+140°F), measured at station  |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Dimensions:                    | 48.3 cm (19") x 41.3 cm (16.5") x 13.4 cm (5.25")   |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Approximate Weight:            | 19 kg. (40 lbs.)  |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |
| Environmental Spec.            | I.P. 20   |                |                |        |  |           |                |                |                   |         |       |       |       |          |       |       |        |                    |         |        |       |       |          |        |        |        |

### Transmitter

|                                  |  |
|----------------------------------|--|
| Power Output:                    | 1 to 30 W<br>1 to 40 W<br>25 to 100 W  |
| Electronic Bandwidth ≤ 40 W:     | 132 to 174 MHz   |
| Electronic Bandwidth > 40 W:     | 132 to 154 MHz, 150 to 174 MHz   |
| Intermodulation:                 | 40 dB (40 W and 100 W)<br>70 dB (30 W)                                       |
| Spurious and Harmonic Emissions: | –85 dBc  |
| Deviation:                       | ±5 kHz (30 kHz)<br>±5 kHz (25 kHz)<br>±4 kHz (20 kHz)<br>±2.5 kHz (12.5 kHz) |
| Audio Sensitivity:               | –20 dBm to 0 dBm (variable)  |

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## PERFORMANCE SPECIFICATIONS (Continued)

### Transmitter (continued)

|                      |   |
|----------------------|---|
| Audio Response:      | +1, –3 dB from 6 dB per octave pre-emphasis; 300 to 3000 Hz referenced to 1000 Hz at line input |
| Audio Distortion:    | <3% @ 1000 Hz; 60%RSD   |
| FM Hum and Noise:    | 50 dB nominal (30 kHz)<br>50 dB nominal (25 kHz)<br>45 dB nominal (12.5 kHz)                    |
| Frequency Stability: | 1.5 ppm   |

### Receiver

|  |   |
|--|---|
| Electronic Bandwidth w/o Narrow Preselector: | 132 to 174 MHz  |
| Narrow Preselector Bandwidth:                | 4 MHz   |
| Channel Spacing:                             | 12.5 kHz, 20 kHz, 25 kHz, 30 kHz  |
| Sensitivity (12 dB SINAD)                    | 0.35 $\mu$ V  |
| Selectivity:                                 | 80 dB (25 kHz, 30 kHz)<br>75 dB (12.5 kHz)  |
| Intermodulation:                             | 85 dB (25 kHz, 30 kHz)<br>80 dB (12.5 kHz)  |
| Spurious and Image Rejection:                | 90 dB with external Preselector,<br>85 dB nominal with internal Preselector             |
| Off Channel Acceptance:                      | 2 kHz   |
| FM Hum and Noise:                            | 50 dB nominal (25 kHz, 30 kHz)<br>45 dB nominal (12.5 kHz)                              |
| Wireline Output:                             | -20 dBm to 7 dBm @ 100% RSD, 1 kHz  |
| Audio Response (@ Wireline output):          | +1, –3 dB from 6 dB per octave de-emphasis; 300 to 3000 Hz referenced to 1000 Hz output |
| Audio Distortion:                            | <3 % @ 1000 Hz; 60 % RSD  |
| Frequency Stability:                         | 1.5 ppm   |

*Due to Motorola's commitment to quality, all specifications subject to change without notice.*

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## GLOSSARY OF TERMS AND ACRONYMS

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### A

|            |   |
|------------|---|
| AGC        | Automatic Gain Control  |
| Alert tone | Audio signal produced by the station, providing feedback to the user. |
| ASIC       | Application Specific Integrated Circuit                               |
| AUX        | Auxiliary.  |

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### C

|              |  |
|--------------|--|
| CCI          | Control Channel Indicate   |
| CDCSS        | Continuous Digital-Controlled Squelch Systems (DPL)  |
| CTCSS        | Continuous Tone-Controlled Squelch Systems (PL)  |
| CIT          | Central Interconnect Terminal. Used to provide telephone interconnect capability in a trunked station.             |
| CIU          | Console Interface Unit. Interface between operator console and station to provide encryption/decryption functions. |
| Clear        | Channel modulation type in which voice information is transmitted over the channel using analog modulation.        |
| Code detect  | Traditional term used to indicate that a 12kbps CVSD signal is being received on the RF channel.                   |
| Conventional | Term used for standard non-trunked radio system (usually using TRC/DC console).                                    |
| CPI          | Console Priority Interface - option allowing console control of a trunked station.                                 |

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## ***D***

|     |  |
|-----|--|
| DDM | Dual Device Module   |
| DPL | Digital Private Line (See PL)  |
| DSP | Digital Signal Processor, microprocessor specifically designed to perform digital signal processing algorithms.                              |
| DVP | Digital Voice Protection, or Digital Voice Privacy, applies to the Vulcan encryption algorithm and the Motorola product in which it is sold. |

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## ***E***

|     |  |
|-----|--|
| EIA | Electronic Industries Association  |
| E/M | Telephone circuit signalling lines (Ear/Mouth, Ernie/Mary)   |
| EOM | End-Of-Message, 6 kHz signal transmitted at the end of a 12 kbps CVSD signal that is used by the receiving unit for fast muting of the speaker audio for squelch tail elimination. |
| ESD | Electro Static Discharge   |
| ETS | European Telecommunications Standards  |
| EU  | European Union   |

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## ***F to H***

|          |   |
|----------|---|
| Failsoft | Trunked station mode entered when central controller fails. |
| FFSK     | Fast FSK  |
| FM       | Frequency Modulation  |
| FRU      | Field Replaceable Unit.                                     |
| FSK      | Frequency Shift Keying                                      |
| GPI      | General Purpose Input.                                      |
| GPO      | General Purpose Output.                                     |
| HLGT     | High Level Guard Tone                                       |

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## ***I to L***

|      |   |
|------|---|
| IC   | Integrated Circuit  |
| i-f  | intermediate frequency  |
| I/O  | Input or Output   |
| IRB  | Inbound Recovery Board used with the Trunking Controller  |
| IRQ  | Interrupt Request.  |
| ISW  | Inbound Signalling Word, data packet transmitted on the inbound Trunking control channel by the subscriber unit when requesting channel allocation. |
| LLGT | Low Level Guard Tone  |

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## ***M to O***

|        |  |
|--------|--|
| MAN_CS | Manual Channel Select.   |
| MDC    | Motorola Data Communications. 1200 or 4800 baud data signalling scheme.  |
| MISO   | Master In, Slave Out.  |
| MON    | Monitor.   |
| MOSI   | Master Out, Slave In.  |
| MRTI   | Microprocessor Radio-Telephone Interconnect; a Motorola system that provides a repeater connection to the telephone network (The MRTI allows the radio to access the telephone network when the proper access code is received). |
| MSK    | Minimum Shift Keying   |
| OSW    | Outbound Signalling Word, data packet transmitted on the outbound Trunking control channel by the central controller that contains call assignment information for the subscriber.   |

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## ***P***

|      |  |
|------|--|
| PA   | Power Amplifier that transmits final RF signal to transmit antenna   |
| PFC  | Power Factor Correction  |
| PL   | Private-Line tone squelch; a continuous subaudible tone that is transmitted along with the carrier (A radio that has PL on the receive frequency will require both the presence of carrier and the correct PL tone before it will unmute). Also, if there is PL on the transmit frequency, all transmissions by the radio will be modulated with the PL tone. Modulation will be continuous. |
| PLL  | Phase locked loop; a circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.  |
| PSTN | Public Switched Telephone Network  |
| PTT  | Push-to-talk; the switch located on the left side of the radio which, when pressed causes the radio to transmit.   |

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## ***R***

|          |   |
|----------|---|
| RA/RT    | Remote Access/Remote Transmit   |
| RAC      | Repeater Access Control   |
| RdStat   | Receiver Data Status  |
| Repeater | Remote transmit/receive facility that retransmits received signals in order to improve communications range and coverage. |
| RF       | Radio Frequency   |
| RSS      | Radio Service Software; the software application used to program and service the station.                                 |
| RSSI     | Received Signal Strength Indicator; a dc voltage proportional to the received RF signal strength.                         |



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## *S*

|                |  |
|----------------|--|
| SCM            | Station Control Module; station controller.  |
| SINAD          | Acronym for the ratio of signal plus noise plus distortion and noise plus distortion.  |
| SMR            | Schaumburg Manual Revision   |
| Smart Repeater | Trunking system in which channel control is distributed among several repeaters.   |
| Spectra-TAC    | Analog Total Area Coverage voting comparator used to select wide area receivers.   |
| SPI            | Serial Peripheral Interface (clock and data lines); simple synchronous serial interface for data transfer between processors and peripheral ICs. |
| Squelch        | Automatic receiver quieting accomplished by muting audio circuits when received signal levels fall below a pre-determined value.                 |
| SRAM           | Static RAM, memory chip used for scratchpad memory.  |

---

---

## *T*

|                  |  |
|------------------|--|
| TCC              | Trunking Central Controller; main control unit of the trunked dispatch system; handles ISW and OSW messages to and from radios in the field (See ISW and OSW). |
| TOC              | Turn Off Code; alternating binary pattern used by DPL signalling to provide fast muting of the receiving radio.  |
| TRC              | Tone Remote Control  |
| Trunking         | Radio control system which permits efficient frequency utilization and enhanced control features.  |
| Type II Trunking | Motorola trunking system which provides extended features.   |

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## *U, V*

|      |  |
|------|--|
| UHF  | Ultra High Frequency   |
| VHF  | Very High Frequency  |
| VCO  | Voltage-Controlled Oscillator; an oscillator whereby the frequency of oscillation can be varied by changing a control voltage. |
| VOX  | Voice Operated Switch; Used with MRTI.   |
| VSWR | Voltage Standing Wave Ratio.   |

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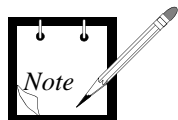
## *W to Z*

|           |  |
|-----------|--|
| WCI       | Wildcard Input   |
| WCO       | Wildcard Output  |
| WFI       | Word Frame Interrupt; used to synchronize trunking data messages in a Smart Repeater system.     |
| Wide Area | Wide area systems allow expanded radio coverage by using multiple receivers and/or transmitters. |
| WL        | Wireline   |
| WL Rx     | Wireline Receive; information from station rf receiver sent to wireline equipment.               |
| WL Tx     | Wireline Transmit; information from wireline equipment sent to station rf transmitter.           |

## 1

## INTRODUCTION

The Motorola MTR2000 Base Station/Repeater provides analog conventional and trunking capabilities in a reliable, software-controlled design. An innovative modular design and microprocessor-controlled Station Control Module (SCM) allows for superior station flexibility and simplified system upgrades.



All of the features described in this manual may not be currently supported. Refer to the “Summary of Operating Features” section for a list of standard features, optional features, and planned future features.

### Flexible Mechanical Design

All elements of the station are designed for EIA 48.3cm (19") rack mounting, allowing the equipment to be mounted in standard telephone-style equipment racks, or various sizes of Motorola cabinets. Figure 1 shows a typical 40W station.



**Figure 1. MTR2000 Station**

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## Electrical Design

### Transmitter Circuitry

The station transmitter circuitry is designed for continuous duty operation and may be operated at full rated power. Output power is continually monitored by an internal directional coupler. The forward power voltage from the coupler feeds a power control loop which continually adjusts and maintains the desired output power. All adjustments are electronic, including deviation and output power.

### Receiver Circuitry

The station receiver circuitry features multiple bandwidth (12.5kHz, 20kHz, 25kHz, and 30kHz) capability. Injection signals for the first and second mixers are generated by frequency synthesizer circuitry electronically controlled by the Station Control Module. All receive signals (analog) are detected and digitized before being sent to the Station Control Module, providing improved, consistent audio quality throughout the coverage area.

### Station Control Module

The Station Control Module is microprocessor-based and features extensive use of ASIC and digital signal processing technology. The module serves as the main controller for the station, providing signal processing and operational control for the station modules.

### Wireline Circuitry

The station wireline circuitry options provide a wide variety of telephone interfaces and control mechanisms such as Tone Control. Telephone line connections are easily made to the wireline circuitry via connectors on the rear of the station.

---

## Trunking Capability

When equipped for trunking capability, the station can operate in Motorola's Smartnet™ or the most advanced wide-area trunking system – *SmartZone*. The station can operate as a remote voice channel or control channel repeater. The station interfaces to a Trunking Central Controller (TCC) which provides the call processing and channel assignment tasks.

---

## Summary of Operating Features

### Standard Features

The following are a few of the standard features:

- FRU maintenance philosophy (reducing down time).
- Easily programmed via Radio Service Software (RSS).
- Extensive Self-Test Diagnostics and Alarm Reporting through RSS.
- Expansion and upgrades performed by module replacement.
- Highly reliable and accurate continuous duty transmitter circuitry.
- Compatible (with appropriate options) with conventional analog signaling.
- Wide operating temperature range: -30°C to +60°C (-22°F to +140°F).
- Battery Backup Connector – allows connection to battery backup system which automatically reverts to battery backup operation in the event of ac power failure.
- RA/RT
- Wide voltage supply range (AC or DC), with no setup configuration.

### Optional Features

The following are some of the leading optional features for the station:

- Double Circulator Option – provides additional isolation and intermodulation protection for rf-congested transmitter sites (not available on 350MHz stations).
- Microprocessor Radio Telephone Interconnect (MRTI) – allows connection of conventional station to the telephone network.
- Trunking – allows trunking repeater to operate as part of a *Smartnet* or *SmartZone* system; through Auxiliary I/O board (CLN1206).
- Wildcard Input/Output; through Auxiliary I/O board (CLN1206).
- Main Standby; through Auxiliary I/O board (CLN1206).
- Multi-coded Squelch Interface; through Zetron Model 38 Repeater Panel.
- Console Priority Interface; through 8-Wire Wireline Interface Board (CLN1205).
- Auxiliary Input/Output for conventional operation; through Auxiliary I/O board (CLN1206).

### Features Not Offered

Please disregard any references to the following **items** since they are **not available for the MTR2000**:

- DC Remote control for the 4-wire Wireline Interface Board, CLN1203.
- Second Receiver configuration of the MTR2000.

# 2

## STATION COMPONENTS

Figure 2 shows the modules and components that comprise a station.

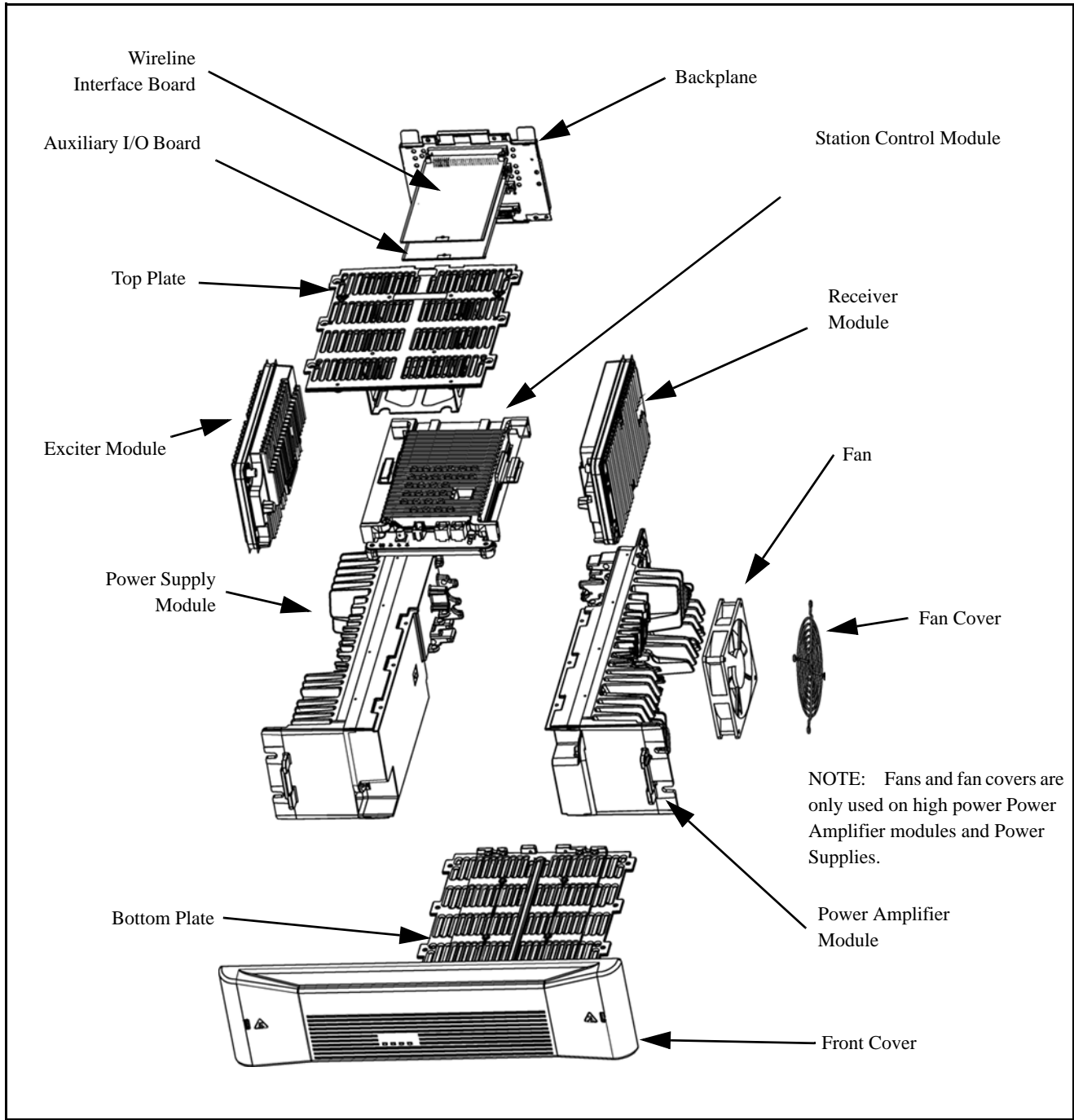


Figure 2. MTR2000 Station Components

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# 3

## FUNCTIONAL THEORY OF OPERATION

The following functional theory of operation provides an overview of the station circuitry. For a more thorough functional description of a particular module, refer to the STATION MODULES section of the appropriate band-specific Instruction Manual. The block diagram in Figure 3 supports the following functional theory of operation.

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### Transmitter Circuitry Operation

#### Introduction

The Transmitter Circuitry comprises two modules, the Exciter Module and the Power Amplifier (PA) Module. These modules combine to generate, modulate, and amplify the rf signal which is transmitted via the site transmit antenna. Modulation sensitivity and power output are adjusted electronically for each channel (through the Radio Service Software), under the direct control of the Station Control Module (SCM).

#### Exciter Module Operation

The Exciter Module, which interfaces directly to the SCM, generates a modulated rf signal at the desired transmit frequency and sends this signal to the PA for amplification. The circuitry operates as follows.

The transmit synthesizer and VCO (voltage-controlled oscillator) circuitry on the Exciter Module accept frequency programming data from the SCM (via the SPI bus) and generate an rf carrier at the specified frequency. The VCO is directly modulated by transmit audio/data from the SCM. The resulting modulated rf signal (at a level of approximately +12 dBm) is then fed to the PA.

#### Power Amplifier Module Operation

The PA modules are designed for continuous-duty operation across all bands and power levels. The actual circuit stages employed in a PA depend on the specific frequency band, power output level and intermodulation requirements. All PA modules contain an Intermediate Power Amplifier (IPA) at the input, a low-pass filter/directional coupler at the output, and diagnostic and power control circuitry.

High power (100 W) PA modules employ a single internal circulator to protect the PA from transmitter intermodulation and antenna mismatch (VSWR). The low power 30 W PA module employs two internal circulators. All PA stages and circulators are broad-band devices and require no tuning to operate at the station site.

The modulated rf signal from the Exciter Module is input to the IPA in the PA Module, and amplified to within a range of 0 to 10 W (depending on power control signals from the SCM). In PA Modules operating below 600MHz, the rf signal is fed to either a Butterfly Module (30W/40 W PA models) or a Dual Device Module (DDM – 100 W PA models). In PA Modules operating above 600 MHz, a 15 W driver is introduced between the Pre-driver stage and the Final Module. The gain of the Pre-driver stage is controlled by a power control voltage

which is derived from power control signals (from the SCM) and high VSWR/thermal protection circuitry on the PA output board.

A combination of hardware and software controls are used to regulate the power output level. To set the power and current limits, the SCM provides software control through a D/A converter connected to the SPI bus. This control relies on various monitored PA signals which are fed back to the SCM via an A/D converter (also connected to the SPI bus).

The directional coupler is essentially a calibrated wattmeter which feeds a dc voltage proportional to the output power to the power control circuitry to serve as the feedback signal in the power control loop. Under normal operating conditions, the power control circuitry compares this dc voltage from the directional coupler to a reference voltage from the D/A converter which represents the desired output power. Based on the comparison, a power control voltage is generated to control the output power from the PA Module.

The modulated rf signal is amplified by the Driver/Final Module and is output to the site transmit antenna via a circulator and a harmonic filter/coupler. During excessive output VSWR, the ratio of the forward and reflected voltages from the directional coupler may be used to reduce, or turn off, the transmitter power. Additional circuitry is also provided to reduce output power during excessive current drain and high temperature conditions, and to control the fan used in high power PA Modules.



---

## Receiver Circuitry Operation

### Introduction

The Receiver Circuitry accepts receive rf signals from the site receive antenna, performs filtering and dual conversion, and outputs a digitized receive signal to the Station Control Module. The receiver module utilized may have either an internal varactor-tuned preselector filter, or an external metal preselector filter.

### Receiver Module Operation

The receive signal is input from the site receive antenna to the receiver module, or to an external preselector filter (a separate assembly attached to the rear of the station which provides highly selective bandpass filtering). The signal is fed through a low-pass filter, varactor-tuned preselector (if external preselector is not used), rf amplifier and image filter to the rf input of the first mixer. The filtered signal is mixed with an injection signal generated by the receive synthesizer/VCO, resulting in a first i-f (intermediate frequency) signal. The injection signal frequency is determined by frequency programming data from the Station Control Module via the SPI bus. The specific frequency of the first i-f depends on the frequency band of the station.

The first i-f signal is filtered and input to a custom receiver IC. This component contains circuitry for generating the second injection signal, mixing down the first i-f to 450 KHz, amplification and A/D (analog-to-digital) conversion of the second i-f signal, resulting in a digitized receive signal. This signal is fed as differential data to the Station Control Module.

---

## Station Control Module Operation

### Introduction

The Station Control Module (SCM) is the microprocessor-based controller for the station. Major components include an MC68356 microprocessor, which combines a 68302 Integrated Multiprotocol Processor (IMP) with a 56002 Digital Signal Processor (DSP), a DSP ASIC device, and several Codec filter devices.

### Station Control Module Operation

The MC68356 forms the heart of the SCM. The 68302 portion is the Host Microprocessor ( $\mu$ P), which serves as the controller for the SCM and operates from station software stored in FLASH memory. This software determines the system capabilities of the station. The Host  $\mu$ P communicates with the station modules and the SCM circuitry via address and data buses, three SCI (Serial Communication Interface) ports, and an SPI bus.

The DSP portion of the MC68356, with the support of the DSP ASIC, perform the necessary digital processing for the station audio and data signals. The DSP circuitry interfaces with the Receiver Module (receive audio), the Exciter Module (VCO modulation signal), the Wireline Interface Board (wireline audio), and external audio devices (microphone and speaker).

The 2.1 MHz Reference Oscillator generates the reference signal used by the Receiver and Exciter Modules.

---

## Wireline Interface Board Operation

### Introduction

The Wireline Interface Board (WIB) serves as the interface between the customer analog telephone lines and the serial data signals of the station. WIBs are offered to handle 2-wire, 4-wire and 8-wire configurations. In general, the WIB processes and routes all wireline audio signals between the station and the landline equipment (such as consoles, modems, etc.). Landline-to-station and station-to-landline audio signals are connected to the WIB via copper pairs at the rear of the station.

### Wireline Interface Board Operation

The WIB contains a PCM Codec-filter device to perform the audio digitization and reconstruction, as well as the band-limiting and smoothing required by PCM systems. Analog signals are routed as follows:

- Inbound analog signals are converted to digital signals and routed to the SCM as wireline transmit data (WL TxD).
- Outbound PCM data signals are converted to analog signals and routed to the Line 2 output.
- A latch receives control signals from the SCM (via the SPI bus) to control the gating of the audio signals.



For a list of the actual features supported, refer to the “Summary of Operating Features” on page 3, or the MTR2000 System Planner.

---

## Auxiliary I/O Board Operation

### Introduction

The Auxiliary I/O Board serves as the interface between the customer auxiliary equipment and the Station Control Module (SCM). In general, the Auxiliary I/O Board routes all auxiliary equipment control signals between the SCM and the auxiliary equipment (e.g., a trunking controller).

### Auxiliary I/O Board Operation

The Auxiliary I/O Board contains SPI Input Buffers and associated circuitry which provides an input signal path from auxiliary equipment to the station SCM.

The input circuitry supports 16 general purpose inputs:

- 14 are transistor buffered inputs; 16 V maximum, 10 k $\Omega$
- 2 are opto isolated inputs; 60 mA forward current, 3 V dropout voltage, 2 kV isolation.

The Auxiliary I/O Board contains SPI Output Latches and associated circuitry which provides an output signal path from the station SCM to auxiliary equipment.

The output circuitry supports 16 general purpose outputs:

- 14 are open collector transistor outputs; maximum 40 V, 100 mA sink current
- 2 are dry contact outputs (relay); maximum 250 V, 1 A)

Not all inputs and outputs are supported, see Table 4, on page 33 through Table 8, on page 37.



## Power Supply Module Operation

Power Supply Modules are offered to handle:

- ac or dc input power
- low power (250 W) or high power (500 W) station requirements

A high power Power Supply Module (500 W) is used in a station with a high power Power Amplifier Module (e.g., rated at 100 W or 75 W output power).

A low power Power Supply Module (250 W) is used in a station with a low power Power Amplifier Module (e.g., rated at 40 W output power), or if the station is configured as a Satellite Receiver.

ac Input Power      The 250 W models generates the +5.1 V and +14.2 V operating voltages for the station modules.

The 500 W models generates the +5.1 V, +14.2 V, and +28 V operating voltages for the station modules.

These modules have power factor correction and include a connection for battery backup.

**Table 1.      Power Supply Module Models**

| Model                              | Supplied by | Input Voltage Range        | Output Voltages            | Power Factor Correction                         |
|------------------------------------|-------------|----------------------------|----------------------------|---|
| <b>Stations with Low Power PA</b>  |             |                            |                            |   |
| DLN6624                            | ASTEC       | 85 to 264 Vac, 47 to 63 Hz | +5.1 V and +14.2 V         | Provided internally within power supply module. |
| <b>Stations with High Power PA</b> |             |                            |                            |   |
| DLN6622                            | ASTEC       | 85 to 264 Vac, 47 to 63 Hz | +5.1 V, +14.2 V, and +28 V | Provided internally within power supply module. |

- dc Input Power      For dc-only operation the 250 W Power Supply Module (DLN6624) accepts a dc input (+10.8 to +16 Vdc). The output voltages are:
- the input filtered voltage.
  - a regulated +5.1 Vdc.
- For dc-only operation the 500 W Power Supply Module (DLN6622) accepts a dc input (+21 to +32 Vdc).
- The output voltages are:
- the input filtered voltage.
  - a regulated +5.1 Vdc.
  - a regulated +14.2 Vdc.

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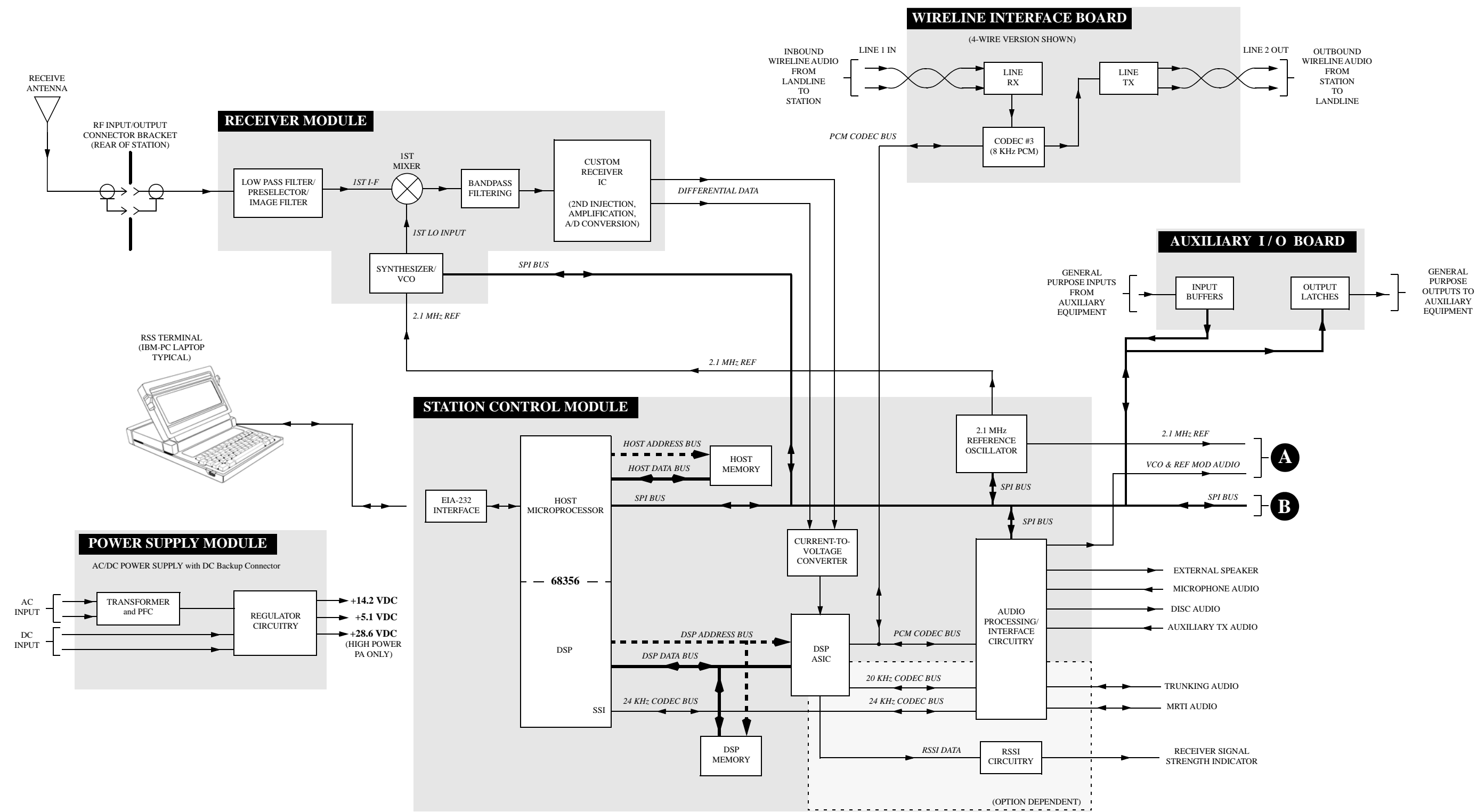


Figure 3. MTR2000 Station Functional Block Diagram (Sheet 1 of 2)



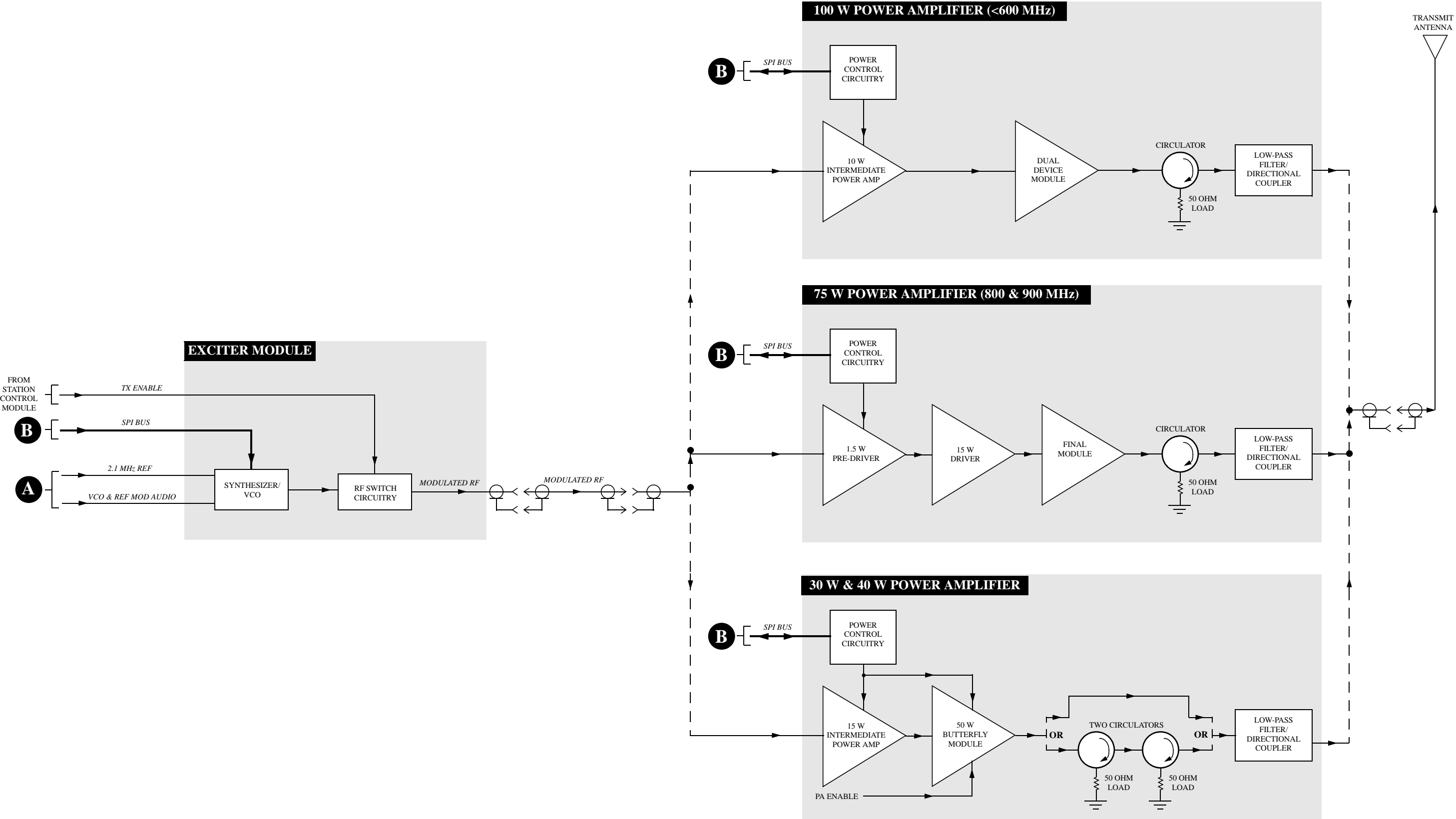


Figure 3. MTR2000 Station Functional Block Diagram (Sheet 2 of 2)

## 1

## PRE-INSTALLATION CONSIDERATIONS

Proper installation ensures the best possible performance and reliability of the station equipment. Pre-installation planning is required. This includes considering the mounting location of the equipment in relation to input power, antennas, and telephone interfaces. Also to be considered are site environment conditions, the particular mounting method (several available), and required tools and equipment.

If this is the first time installing this type of equipment, it is highly recommended that the user read:

- this entire installation section before beginning the actual installation, and
- the Motorola Quality Standards Fixed Network Equipment Installation manual, R56 (68P81089E50); specifically refer to the information on ground connection for lightning protection.

### Installation Overview

The following information is an overview for installing the station and ancillary equipment. Step-by-step procedures for each of the major installation tasks are then provided beginning in Section 2, Mechanical Installation.

- Plan the installation, paying particular attention to environmental conditions at the site, ventilation requirements, and grounding and lightning protection.
- Unpack and inspect the equipment
- Mechanically install the equipment at the site
- If a Wireline Interface Board or an Auxiliary I/O Board is included with the station, configure the board jumpers for required operation
- Make necessary electrical and cabling connections, including the following:
  - AC input cabling
  - Coaxial cables to transmit and receive antennas
  - Phone line connections
  - System cables
- Perform a post-installation functional checkout test of the equipment to verify proper installation

- Proceed to the Optimization procedures to customize the station parameters per customer specifications (e.g., operating frequency, PL, codes, etc.)



Regulatory requirements may require the use of an optional high stability reference for some modes of operation. It is recommended that the user check current local regulations prior to operation.

---

## Environmental Conditions at Intended Installation Site



### IMPORTANT

**If the station is to be installed in an environment which is unusually dusty or dirty (and so does not meet the air quality requirements), the air used to cool the station modules must be treated using appropriate filtering devices. Dust or dirt accumulating on the internal circuit boards and modules is not easily removed, and can cause such malfunctions as overheating and intermittent electrical connections.**

The station may be installed in any location suitable for electronic communications equipment, provided that the environmental conditions do not exceed the equipment specifications for temperature, humidity, and air quality. These are:

|                             |   |
|-----------------------------|---|
| Operating Temperature Range | <p>–30°C (–22°F) to +60°C (+140°F)</p> <p>This is the temperature measured in close proximity to the station. For example, if the station is mounted in a cabinet, the temperature within the cabinet would be measured.</p>  |
| Humidity                    | <p>Not to exceed 95% relative humidity @ 50°C (122°F).</p>  |
| Air Quality                 | <p>For equipment operating in an environmentally controlled environment with the station(s) rack mounted, the airborne particulates level must not exceed 25 µg/m<sup>3</sup>.</p> <p>For equipment operating in an area which is not environmentally controlled (station(s) cabinet mounted), the airborne particulates level must not exceed 90 µg/m<sup>3</sup>.</p> |

## Equipment Ventilation

The high-power (100/75 W) stations are equipped with cooling fans that are used to provide forced convection cooling.

When planning the installation, observe the following ventilation guidelines:

### Mounting the MTR2000 in a Cabinet



- Customer-supplied cabinets must be equipped with ventilation slots or openings in the front (for air entry) and back or side panels (for air to exit). If several stations are installed in a single cabinet, be sure ventilation openings surround each station to allow for adequate cooling.
- All cabinets must have at least 15 cm (6 in) of open space between the air vents and any wall or other cabinets. This allows adequate air flow.
- When multiple cabinets (each equipped with several stations) are installed in an enclosed area, make sure the temperature within each cabinet does not exceed the recommended / maximum operating temperature of +60°C (+140°F). It may be necessary to have air conditioning or other climate control equipment installed to satisfy the environmental requirements.

**High Power Stations:** The mounting of only **ONE STATION PER CABINET** is recommended. More than one station per cabinet will result in degradation of thermal specifications at high ambient temperatures.

**Low Power Stations:** In order to maintain thermal specification of –30°C (–22°F) to +60°C (+140°F), the low power stations must be mounted in a cabinet with additional cooling. A single low power station mounted in a cabinet without additional cooling, will operate at thermal specification performance of –30°C (–22°F) to +54°C (+129°F).

Appropriate precautions should be taken to ensure that station ambient temperature does not exceed +60°C (+140°F).

If multiple stations are required, **AND THERMAL SPECIFICATION DEGRADATION IS ACCEPTABLE**, the following is recommended when no cabinet fans are used. Up to three stations can be mounted in a 76.2 cm (30 in) or larger cabinet with two rack units of spacing between each station. This will result in thermal specification performance of –30°C (–22°F) to +40°C (+104°F).

### Mounting the MTR2000 in a Rack



When mounting multiple stations in a rack, ensure that the minimum spacing between stations is:

- 3 rack units (13.3 cm or 5.25 in) for VHF and UHF low power stations, and 350 MHz stations.
- 1 rack unit (4.4 cm or 1.75 in) for VHF and UHF high power stations, 800 MHz stations, and 900 MHz stations.

This spacing needs to be complied with to ensure that the thermal rating of the station is not exceeded.

---

## AC Input Power Requirements



The station is equipped with a switching power supply, this assembly operates from 85 Vac to 264 Vac at 47 to 63 Hz ac input power. A standard 3-prong line cord is supplied to connect the power supply to the ac source.

It is recommended that a standard 3-wire grounded electrical outlet be used as the ac source.

**The ac socket-outlet must be installed near the equipment and must be easily accessible.**

The outlet must be connected to an ac source capable of supplying a maximum of 1020 VA. For a nominal 110/120 Vac input, the ac source must supply 8.5 A and should be protected by a circuit breaker rated at 15 A. For a nominal 220/240 Vac input, the ac source must supply 4.25 A and should be protected by a circuit breaker rated at 10 A.

### Requirement for European Union (EU) Countries

Beginning January 1, 2001, input harmonic current specifications were changed for most electronic telecommunication equipment installed in EU countries. Accordingly, power factor correction is necessary for MTR2000 stations.

Power Supply models DLN6622 and DLN6624 have internal power factor correction.

---

## Equipment Mounting Methods

The station equipment may be mounted in a rack or cabinet (available as options).

The station can be shipped:

- ...in an floor-mount indoor cabinet. Each floor-mount cabinet has front and rear vented doors and has the capacity to hold a minimum of a single station (see thermal limitations described under Equipment Ventilation), and required ancillary equipment. The larger cabinets provide additional room for supplementary peripheral equipment.
- ...in a rack. Open frame racks accept multiple stations and ancillary equipment; EIA 48.3cm (19in) rack configuration.

**Floor-mount Cabinet**

The physical dimensions for all available floor-mount cabinets are shown in Figure 2. All dimensions are common to all cabinets, except for cabinet height. The cabinet options and associated height are:

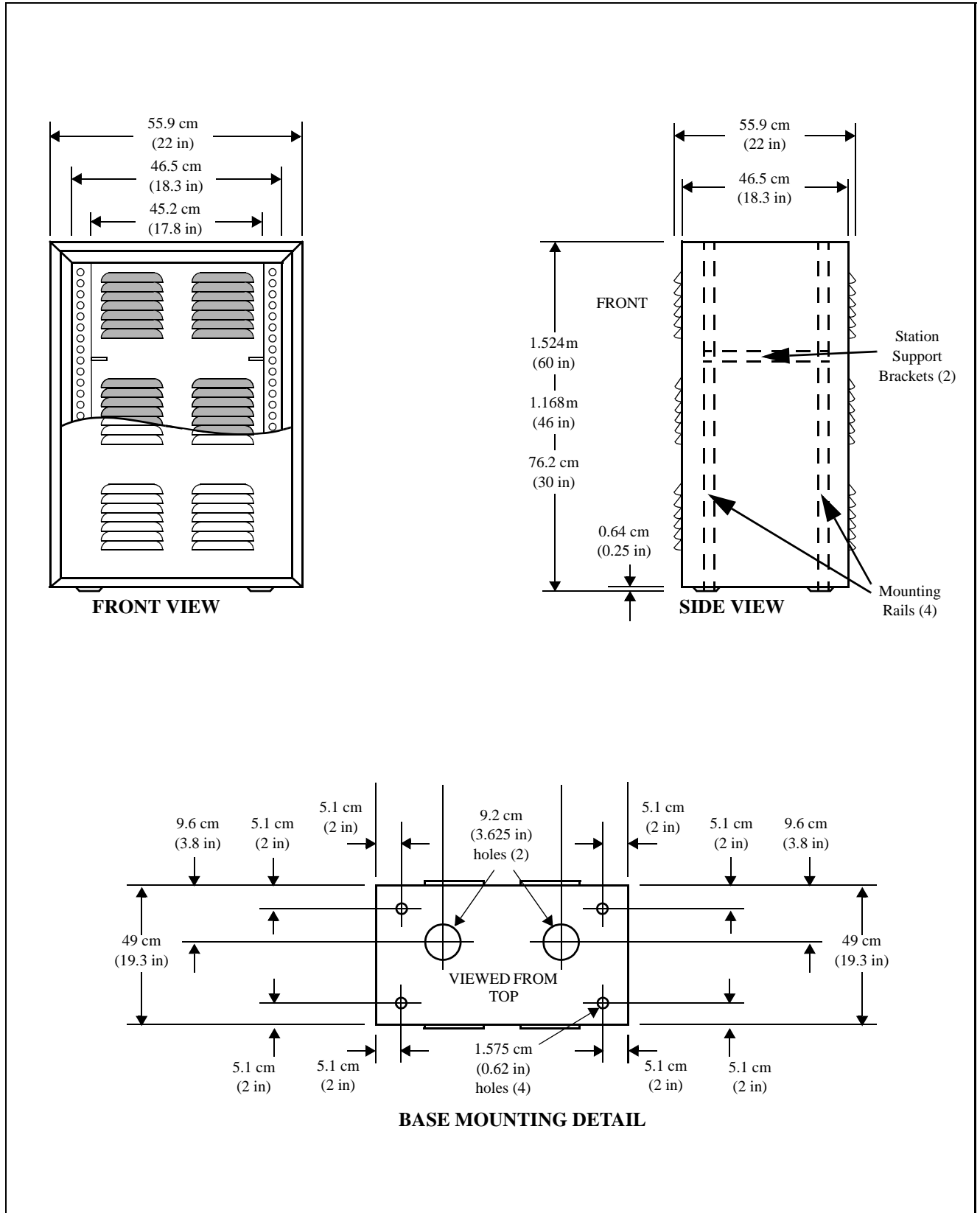
| Cabinet Option | Height        |
|----------------|---------------|
| X52AF          | 76.2cm (30in) |
| X308AD         | 1.168m (46in) |
| X180AC         | 1.524m (60in) |

Minimum recommended clearances are 76.2cm (30in) front and 91.44cm (36in) rear for minimum installation access. Refer to Equipment Ventilation for recommended ventilation clearances.

For improved access to the unit, a tray slide is available; option X968AA.



**Ensure that the cabinet is securely anchored to the floor, thereby avoiding possible equipment tipping and personal injury. Refer to Mounting Procedures – Mounting Floor-mount Cabinets for details on proper cabinet installation.**



**Figure 1. Floor-mount Cabinet – Dimensions and Clearances**



## Modular Racks

The rack options, associated height and available number of racking units are:

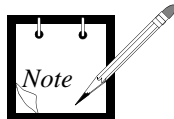
| Rack Option | Rack Height     | Number of Racking Units |
|-------------|-----------------|-------------------------|
| X741AF      | 76.2 cm (30 in) | 16                      |
| X742AF      | 1.143 m (45 in) | 24                      |
| X743AF      | 1.32 m (52 in)  | 27                      |

The physical dimensions and clearances for all available modular racks are shown in Figure 2. The top and bottom plates are identical. All dimensions and clearances are common to all racks, except for the 2 dimensions identified below. The rack options and associated dimensions are:

| Rack Option | Dimension A       | Dimension B         |
|-------------|-------------------|---------------------|
| X741AF      | 79.2 cm (31.2 in) | 26.1 cm (10.27 in)  |
| X742AF      | 1.147 m (45 in)   | 27.25 cm (10.73 in) |
| X743AF      | 1.28 m (52 in)    | 31.15 cm (12.26 in) |

Recommended clearance front and rear is 91.44 cm (36 in) minimum for servicing access. Refer to Equipment Ventilation for recommended ventilation clearances.

FRU kit CLN6679A (MTR2000 Rack Mounting Hardware) is included with each Rack Option. This allows proper installation of the MTR2000 station within the rack's centre of gravity.



This kit includes two rack mount standoffs and eight mounting screws.

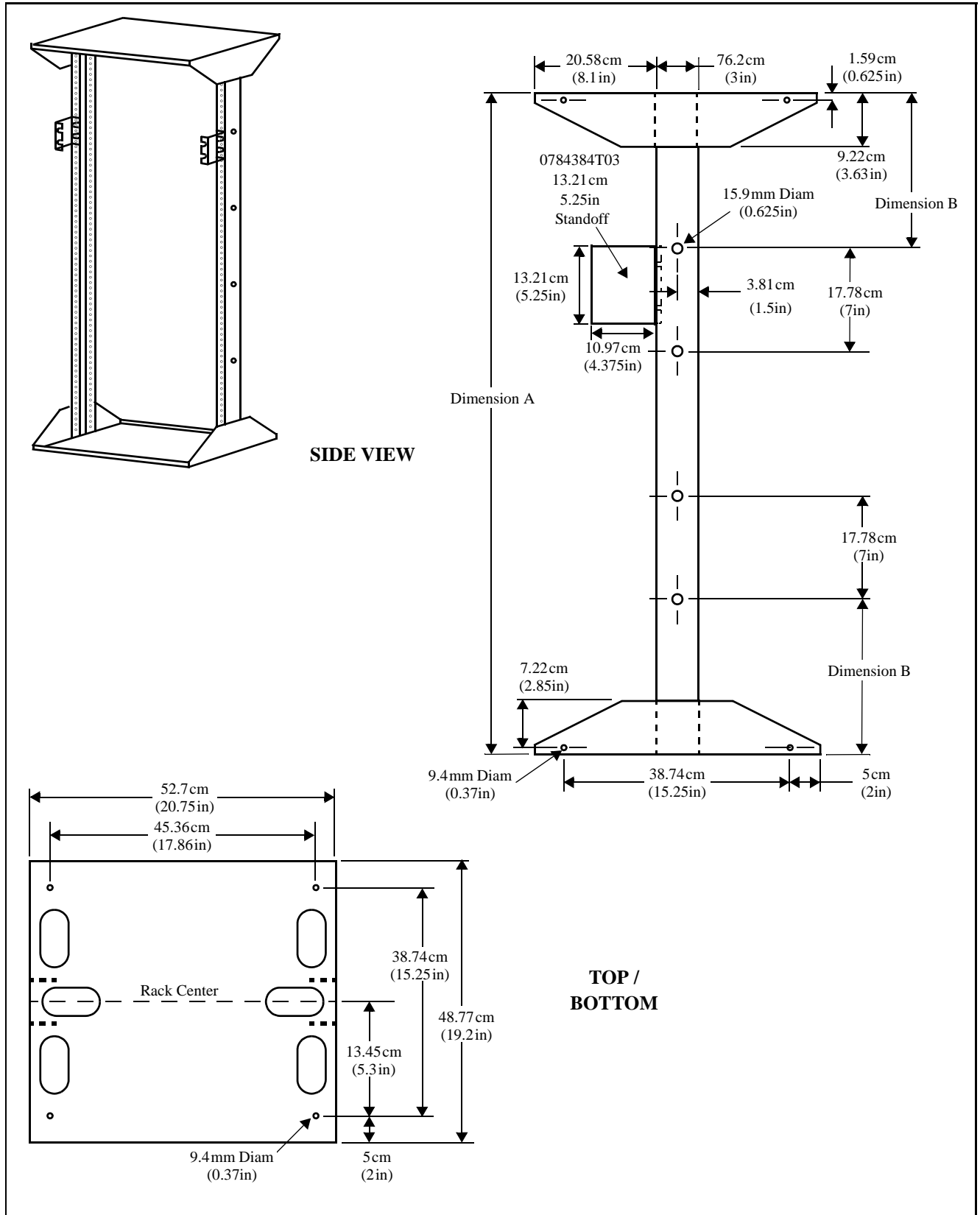


Figure 2. Modular Rack – Dimensions and Clearances

Site Grounding and Lightning Protection



IMPORTANT

Site Grounding Lightning Protection Recommendations

Proper site grounding and lightning protection are vitally important considerations. Failure to provide proper lightning protection may result in permanent damage to the radio equipment.

One of the most important considerations when designing a communications site is the ground and lightning protection system. While proper grounding techniques and lightning protection are closely related, the general category of site grounding may be divided as follows:

- Electrical Ground Ground wires carrying electrical current from circuitry or equipment at the site is included in the category of electrical ground. Examples include the ac or dc electrical power used to source equipment located at the site, telephone lines, and wires or cables connected to alarms or sensors located at the site.
  - RF Ground This type of ground is related to the transmission of radio frequency energy to earth ground. An example of rf grounding is the use of shielding to prevent or at least minimize the leakage of unwanted rf transmissions from communications equipment and cables.
  - Lightning Ground Providing adequate lightning protection is critical to a safe and reliable communications site. Telephone lines, rf transmission cables, and ac and dc power lines must all be protected to prevent lightning energy from entering the site building.
- Although a comprehensive coverage of site grounding techniques and lighting protection is not within the scope of this manual, there are several excellent industry sources for rules and guidelines on ground and lightning protection at communications sites.



Motorola recommends the following reference source:  
Motorola Quality Standards Fixed Network Equipment  
Installation manual, R56.....68P81089E50

Equipment Grounding Guidelines

The station is equipped with a ground screw located on the rear of the station Power Supply module. This screw is used to connect the station to the site ground point. It is assumed that all telephone lines, antenna cables, and ac or dc power cabling has been properly grounded and lightning protected by following the rules and guidelines provided in the above reference.

---

## Recommended Tools and Equipment

In addition to the typical compliment of hand tools, the following tools and equipment are recommended for proper installation of the station equipment.

- Tarpaulin or plastic drop cloth or cover surrounding equipment while drilling concrete anchor holes (for installations where cabinet or rack is being anchored to concrete).
- Vacuum cleaner for removing concrete dust caused by drilling.

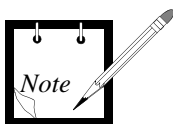
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## Equipment Unpacking and Inspection

The station equipment may be shipped by either air freight or electronic van (as specified by customer), except where noted.

- If no cabinet or rack is desired, the station is shipped in a box; the station is positioned between pieces of cushioned corrugated cardboard.
- All available cabinets are shipped with the station(s) installed in the cabinet, with the cabinet bolted to a wooden skid and covered with a cardboard box with corrugated interior corner braces.
- Stations to be used in open frame racks are shipped with the station and ancillary equipment mounted in the rack and covered by an antistatic plastic bag. All rack shipments are electronic van only.

Thoroughly inspect the equipment as soon as possible after delivery. If any part of the equipment has been damaged in transit, immediately report the extent of the damage to the transportation company and to Motorola.



Antistatic plastic bags should be kept for future shipping/transporting of station.

---

## Cabinet Unpacking



When a station (mounted in a cabinet) is delivered from Motorola, it arrives in suitable packing materials. **If the unpacked equipment is damaged, return it to Motorola in its original packaging.**

**Equipment should be handled in its original packaging until it is delivered to its final destination. If the equipment is damaged while being moved without the original packaging, the warranty claim is not valid.**

## 2

## MECHANICAL INSTALLATION

This section describes the procedures to unpack and mechanically install the station equipment. A variety of mounting methods are possible, depending on whether a cabinet or rack (if any) has been selected to house the station(s). Installation procedures are provided for each of the cabinet and rack types, as well as the slide rail.



### IMPORTANT

**Be sure to observe proper electrostatic discharge precautions if modules must be removed from the station.**

## Unpacking Equipment

### Introduction

Station equipment packing methods vary depending upon the type of optional rack or cabinet selected by the customer. Unpacking procedures for these various methods are provided in the following paragraphs.



### IMPORTANT

**The equipment must be immediately inspected for damage after unpacking, and a report of the extent of any damage made to the transportation company and to Motorola.**

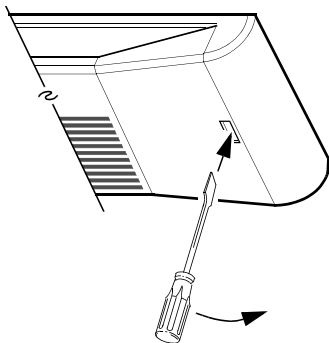
### Unpacking Stations

The station is shipped in a carton, cushioned by four plastic inserts at the corners of the carton.



### WARNING

**Improper handling of the station may cause personal injury or damage to the station. DO NOT pick up the station by holding the Preselector (if so equipped). Use the handles on the front of the station, or the Power Supply and Power Amplifier casings when picking up the station.**



### Front Panel – Removal and Replacement

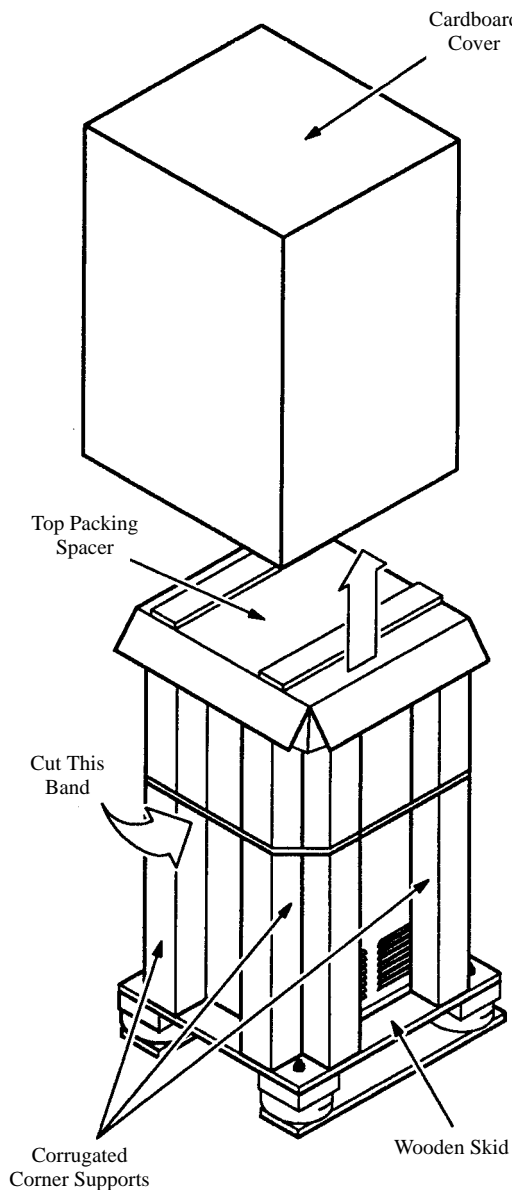
Remove station front panel by inserting a small flat-blade screwdriver into one of two access holes at either end of the panel and, by carefully moving the handle of the screwdriver away from the center, release the front panel locking clip from the chassis and pull away the panel.

Replace station front panel by inserting one of the front panel locking clips into corresponding latch on the station housing, and carefully pressing the panel on the opposite side until the second locking clip snaps into place.

## Unpacking Floor-mount Cabinets

The floor-mount cabinets are shipped mounted to a wooden skid, secured with corrugated corner braces held by a plastic strap, and covered with a cardboard cover. Unpack the equipment as described in Figure 3.

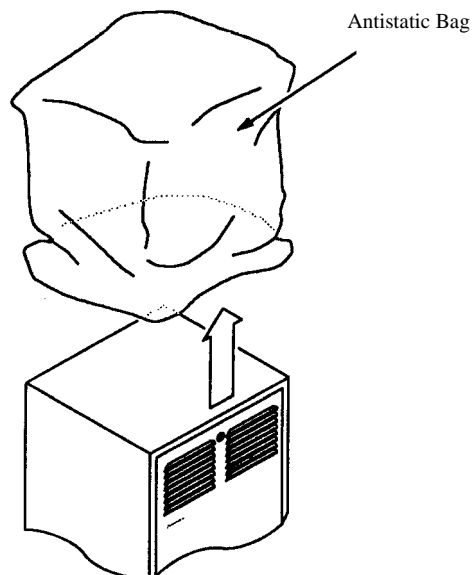
1. Remove cardboard cover from station.



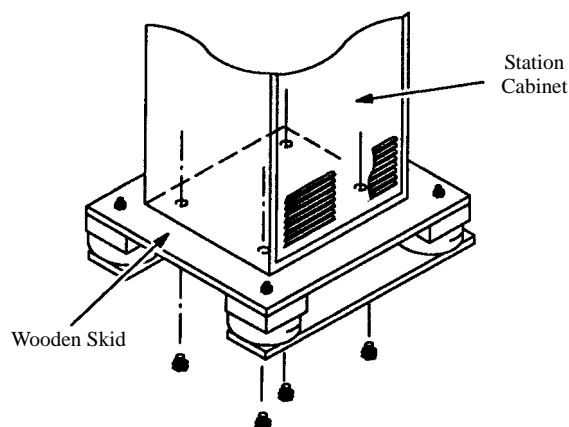
2. Cut band as shown.

3. Remove top packing spacer and corrugated corner supports.

4. Remove antistatic bag. **Do not** discard bag, it will be reinstalled to protect equipment during installation.



5. Depending on cabinet type, either open or remove front and rear doors to gain access to the four (4) bolts securing the station to the wooden skid. Remove the bolts and nuts as shown.



6. Use hoist to lift the station from the skid. Remove skid and return station to floor.

7. Replace antistatic bag over station to provide protection during installation.

Figure 3. Unpacking Procedures - Floor-mount Cabinets

---

## Mounting Procedures

### Introduction

In most cases, stations are shipped in the selected cabinet or rack (i.e., the station is mounted and cabled), and may be installed by following the procedures below. However, the following three scenarios require special mounting procedures:

- Customer plans to mount equipment in customer-supplied rack or cabinet, and orders equipment to ship from the factory without a rack or cabinet.
- Customer orders two stations in a single rack.
- Customer requires slide rail assembly.

### Installing Racks

In a typical installation, the rack is bolted to a concrete floor to provide stability.

The following procedure describes the steps necessary to bolt the rack to a concrete floor. Be sure to check with local authorities to verify that the following procedure conforms to local building codes and regulations *before permanently installing the rack*.

1. Carefully align the rack at the desired anchoring location.
2. Use the rack mounting foot as a template and mark the location of the six 19 mm (3/4 in) diameter mounting holes. All six anchoring positions must be used.
3. Move the rack aside, drill holes in the concrete floor, and install the mounting anchors (RAM RD-56 anchors recommended) per instructions provided with the anchors. Make sure that none of the anchors comes in contact with the reinforcing wire mesh buried in the concrete; the rack must be electrically isolated from any other equipment or materials at the site.
4. Align the rack with the installed anchors and lightly secure the rack to the floor using the proper mounting hardware. **Do not tighten the mounting hardware at this time.**
5. Check the vertical plumb of the rack. Also check that the top is level. Use shims (flat washers or flat aluminum plates) as necessary under the rack mounting foot to achieve vertical plumb and horizontal level.
6. Tightly secure the rack to the floor anchors making sure that it remains vertically plumb and horizontally level.
7. After all debris is removed and cement dust is cleared away, remove whatever protective covering has been placed on the equipment, including the antistatic bag.



**Cement dust from concrete flooring is harmful to electronic equipment and wiring. Make sure that the rack and any collocated equipment are protected prior to drilling holes in the concrete floor. Use a tarpaulin, cloth, or plastic sheeting to cover exposed equipment. (The rack should be already covered**



with an antistatic bag; do not remove the bag at this time.) Use a vacuum while drilling the holes to minimize the spread of concrete dust. Carefully clean up any accumulated dust and debris from the anchor installation before uncovering the equipment.

### Mounting Floor-mount Cabinets

Each cabinet bottom is pre-drilled with four (4) mounting holes to allow attachment to the site floor. If installing on a concrete floor, use the cabinet as a template, mark the hole locations, and follow the procedures above for anchoring equipment racks. If installing on a wooden floor, use lag bolts and washers (customer supplied) to secure the cabinet to the floor.

### Transferring Equipment from Shipping Container to Rack or Cabinet

As mentioned under Equipment Unpacking and Inspection, a station can be shipped in a box. Upon delivery, the equipment must be removed from the container and transferred to a Motorola-supplied rack or cabinet, or to a customer-supplied rack or cabinet.



Customer-supplied cabinets and racks must have mounting rails and hole spacing compatible with EIA Universal 48.3cm (19in) specifications. Cabinets must provide adequate ventilation (as detailed under Equipment Ventilation) and must meet the following criteria:

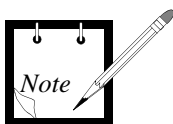
- 41.3cm (16.25in) deep
- 48.3cm (19in) wide
- 13.4cm (5.25in) high
- Two mounting rails 5 cm (2in) from front of cabinet with front mounting holes 5.7 cm (2.25in) apart (center to center).

Contact Motorola Engineering for specific questions regarding mounting equipment in customer-supplied cabinets.

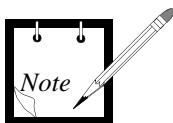
## Installing Slide Rail Assembly in a Motorola Cabinet

Referring to Figure 4, perform the following procedure to install slide rail option X968AA.

On a bench-top, working on one side of the slide rail assembly at a time...



Working in the cabinet...



1. Remove the Inner-Slide Rail from the slide assembly (left and right) by depressing the Slide Locking Latch and sliding the Inner-Slide Rail out from the slide assembly.
2. Install the Inner-Slide Rail (left) on the Power Supply side by:
  - removing the 2 bottom screws from the station power supply EMI cover, and
  - installing the Inner-Slide Rail (left) with the supplied screws.
3. Install the Inner-Slide Rail (right) on the PA side using the holes in the PA casing.
4. Attach each Outer-Slide Rail to a Cabinet Bracket with supplied screws.

The left and right Cabinet Brackets are identical.

The Locking Tab of each Outer-Slide Rail must face towards the rear of the cabinet.

5. The cabinet must have a set of vertical cabinet rails in the back as well as the front. If there is no set in the back, these must be installed. The back rail is installed the same as the front rail, with the supplied screws.
6. Install each assembled Cabinet Bracket (with attached Outer-Slide Rail) to the appropriate side of the cabinet.

The U-shaped cutout of the Cabinet Bracket must face up.

7. Slide the station (with an Inner-Slide Rails mounted on each side) into the Outer-Slide Rails in the cabinet; an audible snap is heard. Continue sliding the station in until the station is fully seated.
8. Secure the station to the cabinet front rails with the supplied screws.

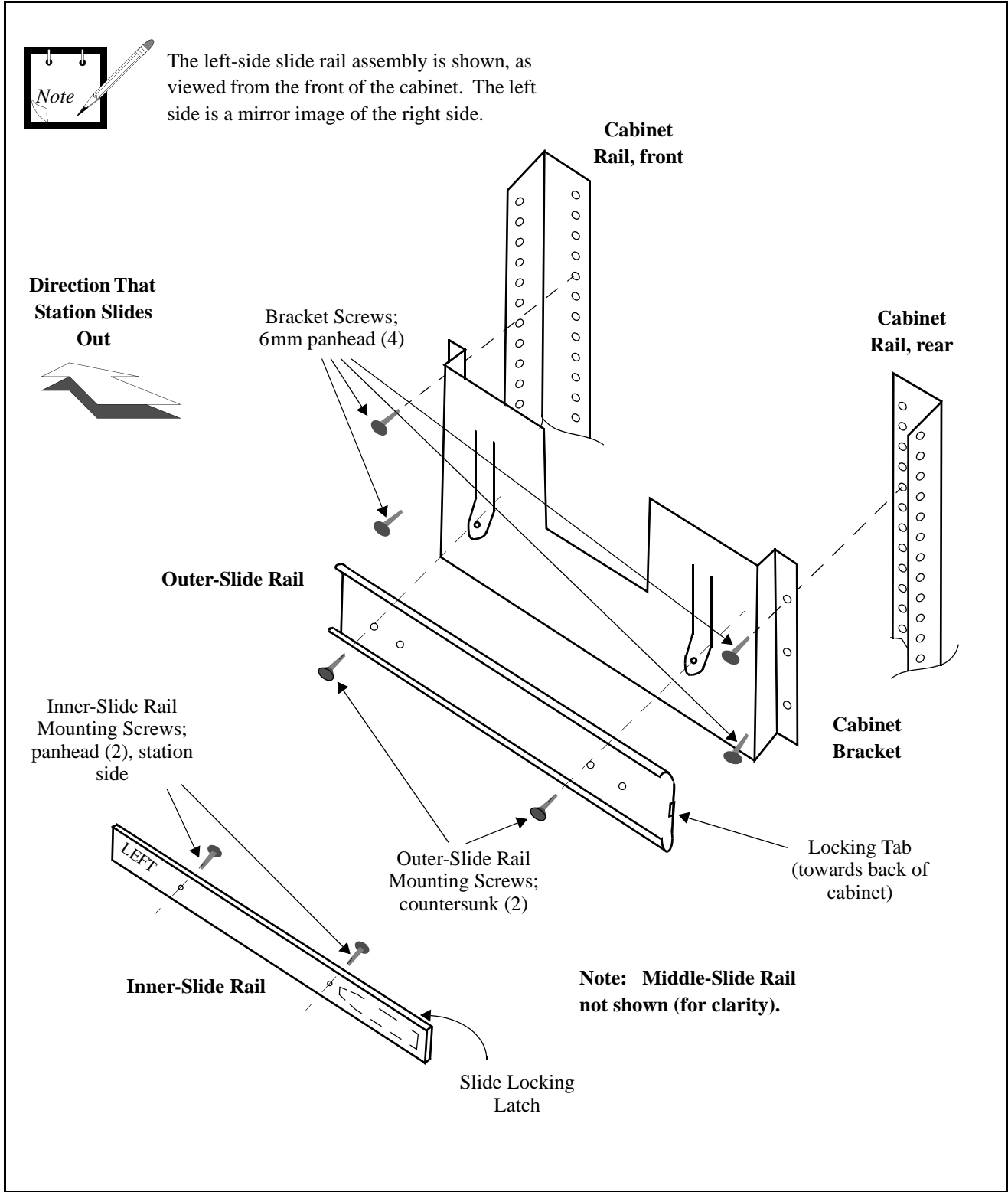


Figure 4. Slide Rail Installation; Option X968AA (Left Side Shown)

## Installing Slide Rail Assembly in a Non-Motorola Cabinet

Referring to Figure 5, perform the following procedure to install slide rail option X346AB.

On a bench-top, working on one side of the slide rail assembly at a time...



Working in the cabinet...

1. Remove the Inner-Slide Rail from the slide assembly (left and right) by depressing the Slide Locking Latch and sliding the Inner-Slide Rail out from the slide assembly.
2. Install the Inner-Slide Rail (left) on the Power Supply side by:
  - removing the 2 bottom screws from the station power supply EMI cover, and
  - installing the Inner-Slide Rail (left) with the supplied screws.
3. Install the Inner-Slide Rail (right) on the PA side using the holes in the PA casing.
4. Attach each Outer-Slide Rail to the cabinet Brackets with supplied screws. Only use the lower slot of each bracket. Leave the screws loose; they will be tightened when the brackets are mounted in the cabinet (step 7).

The left and right Cabinet Bracket sets are identical.

The Locking Tab of each Outer-Slide Rail must face towards the rear of the cabinet.

5. Install a cage nut in line with clearance hole in Threaded Strip prior to fitting the Front Bracket to the front cabinet rail. This nut is required for mounting the station (in step 9). The cage nuts are provided with the cabinet.
6. Fit the Short Bracket and Long Bracket (with attached Outer-Slide Rail) to the Front and Rear Cabinet Rails using the Bracket Mounting Screws and Threaded Strips.
7. Tighten the Outer-Slide Rail hardware after positioning the Outer-Slide Rail front side in line with the inner surface of the Front Cabinet Rails.
8. Slide the station (with an Inner-Slide Rails mounted on each side) into the Outer-Slide Rails in the cabinet; an audible snap is heard. Continue sliding the station in until the station is fully seated.
9. Secure the station to the Front Cabinet Rails with the supplied Station Mounting Screws.

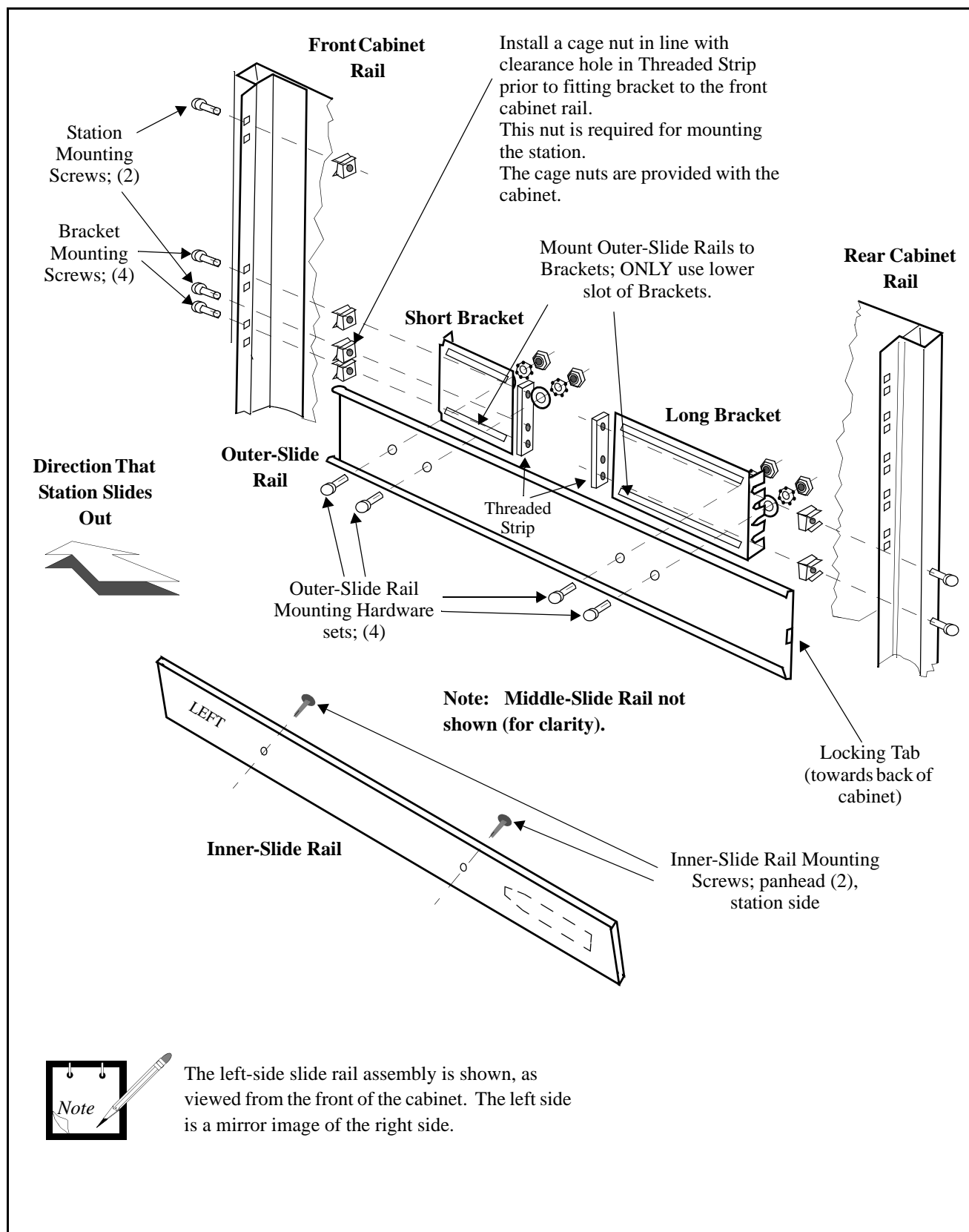


Figure 5. Slide Rail Installation; Option X346AB (Left Side Shown)

# 3

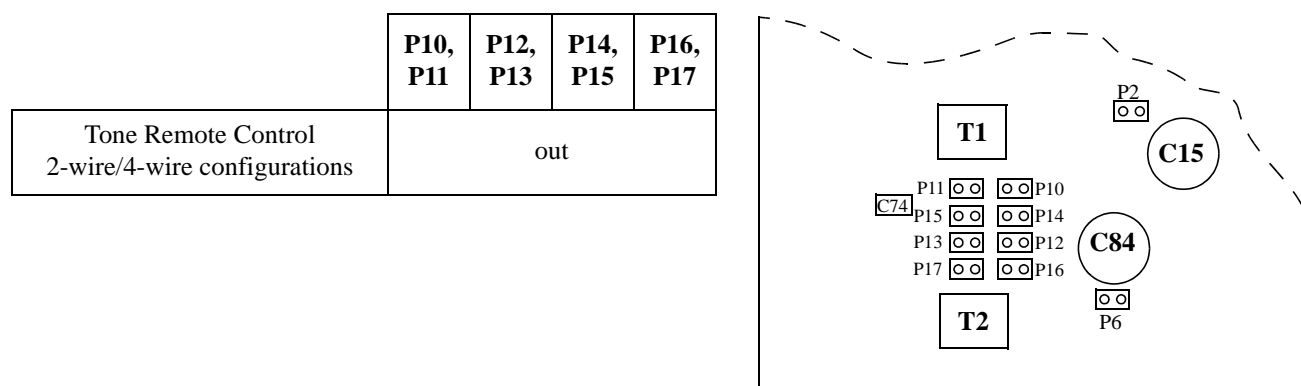
## BOARD CONFIGURATION

Most station configuration parameters are altered through the Radio Service Software (RSS) with the exception of some parameters for the following boards, which are configured through jumpers:

- 4-Wire Wireline Interface Board (CLN1203),
- 4-Wire Euro Wireline Interface Board (CLN1204),
- Auxiliary I/O Board (CLN1206).

### 4-Wire Wireline Interface Board

Model CLN1203 WIB supports tone control of the station. CLN1203 provides a fixed impedance of  $600\Omega$  to the wireline. Figure 6 shows the jumper locations for tone control.



**Figure 6. CLN1203 Wireline Interface Board Jumper Settings**

### 4-Wire Euro Wireline Interface Board

Figure 7 shows the correct settings of impedance matching jumpers for the model CLN1204 WIB, as determined by the country in which the station is being operated. Incorrect jumper settings may violate local telecommunications authority regulations and place the equipment in an unapproved status. Some countries also specify a maximum allowed line input level. Refer to the RSS Online Help, under Line Level.

√ = Jumper In

A = Pin 1 connects to Pin 2

\* This setting represents a standard 600 ohm matching and is the factory default.

B = Pin 3 connects to Pin 4

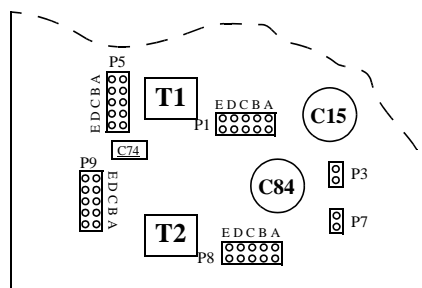
C = Pin 5 connects to Pin 6

D = Pin 7 connects to Pin 8

E = Pin 9 connects to Pin 10



Canada and the U.S. wireline requirements are supported by Wireline board model CLN1203.



| Country           | Reference Impedance       | P1, P5, P8, P9 |   |   |   |   | P3, P7 |
|-------------------|---------------------------|----------------|---|---|---|---|--------|
|                   |                           | A *            | B | C | D | E |        |
| Australia         | 120 $\eta$ F              |                |   | √ |   |   | √      |
| Spain             | 220 $\Omega$ 820 $\Omega$ |                |   | √ |   |   | √      |
| Austria           |                           |                |   | √ |   |   | √      |
| Germany (2-wire)  |                           |                |   | √ |   |   | √      |
| Luxemburg         | 115 $\eta$ F              |                |   | √ |   |   | √      |
| South Africa      | 220 $\Omega$ 820 $\Omega$ |                |   | √ |   |   | √      |
| Switzerland       |                           |                |   | √ |   |   | √      |
| Belgium           | 72 $\eta$ F               |                |   | √ |   |   | √      |
|                   | 150 $\Omega$ 830 $\Omega$ |                |   |   |   |   |        |
| Cyprus            |                           | √              |   |   |   |   | √      |
| Former USSR       |                           | √              |   |   |   |   | √      |
| Former Yugoslavia |                           | √              |   |   |   |   | √      |
| Germany (4-wire)  |                           | √              |   |   |   |   | √      |
| Greece            | 600 $\Omega$              | √              |   |   |   |   | √      |
| Italy             |                           | √              |   |   |   |   | √      |
| Netherlands       |                           | √              |   |   |   |   | √      |
| Portugal          |                           | √              |   |   |   |   | √      |
| Denmark           | 330 $\eta$ F              |                |   |   | √ |   | √      |
|                   | 400 $\Omega$ 500 $\Omega$ |                |   |   |   |   |        |
| Ireland           |                           |                |   |   | √ |   | √      |
| UK                | 310 $\eta$ F              |                |   |   | √ |   | √      |
|                   | 370 $\Omega$ 620 $\Omega$ |                |   |   |   |   |        |
| Finland           | 115 $\eta$ F              |                | √ |   |   |   | √      |
|                   | 220 $\Omega$ 820 $\Omega$ |                |   |   |   |   |        |
| France            | 115 $\eta$ F              |                | √ |   |   |   | √      |
|                   | 220 $\Omega$ 820 $\Omega$ |                |   |   |   |   |        |
| Norway            | 115 $\eta$ F              |                | √ |   |   |   |        |
|                   | 220 $\Omega$ 820 $\Omega$ |                |   |   |   |   |        |
| Sweden            | 30 $\eta$ F               |                |   |   |   | √ |        |
|                   | 900 $\Omega$              |                |   |   |   |   |        |

Figure 7. CLN1204 Wireline Interface Board Jumper Settings

## Auxiliary I/O Board

Jumpers are provided to route inputs and outputs in a specific direction to and from the SCM; the SCM determines the functionality of the inputs and outputs.

The board jumpers are shown in Figure 8.

GPI\_14 is a special input which can be jumpered to be a transistor input or opto isolated. In addition it can be dedicated to the Ext\_PTT\* Line routed to the SCM. This function is a fast external PTT\* (an active low function).

The board jumper settings for P2, P9, P6 are provided in Table 1. Settings for P5 are provided in Table 2. Settings for P3, P4 are provided in Table 3.

P7 and P8 are not used.

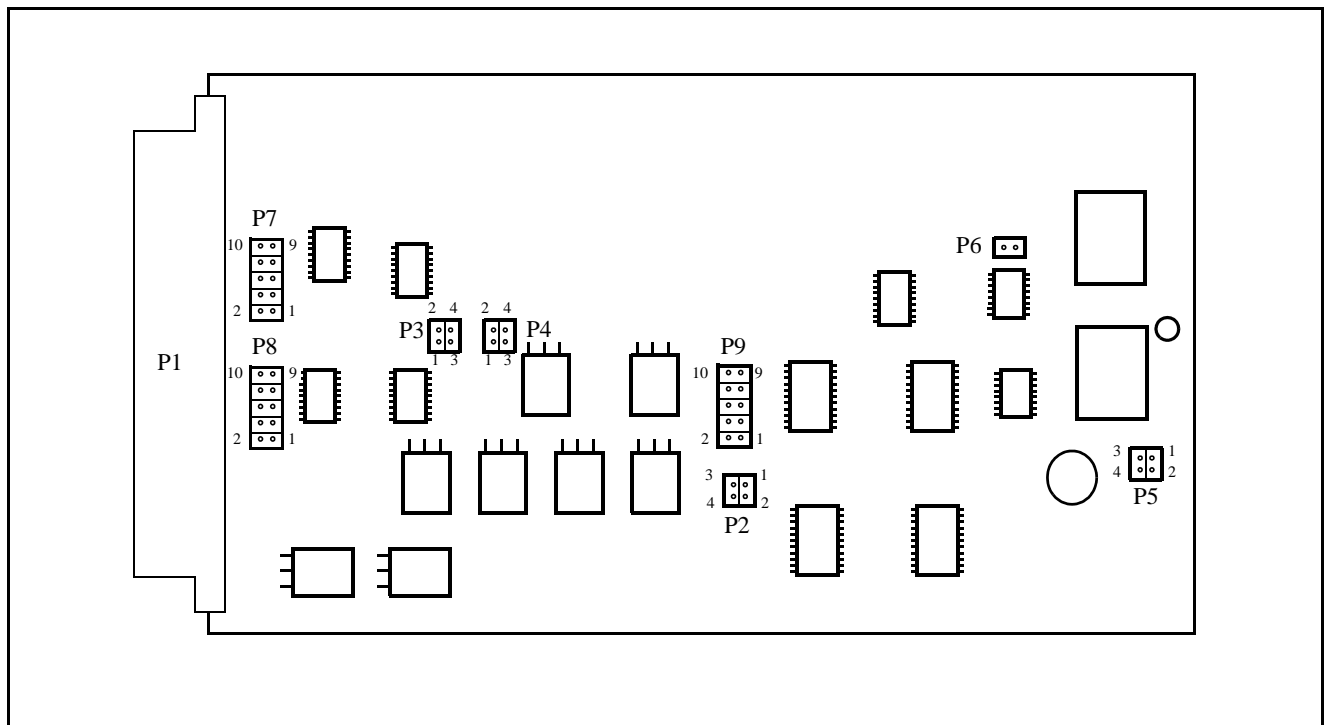


Figure 8. CLN1206 Auxiliary I/O Board Jumpers



**Table 1. Configuring Input GPI\_14 Function**

| Function on GPI_14 | Input Type                              | System Connector Input Pins | Auxiliary I/O Board Jumpers |               |                    |
|--------------------|---|-----------------------------|-----------------------------|---------------|--------------------|
|                    |   |                             | P2                          | P9            | P6<br>(See Note 1) |
| Fast External PTT* | via Optocoupler (E/M sub). (See Note 2) | A29 Opto +<br>A26 Opto –    | 3 - 4, 1 - 2                |               | In                 |
|                    | via Transistor                          | B26                         |                             | 9 - 10, 7 - 8 | In                 |
| Fast External PTT  | via Optocoupler (E/M sub)               | A29 Opto +<br>A26 Opto –    | 3 - 4, 1 - 2                |               | Out                |
|                    | via Transistor                          | B26                         |                             | 9 - 10, 7 - 8 | Out                |

**Table 2. Configuring Output GPO\_14 Function**

| Function on GPO_14                      | Output Type       | System Connector (J5) Output Pins | Auxiliary I/O Board Jumper P5 |
|---|-------------------|-----------------------------------|-------------------------------|
| AC Fail                                 | via Relay Closure | B29, A30                          | 2 - 4                         |
| SPI Latch for GPO_14 (software defined) | via Relay Closure | B29, A30                          | 1 - 2                         |



The shaded areas indicate default manufacturing settings.

Note 1: This is an active low; that is, no current to the Opto Input.

Note 2: This configuration, with P6 out (PTT when current to the Opto Input) represents the E Signal of 4 wire E&M Trunk Type I Phone Signalling. The opposite direction of the E&M is covered in Note 3.



**In this configuration the second remaining unused input type must be jumpered to the SPI Buffer. The Buffer Input should never be left floating; otherwise the IRQ Generator will not function properly (i.e., use either P2-1&2 or P9-7&8).**

**Table 3. Configuring Output GPO\_15 Function**

| Function on GPO_15                      | Output Type                       | System Connector (J5)<br>Output Pins | Auxiliary I/O Board<br>Jumpers |       |
|---|-----------------------------------|--------------------------------------|--------------------------------|-------|
|   |                                   |                                      | P3                             | P4    |
| Fast Carrier Detect                     | via Relay Closure                 | C3, B3                               | 2 - 4                          | 2 - 4 |
|   | via Open Collector                | B21 (see Note 4)                     | 3 - 4                          | 2 - 4 |
| RdStat                                  | via Relay Closure<br>(see Note 3) | C3, B3                               | 2 - 4                          | 1 - 3 |
|   | via Open Collector                | B21 (see Note 4)                     | 3, 4                           | 1, 3  |
| SPI Latch for GPO_15 (software defined) | via Relay Closure                 | C3, B3                               | 1 - 2                          |       |
|   | via Open Collector                | B21 (see Note 4)                     | 1 - 3                          |       |



Note 3: This configuration represents the M Signal of 4 wire E&M Trunk Type I Phone Signalling. The opposite direction of the E&M is covered in Note 2.

Note 4: Indicates that the configuration is only available when the board is plugged into Option slot 1.

## 4

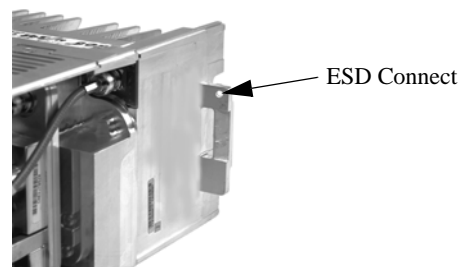
## ELECTRICAL CONNECTIONS

After the station equipment has been mechanically installed, electrical connections must be made. This involves making the following connections to:

- power supply,
- antenna coax cables,
- system cables, and
- telephone lines.

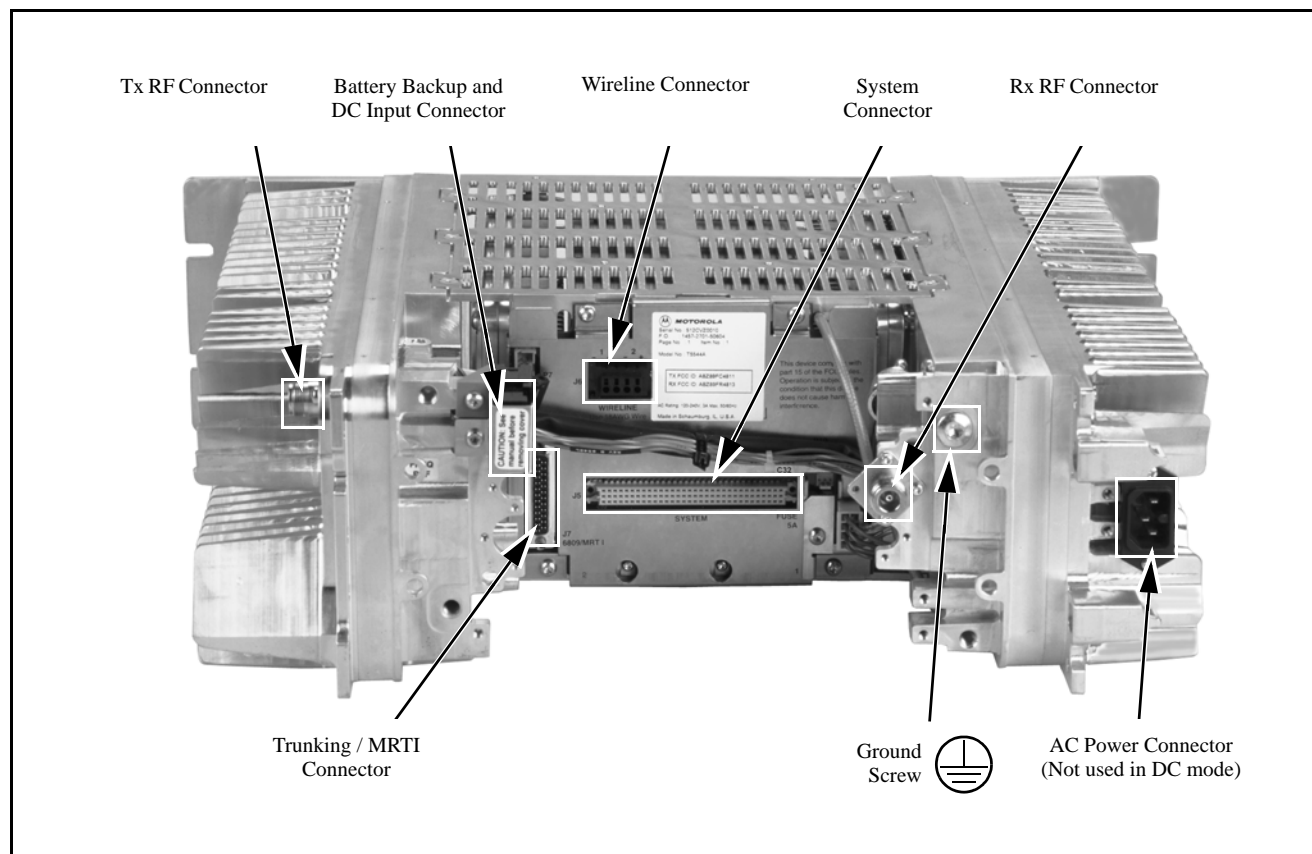


**When installing option boards, ensure that an Electro-Static Discharge (ESD) cable is connected (via banana plug) to the hole in the front-right handle of the station when installing option boards. Otherwise, the option boards may be damaged.**



There are also electrical connections associated with maintenance and troubleshooting of the station. These connectors are located on the front of the Station Control Module (see Station Operation section for position of these connectors).

Figure 9 shows the position of the station external connectors located at the rear of the station.



**Figure 9. Location of External Connectors at Rear of Station**

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## Power Supply Connections



### AC Input Power Connection

**Do not apply ac power to the station at this time. Make sure that the circuit breaker associated with the ac outlet is turned to OFF.**



**The ac socket-outlet must be installed near the equipment and must be easily accessible.**

Each station is shipped with an 2.5 m (8 ft) 3-conductor line cord. Figure 9 shows the ac line cord connector. Insert the plug into an appropriate grounded outlet.

The North American line cord is equipped with a NEMA 5–15 plug, intended for 110/120 Vac operation.

The optional European line cord (Option X189AA) is equipped with a “Schuko” style CEE VII (7) plug, intended for 220/240 VAC operation.

Plugs for other countries are available as the following options:

| Location  | Option Number |
|-----------|---------------|
| U. K.     | X162AD        |
| Australia | X191AD        |

If an alternate line cord is required, obtain a line cord employing “HAR” flexible cord with fittings approved by the safety testing agency in the end- use country.

## Ground Connection

The station is equipped with a ground screw located on the rear of the station Power Supply module. Connect the ground screw to the site ground point.



**Refer to Motorola Quality Standards Fixed Network Equipment Installation manual, R56 (68P81089E50) for complete information regarding lightning protection.**



**The station is to be connected to a battery supply that is in accordance with the applicable electrical codes for the end use country; for example, the National Electrical Code ANSI/NFPA No. 70 in the U.S.**

## DC Input Power Connection

For DC-only operation, the DC source power is connected to the station through the battery backup connector shown in Figure 9, and described in “Battery Connection” on page 29.



**Ensure that the appropriate voltage is connected; that is, Nominal 14.2 Vdc (10.8 to 16.0 Vdc) for a low power station, or Nominal 28.6 Vdc (21.0 to 32.0 Vdc) for the high power station.**

## Battery Connection

Battery backup interface offers the capability of connecting to battery backup power in the event of an AC power line failure.

The battery backup system is connected to the station through the red and black connector mounted at the rear of the station. The connector has a cover with the following label. This label directs the technician to read the information provided below:

**CAUTION: See manual before removing cover.**

This battery backup system must have, at a minimum, a disconnect relay controlled by an AC fail detector.



**DO NOT connect a battery directly to the station. Damage to batteries as well as to the station may occur. Batteries must be connected to the station through an Argus Technologies Battery Reverting Charger, Model #010-519-20 (Motorola Model #L1883) for 12V charging systems, and Argus Technologies Model #010-523-20 (Motorola Model #L1884) for 24V charging systems. These systems were developed specifically for this interface and tested by Motorola for proper station operation. Damage resulting from use of any other charging systems will void the warranty. Refer to qualified sales/service representative for charger ordering information.**



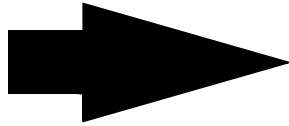
The station is to be connected to a battery supply that is in accordance with the applicable electrical codes for the end use country; for example, the National Electric Code ANSI/NFPA No.70 for the U.S.

Cables are supplied with the charging option. **Do not make connections directly from the station to the storage battery.** Connect as shown in Figure 10.

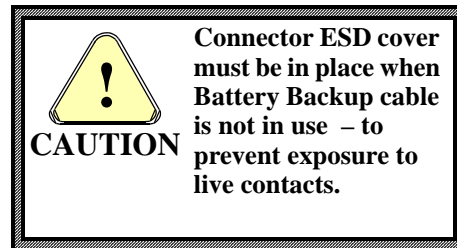
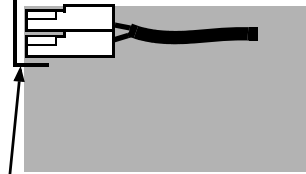
Required input power:

- Voltage - 14.2 Vdc Low Power (LP)  
28.4 Vdc High Power (HP)
- Current - 11.5 Amps LP  
13.0 Amps HP

Both positive and negative terminals must be protected with appropriate fast acting fuses. Secondary circuitry must be SELV type and be installed nearby, preferable in the same building. All installations shall be carried out by trained service personnel only.



DC input Connector located at rear of the station for hooking up the **Battery backup system.**



**Figure 10. Making Connections to Storage Battery**

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## RF Antenna Connections

The transmit and receive antenna rf connections are made using two separate N-type connectors. Coax cables from the receive and transmit antennas must be connected to the two N-type connectors. The position of these connectors is shown in Figure 9.

In the case where an optional Antenna Relay is used on the station, the coax cable from the single transmit/receive antenna is connected to the middle N-type connector of the Antenna Relay.



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## System Cable Connections

System connections are made through one or both of the following connectors:

- the Trunking/MRTI connector and
- the System connector.

**Trunking/MRTI Connector**      The location of the Trunking/MRTI connector and System connector on the station rear panel is shown in Figure 9.

The following cables are available for trunking system applications:

- 7.62m (25ft) Trunk Cable, part # 3083765X04
- 15.24m (50ft) Trunk Cable, part # 3083765X05
- 22.86m (75ft) Trunk Cable, part # 3083765X06
- 30.48m (100ft) Trunk Cable, part # 3083765X07

The following cable is available for MRTI applications:

- Interface cable for Zetron model 30, kit # TTO4097

**System Connector**      The cable connected to the System connector can be configured for various system options.

A generic System cable is available for variety of applications such as Wild Card, Main Standby, and Auxiliary Input/Output:

- generic System cable, kit # TKN9205A

This cable provides a housing shell for connection to the 96 pin backplane connector, 30 loose pins, and a quantity of 30 of 24 gauge wires (2 meter long with a pin for header on one end and unterminated at the other end).

Table 4 provides a description of commonly used System Connector pins.

Table 4. System Connector – Commonly Used Pins

| Pin Function       |   | Pin #   | Pin Signal Characteristics  |
|--------------------|---|---|---|
| Name               | Description   |   |   |
| RdStat             | TTL compatible logic output indicating Rx. Activation status.   | C2, B21, B3/C3                                  | 0.0 to 0.2 Vdc with squelched receiver, 4.8 to 5.2 Vdc with unsquelched receiver.   |
| Disc. Rx. Audio    | Unfiltered and unsquelched discriminator audio without de-emphasis.                                       | C17   | 80mV minimum to 400mV maximum for 60% system deviation. Output level is RSS programmable.   |
| RSSI               | DC output volts related to received carrier level.  | C11   | Typically 0.5 Vdc for –120dBm to 3.5 Vdc for –40 dBm carrier. Variation with carrier level @ approximately 40mV/dBm.  |
| Cntrl 14.2 V       | 14.2 volts dc output. For dc-only 250W power supplies, this voltage is equal to the input supply voltage. | A18, B18, C18<br>C32, B32, C32                  | Total current through all of these pins should not exceed 1Amp.   |
| 5 V                | 5.1 ± 0.25 volts dc output.   | A20, B20, C20                                   | Total current through all of these pins should not exceed 500 mA.   |
| GND                | Ground.   | A19, B19, C19<br>A27, B27, C27<br>A31, B31, C31 | Total current through all of these pins should not exceed 1.5 Amp.  |
| Aux. Tx Audio      | Tx. modulation input from external source.  | A17   | RSS programmable sensitivity. For R03.01 (host software) and earlier, the fixed sensitivity is @ 172 mVrms for 60% system deviation. RSS programmable for pre-emphasized or flat response. DC offset +2.4V. High impedance input.                 |
| Ext. PTT           | External Tx. keying signal.   | C10   | Grounding Ext. PTT pin causes Tx to key. 5.0Vdc on pin when Tx is not keyed. Note: To transmit signalling code (PL / DPL) by external PTT, it should be mapped (via RSS) to Wireline, and external modulation input should be routed to wireline. |
| AC_Fail            | Logic output to indicate failure of AC line input.  | A4  | Requires a Battery Revert dc supply. Line goes high (5.0Vdc) if AC fails.   |
| Wireline Pair 3+/- | Additional wireline for other functions.  | C28, C30  | Line sensitivity and operation identical to line pairs 1 and 2 (see Table 10).  |
| Wireline Pair 4+/- |   | B28, B30  |   |

Table 5 provides a summary of the Auxiliary Inputs / Outputs (Wildcard I/O) currently available through the System Connector.

Table 5. Summary of Auxiliary Inputs/Outputs at the System Connector

| Auxiliary I/O<br>GPI... | System<br>Connector (J5) Pin | Auxiliary I/O<br>GPO... | System<br>Connector (J5) Pin   |
|-------------------------|------------------------------|-------------------------|--|
| 3                       | A5                           | 0                       | A12  |
| 4                       | C5                           | 2                       | A11  |
| 7                       | A22                          | 8                       | A1   |
| 9                       | A28                          | RX Lock                 | B1   |
| 10                      | C12                          | TX Lock                 | C1   |
| 11                      | B12                          | 13                      | B2   |
| 12                      | B11                          | 15                      | B21  |
| 13                      | B9                           | 15 (relay)              | C3, B3<br>See Table 3, on<br>page 25, and B3, C3 in<br>Table 7, on page 36 and<br>Table 8, on page 37. |

Details of the System connector pinouts are provided in:

- Table 7, Row A pin assignments
- Table 7, Row B pin assignments
- Table 8, Row C pin assignments

The following symbols and abbreviations are used in Tables 7 to 8:

- \* = line is Active Low
- NS = Not Supported; **this pin should not be used.**
- Aux I/O = Indicates that the Aux I/O board must be present for this functionality.
- WCI = Wild Card Input
- WCO = Wild Card Output



The RSS Online Help provides the most current information on the System Connector pin assignments.

Table 6. J5 SYSTEM CONNECTOR, Row A Pins

| Pin #   | Pin Assignment                | Input/<br>Output | To/From                      | Signal Characteristics  |
|---|-------------------------------|------------------|------------------------------|---|
| 1   | GPO_8 (WCO)                   | O                | J1-C32, J2-C32               | OCO, 100mA, 40V   |
| 2   | PA Fail (Aux I/O)             | O                | J1-C31, J2-C31               | OCO, 100mA, 40V, active low   |
| 3   | SCI_CLK1                      | O                | J1-C30, J2-C30, J3-C28       | Do not use.   |
| 4   | AC Fail                       | O                | P8-5, J1-C29, J2-C29, J3-C24 | TTL output, active high   |
| 5   | GPI_3 (WCI)                   | I                | J1-C28, J2-C28               | Pulled up transistor input, 16V max   |
| 6   | GPI_15 (–) (NS)               | I                | J1-C27, J2-C27               | Negative side opto-isolated input, see C7   |
| 7   | Ext Failsoft (Aux I/O)        | I                | J1-C26, J2-C26               | Pulled up transistor input, 16V max   |
| 8   | GPI_1 (NS)                    | I                | J1-C25, J2-C25               |   |
| 9   | GPI_2 (NS)                    | I                | J1-C24, J2-C24               | Pulled up transistor input, 16V max   |
| 10  | VSWR_Fail* (Aux I/O)          | O                | J1-C23, J2-C23               | Pulled up transistor output (10kohms to +5Vdc), active low  |
| 11  | GPO_2 (WCO)                   | O                | J1-C22, J2-C22               | Pulled up transistor output (10kohms to +5Vdc)  |
| 12  | GPO_0 (WCO)                   | O                | J1-B25, J2-B25               |   |
| 13  | Antenna Relay                 | O                | P10-1, J3-C26                | OCO, 200mA, active low  |
| 14  | Not Supported                 | O                | J1-C18, J2-C18, J3-C19       |   |
| 15  | Spare 310                     | –                | –                            |   |
| 16  | Spare 308                     | –                | –                            |   |
| 17  | Aux TX Audio                  | I                | J1-C16, J2-C16, J3-C16       | RSS programmable input sensitivity  |
| 18  | Cntrl 14.2 VDC                | O                | P8 pins 3, 4 (thru F2)       | +14.2Vdc, Note 1  |
| 19  | GND                           | –                | Station ground               |   |
| 20  | 5 VDC                         | O                | P8 pins 7, 8                 | +5.1 ± 0.25 Vdc   |
| 21  | Not Supported                 | O                | J3-C12                       |   |
| 22  | GPI_7 (WCI)                   | I                | J1-C11, J2-C11               | Pulled up transistor input, 16V max.  |
| 23  | Spare 323                     | –                | –                            |   |
| 24  | Spare 320                     | –                | –                            |   |
| 25  | Spare 903                     | –                | –                            |   |
| 26  | Ext PTT or GPI_14 (–), Note 2 | I                | J1-C7, J2-C7                 | Negative side opto-isolated input, see A29  |
| 27  | GND                           | –                | Station ground               |   |
| 28  | GPI_9 (WCI) or GPO_3 (NS)     | I/O              | J1-C6, J2-C6                 | Caution: See Auxiliary I/O section for jumpering information  |
| 29  | Ext PTT or GPI_14 (+), Note 2 | I                | J1-C5, J2-C5                 | Positive side opto-isolated input, see A26  |
| 30  | AC Fail or GPO_14, Note 3     | O                | J1-C4, J2-C4                 | One side of normally open relay, see B29  |
| 31  | GND                           | –                | Station ground               |   |
| 32  | Cntrl 14.2 VDC                | O                | P8 pins 3, 4 (thru F2)       | +14.2Vdc, Note 1  |
| <b>Note 1:</b> For dc-only 250W power supplies, this voltage is equal to the input supply voltage.<br><b>Note 2:</b> This pin can be jumpered for Ext PTT (supported) or GPI_14 (not supported). See Aux I/O jumpers P2 and P9. |                               |                  |                              | <b>Note 3:</b> This pin can be jumpered for AC Fail (supported) or GPO_14 (not supported). See Aux I/O jumper P5. |

Table 7. J5 SYSTEM CONNECTOR, Row B Pins

| Pin # | Pin Assignment             | Input/<br>Output | To/From                | Signal Characteristics                                       |
|-------|----------------------------|------------------|------------------------|--|
| 1     | RX Lock (Aux I/O)          | O                | J1-B32, J2-B32         | OCO, 100mA, 40V; active high                                 |
| 2     | GPO_13 (WCO)               | O                | J1-B31, J2-B31         | OCO, 100mA, 40V  |
| 3     | RdStat or GPO_15, Note 4   | O                | J1-B30, J2-B30         | One side of normally open relay, see C3                      |
| 4     | Carrier Detect Switch      | O                | J1-B29, J2-B29, J3-B24 | TTL output, active high                                      |
| 5     | GPI_8 (NS)                 | I                | J1-B28, J2-B28         | Pulled up transistor input, 16V max                          |
| 6     | GPI_5 (NS)                 | I                | J1-B27, J2-B27         |  |
| 7     | Ext Repeat* (Aux I/O)      | I                | J1-B26, J2-B26         |  |
| 8     | Trunk Duplex Enable*       | I                | J3-B25                 | TTL input  |
| 9     | GPI_13 (WCI) or GPO_7 (NS) | I/O              | J1-B24, J2-B24         | Caution: See Auxiliary I/O section for jumpering information |
| 10    | Spare 311                  | –                | N/C                    |  |
| 11    | GPI_12 (WCI) or GPO_6 (NS) | I/O              | J1-B22, J2-B22         | Caution: See Auxiliary I/O section for jumpering information |
| 12    | GPI_11 (WCI) or GPO_5 (NS) | I/O              | J1-B23, J2-B23         |  |
| 13    | Spare 301                  | –                | N/C                    |  |
| 14    | Not Supported              | I                | J1-B19, J2-B19, J3-B19 | TTL input  |
| 15    | GND                        | –                | Station ground         |  |
| 16    | Spare 300                  | –                | –                      |  |
| 17    | Spare 321                  | –                | –                      |  |
| 18    | Cntrl 14.2 VDC             | O                | P8 pins 3, 4 (thru F2) | +14.2 Vdc, Note 1  |
| 19    | GND                        | –                | Station ground         |  |
| 20    | 5 VDC                      | O                | P8 pins 7, 8           | +5.1 ± 0.25 Vdc  |
| 21    | RdStat or GPO_15, Note 4   | O                | J1-B12                 | OCO, 100mA, 40V  |
| 22    | Spare 322                  | –                | –                      |  |
| 23    | Spare 325                  | –                | –                      |  |
| 24    | Spare 309                  | –                | –                      |  |
| 25    | Spare 902                  | –                | –                      |  |
| 26    | Ext PTT or GPI_14, Note 2  | I                | J1-B7, J2-B7           | Pulled up transistor input, 16V max, see A29                 |
| 27    | GND                        | –                | Station ground         |  |
| 28    | Line 4+                    | O                | J4-C10                 | Wireline output balanced, (+)                                |
| 29    | AC Fail or GPO_14, Note 3  | O                | J1-B4, J2-B4           | Other side of normally open relay, see A30                   |
| 30    | Line 4–                    | O                | J4-A9                  | Wireline output balanced, (–)                                |
| 31    | GND                        | –                | Station ground         |  |
| 32    | Cntrl 14.2 VDC             | O                | P8 pins 3, 4 (thru F2) | +14.2 Vdc, Note 1  |

**Note 4:** This pin can be jumpered for RdStat (supported) or GPO\_15 (supported). See Aux I/O jumpers P3 and P4.

Table 8. J5 SYSTEM CONNECTOR, Row C Pins

| Pin #  | Pin Assignment                    | Input/<br>Output | To/From                | Signal Characteristics  |
|--|-----------------------------------|------------------|------------------------|---|
| 1  | TX Lock (Aux I/O)                 | O                | J1-A32, J2-A32         | OCO, 100mA, 40V; active high  |
| 2  | Rdstat-R2 Control                 | O                | J1-A31, J2-A31, J3-A26 | TTL output, high when unsquelched   |
| 3  | RdStat or GPO_15, Note 4          | O                | J1-A30, J2-A30         | Other side of normally open relay, see B3   |
| 4  | Failsoft Output (Aux I/O)         | O                | J1-A29, J2-A29         | OCO, 100mA, 40V, active low   |
| 5  | GPI_4 (WCI)                       | I                | J1-A28, J2-A28         | Pulled up transistor input, 16V max   |
| 6  | Rx Inhibit                        | I                | J1-A27, J2-A27, J3-B26 | TTL input; active low   |
| 7  | GPI_15 (+) (NS)                   | I                | J1-A26, J2-A26         | Positive side opto-isolated input, see A6   |
| 8  | Trunk TX Inhibit*                 | I                | J3-A25                 | TTL input   |
| 9  | RF Relay Control Out (Aux I/O)    | O                | J1-B5, J2-B5           | OCO, 200mA, 40V, active high  |
| 10   | Ext PTT* Out (Aux I/O),<br>Note 5 | I                | J1-A23, J2-A23, J3-A23 | TTL input   |
| 11   | RSSI                              | O                | J1-A22, J2-A22, J3-A22 | Typically 0.5Vdc for –120dBm to 3.5 Vdc for –40 dBm carrier. Variation with carrier level @ approximately 40mV/dBm. |
| 12   | GPI_10 (WCI) or GPO_4 (NS)        | I/O              | J1-A24, J2-A24         | Caution: See Auxiliary I/O section for jumpering information  |
| 13   | Spare 304                         | –                | –                      |   |
| 14   | Not Supported                     | O                | J1-A19, J2-A19, J3-A19 |   |
| 15   | GND                               | –                | Station ground         |   |
| 16   | GND                               | –                | Station ground         |   |
| 17   | Disc RX Audio                     | O                | J1-A16, J2-A16, J3-A16 | Discriminator audio, flat response; 80mV to 400mV for 60% deviation   |
| 18   | Cntrl 14.2 VDC                    | O                | P8 pins 3, 4 (thru F2) | +14.2Vdc, Note 1  |
| 19   | GND                               | –                | Station ground         |   |
| 20   | 5 VDC                             | O                | P8 pins 7, 8           | +5.1 ± 0.25 Vdc   |
| 21   | Not Supported                     | O                | J3-A12                 |   |
| 22   | Spare 302                         | –                | –                      |   |
| 23   | Spare 324                         | –                | –                      |   |
| 24   | GPIO_0 (CNTR I/O)                 | I/O              | J1-A9, J2-A9, J3-A17   | TTL input/output  |
| 25   | Spare 317                         | –                | –                      |   |
| 26   | Spare 901                         | –                | –                      |   |
| 27   | GND                               | –                | Station ground         |   |
| 28   | Line 3+                           | I                | J4-C12                 | Wireline input balanced, (+)  |
| 29   | GPIO_1 (CNTR I/O)                 | I/O              | J1-A4, J2-A4, J3-A13   | TTL input/output  |
| 30   | Line 3–                           | I                | J4-A11                 | Wireline input balanced, (–)  |
| 31   | GND                               | –                | Station ground         |   |
| 32   | Cntrl 14.2 VDC                    | O                | P8 pins 3, 4 (thru F2) | +14.2Vdc, Note 1  |
| <b>Note 5:</b> Ext PTT signal output, taken from Ext PTT input. The output signal can be inverted, depending on jumper settings. See jumpers P2, P6, P9. |                                   |                  |                        |   |

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# Telephone Line Connections

## Introduction

In conventional systems where the station is controlled by a remote console, or in wide area systems utilizing comparators, phone lines must be connected between the station and the remote equipment. The phone lines may carry analog voice, or encoded voice. Also carried on the phone lines are Tone Remote Control (type of remote control signalling). The following information defines the specifications for the phone lines, the location on the station backplane for phone line connections, and which of the four (4) wireline circuits to use for various system types.

## Telephone Line Specifications

Most telephone companies recognize either “3002” or “Type 5” as designations to define phone line types and associated electrical specifications. Telephone lines meeting the specifications for either of these types are acceptable for use with the station. Table 9 shows the specifications for “3002” or “Type 5” phone line types.

Table 9. Type 5 and “3002” Phone Line Specifications

| Parameter   | Type 5 Specification                                 | 3002 Specification                                   |
|---|--|--|
| Loss Deviation  | $\pm 4.0\text{dB}$                                   | $\pm 4.0\text{dB}$                                   |
| C–Notched Noise   | 51 dBmCO   | 51 dBmCO   |
| Attenuation Distortion:<br>504 to 2504 Hz<br>404 to 2804 Hz<br>304 to 3004 Hz | –2.0 to +8.0dB<br>–2.0 to +10.0dB<br>–3.0 to +12.0dB | –2.0 to +8.0dB<br>–2.0 to +10.0dB<br>–3.0 to +12.0dB |
| Signal To C–Notched Noise Ratio   | $\geq 24\text{dB}$                                   | $\geq 24\text{dB}$                                   |
| Envelope Delay Distortion:<br>804 to 2604Hz                                   | 1750 $\mu\text{sec}$                                 | 1750 $\mu\text{sec}$                                 |
| Intermodulation Distortion:<br>R2<br>R3                                       | $\geq 27\text{dB}$<br>$\geq 32\text{dB}$             | $\geq 25\text{dB}$<br>$\geq 30\text{dB}$             |
| Phase Jitter:<br>20 to 300Hz<br>4 to 300Hz                                    | $\leq 10\text{ Degrees}$<br>$\leq 15\text{ Degrees}$ | $\leq 25\text{ Degrees}$<br>$\leq 30\text{ Degrees}$ |
| Frequency Shift   | $\pm 3\text{Hz}$                                     | $\pm 5\text{Hz}$                                     |



## Location of Telephone Line Connections

### Wireline Connector

When 4-wire (2 line) telephone connections are required, Line 1 and Line 2 are provided through the 4-position wire wrap terminal connector. Table 10 provides a description of the Wireline connector line pair assignments.

Table 10. Wireline Connector Line Pair Assignments

| Line Pair | Functionality   |
|-----------|---|
| 1 +/–     | Tx wireline input for 4 wire configuration.<br>Input level is programmable by RSS between 0 dBm to –50 dBm.<br>Do not use this line pair for 2 wire wireline configuration.         |
| 2 +/–     | Rx wireline output for 4 wire configuration.<br>Output level is programmable between +7 dBm to –20 dBm for 100% deviation.<br>Use this line pair for 2 wire wireline configuration. |

Connector 4 has 8 holes:

- the round holes are for wire insertion, and
- the square holes are for insert release.

This wire-trap terminal connector accepts only 0.52 sq mm (20 AWG) to 0.2 sq mm (24 AWG); solid wire **or** stranded wire with a tin topcoat. Wires inserted into the connector should be stripped to length 9.53 mm (0.375 in).

As a removal release tool, use either:

- a stripped wire of any of above sizes, or
- the Wireline connector tool, part number 6600809D00.



**CAUTION**

**Before applying excessive pullout force on the telephone connection wires, be sure to release wires properly.**

### System Connector

When 8-wire (4 line) telephone connections are required:

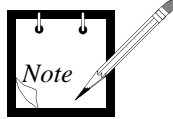
- Line 1 and Line 2 are provided through the 4-terminal Telephone connector.
- Line 3 and Line 4 are provided through the System connector.

The location of the Telephone and System connectors on the station rear panel is shown in Figure 9.

Table 4 describes the System connector pin assignments for Line Pairs 3 and 4.

## System Type vs. Wireline Circuit

Table 11 shows which of the four (4) wireline circuits to use for various system types.

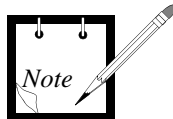


Stations equipped with a 4-wire Wireline Interface can support a single 4-wire or a single 2-wire telephone line connection.

Stations equipped with an 8-wire Wireline Interface can for example support a two 4-wire or a single 2-wire telephone line connection.

Table 11. System Types vs. Wireline Circuit Matrix

| System Type                                     | Line 1<br>(Note i)    | Line 2<br>(Note i) | Line 3     | Line 4     |
|---|-----------------------|--------------------|------------|------------|
| Conventional Local Area Analog                  | Console               | Console            | Not used   | Not used   |
| Conventional Wide Area Analog                   | Comparator or Console | Comparator         | Not used   | Not used   |
| Trunked Local Area Clear, without CPI           | CIT                   | CIT                | Not used   | Not used   |
| Trunked Local Area Clear, with CPI              | Console               | Console            | CIT        | CIT        |
| Trunked Wide Area Clear without CPI             | Comparator            | Comparator         | Not used   | Not used   |
| Trunked Wide Area Clear, with CPI               | Console               | Console            | Comparator | Comparator |
| Trunked AMSS Clear                              | Comparator            | Comparator         | Not used   | Not used   |
| Redundant Trunking Clear, Wide Area without CPI | Comparator            | Comparator         | Not used   | Not used   |



- i) For 4-wire systems, Line 1 is transmit audio (landline to station), and Line 2 is receive audio (station to landline). For 2-wire systems, Line 2 is transmit and receive audio.
- ii) A CPI is a Console Priority Interface.; used in Trunking systems.  
A CIT is a Central Interconnect Terminal; used in Trunking systems.
- iii) Transmit audio with respect to consoles, comparators, CIT, and DVM modems are outputs.  
Transmit audio with respect to stations is an input.
- iv) Receive audio with respect to consoles, comparators, CIT, and DVM modems are inputs.  
Receive audio with respect to stations is an output.

---

## Station Maintenance Connections

Table 12 provides a description of the maintenance connections located on the front of the Station Control Module.

Table 12. Station Maintenance Connections on the SCM

| Connector Name                                     | Function   | Details  |
|--|--|--|
| 5/10MHz<br>External<br>Reference Signal<br>(J5603) | External<br>Reference signal<br>for internal<br>system clock | 5MHz or 10MHz external<br>reference may be used.<br>Select desired frequency through<br>RSS. High impedance input.<br>Minimum level is 1 Vpp for either<br>type of input. Maximum level<br>should not exceed 3 Vpp.  |
| Service Speaker<br>(P5601)                         | Output to Power<br>Voice speaker                             | Adjustable between 0 to 500mV<br>across 1 Kohm @60% system<br>deviation. Audio signal appears<br>between pins 3 and 4 on the<br>connector. Must use speaker type<br>HSN1000 via adapter cable<br>Part.No. 0185180U01.  |
| RSS (P5600)  | Serial Port  | For connection to serial port of a<br>computer via cable Part No.<br>3082056X02. The Radio Service<br>Software (RSS) application is run<br>on the computer.  |
| Microphone<br>(P5602)                              | Local Microphone<br>Input                                    | Use local microphone type<br>GMN6147 or equivalent.<br>Modulation sensitivity for 60%<br>system deviation is typically<br>300mV. This microphone should<br>be equipped with 3 control buttons<br>for speaker volume control, Rx.<br>monitor and Intercom control<br>functions. |

## 5

## POST INSTALLATION CHECKLIST

After the station equipment has been mechanically installed and all electrical connections have been made, power may now be applied and the station checked for proper operation.

---

**Applying Power**

Before applying power to the station, make sure all boards are securely seated in the appropriate connectors on the backplane and that all rf cables are securely connected.

Turn ON the circuit breaker controlling the ac outlet that is supplying power to the station Power Supply Module, or switch on the DC-supply to a station with a DC-only Power Supply Module.

**Changing Fuse**

To replace the station fuse:

1. Turn off station power at source (e.g., ac breaker).
2. Remove fuse cover plate located on the backplane shield by unscrewing one M4 screw.
3. Pull defective fuse carefully with small needle nose pliers.
4. Replace new fuse (part # 6583049X16) carefully with small needle nose pliers.

**CAUTION**

**For continued protection of the station against risk of fire, replace the fuse only with the same type and rating of fuse.**

5. Restore power to the station.

Verifying Proper Operation

Operation of the station can be verified by:

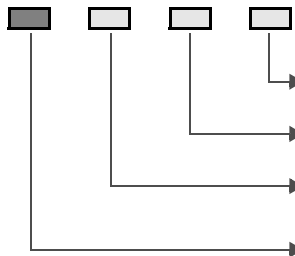
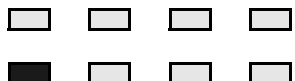
- observing the state of the 4 LEDs located on the front panel
- listening to audible alarms, and
- exercising radio operation.



Some station components can become extremely hot during station operation. Turn off all power to the station, and wait until sufficiently cool before touching the station.

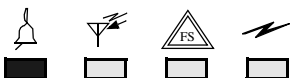
Front Panel LEDs

After turning the station power ON (or after a station reset), the 4 LEDs on the station front panel:



1. Are all lit for about 3 seconds to indicate that they are functional. The **Station Status** LED appears yellow since both the red and green LEDs of this bicolor indicator are lit at the same time.
2. All go off for about 15 seconds.
3. All stay off except for the **Station Status** LED which goes red for about 6 seconds.
4. Now indicate operational status of the station. The 4 LEDs indicate:
  - **PA Keyed** LED; green – station PA is keyed.
  - **FailSoft** LED; yellow – (if set up for trunking) station is not being controlled from the trunking central controller.
  - **Rx Active** LED; green – station is unsquelched.
  - **Station Status** LED; red/green – operational status of station.

Station Status LED



This two-color **Station Status** LED (i.e., red or green) indicates the following:

| LED Color | LED State            | Indicates that the...   |
|-----------|----------------------|---|
| Off       | Off                  | 5V power is not present   |
| Red       | On                   | Station is Not Operational – major failure                      |
| Red       | Flashing             | Station is Operational but Not Fully Functional – minor failure |
| Green     | On                   | Station is Operating Normally                                   |
| Red/Green | Alternately Flashing | Station is in Boot Mode   |
| Green     | Flashing             | Station is in Service Mode                                      |

A major failure renders the station unusable. These failure could be caused by one of the following conditions:

- Rx or Tx synthesizer out of lock
- PA failure,
- Sharp (i.e., 10dB) rf power cutback,
- self test failure



**A random flashing of the Station Status LED indicates major failure of the Station Control Module; since a control module reset turns the LEDs on.**

A minor failure limits the functionality of the station. These failures could be caused by one of the following conditions:

- ac source power failure
- exciter or receiver analog metering voltage degradation
- wireline loopback failure
- invalid local channel selection

Boot mode is the mode the station is in during the loading of software into the station's Flash memory.

Service mode is the mode the station is in during normal maintenance and service periods. These modes include the following conditions:

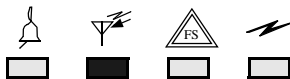
- Intercom
- Access Disable
- Power Control Disable
- PL Disable
- Failsoft Disable
- Service PTT

The Radio Service Software (RSS) can be used to determine which failure or service modes are active.



**Service mode indicates that the station is not fully functional.**

#### RX Active LED

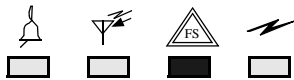


This **RX Active** LED indicates the following:

| LED Color | LED State | Indicates that the... |
|-----------|-----------|-----------------------|
| Green     | On        | Receiver is active.   |

This LED is lit when receive activation criteria (user defined) are satisfied; i.e., the radio is unsquelched.

FailSoft  
LED

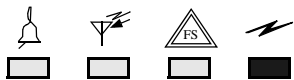


This **FailSoft** LED indicates the following:

| LED Color | LED State | Indicates that the ...                           |
|-----------|-----------|--|
| Yellow    | Flashing  | station is in the Trunking system Failsoft mode. |

This LED is lit when no activity is detected on the transmit data signal from the trunking central controller; the station is in Failsoft mode. This condition usually indicates a failed link to the trunking central controller.

PA Keyed  
LED



This **PA Keyed** LED indicates the following:

| LED Color | LED State | Indicates that the ...                         |
|-----------|-----------|--|
| Green     | On        | PA is keyed.                                   |
| Green     | Flashing  | PA is keyed, but operating with power cutback. |

Listening For Audible Alarms

With a Service Speaker connected to the station (see Station Operation, Service Connections), any active audible alarms can be heard.

| Alarm   | Sound               | Indicates that ...  |
|---------|---------------------|---|
| AC Fail | a single short beep | a station configured with DC-revert has detected an AC power failure. |
| PA Fail | two short beeps     | the station has been keyed, and the Power Amplifier has failed.       |

The audible alarms are repeated every 10 seconds. If more than one alarm is active, they are offset by 2 seconds.

Exercising Radio Operation

Operation of the station radio can be verified by exercising the radio’s two-way operation. This may be carried out when an external speaker and microphone are connected to the Station Control Module (SCM).

The kit # for the speaker is HSN1000. The external speaker requires an adaptor cable, part # 0185180U01.

**Using a speaker other than the recommended HSN1000 may result in the station blowing a fuse.**

The kit number for the microphone is GMN6147B.



---

# 6

## OPTIMIZATION

After the station and ancillary equipment have been mechanically installed, properly cabled, and power applied, the equipment must then be optimized; that is, before placing the station in operation. Optimizing is performed through the Radio Service Software (RSS), kit number RVN4148.

After the station is operational, the station's codeplug data must be copied to a PC- compatible computer.



**In order to program an MTR2000 station for Trunking operation, kit number RVN4148C (or later) of the RSS must be used. The current version is available through the U.S. and Canada Americas Aftermarket Division (AAD).**

---

### Optimizing Tasks

Optimization involves the following tasks:

1. Reading the station codeplug from the station (this ensures a match between the station serial number (resident in the codeplug) and the serial number (part of the customized station codeplug data) that is written back to the station (see task 5).
2. Customizing the station codeplug and saving the data to the station
3. Aligning the station for:
  - Rx Wireline
  - Tx Wireline
  - Receiver RSSI calibration (option)
  - Receiver Squelch Adjust
4. Performing post-optimization procedures.
5. Writing the customized codeplug to the station codeplug.

For details on these tasks, refer to the *Optimizing a New Installation* topic of the Radio Service Software (RSS) Online Help.

---

### Copying Station Codeplug Data To a PC-compatible Computer



**A copy of each station's codeplug data must be made on an IBM-PC compatible computer. This is done through the Radio Service Software (RSS). See the RSS Startup Manual, 68P81096E15.**



# 7

## INSTALLING STATION HARDWARE OPTIONS

When a station is ordered with an Antenna Relay or External Preselector option, the respective module is attached to the station when delivered.

When a station is ordered with an External Double Circulator option, this circulator is provided in a peripheral tray.

In the case where an option is later added to the station, it can be installed according to the information provided in the Ancillary Equipment sections of the appropriate Instruction manual. Also refer to the Troubleshooting section for information on tuning the External Preselector.



# STATION OPERATION

## 1

### DESCRIPTION

This section describes the LED indicators and connectors provided on the station.

The set of LEDs indicate the operational status of the station.

There are two sets of connectors for devices external to the station:

- One set connects to external devices to enable full operation of the station. These are located at the back of the station.
- Another set connects to external devices for servicing the station. These are located on the Station Control Module.

LED Indicators

A set of 4 LEDs is located on the station front panel. The position of the 4 LEDs on the front panel is shown in Figure 1. These LEDs indicate the status of the station during normal operation.

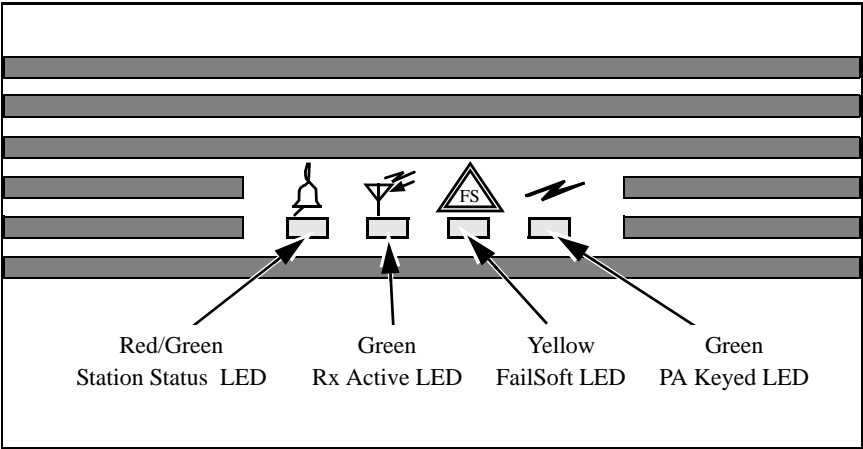






Figure 1. Front Panel LEDs

For further information on the states indicated by these LEDs, refer to the INSTALLATION section, Post Installation Checklist, Verifying Proper Operation.

|   | Function       | Color       | Indicates ...   |
|---|----------------|-------------|---|
|  | Station Status | red / green | ... operational status of station.  |
|  | Rx Active      | green       | ... that the station Rx activation criteria are satisfied. This could be:<br>- RF carrier only,<br>- PL/DPL only, or<br>- RF carrier plus PL/DPL. |
|  | FailSoft       | yellow      | ... (if set up for trunking) that the station is not being controlled from the trunking central controller.                                       |
|  | PA Keyed       | green       | ... that station PA is keyed.   |

---

## External Device Connections

Refer to INSTALLATION, Electrical Connections for the position of the station external connectors and line cord, located on the back panel.

A BNC connector on the front of the SCM allows the station to be connected to a 5 MHz or 10 MHz external reference signal.

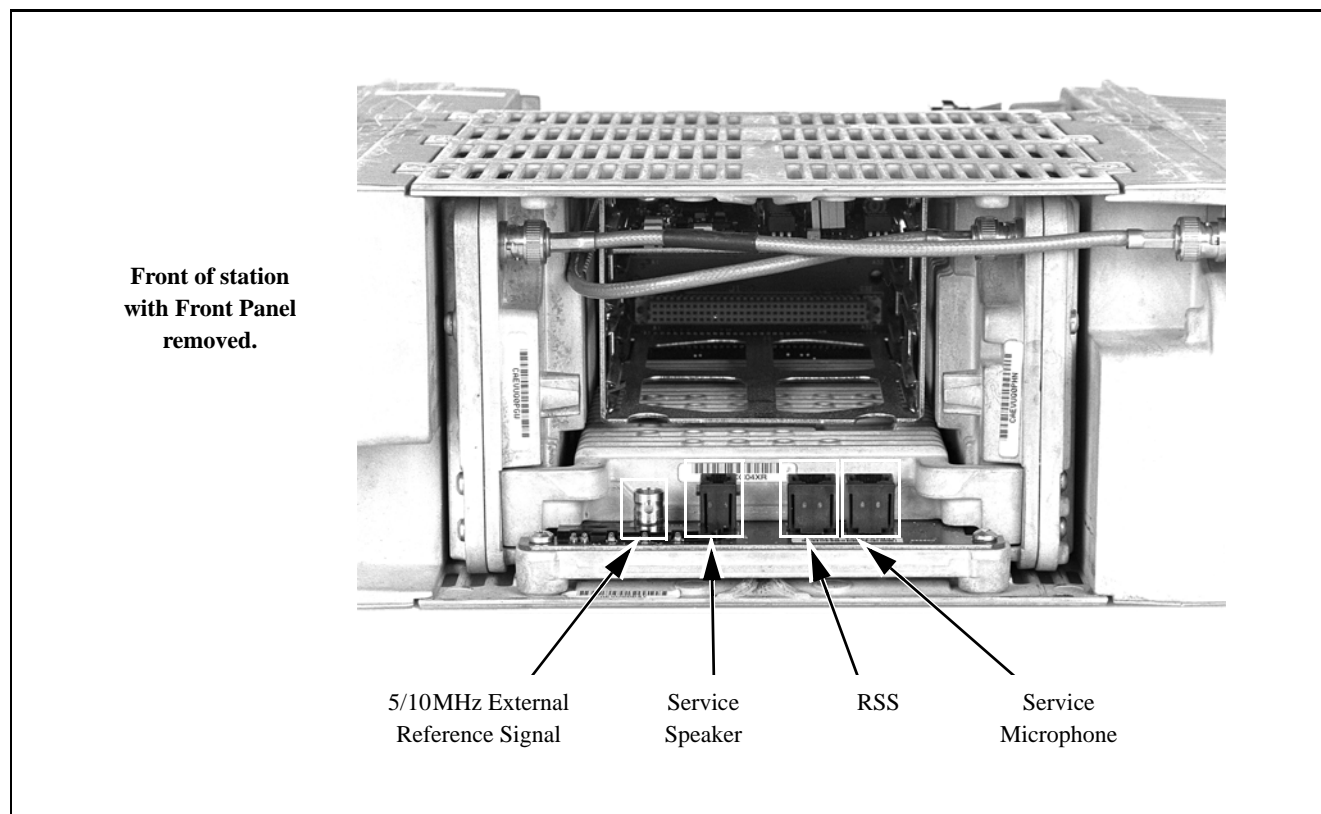
Figure 2 shows the position of the BNC connector on the SCM.

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## Service Connections

Service ports and LEDs are located on the front of the Station Control Module (SCM).

Figure 2 shows the position of the connectors on the SCM.



**Figure 2. SCM Connectors**

The service ports include connectors for:

- 5/10 MHz External Reference Signal
- Service Speaker:  
connects between the telephone connector on the Station Control Module and an external speaker/amplifier (with a 6 pin molex connector) via an adaptor cable; part number 0185180U01.
- RSS:  
connects between the telephone connector on the Station Control Module and the DB9 connector on a PC. A DB25 connector can also be used to connect to the PC, when used with a DB25-DB9 adaptor.
- Service Microphone:  
connects between the telephone connector on the Station Control Module and a service microphone.



# ROUTINE MAINTENANCE

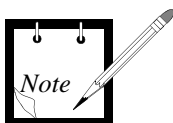
**For MTR2000 Station  
and Ancillary Equipment**

## 1

## INTRODUCTION

This section provides routine maintenance recommendations and procedures for the station and associated ancillary equipment.

### Routine Maintenance Overview



It is recommended that the station be cleaned with a soft dry cloth when the station is being serviced.

The station and ancillary equipment have been designed with state-of-the-art technology and operate under software control, thus requiring minimal routine maintenance. Virtually all station operating parameters are monitored and self-corrected by the Station Control Module, making virtually all periodic adjustments and tuning unnecessary.

Providing that the equipment is installed in an area which meets the specified environmental requirements (see Installation section, Pre-Installation Considerations for environmental specifications), the only routine maintenance task required is the calibration of the station reference oscillator circuit. Details are provided under the heading Calibrating Station Reference Oscillator.

2

RECOMMENDED TEST EQUIPMENT

The following list of test equipment is recommended to perform calibration of the station reference oscillator.

List of Test Equipment

- R2001 or R2600 Communications Analyzer with optional external frequency standard
- 2 portable radios (for the operating band) if available
- In-line wattmeter
- IBM PC (or 100% compatible) equipped with Microsoft Windows™ 3.1, 95, 98 or 2000, and Motorola Radio Service Software (RSS) application.

3

CALIBRATING STATION REFERENCE OSCILLATOR

The circuit devices responsible for determining the station reference frequency exhibit slight variations in their operating characteristics over time (“infant aging”). Approximately 90% of the component aging process occurs during the first year of operation. After the first year, the devices remain stable for a substantially longer period of time. Therefore, it is recommended that the station reference oscillator (internal) be calibrated after one year of operation, and thereafter less often; Table 1 provides a recommended schedule of periodic calibration.

Station Reference Calibration Schedule

After performing the initial one year calibration procedure, periodic calibration is required according to the schedule shown below. Note that the intervals are affected by the accuracy (in PPM) required either for regulatory compliance or by the system requirements, whichever is more stringent.

Table 1. Recommended Intervals for  
Calibrating Station Reference Oscillator  
(After Initial One-Year Calibration)

| Accuracy Desired/Required | Recommended Interval |
|---------------------------|----------------------|
| ±5 PPM                    | Every 4 years        |
| ±3.5 PPM                  | Every 2 years        |
| ±2 PPM                    | Once yearly          |

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## Station Reference Calibration Procedure

### Manual Alignment Procedure

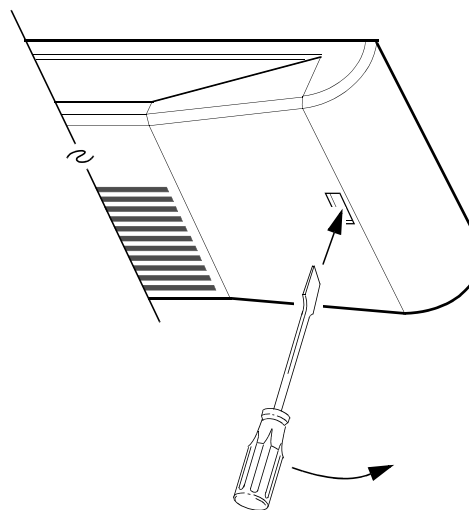
It is recommended that the frequency measurement equipment have an accuracy ten times greater than the accuracy required by the measurement. For example, if the frequency must be measured to within  $\pm 5$  PPM, the accuracy of the measurement equipment should be  $\pm 0.5$  PPM.

Perform the following procedure to calibrate the station reference oscillator circuitry.

1. Perform necessary setup for measuring transmitter frequency (typically an R2001 with external frequency standard).
2. Remove station front panel by inserting a small flat-blade screwdriver into one of two access holes at either end of the panel and, by carefully moving the handle of the screwdriver away from the center, release the front panel locking clip from the chassis and pull away the panel (refer to Figure 1).



**Some station components can become extremely hot during station operation. Turn off all power to the station, and wait until sufficiently cool before touching the station.**



**Figure 1. Front Panel Removal**

3. Connect IBM PC (or compatible) to RSS port connector located on the front of the Station Control Module (see RSS Startup Manual for details on making connection).



4. Launch the RSS application (under Microsoft Windows 3.1 , 95, 98 or 2000) and access the **Alignment** panel.

Refer to the RSS Startup Manual, 68P81096E15, for complete details on installing and starting the RSS application.

5. With the mouse, press the **PTT** button on the **Station Operation Controls** panel to key the station.
6. Adjust the reference oscillator slider (if necessary) by dragging it with the mouse while observing the frequency reading on the frequency measuring equipment. Continue adjustment until you obtain a reading as close as possible to the transmit frequency. (The RSS display indicates the current setting of the transmit frequency within the possible range. This graph is provided as a guide only and may not be used to adjust the frequency.)

### Auto-Calibrate Alignment Procedure (Standard SCM Only)

Perform the following procedure to calibrate the station reference oscillator using a 5/10 MHz external reference signal.



The accuracy of this procedure depends on the accuracy of the 5/10 MHz external reference signal. Be sure the 5/10 MHz external reference signal provides the necessary accuracy (as described in Table 1).

1. Connect the output of a stable 5/10 MHz reference source to the BNC connector located on the front of the Station Control Module.
2. Set the 5/10 MHz source for a  $1.0 \pm 0.5$  Vrms output. The Station Control Module senses the 5/10 MHz input and commences calibrating the reference oscillator using the 5/10 MHz signal as a reference.
3. Connect the station RSS port to a PC and start up the MTR2000 Radio Service Software application.
4. Within the RSS application, access the **Service** menu **Alignment** window. The Online Help associated with this window provides details for the following alignment functions:
  - Reference Oscillator
  - Audio Input/Output
  - Receiver
  - Transmitter



**MOTOROLA**

# **TROUBLESHOOTING**

**For MTR2000 VHF Station  
and Ancillary Equipment**

## **1**

## **INTRODUCTION**

This section provides troubleshooting recommendations and procedures for the VHF station and associated ancillary equipment.

### **Troubleshooting Overview**

The troubleshooting procedures and supporting diagrams provided in this section allow the service technician to isolate station faults to the Field Replaceable Unit (FRU) level. Defective FRUs are then replaced with known good ones to restore the station to proper operation.

Troubleshooting information includes:

- Troubleshooting flow charts
- Interpreting front panel LED indicators
- Module replacement procedures
- Post-repair procedures for performing alignment following replacement of defective modules.

## 2

## RECOMMENDED TEST EQUIPMENT

The following list of test equipment is recommended to perform troubleshooting procedures on the VHF station and ancillary equipment.

---

### List of Test Equipment

- Motorola R2001 or R2600 Communications Analyzer
- PC running Microsoft Windows<sup>™</sup> 3.1 or Windows<sup>™</sup> 95, and Radio Service Software (RSS)
- RSS cable; part #3082056X02
- In-Line Wattmeter (Motorola S-1350 or equivalent)
- Dummy Load (50  $\Omega$ , station wattage or higher)
- Microphone with PTT switch (GMN6147B or equivalent).
- Service speaker (HSN1000)
- Service Speaker adaptor cable; part # 0185180U01

**3****TROUBLESHOOTING PROCEDURES**

The troubleshooting and repair philosophy for the MTR2000 station and ancillary equipment is one of Field Replaceable Unit (FRU) substitution. The station comprises self-contained FRUs which, when determined to be faulty, may be replaced with known good FRUs to quickly bring the station back to normal operation. The faulty FRU must then be shipped to the Motorola System Support Center repair depot for further troubleshooting and repair to the component level.

Because the station is computer-controlled and employs state-of-the-art digital signal processing techniques, many of the troubleshooting procedures require the use of the Radio Service Software (RSS) application. The RSS is run on a PC (or compatible) with Microsoft Windows 3.1 or Windows<sup>™</sup> 95, and RS-232 communication port capabilities. The RSS allows the technician to run diagnostics, and set up the equipment for various audio and RF tests. Complete details on RSS operation are provided within the RSS application via Online Help facilities. The RSS Startup Manual (68P81096E15) provides complete details on installing and starting the RSS program.

---

## Troubleshooting Overview

### Introduction

Two procedures are provided for troubleshooting the station and ancillary equipment. Each procedure is designed to quickly identify faulty modules, which may then be replaced with known good modules to restore proper station operation.

### Procedure 1 – Routine Site Visit Functional Checkout

Procedure 1 consists of a quick series of non-intrusive tests performed during a routine site visit. This procedure allows the technician to verify the proper station operation without taking the station out of service. An overview of the procedure is shown in the flow chart of Figure 1.

### Procedure 2 – Troubleshooting A Reported/Suspected Problem

Procedure 2 should be used when an equipment problem has been either reported or is suspected. This procedure comprises both non-intrusive (equipment not taken out of service) and intrusive (requiring the equipment be temporarily taken out of service) tests that allow the technician to troubleshoot reported or suspected equipment malfunctions. An overview of the procedure is shown in the flow chart of Figure 2.



**Some station components can become extremely hot during station operation. Turn off all power to the station, and wait until sufficiently cool before touching the station.**

### How to Use These Troubleshooting Procedures

Perform the following basic steps in order to efficiently troubleshoot the station equipment.

1. Select the appropriate troubleshooting procedure flow chart (Procedure 1 or Procedure 2).
2. Perform the tasks given in the selected flow chart. Tasks requiring additional explanation are identified with an arrow (➞) and an appropriate reference. Locate the additional information, perform the tasks (if any), and return to the flow chart.
3. Once the faulty module has been identified, proceed to Module Replacement Procedures, Section 4.



**The station circuitry contains many CMOS and other static-sensitive devices. When servicing the equipment, take precautionary measures to prevent damage of station modules by static discharge. Refer to Anti-Static Precautions of Section 3 before servicing the station.**

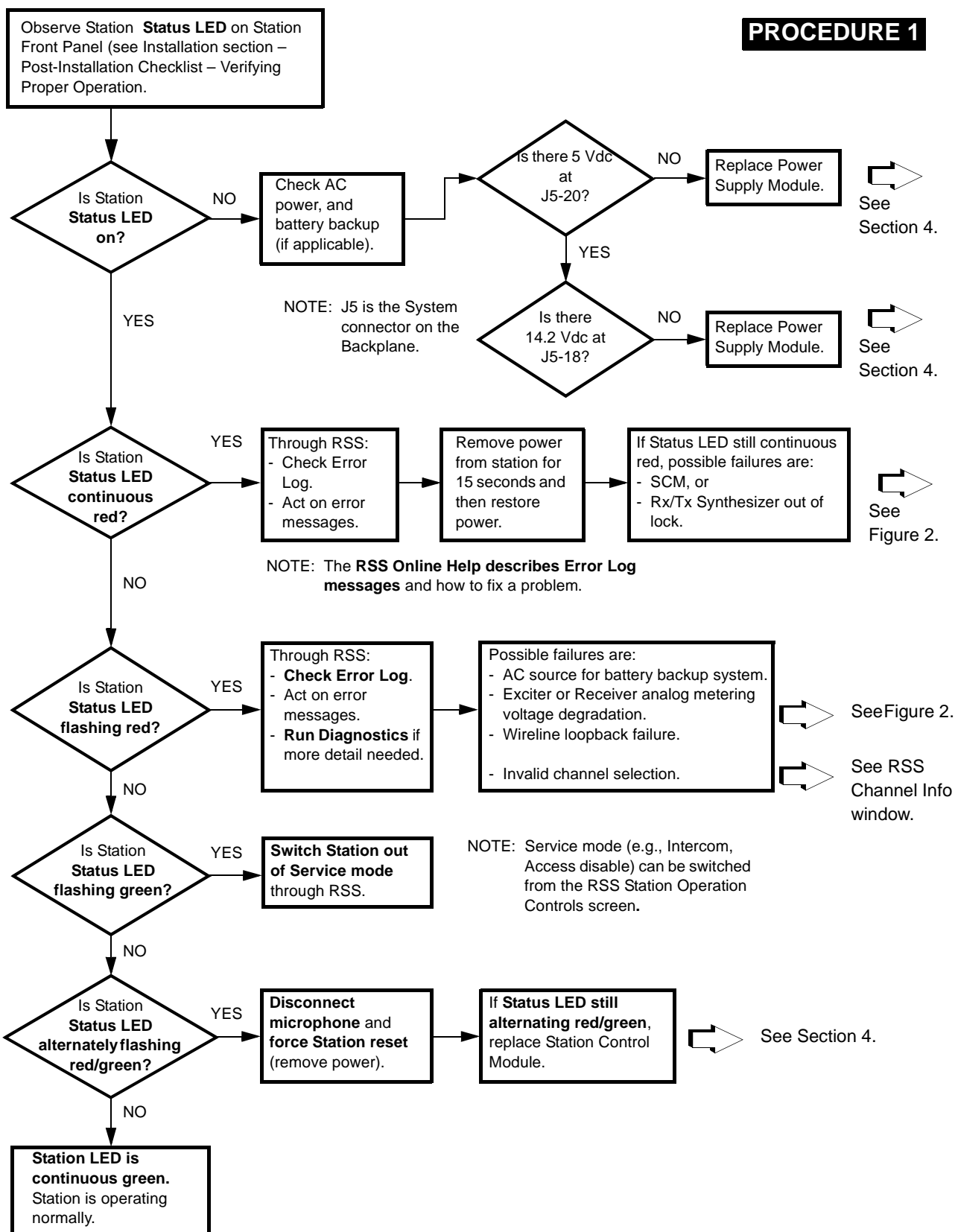


Figure 1. Procedure 1 – Routine Site Visit (Sheet 1 of 2)

**PROCEDURE 1**

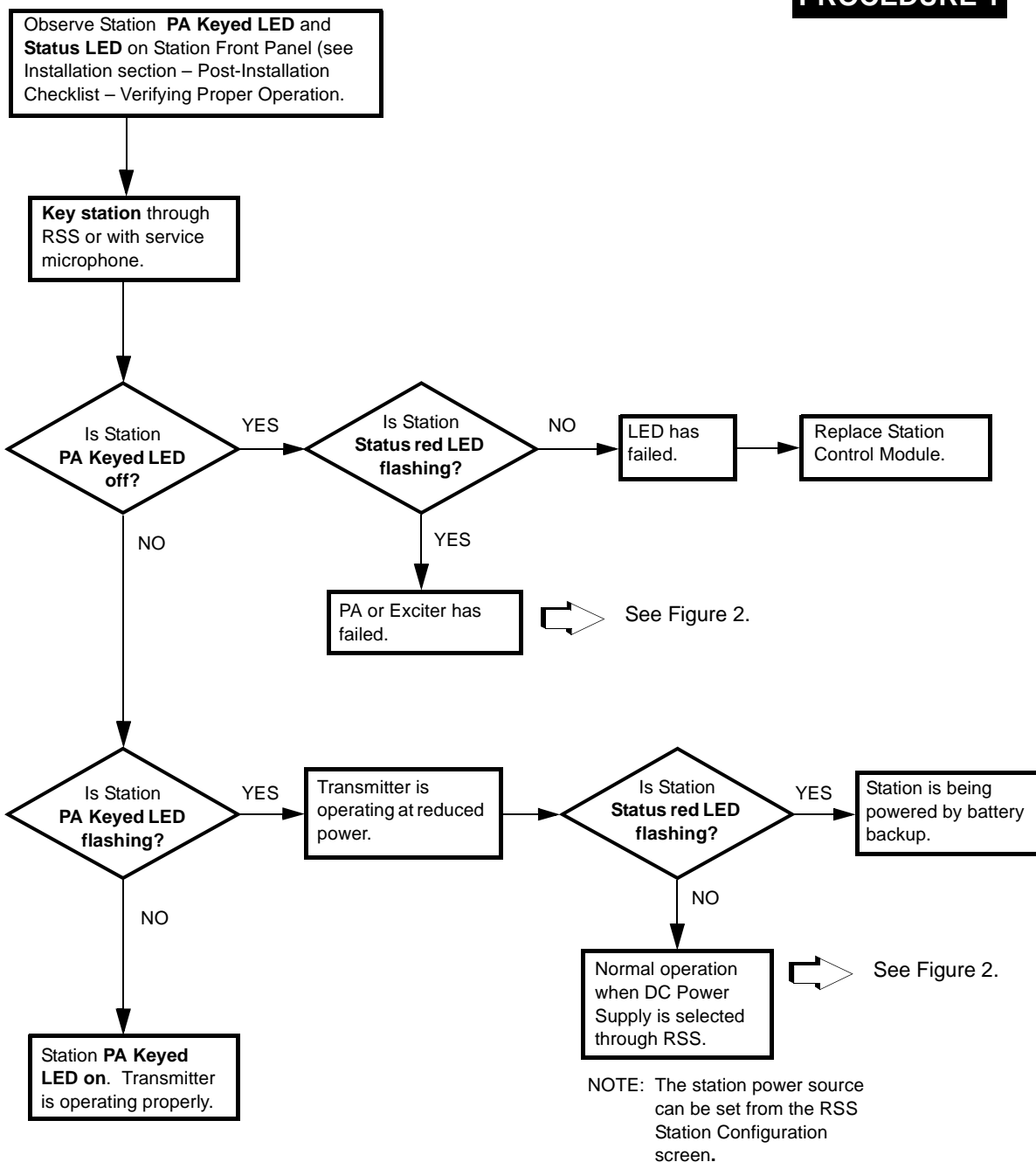
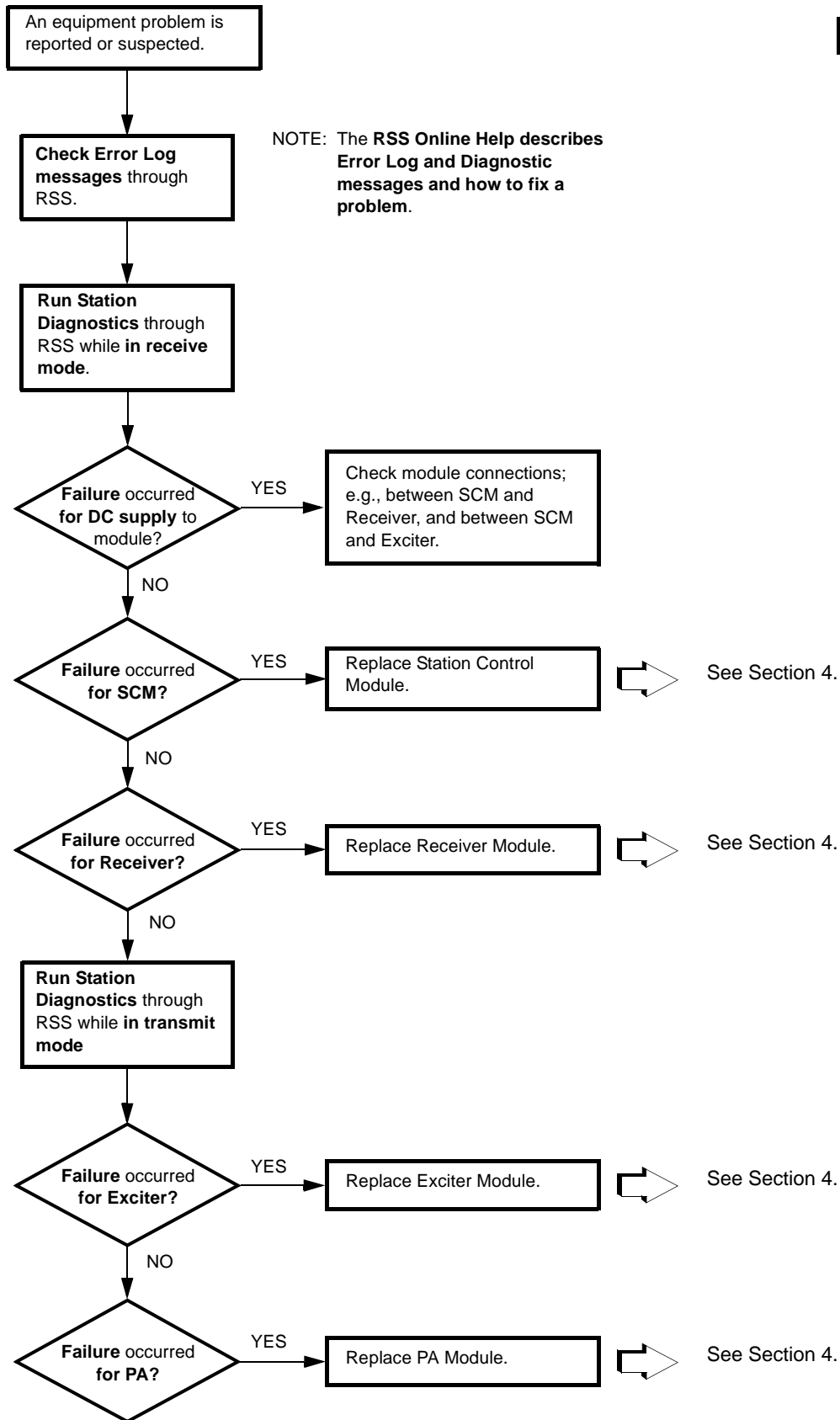


Figure 1. Procedure 1 – Routine Site Visit (Sheet 2 of 2)

**PROCEDURE 2**



**Figure 2. Procedure 2 – Station Troubleshooting**



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## Interpreting LED Indicators

Four LED indicators are provided on the front of the Station Control Module (viewable on the front panel) that indicate specific operating conditions. The service technician may observe these LEDs to obtain a quick status indication of the station equipment.

For information on the operating conditions indicated by these LEDs, refer to the INSTALLATION section, Post-Installation Checklist, Verifying Proper Operation.

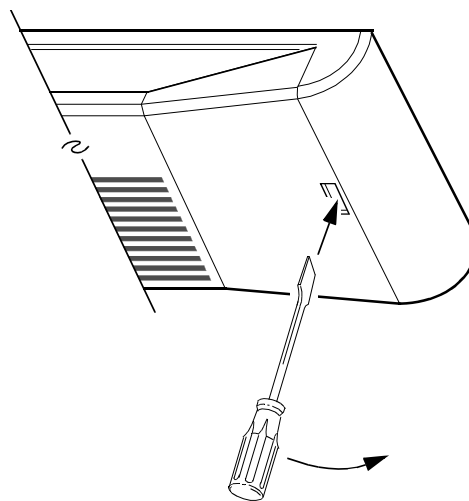
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## Removing/Replacing Station Front Panel

Connection of service aids (mic, speaker, etc.) or removal of any of the station modules or option cards necessitates first removing the front panel.

### Removal Procedure

Remove station front panel by inserting a small flat-blade screwdriver into one of two access holes at either end of the panel and, by carefully moving the handle of the screwdriver away from the center, release the front panel locking clip from the chassis and pull away the panel (refer to Figure 3).

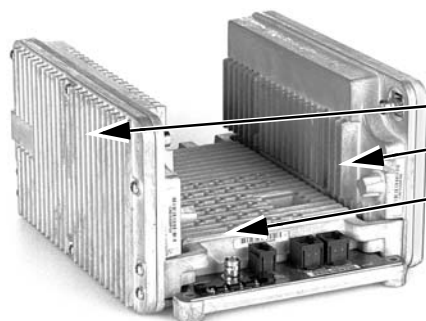


**Figure 3. Front Panel Removal**

### Replacement Procedure

Replace station front panel by inserting one of the front panel locking clips into corresponding latch on the station housing, and carefully pressing the panel on the opposite side until the second locking clip snaps into place.

## Accessing Station Control Cluster

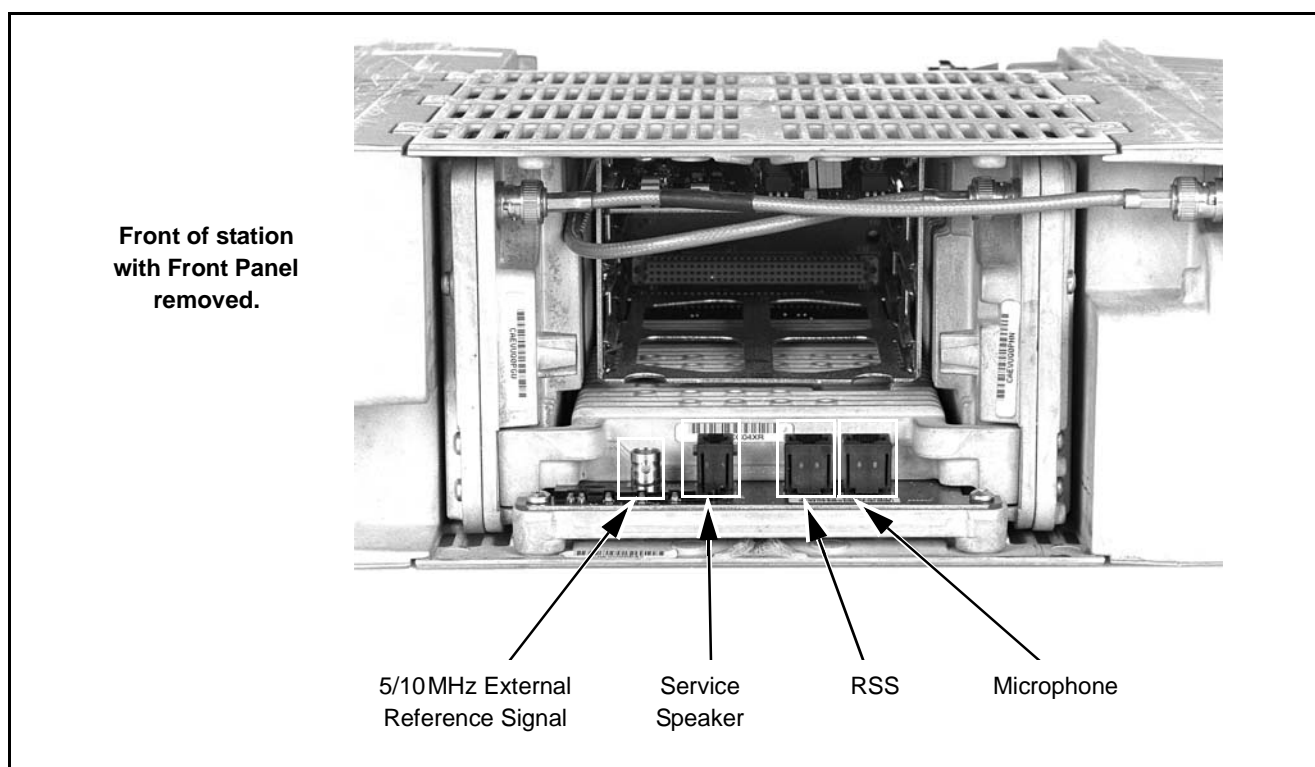


By removing the front panel, the station control cluster is accessible (refer to Figure 4). The station control cluster consists of the:

- Exciter Module
- Receiver Module
- Station Control Module (SCM)

Connectors on the Exciter and Receiver modules mate with connectors on either side of the SCM to form the control cluster. Service connectors are provided on the front of the SCM, including connectors for:

- RS-232 port (P5600),  
8-contact modular jack, provides connection to Serial Communications port on a PC running Radio Service Software (RSS)
- external speaker/amplifier (P5601),  
4-contact modular jack
- microphone (P5602),  
8-contact modular jack, and
- 5/10 MHz external reference input (J5603),  
BNC connector



**Figure 4. SCM Service Connectors**

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## Using the Service Mic

The Service mic buttons (see Figure 5) provide local control of station operation. All of these operating functions can also be controlled through the RSS (through the Station Control area of the Station Operation Controls window).

### Speaker Volume Control

To increase the speaker volume, press this button. Each button press increases the volume by one step (approximately 2 dB). There are 16 steps from the lowest volume level.

To set the speaker to the lowest volume, press and hold this button longer than 2 seconds.

The speaker volume cannot be decreased in steps. To lower the volume, reset the volume to the lowest setting and then increase it to the desired level.

### Monitor Button

To step through the sequence of station audio monitor modes, press this button. The selectable modes are:

- **Off** (no carrier squelch and no PL/DPL)  
Listen to the channel with the station unsquelched and PL/DPL disabled; that is, hear everything on the channel.
- **CSQ** (carrier squelch and no PL/DPL)  
If the station is already unsquelched (as determined by station codeplug value) then no change is heard when the CSQ mode is selected. This mode enables the station to operate in carrier squelch mode; that is, with PL/DPL disabled.
- **Normal** (carrier squelch and PL/DPL set by codeplug)  
Listen to normal radio audio operation for the channel, which is determined by the station codeplug.

### Intercom On/Off Button

To toggle the Intercom mode, press this button. Intercom mode provides communication between the station and a Remote Controller (over a wireline connection).

When in Intercom mode (indicated by the Station Status LED flashing green), press the PTT button to communicate over the wireline without keying the transmitter

PTT / Intercom Button

The function controlled by this button depends on whether or not Intercom mode has been selected (see above button).

- When Intercom mode is not selected (i.e., off), key and dekey the station by pressing the PTT/Intercom button. To key the station transmitter, press this button. To dekey the station transmitter, release this button.

OR

- When Intercom mode is selected (i.e., on), press the PTT/Intercom button to talk over the wireline connection; the transmitter is not keyed.

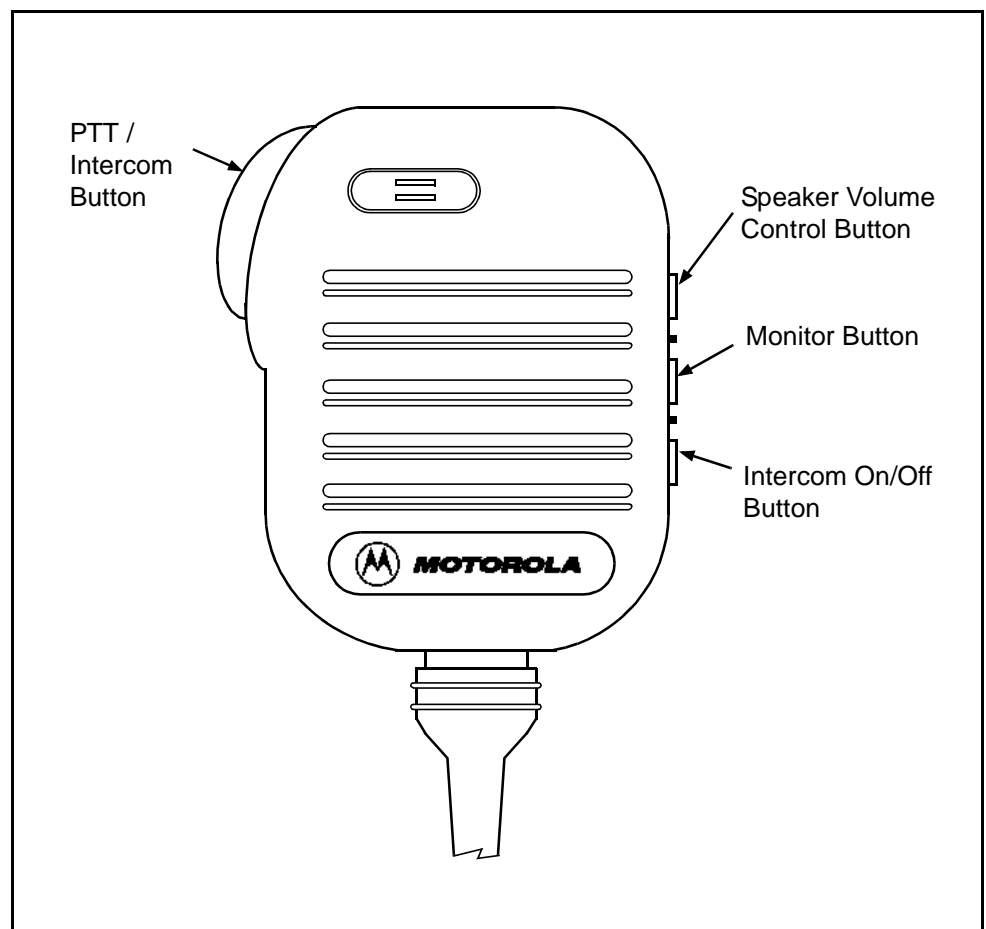


Figure 5. Service Mic Buttons

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## Verifying Transmitter Circuitry



Performing this procedure requires that the station be taken out of service. It is recommended that, unless the station is already out of service due to an equipment malfunction, this procedure be performed during off-peak hours so as to minimize the disruption of service to the system subscribers.

### Introduction

While most module faults can be detected by running the station diagnostics provided by the RSS, the following procedure provides a more traditional method of troubleshooting the transmitter circuitry. This procedure is useful in the event that the RSS is not at hand or for some reason cannot be utilized (PC malfunction, etc.).

This procedure allows the service technician to make minor adjustments and verify proper operation of the station transmit circuitry, including:

- Exciter Module
- Power Amplifier Module
- Power Supply Module
- Transmitter-related circuitry in the SCM
- Wireline Board

In general, the transmitter circuitry is exercised by injecting and measuring signals using a Motorola R2001 or R2600 Communications Analyzer (or equivalent). Incorrect measurement values indicate a faulty module(s); measurement values within the acceptable range verify proper operation of the above listed modules and circuitry.

### Required Test Equipment

The following test equipment is required to perform the procedure:

- Motorola R2001 or R2600 Communications Analyzer (or equivalent)
- Microphone with PTT switch (GMN6147B or equivalent)
- In-Line Wattmeter (Motorola Model S-1350 or equivalent)
- Dummy Load (50Ω, station wattage or higher)

## Verifying Transmitter Circuitry Procedure

1. Connect test equipment by performing Steps 1 to 5 shown in Figure 6.



In the following steps, suspected faulty modules are ranked in order of most to least likelihood.

2. Press the PTT button of the microphone and observe the **PA Keyed** LED indicator (DSG5602) on the Station Control Module.

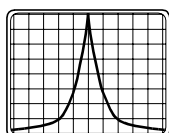


- If **PA Keyed** fails to light, suspect the following:

Faulty Power Amplifier Module  
 Faulty Exciter Module  
 Loose or bad Exciter-to-PA RF cable  
 Loose or bad PA-to-antenna RF output cable  
 Improperly terminated PA RF output cable  
 Faulty Station Control Module  
 Faulty Backplane  
 Faulty Antenna Relay

3. Measure output power by pressing the PTT button and observing reading on in-line wattmeter.

- If PA output not at proper power (as set for particular site), adjust the output power as described in the RSS online help.



4. If PA output power OK, set up R2001 or R2600 for spectrum analyzer display. Press the PTT button and observe the display. The display should show a single frequency carrier:

- If the display shows multiple carriers evenly spaced about the carrier, suspect a faulty Exciter module or PA module.
- If the display shows a solid carrier but off frequency, suspect the following:  
 Faulty Exciter or Station Control Module  
 Faulty external 5/10 MHz reference source (if used)
- If the display shows a single carrier moving erratically, suspect:  
 Faulty Station Control Module  
 Faulty Exciter Module

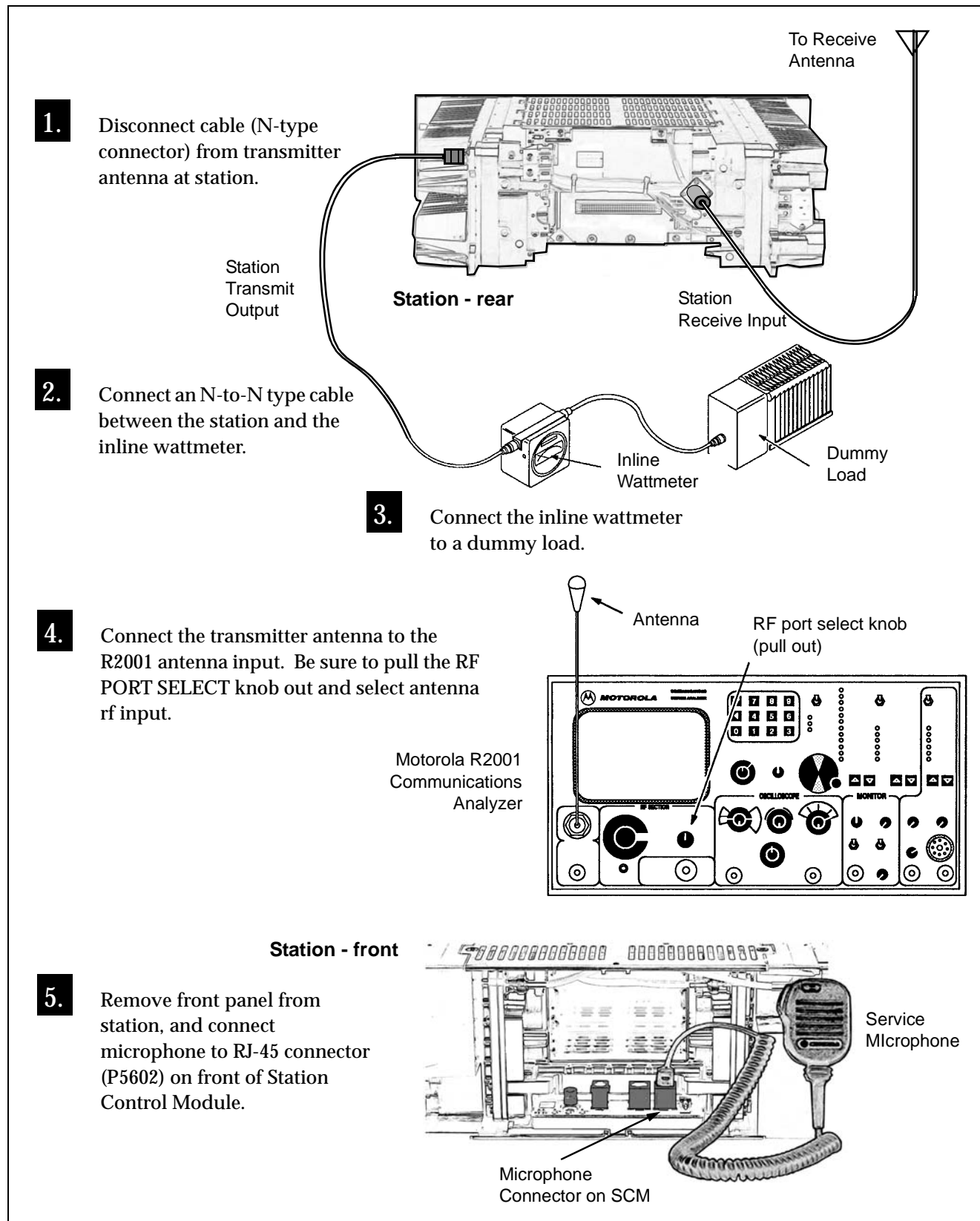
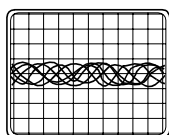


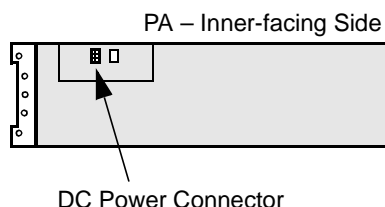
Figure 6. Test Equipment Setup for Verifying Transmitter Circuitry



5. If display OK, set up R2001 or R2600 to display modulation. Using the microphone, push the PTT button and speak into the microphone. Verify that the display shows an audio signal.
  - If proper display is not obtained, suspect faulty SCM or Exciter Module.
6. Set the R2001 or R2600 for GEN/MON MTR. Press the PTT button and speak loudly into the microphone to cause maximum deviation. Display should read:
  - $\pm 5$  kHz maximum for a 25 or 30 kHz system.
  - $\pm 4$  kHz maximum for a 20 kHz system.
  - $\pm 2.5$  kHz maximum for a 12.5 kHz system.
  - If proper display is not obtained, suspect faulty SCM or Exciter Module.
7. This completes the Verifying Transmitter Circuitry test procedure. If all displays and measurements are correct, the transmitter circuitry may be considered to be operating properly. Remove test equipment, restore the station to normal service, and return to the troubleshooting flow chart to resume troubleshooting sequence.

## Station Reset

In the event that the station repeatedly resets:



1. Disconnect dc power to PA and connect a load to the PA Module.
2. Power on the station.
3. If the station is not resetting, there is a problem with the PA.  
If the station is resetting, there is a problem with another module in the station.
4. Reconnect dc power to PA.
5. If the station is resetting, there is a problem with the PA.
6. If the station does not reset, key the station.
7. If the station is resetting, there is problem with the PA.  
If the station is not resetting, there is a problem with the antenna, feed line, or peripherals.



---

## Verifying Receiver Circuitry



Performing this procedure requires that the station be taken out of service. It is recommended that, unless the station is already out of service due to an equipment malfunction, this procedure be performed during off-peak hours so as to minimize the disruption of service to the system subscribers.



If the station operates as a repeater, the transmit output from the station must be connected to a dummy load to prevent over-the-air broadcast during receiver testing.

### Introduction

While most module faults can be detected by running the station diagnostics provided by the RSS, the following procedure provides a more traditional method of troubleshooting the receiver circuitry. This procedure is useful in the event that the RSS is not at hand or for some reason cannot be utilized (PC malfunction, etc.).

This procedure allows the service technician to make minor adjustments and verify proper operation of the station receive circuitry, including:

- Receiver Module
- Power Supply Module
- Station Control Module

In general, the receiver circuitry is exercised by injecting and measuring signals using a Motorola R2001 or R2600 Communications Analyzer (or equivalent). Incorrect measurement values indicate a faulty module(s); measurement values within the acceptable range verify proper operation of the above listed modules and circuitry.

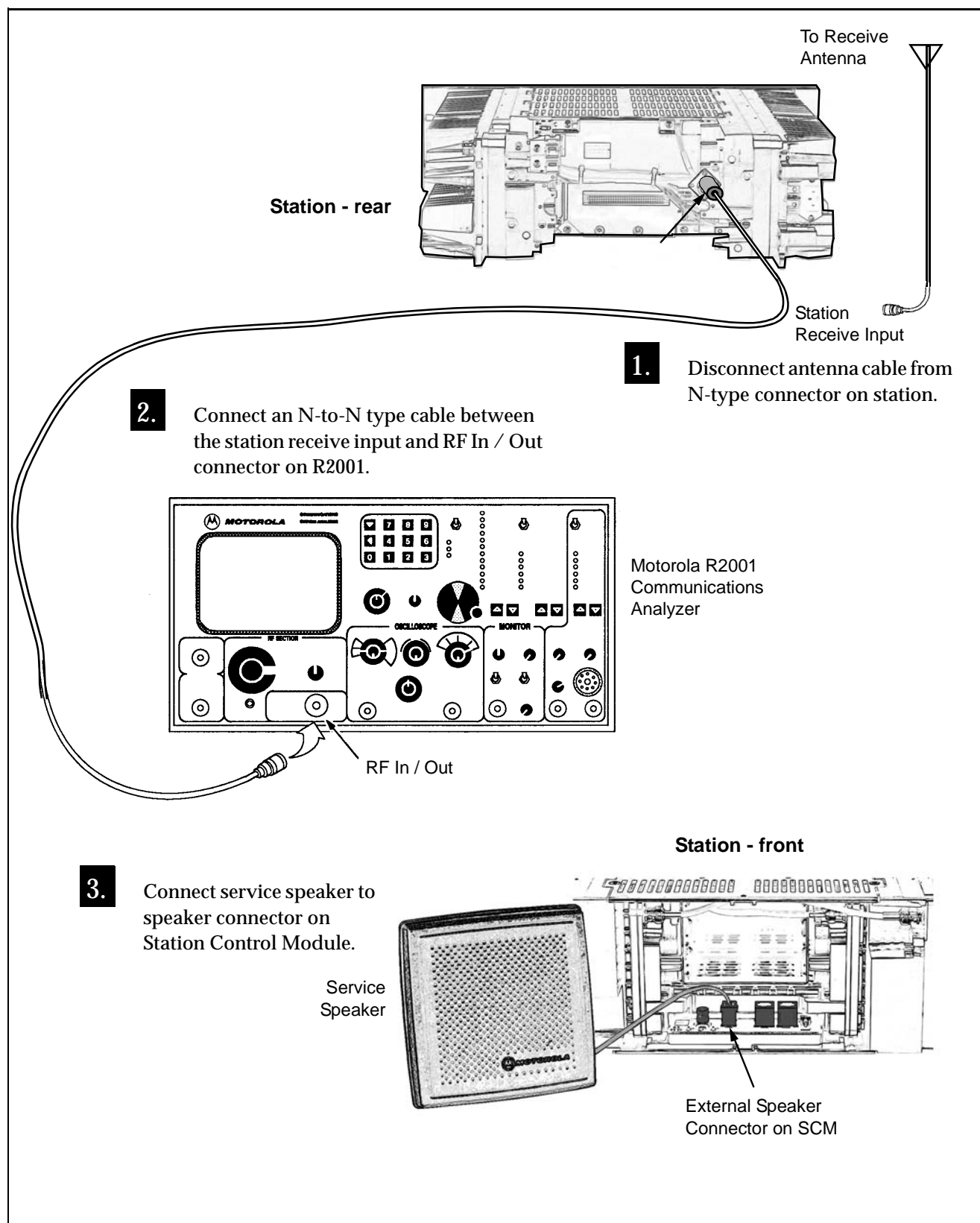
### Required Test Equipment

The following test equipment is required to perform the procedure:

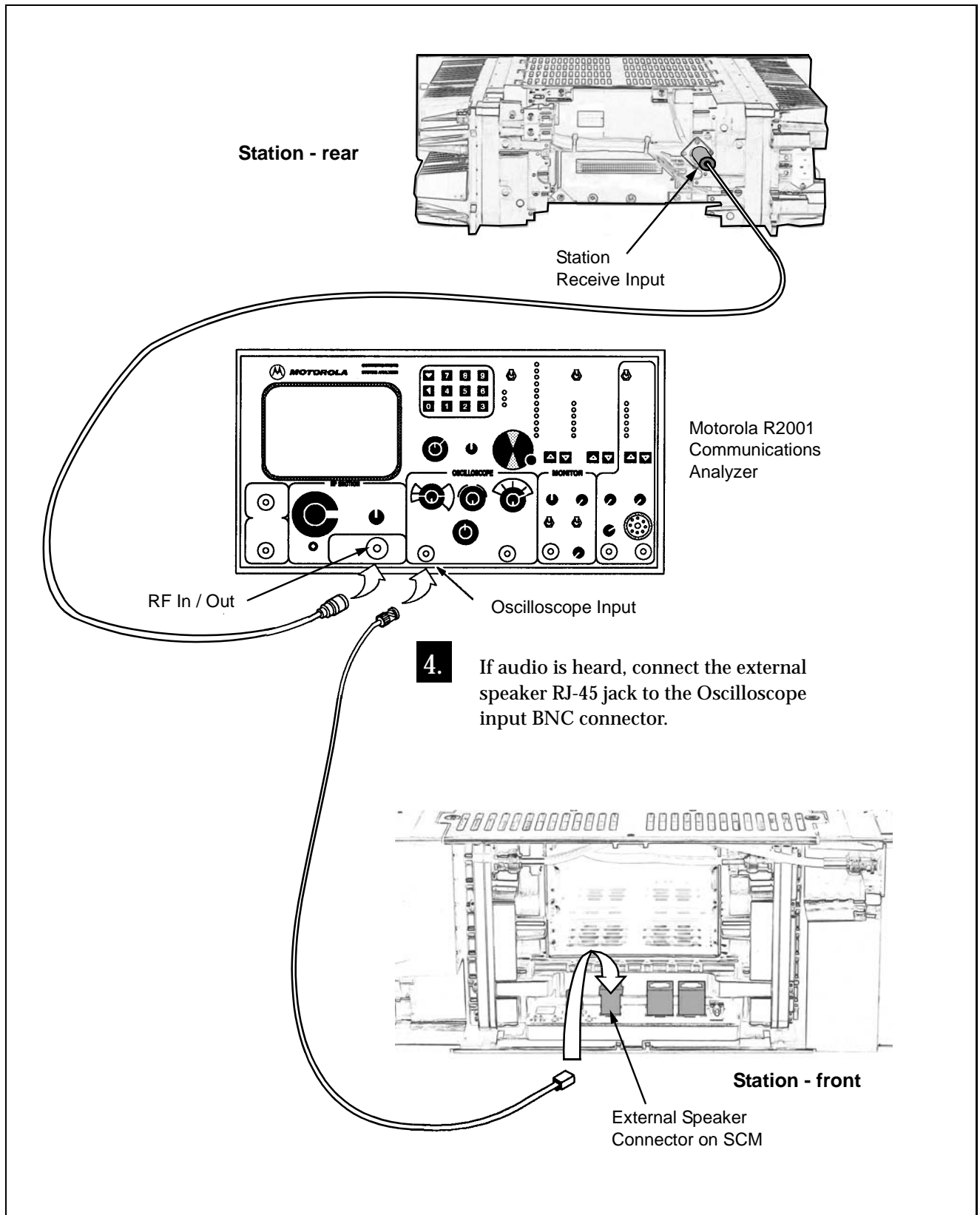
- Motorola R2001 or R2600 Communications Analyzer (or equivalent)
- Male N-type to Male N-type coaxial cable
- RJ-45 to BNC 15cm (6 inch) cable; part # 3083191X02
- Service Speaker; part # HSN1000
- Service Speaker adaptor cable; part # 0185180U01
- Dummy Load (50Ω, station wattage or higher) required for repeater stations only

## Verifying Receiver Circuitry Procedure

1. Connect test equipment by performing Steps 1 to 3 shown in Figure 7.
2. Using the RSS, disable PL and unsquelch the Receiver such that noise is heard through the external speaker. If no audio is heard, suspect the following:
  - Faulty Receiver Module
  - Faulty Station Control Module
  - R2001 or R2600 is outputting a carrier signal without modulation
3. Set R2001 or R2600 to generate a 0.5  $\mu\text{V}$  (-113 dBm) FM signal at the receiver frequency, modulated by a 1 kHz tone at 3 kHz deviation for 25 /30 kHz channel spacing. The 1 kHz tone should be audible through the external speaker. If no audio is heard, suspect the following:
  - Faulty Receiver Module
  - Faulty antenna-to-Receiver preselector RF cable (for station with external metal preselector)
  - Faulty R2001- or R2600-to-station RF cable
  - Faulty Antenna Relay
4. If audio is heard, connect the external speaker RJ-45 jack to the Oscilloscope input BNC connector, as shown in step 4 of Figure 7.
5. Using the RSS or Servie mic, increase the audio volume to maximum. Measure the audio level using the R2001 or R2600.
  - Audio level should measure approximately 0.75 to 1.5 Vpp. If not, suspect faulty SCM.
6. Change R2001 or R2600 injection signal level to 0.25  $\mu\text{V}$  (-119 dBm).
7. Measure the receiver 12 dB SINAD sensitivity. Set the signal strength of the communications analyser to the rated sensitivity of -116 dBm (0.35  $\mu\text{V}$ ).
  - If the SINAD level is less than 12 dB, suspect faulty Receiver Module or SCM.
8. This completes the Verifying Receiver Circuitry test procedure. If all displays and measurements are correct, the receiver circuitry may be considered to be operating properly. Remove test equipment, restore the station to normal service, and return to the troubleshooting flow chart to resume troubleshooting sequence.



**Figure 7. Test Equipment Setup for Verifying Receiver Circuit**



**Figure 7. Test Equipment Setup for Verifying Receiver Circuit (Continued)**

# 4

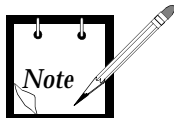
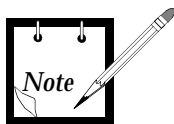
## MODULE REPLACEMENT PROCEDURES

Station modules suspected of being faulty must be replaced with known good modules to restore the station to proper operation. The following procedures provide instructions for replacing each of the station modules and performing any required post-replacement adjustments or programming.

### General Replacement Procedures



#### IMPORTANT



**DO NOT insert or remove station modules with power applied. This may result in damage to the modules. Always turn off the station by removing the source of ac power (and battery backup power, if used) before inserting or removing modules.**

**MTR2000 modules are not field-repairable.** Contact the System Support Center at the phone number listed in the first section of this manual for information on obtaining replacement modules.

**All screws used in the station are T-20 Torx-head screws, unless otherwise noted.**

### Anti-Static Precaution

The station circuitry contains many CMOS and other static-sensitive devices. When servicing the equipment, you must take precautionary steps to prevent damage to the modules from static discharge. Complete information on prevention of static protection is provided in Motorola publication 68P81106E84, available through Motorola Americas Parts Division (APD) or a local support Motorola facility (see the list of Motorola facilities in the front matter of this manual, under Service and Replacement Modules). Some additional precautions are as follows:

- Always wear a static-grounding wrist strap (Motorola Part No. RSX-4015A, or equivalent) while handling any station board or module to minimize static buildup. The static-grounding wrist strap is connected to the front-right handle of the station.
- Avoid touching conductive parts of any module with your hands.
- Avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) during service to minimize static buildup.
- Be sure to ground all electrically-powered test equipment. Connect a ground lead (–) from the test equipment to the module or board before connecting the test probe (+). When testing is complete, remove the test probe first, then remove the ground lead.

- All spare modules should be kept in a conductive bag for storage and transporting.
- When shipping modules to the repair depot, always pack in conductive material.



**When wearing a Conductive Wrist Strap, be careful near sources of high voltage. The low impedance provided by the wrist strap also increases the danger of lethal shock from accidentally touching high voltage sources.**

### Care of Gold-Plated Connector Contacts

The connections between the modules and the station backplane board are made with gold-plated connector contacts to provide maximum reliability. Gold-plated materials do not form a non-conductive oxide layer, and therefore should not require cleaning under normal conditions.

When the modules have been subjected to many extraction/insertion cycles, or if the station is operated in a dusty environment, the contacts may require cleaning. Do not use an eraser or any type of abrasive substance to clean either the module or backplane connector contacts. Any type of abrasive cleaning (typically employed for cleaning non gold-plated contacts) can result in the removal of the gold plating or bending of the connector contacts.

If cleaning of the gold-plated contacts is required, use a soft cloth dampened with alcohol to lightly wipe the contacts. Be sure not to touch the contact surfaces with your fingers, as finger oils and salts can contaminate the contact surfaces.



### Power Down Station Before Removing/Inserting Modules

Before removing or inserting the station cluster or an option module into the station to engage the backplane connector, be sure to turn off the station power by turning off the breaker at the ac source, or disconnecting the station ac line cord.



**If the station is equipped with battery backup, disconnecting the station ac line cord will not turn the station off. You must also disconnect the battery backup cable from the station power supply module. Remember to reconnect the battery cable before restoring the station to operation.**

### Front Panel Removal

Removal of any of the station modules or option cards necessitates first removing the front panel, as detailed in Section 3, Removing/Replacing Station Front Panel.

## Validating Repairs

After replacing a faulty module with a known good module, perform one of the following tests to validate the repair before leaving the site.

- If the faulty module was detected as the result of running station diagnostics via the RSS, run the diagnostics again after the repair is made to ensure that the replacement module passes all diagnostic tests.
- If the faulty module was detected by an operational failure, perform the operation to ensure that the repair corrected the reported/detected failure.

## Replacing Fans

If a fan on a 500 W Power Supply Module or on a high power Power Amplifier fails, it can be replaced without having to exchange the entire module. The fan can be ordered with part number 59-83663R09.

The procedure is:

1. Turn off station power by turning off breaker at ac source.
2. Remove screws (4) securing fan to PA or Power Supply casting.
3. Unplug fan electrical power connector.
4. Lift the fan away from the casting (the electrical power connector will detach when the fan is lifted).
5. Ensure that the correct fan is being installed.
6. Position the fan on the casting.
7. Push the power connector into the plug in the casting.
8. Secure the fan to the casting with the 4 screws.
9. Restore power to the station.

## Replacing Fuses

The procedure is:

1. Turn off station power from source (e.g., ac breaker).
2. Remove fuse cover plate located on the backplane shield by unscrewing one M4 screw.
3. Pull defective fuse carefully with small needle nose pliers.
4. Replace new fuse (part # 6583049X16) carefully with small needle nose pliers.

**For continued protection of the station against risk of fire, replace the fuse only with the same type and rating of fuse.**

5. Restore power to the station.



**IMPORTANT**

---

## Ordering Replacement Modules

All FRU Modules are ordered through the Americas Parts Division or another appropriate facility (see Service and Replacement Modules in front of this manual).

---

## Replacing Power Amplifier Module

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. If station is equipped with an external preselector, label and disconnect corresponding RF coax cables to preselector and remove screws securing preselector to station.
3. Label and disconnect all cables, as follows:
  - RF output coax cable to antenna port
  - RF input coax cable from Exciter Module
  - Control Cable (10-conductor ribbon cable which connects to J03)
  - PA Power Cable (6-conductor cable which connects to J02)
4. Remove screws securing battery backup connector to PA casting.
5. Remove the station from the rack, cabinet, or wallmount bracket (if so mounted).
6. Remove six screws securing top and bottom plates to PA casting and remove PA Module.
7. Ensure that the correct PA Module is being installed.
8. Install replacement PA Module.
  1. Line up holes in the PA casting with corresponding holes in the top and bottom plates.
  2. Replace the screws according to the order indicated by the label numbers on the top and bottom plates; that is start with screw #1, positioned toward the front of the station.
  3. Reconnect all cables.
  4. Secure battery backup connector to PA casting.
9. If required, reinstall external preselector and reconnect all cables.
10. Restore power to the station.



11. Integrate the PA Module into the station.
  1. Access the appropriate RSS application screen through path:  
Service → Station Alignment → Transmitter → Power Amplifier.
  2. Enter the PA Module Calibration number into the appropriate data field. The Calibration number is printed on the label located on the front of the PA Module.

### **Post-Replacement Optimization Procedure**

Perform the Power Output alignment procedure located in the RSS Service menu online help facility.

---

## Replacing Power Supply Module

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. If station is equipped with an external preselector, label and disconnect corresponding RF coax cables to preselector and remove screws securing preselector to station.
3. If station is equipped with an antenna relay, disconnect control cable and remove screws securing relay to station.
4. Remove screws (2) securing battery backup connector to PA casting.
5. Label and disconnect all wires/cables, as follows:
  - PA Power Cable (6-conductor cable which routes power to PA)
  - Station Power Cable (8-conductor cable which routes power to backplane)
6. Remove six screws securing top and bottom plates to Power Supply casting and remove Power Supply Module.
7. Remove the station from the rack, cabinet, or wallmount bracket (if so mounted).
8. Ensure that the correct Power Supply Module is being installed.
9. Install replacement Power Supply Module.
  1. Line up holes in the PA casting with corresponding holes in the top and bottom plates.
  2. Replace the screws according to the order indicated by the label numbers on the top and bottom plates; that is start with screw #1, positioned toward the front of the station.
  3. Reconnect all cables.
  4. Secure battery backup connector to PA casting.
10. If required, reinstall external preselector and antenna relay, and reconnect all cables.
11. Restore power to the station.

### Post-Replacement Optimization Procedure

Replacement Power Supply Modules are factory aligned. Therefore, no post-replacement optimization is required for this module.

---

## Replacing Exciter Module

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. Remove the station control cluster:
  1. Remove module lock screws (2) from front of station control cluster.
  2. Disconnect BNC connectors on RF cables connecting PA Module to Exciter Module, and Receiver Module to Receive antenna port.
  3. By pulling forward on cluster pull tabs, carefully slide station control cluster out of station.
3. Remove screws (4) securing Exciter Module to cluster and disconnect Exciter Module from Station Control Module (SCM).
4. Ensure that the correct Exciter Module is being installed.
5. Install replacement Exciter Module by plugging module into connector on SCM, replacing screws (4), and sliding the cluster back into the station (along the guide rails) to mate with the connector on the backplane. (Do not slam the station control cluster against the backplane or push any harder than necessary to seat the connector.)
6. Install module lock screws (2) to front of station control cluster and reconnect the RF cables from the PA Module and the Receive antenna port to their respective modules.
7. Restore power to the station.

### Post-Replacement Optimization Procedure

1. Perform the TX Deviation Gain Adjust alignment procedure, located in the RSS Service menu online help facility. Access the RSS application screen through path Service → Station Alignment → Transmitter → Tx Deviation.
2. Perform the Reference Modulation alignment procedure, located in the RSS Service menu online help facility. Access the RSS application screen through path Service → Station Alignment → Transmitter → Ref. Modulation.

---

## Replacing Station Control Module

### Replacement Procedure

1. If the Station Control Module (SCM) is capable of communicating with the RSS, connect the PC to the RSS port, start the RSS program, and save the codeplug from the station to a file on the PC hard disk. This will allow the codeplug information to be downloaded to the codeplug located on the replacement SCM. If the module cannot communicate with the RSS, an archive file (if present on hard disk) of the particular codeplug may be downloaded. If no archive codeplug file exists, you must program the codeplug as described in the RSS online help facility.
2. Turn off station power by turning off breaker at ac source.
3. Remove the station control cluster:
  1. Remove module lock screws (2) from front of station control cluster.
  2. Disconnect BNC connectors on RF cables connecting PA Module to Exciter Module, and Receiver Module to Receive antenna port.
  3. By pulling forward on cluster pull tabs, carefully slide station control cluster out of station.
4. Remove screws (4) securing Exciter Module, and screws (4) securing Receiver Module to the SCM, and disconnect both modules from the SCM.
5. Ensure that the correct Station Control Module is being installed.
6. Install replacement Station Control Module by plugging Exciter Module and Receiver Module into respective connectors on new SCM, replacing screws, and sliding the cluster back into the station (along the guide rails) to mate with the connector on the backplane. (Do not slam the station control cluster against the backplane or push any harder than necessary to seat the connector.)
7. Install module lock screws (2) to front of station control cluster and reconnect the RF cables from the PA Module and the Receive antenna port to their respective modules.
8. Restore power to the station.

### Post-Replacement Optimization Procedure

1. Replacement Station Control Modules are shipped with default data programmed into the codeplug (Flash EPROM located on board). After replacing a Station Control Module, you must download codeplug data (unique to the particular station) to the replacement mod-

ule codeplug. Simply retrieve the file from your archive and follow the instructions in the RSS online help facility for saving data to the codeplug.

2. Calibrate the reference oscillator (station reference) by performing the procedure in the Routine Maintenance section of this manual.
3. Perform the TX Deviation Gain Adjust alignment procedure located in the RSS Service menu online help facility.
4. Perform the Reference Modulation alignment procedure located in the RSS Service menu online help facility.

---

## Replacing Receiver Module

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. Remove the station control cluster:
  1. Remove module lock screws (2) from front of station control cluster.
  2. Disconnect BNC connectors on RF cables connecting PA Module to Exciter Module, and Receiver Module to Receive antenna port.
  3. By pulling forward on cluster pull tabs, carefully slide station control cluster out of station.
3. Remove screws (4) securing Receiver Module to cluster and disconnect Receiver Module from Station Control Module (SCM).
4. Ensure that the correct Receiver Module is being installed.
5. Install replacement Receiver Module by plugging module into connector on SCM, replacing screws, and sliding the cluster back into the station (along the guide rails) to mate with the connector on the backplane. (Do not slam the station control cluster against the backplane or push any harder than necessary to seat the connector.)
6. Install module lock screws (2) to front of station control cluster and reconnect the RF cables from the PA Module and the Receive antenna port to their respective modules.
7. Restore power to the station.

### Post-Replacement Optimization Procedure

1. Perform the Squelch Adjust procedure and the RSSI alignment procedure (if applicable) located in the RSS Service menu online help facility.
2. If the station includes an external Preselector, perform the Preselector Field Tuning Procedure of this section.
3. Perform the Preselector Field Tuning Procedure for the internal varactor-tuned preselector of this section.

---

## Replacing External Preselector

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. Disconnect cable to Receive antenna connection and cable to Receiver Module.
3. Remove screws (2) securing External Preselector to back of station.
4. Ensure that the correct External Preselector is being installed.
5. Install replacement External Preselector by reconnecting the 2 cables and securing the External Preselector to the station with the 2 screws.
6. Restore power to the station.

### Post-Replacement Optimization Procedure

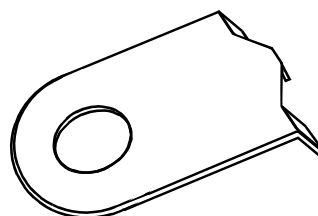
1. Perform the Preselector Field Tuning Procedure of this section.

---

## Replacing Wireline Interface Board

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. Ensure that an ESD cable is connected to the station.
3. Remove Wireline Interface Board from top option card slot by carefully pulling straight out from the station. Use the Option Card tool (part # 6683334X01) to pull the card out. Make sure that the board is placed on properly grounded anti-static surface.



4. Ensure that the correct Wireline Board is being installed.
5. Set all jumpers on replacement board to match those on the faulty board. These include input/output impedance matching jumpers (refer to Wireline Interface Board section of this manual for more information).
6. Install replacement Wireline Interface Board by sliding board into top option card slot, and firmly seating the board Euro-card connector into the mating backplane connector. (Do not slam the board against the backplane or push any harder than necessary to seat the connectors.)
7. Restore power to the station.

### Post-Replacement Optimization Procedure

1. Perform the Rx Wireline and Tx Wireline adjustment procedures located in the RSS Service menu online help facility. This includes selecting the 2-wire or 4-wire configuration. Ensure that the Wireline Board is aligned according to relevant leased line specifications.

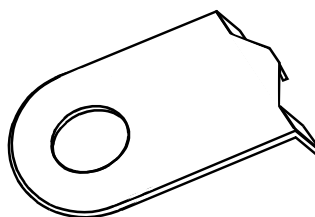


---

## Replacing Auxiliary I/O Board

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. Ensure that an ESD cable is connected to the station.
3. Remove Auxiliary I/O Board from middle (Option Card #1) or bottom (Option Card #2) card slot by carefully pulling straight out from the station. Use the Option Card tool (part # 6683334X01) to pull the card out. Make sure that the board is placed on properly grounded anti-static surface.



4. Ensure that the correct Auxiliary I/O Board is being installed.
5. Set all jumpers on replacement board to match those on the faulty board. Refer to Auxiliary I/O Board section of this manual for more information.
6. Install replacement Auxiliary I/O Board by sliding board into middle or bottom option card slot, and firmly seating the board Euro-card connector into the mating backplane connector. (Do not slam the board against the backplane or push any harder than necessary to seat the connectors.)
7. Restore power to the station.

### Post-Replacement Optimization Procedure

1. Perform the Auxiliary I/O adjustment procedures located in the RSS Service menu online help facility. Ensure that the Auxiliary I/O Board is aligned according to auxiliary equipment specifications.

---

## Replacing Backplane Board

### Replacement Procedure

1. Turn off station power by turning off breaker at ac source.
2. Remove all option boards from the option card slots as described in Replacing Wireline Interface Board. Make sure that all boards are placed on properly grounded anti-static surface.
3. Remove the station control cluster:
  1. Remove module lock screws (2) from front of station control cluster.
  2. Disconnect BNC connectors on RF cables connecting PA Module to Exciter Module, and Receiver Module to Receive antenna port.
  3. By pulling forward on cluster pull tabs, carefully slide station control cluster out of station.
4. If station is equipped with an external preselector, label and disconnect corresponding RF coax cables to preselector and remove screws securing preselector to station.
5. If station is equipped with an antenna relay, disconnect control cable and remove screws securing relay to station.
6. Remove ty-wraps securing battery backup cable and Power Supply-to-PA cable.
7. Label all cables/wirelines connected to the rear of the Backplane Board and disconnect all cables/wirelines.
8. Remove screws which secure the metal shield and backplane board to the top and bottom plates.
9. Remove the metal shield and backplane.
10. Ensure that the correct Backplane Board is being installed.
11. Install the replacement Backplane Board and metal shield using the screws removed previously, reconnect all cables, and reinstall all modules, boards and assemblies.

### Post-Replacement Optimization Procedure

Using the RSS, run a complete set of diagnostics to exercise all boards and modules.

# 5

## PRESELECTOR FIELD TUNING PROCEDURES

Depending on the configuration, the station may have an external preselector assembly, an internal preselector, or both. The external preselector assembly is a 5-pole bandpass filter equipped with tuning slugs to adjust the pass-band corresponding to the operating frequency(s) of the station. For the internal preselector, circuitry in the Receiver Module provides a varactor-tuned bandpass filter which adapts to the required frequency range under the control of the Station Control Module.

The external preselector must be retuned if the preselector assembly or Receiver Module are replaced in the field, or if the station operating frequency(s) are modified. The internal varactor-tuned preselector is factory-tuned to cover the relevant frequency band in its entirety, and is retuned only if the Receiver Module is replaced in the field or if there is a suspected problem with the Receiver alignment. The tuning procedures follows.



**IMPORTANT**

If the station has both an external preselector assembly and an internal varactor-tuned preselector which must be retuned, you must bypass the external preselector and retune the varactor-tuned preselector first, then reconnect the external preselector and retune it. Also, since this is a non-standard configuration, you can expect a slight degradation in the receiver sensitivity (approximately 1.5 dB) due to preselector insertion losses.

### External Preselector Tuning Procedure



**IMPORTANT**

Tuning for best SINAD response DOES NOT result in optimum tuning of the preselector assembly. You must use this field tuning procedure to obtain optimum preselector performance.

### Required Test Equipment

The following test equipment is required to properly tune the external preselector assembly:

- RF signal generator – Motorola R2600 or R2001 Communications Analyzer (see note below), or HP8656A signal generator (or equivalent)
- Dip/Peak Monitor – HP435B Power Meter (or equivalent) with HP8484A sensitive power head, Boonton Model 92E with BNC input, or R2001/R2600 using the spectrum analyzer function
- Torque driver capable of delivering 1.36Nm (12 in-lb) of torque and 10 mm deep well socket
- Tuning probe – Motorola Part No. 0180763D22, p/o TRN7799A
- Flat-blade screwdriver



The R2600 Communications Analyzer can both generate and measure simultaneously. The R2001 may be used for either the generator or the monitor function, but not both simultaneously. When using R2001 as the signal generator, the RF signal **must** be taken from the Antenna port.

## Calculating Proper Alignment Frequency

Use one of the following two methods to calculate the alignment frequency to be generated by the signal generator.



For stations which are equipped with both an external preselector and an internal varactor-tuned preselector, always tune the external preselector to an **actual receive frequency** after first tuning the varactor-tuned preselector (if required).

For stations with a **single receive frequency**, calculate the alignment frequency as follows:

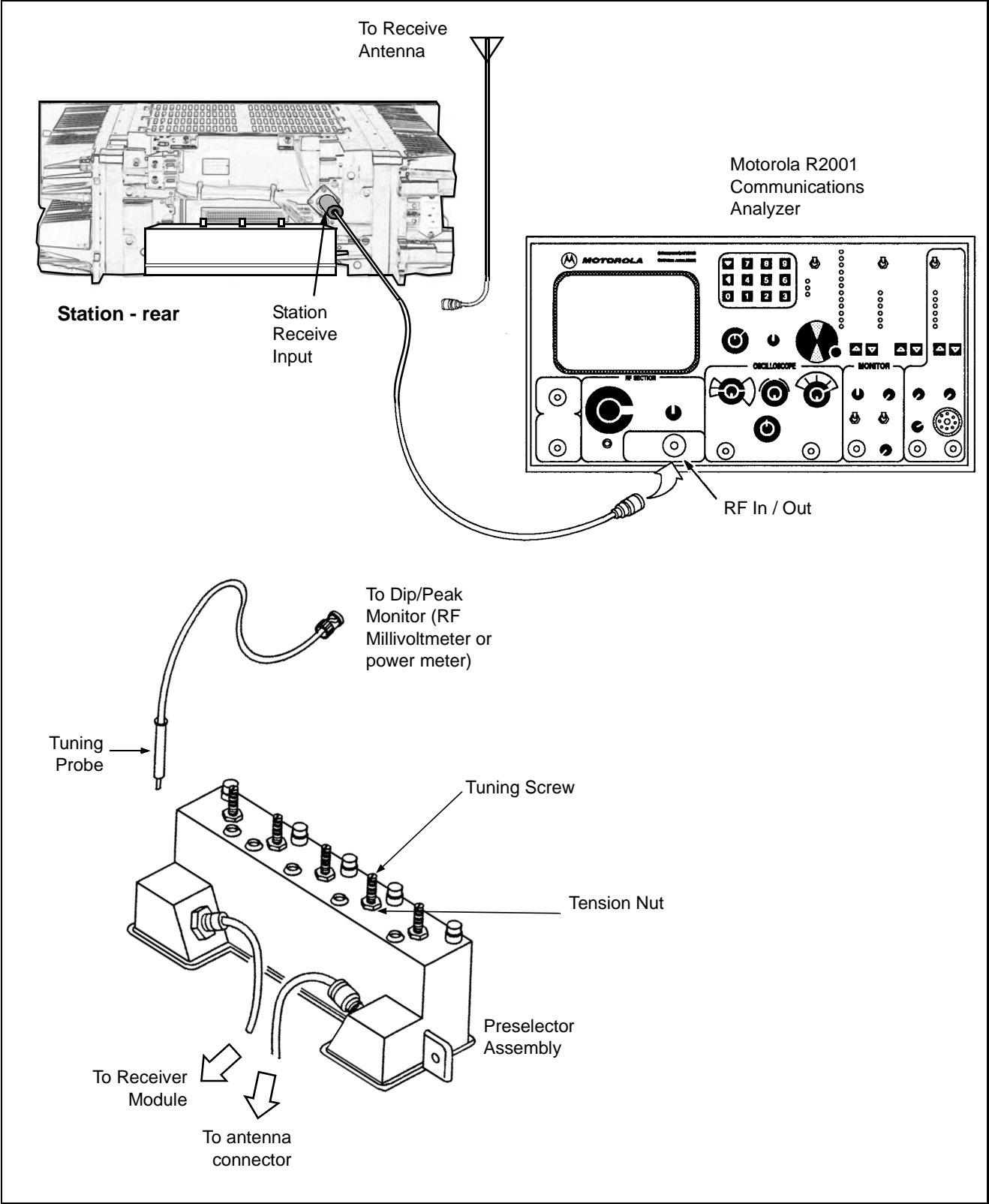
1. The station receive frequency is the midpoint frequency ( $F_{\text{mid}}$ ).
2. If the receive frequency is in the range of 132 to 150 MHz, determine the alignment frequency as follows:
  - If frequency (from Step 1) is  $\leq 148$  MHz, then:  
alignment frequency =  $F_{\text{mid}} - 250$  kHz
  - Otherwise, use actual frequency from Step 1 (see above note).
3. If the receive frequency is in the range of 150 to 174 MHz, determine the alignment frequency as follows:
  - If frequency (from Step 1) is  $\leq 156$  MHz, then:  
alignment frequency =  $F_{\text{mid}} - 250$  kHz
  - Otherwise, use actual frequency from Step 1 (see above note).

For stations with **multiple receive frequencies**, calculate the alignment frequency as follows:

1. Determine the midpoint ( $F_{\text{mid}}$ ) of the station receive frequency range.
2. Calculate a midpoint frequency as follows:
 
$$F_{\text{mid}} = (F_{\text{highest}} + F_{\text{lowest}}) \div 2$$
3. Using  $F_{\text{mid}}$  in place of the station receive frequency, perform Step 2 and Step 3 from previous procedure (i.e., calculation of alignment for single receive frequency).

### Preparing Equipment

1. Make sure the preselector assembly is connected to a functional Receiver Module.
2. Using the torque driver and deep well socket, loosen the five tension nuts on the adjustment screws.
3. Detune the preselector by turning the 5 tuning screws (see Figure 9) clockwise (Be careful not to apply more than 0.34Nm (3 in-lb) of torque to the tuning screws in order to prevent warping the preselector cover and housing):
  - for frequencies > 148 MHz (in the 132 to 150 MHz range), or frequencies > 156 MHz (in the 150 MHz to 174 MHz range), turn clockwise until they are 3 mm (0.125 in.) beyond the tension nut.
  - for frequencies ≤ 148 MHz (in the 132 to 150 MHz range), or frequencies ≤ 156 MHz (in the 150 MHz to 174 MHz range), turn clockwise until threaded portions are 19 mm (0.75 in.) beyond the tension nut.
4. Tighten the tension nuts to 0.68Nm (6 in-lb).
5. Connect the test equipment as shown in Figure 8.



**Figure 8. Test Equipment Setup for External Preselector Field Tuning**

## Tuning Procedure

1. Apply ac power to the station power supply (to provide an active 50  $\Omega$  termination).
2. Adjust the signal generator to the frequency calculated in the previous steps. Set the level to +5 dBm.

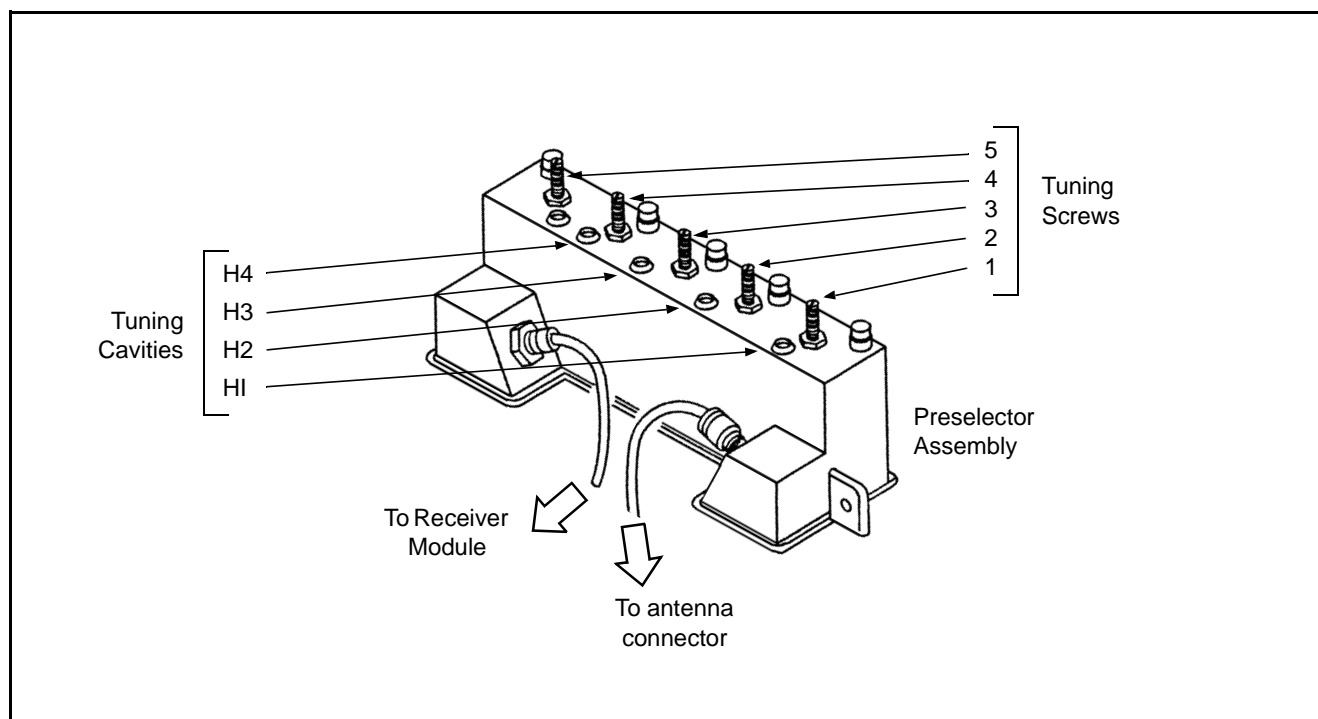


When tuning for a peak or dip, turn the tuning screw a 1/2 turn past the peak or dip to ensure that tuning is to a true peak or dip. Return the screw to the location of the peak or dip after verifying that it is a true peak or dip.

3. Insert tuning probe into cavity H1 (refer to Figure 9) and adjust tuning screw 1 for a **PEAK**.
4. Tighten tension nut on tuning screw 1 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 1 for a **PEAK**.
5. Keep tuning probe in cavity H1 and adjust tuning screw 2 for a **DIP**.
6. Tighten tension nut on tuning screw 2 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 2 for a **DIP**.
7. Insert tuning probe into cavity H2 and adjust tuning screw 3 for a **DIP**.
8. Tighten tension nut on tuning screw 3 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 3 for a **DIP**.
9. Insert tuning probe into cavity H3 and adjust tuning screw 4 for a **DIP**.
10. Tighten tension nut on tuning screw 4 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 4 for a **DIP**.
11. Insert tuning probe into cavity H4. Decrease output from signal generator to -5 dBm.
12. Adjust tuning screw 5 for a **DIP**.
13. Tighten tension nut on tuning screw 5 to at least 1.36Nm (12 in-lb) and fine tune tuning screw 5 for a **DIP**.

The dip of tuning screw 5 will not be as sharp as that for tuning screws 2, 3, and 4.

14. Turn tuning screw 5 counter-clockwise 6 mm (0.25 in.).

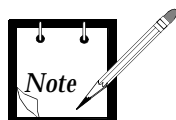


**Figure 9. Location of Tuning Screws and Cavity Probe Holes**

## Varactor-Tuned Preselector Tuning Procedure

The Receiver Module may contain a varactor-tuned preselector which must be retuned whenever the Receiver Module CLN1211 is replaced in the field. The tuning procedure requires application of an RF signal into the receiver and use of the RSS Service menu to set the high and low alignment values of the varactor-tuned preselector. Either the Received Signal Strength Indicator (RSSI) value (if available) or SINAD is read and peaked by changing the preselector alignment values via the RSS. The alignment values 132.025 MHz, 146.025 MHz, 160.025 MHz, and 173.975.025 MHz are stored in memory (within the Station Control Module).

These four alignment values are the only information required to interpolate the tuning voltage of the preselector to any frequency within the 132 to 174 MHz band. To retune this preselector, perform the Varactor-Tuned Preselector alignment procedure located in the RSS Service menu Online Help facility.



The RSSI can be monitored at pin C11 of the Systems connector (J5) on the station backplane (refer to Figure 10 for the location).



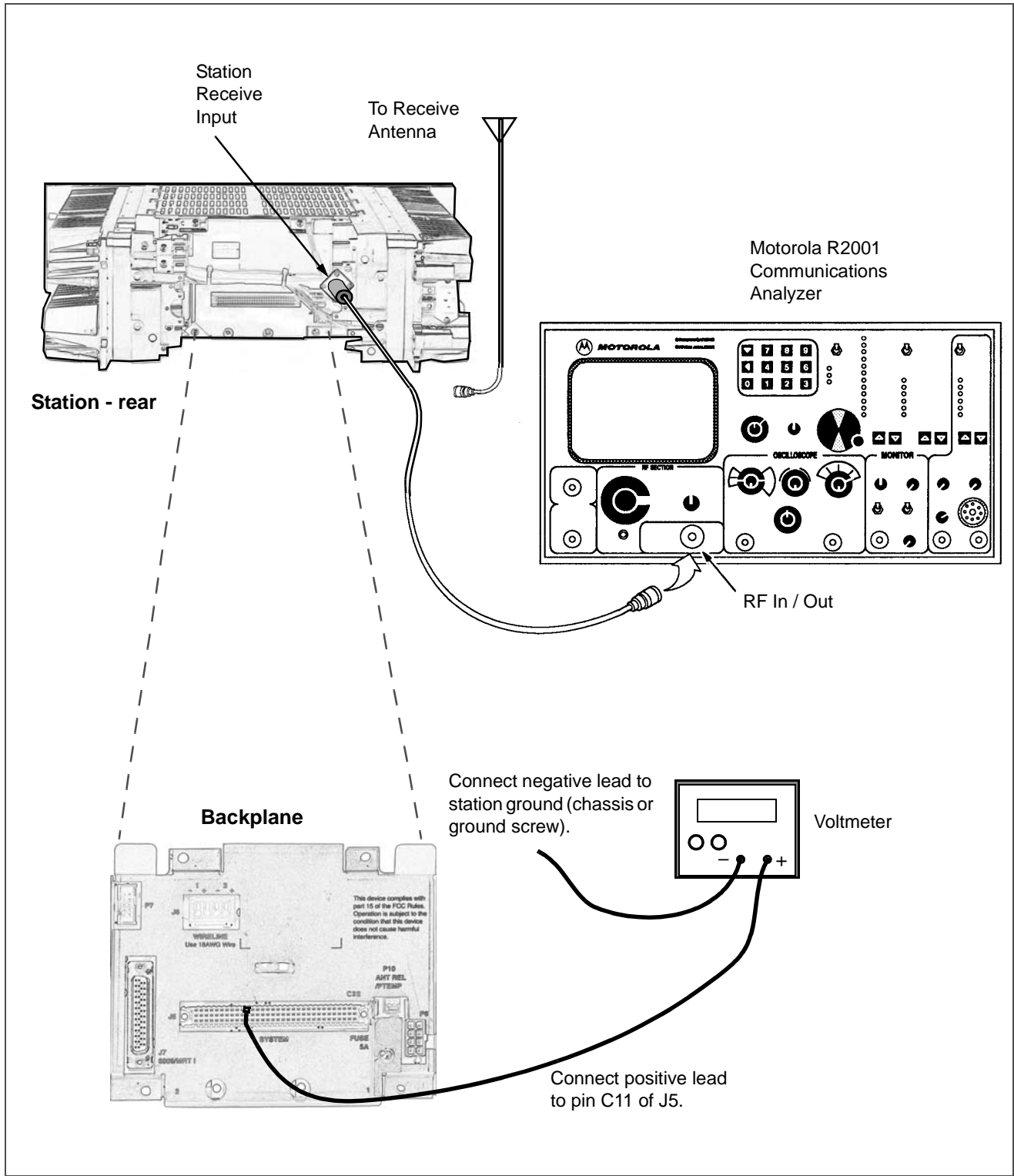


Figure 10. Location of RSSI Monitoring Point (Trunking Stations Only)

**MOTOROLA**

# RECEIVER MODULE

**132 to 174 MHz****MODEL CLN1211 (with Varactor Preselector)****MODEL CLN1212 (without Varactor Preselector)**

## 1

## DESCRIPTION

The CLN1211 and CLN1212 Receiver Modules are described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The Receiver Module provides the receiver functions for the VHF station. The CLN1211 receiver module includes a varactor-tuned preselector; a metal external preselector, which replaces the varactor-tuned preselector, is also available. The receiver module performs highly selective bandpass filtering and dual down conversion of the station receiver RF signal. A custom receiver IC then performs an analog-to-digital conversion of the received signal and outputs a differential data signal to the Station Control Module.

### Overview of Circuitry

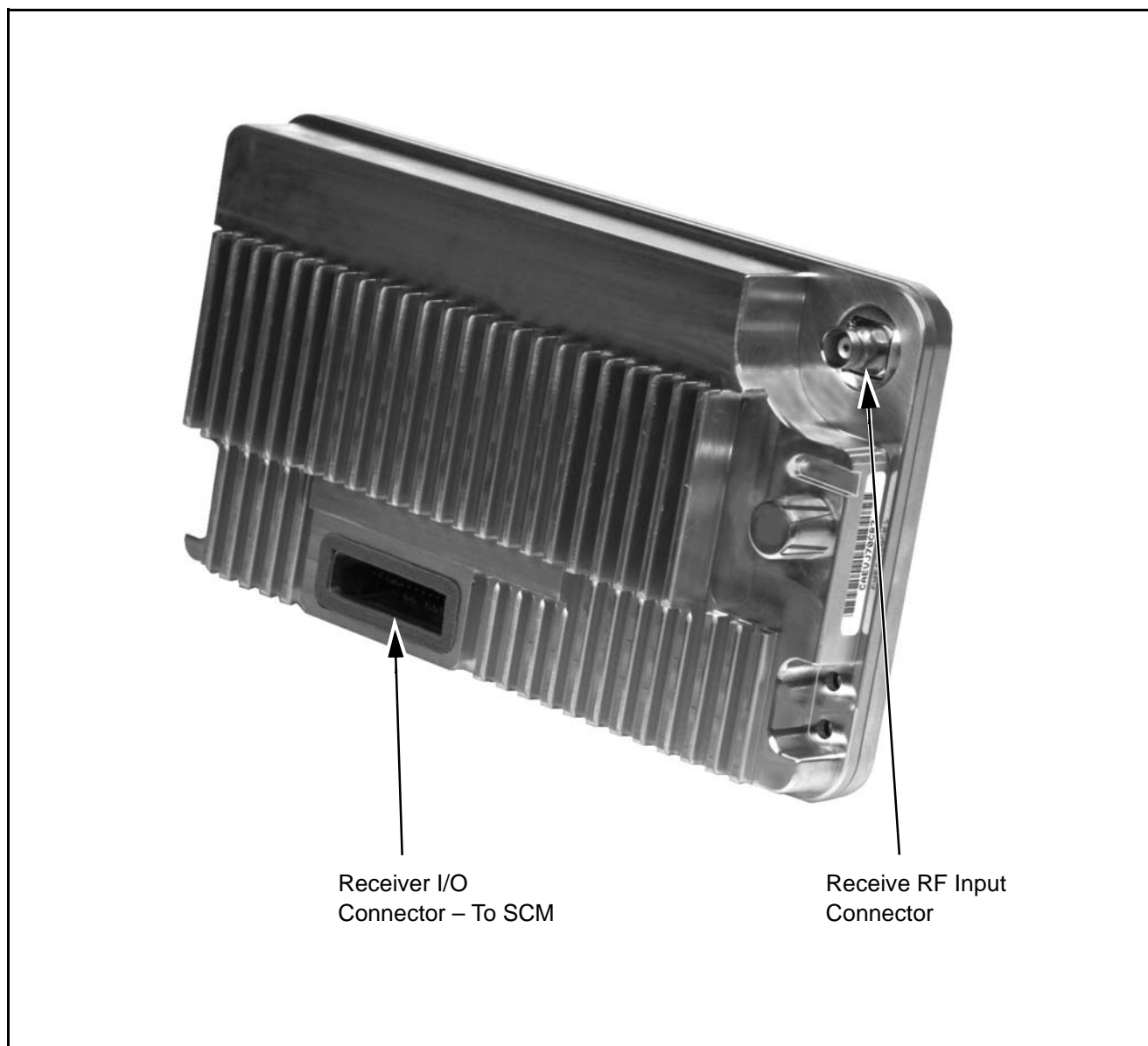
The Receiver Module contains the following circuitry:

- Frequency Synthesizer Circuitry – consisting of a phase-locked loop and VCO, generates the first LO injection signal
- Varactor-tuned Preselector Filter – provides bandpass filtering of the station receiver RF input (not used if metal external preselector is specified).
- Receiver Front End Circuitry – performs filtering, amplification, and the first down conversion of the receiver RF signal
- Custom Receiver IC Circuitry – consists of a custom IC which performs the second down conversion, filtering, amplification, and analog-to-digital conversion of the receive signal
- A/D Converter Circuitry – converts analog receiver status signals to digital format for transfer, upon request, to Station Control Module
- Local Power Supply Regulation – accepts +8V, +10V and +15V inputs and outputs +5V, +10V, and +15V operating voltages.

## 2

## INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the receiver module input and output external connections.



**Figure 1. VHF Receiver Module Inputs/Outputs**

## 3

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the receiver circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the receiver module.

## Synthesizer and VCO Circuitry

### Introduction

The synthesizer and VCO circuitry generates the first LO injection signal for the first mixer in the receiver front end circuitry. Functional operation of these circuits is as follows.

### Phase-Locked Loop

The phase-locked loop (PLL) IC receives frequency selection data from the Station Control Module microprocessor. Once programmed, the PLL IC compares a 2.1 MHz reference signal (from Station Control Module) with a divided-down feedback sample of the VCO output. Depending on whether the feedback signal is higher or lower in frequency than the 2.1 MHz reference, correction pulses are generated. The width of these correction pulses is dependent on the amount of difference between the 2.1 MHz reference and the VCO feedback.

The up/down pulses from the PLL IC are fed to a charge pump which outputs a dc voltage proportional to the pulse widths. This dc voltage is then low-pass filtered and fed to the VCO as the CONTROL VOLTAGE.



If a frequency change is requested by the microprocessor, the low-pass loop filter is momentarily bypassed to accelerate the frequency change.

### VCO

The dc control voltage from the synthesizer is fed to dual VCOs which generate the first LO injection signal. One VCO generates signals in the upper half of the band, while the other VCO generates signals in the lower half of the band. Only one VCO is active at a time. Selection of the active VCO is provided by a BANDSHIFT signal from the PLL IC.

The active VCO responds to the dc control voltage and generates the appropriate RF signal. This signal is fed through a buffer amplifier and impedance matching and output to the first LO injection amplifier in the receiver front end circuitry. A sample of the injection signal is returned to the PLL IC (via a feedback buffer) to serve as a VCO feedback signal.

---

## Receiver Front End Circuitry

The receiver RF input is fed from the antenna to the receiver module (or a 5-pole external preselector filter, if specified, which provides highly selective bandpass filtering). The signal is low-pass filtered, routed through a varactor-tuned preselector (if specified), amplified, image filtered, and fed to one input of the first mixer. The signal is mixed with the first LO injection signal (generated by the synthesizer/VCO circuitry) to produce a 44.85 MHz first i-f signal.

The first i-f signal is 2-pole bandpass filtered and fed to a FET amplifier. The amplifier gain is controlled by AGC properties inherent in the amplifier design. The amplified first i-f signal is then 4-pole bandpass filtered and fed to the RF input of the custom receiver IC.

---

## Custom Receiver IC Circuitry

The custom receiver IC provides additional amplification, filtering, a second down conversion, and finally analog-to-digital conversion of the second i-f signal. The digital receive signal is then sent via differential drive circuitry to the Station Control Module. The data signal contains the necessary I and Q quadrature information, AGC information, and other data transfer information required by the Station Control Module to process the receive signal.



The recovered audio signal is in digital format throughout the station circuitry, resulting in a more noise-free, linear receiver. Analog audio is present only in the external speaker driver circuitry on the Station Control Module and on the Wireline Interface Board at the phone line connection to and from the station.

The remainder of the custom receiver IC circuitry consists of timing and tank circuits to support the internal oscillator, second LO synthesizer circuitry, and second i-f circuitry.

A serial bus allows data communications between the custom receiver IC and a Digital Signal Processor (DSP) located on the Station Control Module (via a DSP ASIC device). This bus allows the DSP to control various current and gain settings, establish the data bus clock rate, program the second LO, and perform other control functions.

---

## A/D Circuitry

Analog signals from various strategic operating points throughout the receiver board are fed to an A/D converter, which converts them to a digital signal and, upon request by the Station Control Module, outputs the signal to the Station Control Module via the SPI bus.

---

## Voltage Regulator Circuitry

The voltage regulator circuitry consists of two +5 V regulators, and filtering circuitry. The +5 V regulators accepts a +8 V input (from a regulator on the backplane) to generate Custom Analog +5 V and Custom Digital +5 V operating voltages to supply the custom Receiver IC and Synthesizer IC.

In addition to the voltage regulator circuitry, +15 V from the Station Control Module is filtered for the synthesizer charge pump. Also, +10 V (from a regulator on the backplane) is filtered to supply a +10 V operating voltage for the receiver board circuitry.

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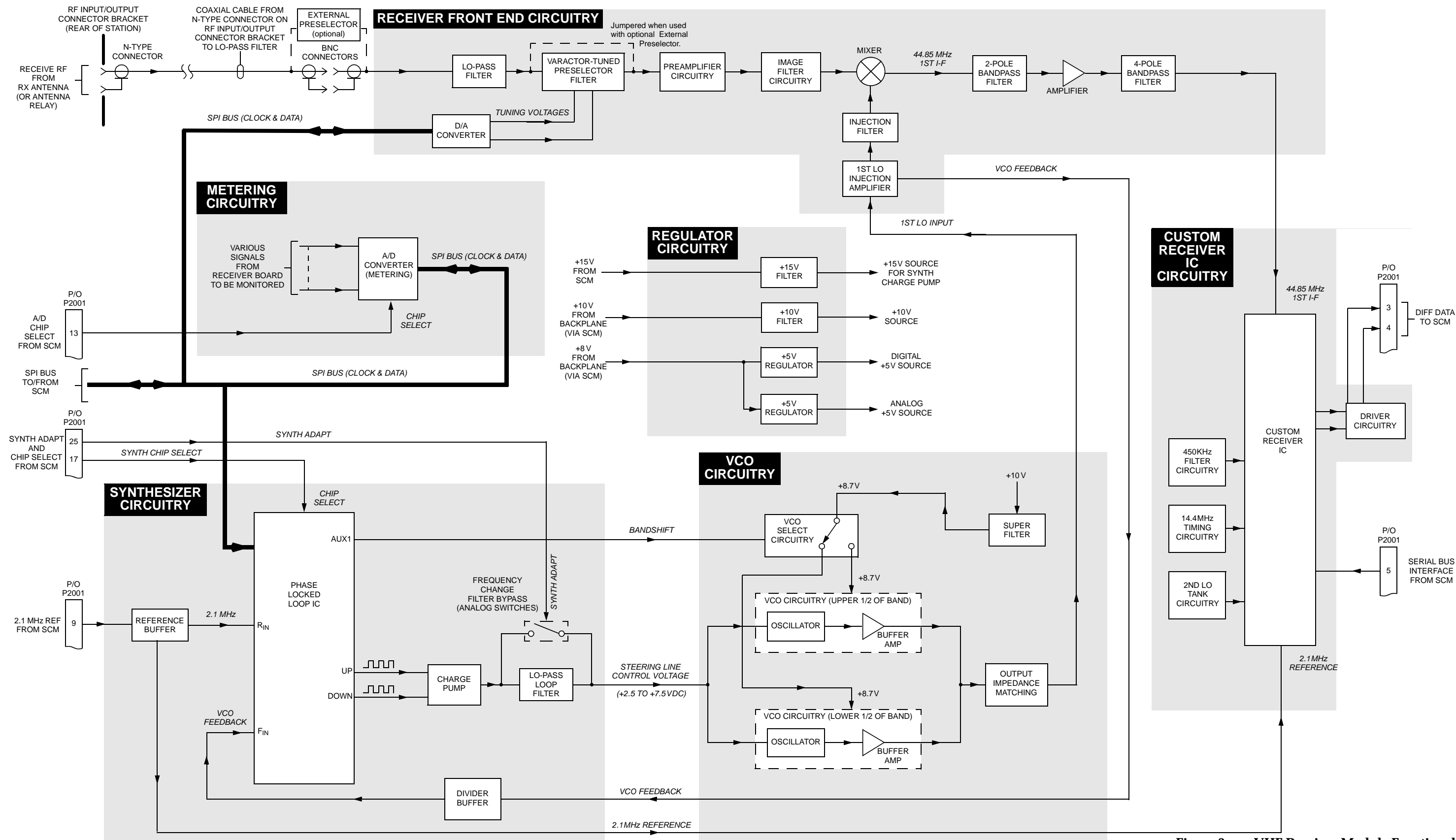


Figure 2. VHF Receiver Module Functional Block Diagram





**MOTOROLA**

# EXCITER MODULE

## MODEL CLN1233 (132 to 174 MHz)

### 1

## DESCRIPTION

The CLN1233 Exciter Module is described in this section. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The Exciter Module (in conjunction with the Power Amplifier Module) provides the transmitter functions for the station. Contained within a metal module housing, the exciter board generates a low-level modulated RF signal which is input to the power amplifier module for further amplification and output to the transmit antenna. The Exciter Module interfaces directly with the Station Control Module, which provides control signals and monitoring, and routes transmit audio to the exciter.

These Exciter Modules differ only in the range of operation, as shown in the title of this section. Unless otherwise noted, the information provided in this section applies to all models.

### Overview of Circuitry

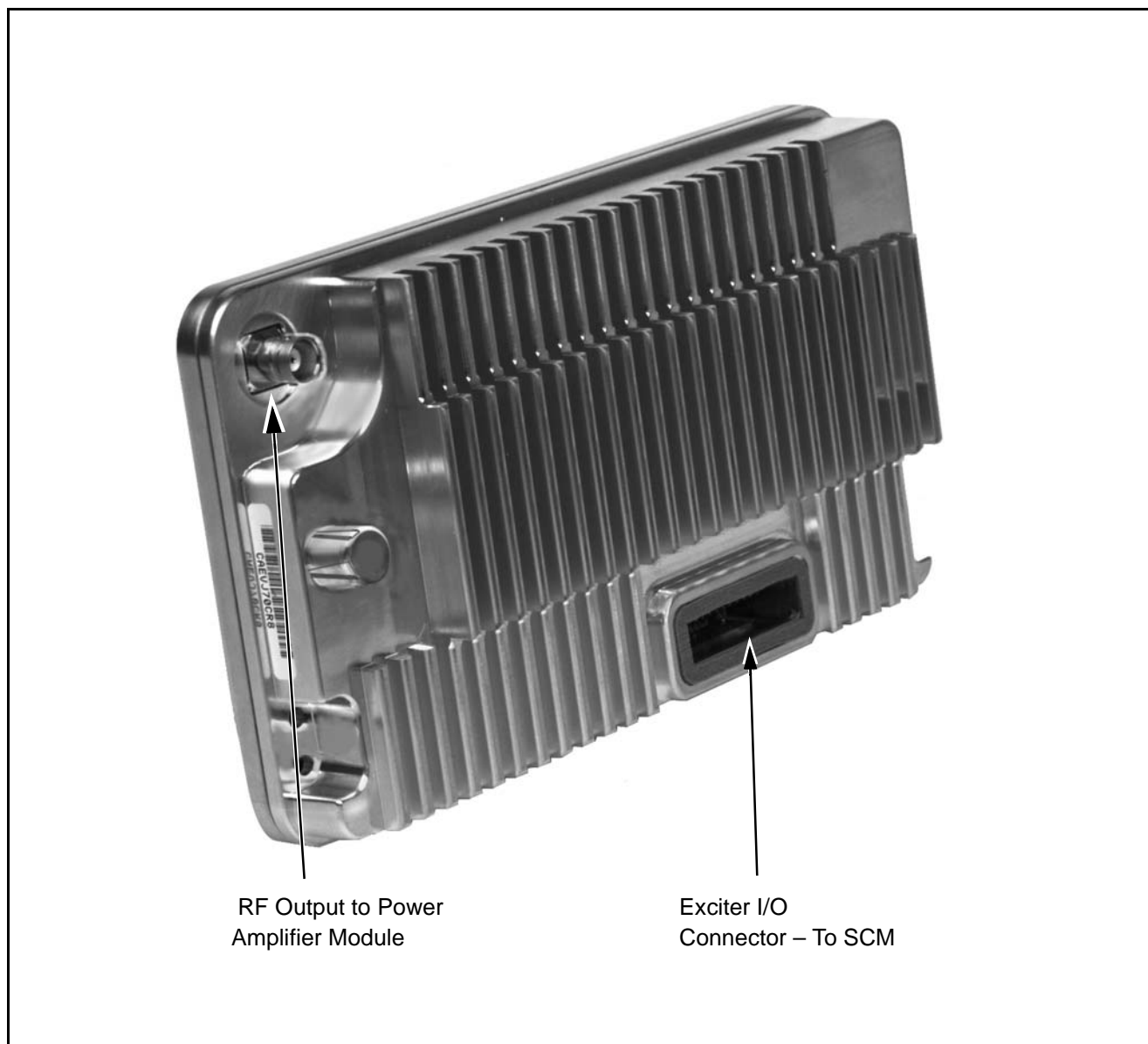
The exciter board contains the following circuitry:

- Frequency Synthesizer Circuitry – consisting of a phase-locked loop and VCO, generates a modulated RF signal at the transmitter carrier frequency
- RF Isolation Switch – allows the SCM to turn on/off the exciter output signal to the power amplifier module
- A/D Converter Circuitry – converts analog exciter status signals to digital format for transfer, upon request, to Station Control Module
- Local Power Supply Regulation/Filtering – accepts +8V, +10V and +15V inputs and outputs +5V, +10V, and +15V operating voltages.

## 2

## INPUT AND OUTPUT CONNECTIONS

Figure 1 shows the exciter module input and output external connections.



**Figure 1. VHF Exciter Module Input/Outputs**

# 3

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the exciter circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the exciter module.

### Synthesizer and VCO Circuitry

#### Introduction

As mentioned previously, the exciter module generates a low-level modulated RF signal which is input to the power amplifier module. The RF carrier is generated by a frequency synthesizer consisting of synthesizer circuitry and VCO circuitry. Exciter module control signals, monitoring, and audio processing are handled by the Station Control Module. Functional operation of the exciter circuits is as follows.

#### Phase-Locked Loop

The phase-locked loop (PLL) IC receives frequency selection data from the SCM microprocessor (via the SPI bus). Once programmed, the PLL IC compares a 2.1 MHz reference signal (from the SCM) with a divided-down feedback sample of the VCO output. Depending on whether the feedback signal is higher or lower in frequency than the 2.1 MHz reference, up/down correction pulses are generated. (The width of these correction pulses depends on the quantitative difference between the 2.1 MHz reference and the VCO feedback.)

The up/down pulses from the PLL IC are fed to a charge pump which outputs a dc voltage proportional to the pulse widths. This dc voltage is then low-pass filtered and fed to the VCO as the CONTROL VOLTAGE.



If a frequency change is requested by the SCM microprocessor, the low-pass loop filter is momentarily bypassed to accelerate the frequency change (via a SYNTH ADAPT signal from the SCM).

#### VCO

The dc control voltage from the synthesizer is fed to dual VCOs which generate the RF carrier signal. Within each band, one VCO generates signals in the upper half of the band, while the other VCO generates signals in the lower half of the band. Only one VCO is active at a time. Selection of the active VCO is provided by a BANDSHIFT signal from the PLL IC.

The active VCO responds to the dc control voltage and generates the appropriate RF signal. This signal is fed through impedance matching, amplification, and filtering and is output to the RF Switch Circuitry. A sample of the output is returned to the PLL IC to serve as a VCO feedback signal.

### Modulation

The active VCO receives an audio/data modulation signal from the Station Control Module via a splatter filter and a low-pass filter/attenuator. This VCO modulation signal modulates the active VCO to produce a modulated low-level RF carrier signal.

Low-frequency modulation signals (below the loop filter corner) tend to be interpreted by the PLL as VCO frequency error. A modulation compensation signal is added to the PLL control voltage to cancel out this effect and allow for low frequency modulation.

### RF Switch Circuitry

The modulated RF signal from the VCO is fed through a buffer/attenuator to an RF switch circuit. Signal TX ENABLE from the SCM controls the switch. The RF signal is output to a BNC connector mounted in one corner of the module, just outside the module cover. A short coaxial cable connects the exciter output to the power amplifier module.

---

## Data Communications

### Communications with Station Control Module

Data communications between the exciter and the Station Control Module microprocessor ( $\mu$ P) is performed via a Serial Peripheral Interface (SPI) bus. This bus allows the SCM  $\mu$ P to send data to the synthesizer PLL IC (to select frequency) and to read the A/D Converter IC (next paragraph).

### A/D Converter Circuitry

Analog signals from various strategic operating points throughout the exciter board are fed to an A/D converter, which converts them to a digital signal and, upon request by the Station Control Module, outputs the signal to the Station Control Module via the SPI bus.

---

## Voltage Regulator/Filter Circuitry

The voltage regulator circuitry consists of a +5 V regulator and filtering circuitry. The +5 V regulator accepts a +8 V input (from a regulator on the backplane) and generates a +5 V operating voltage for the exciter board circuitry.

In addition to the voltage regulator circuitry, +15 V from the Station Control Module is filtered for the synthesizer charge pump. Also, +10 V (from a regulator on the backplane) is filtered to supply a +10 V operating voltage for the exciter board circuitry.

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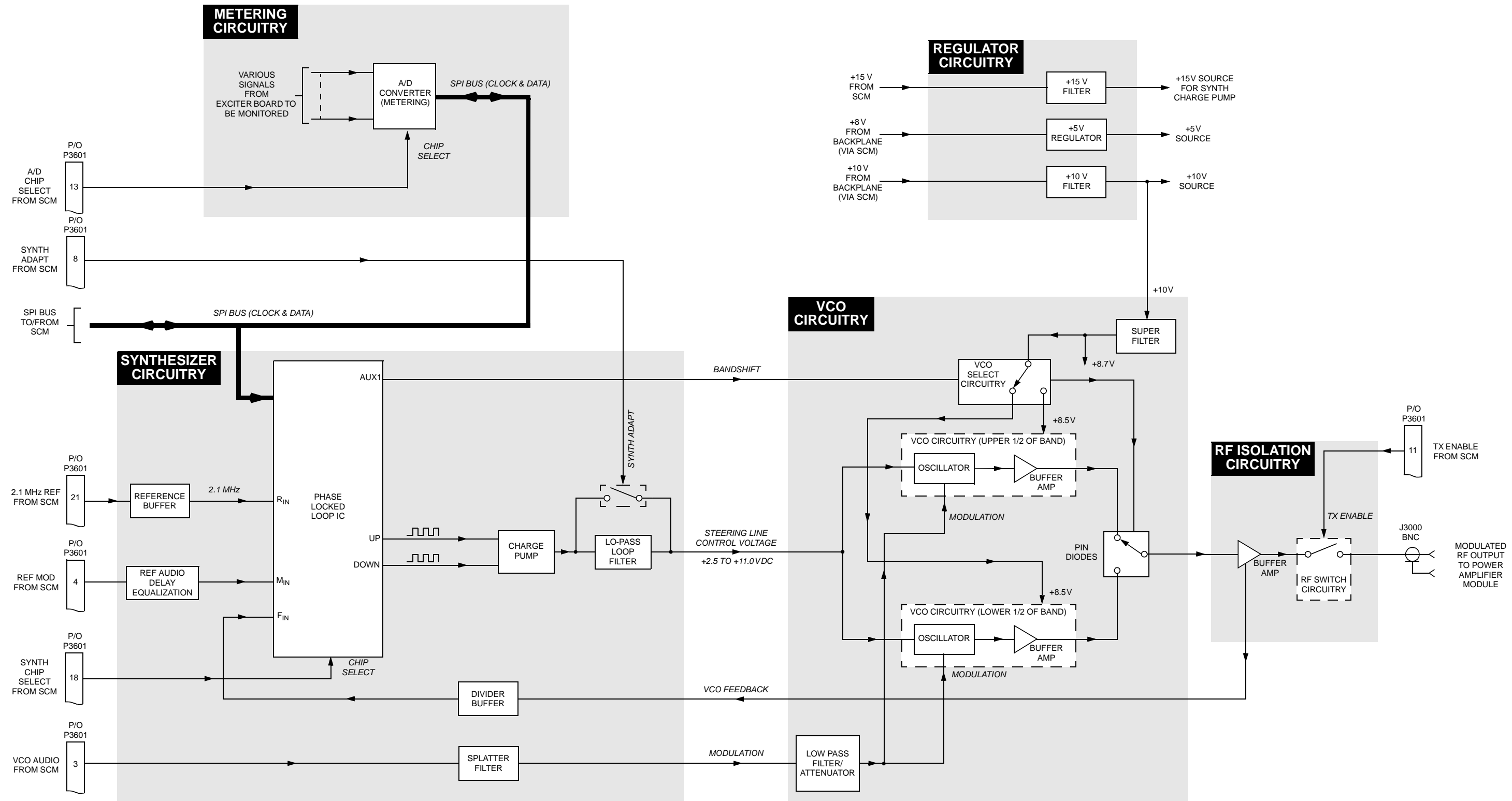


Figure 2. VHF Exciter Module Functional Block Diagram



# POWER AMPLIFIER MODULE

132 to 174 MHz

MODEL CLN1226, 40 W

MODEL CLN1227, 30 W

## 1

## DESCRIPTION

The Models CLN1226, CLN1227 Power Amplifier Modules are described in this section. A general description, identification of inputs/outputs, functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The Power Amplifier Module (PA) accepts a low-level modulated RF signal from the Exciter Module and amplifies the signal for transmission via the site transmit antenna. The output power is continually monitored and regulated by a feedback and control loop, with a power output control voltage being generated by the transmitter control circuitry located on the PA Input/Output boards.

### Overview of Circuitry

The PA contains the following circuitry:

- Intermediate Power Amplifier (IPA) – hybrid substrate amplifier stage which accepts low-level input from Exciter Module, amplifies the signal, and outputs a 0 W to 10 W RF signal
- Butterfly Module – hybrid substrate amplifier stage which accepts output from IPA Hybrid and provides final amplification to 50 W (maximum)
- Directional Coupler/Power Detector/Low Pass Filter – couples amplified RF signal to transmit antenna connector; also generates dc voltages proportional to forward and reflected power for use in TX power control loop; provides harmonic suppression for the station
- Dual Circulator – provides isolation between Power Amplifier output and transmit antenna
- Temperature Sense Circuitry – provides variable resistance signal proportional to heat sink temperature; signal is monitored by the PA power control circuitry



2

IDENTIFICATION OF INPUTS/OUTPUTS

Figure 1 shows the PA Module input and output external connections.

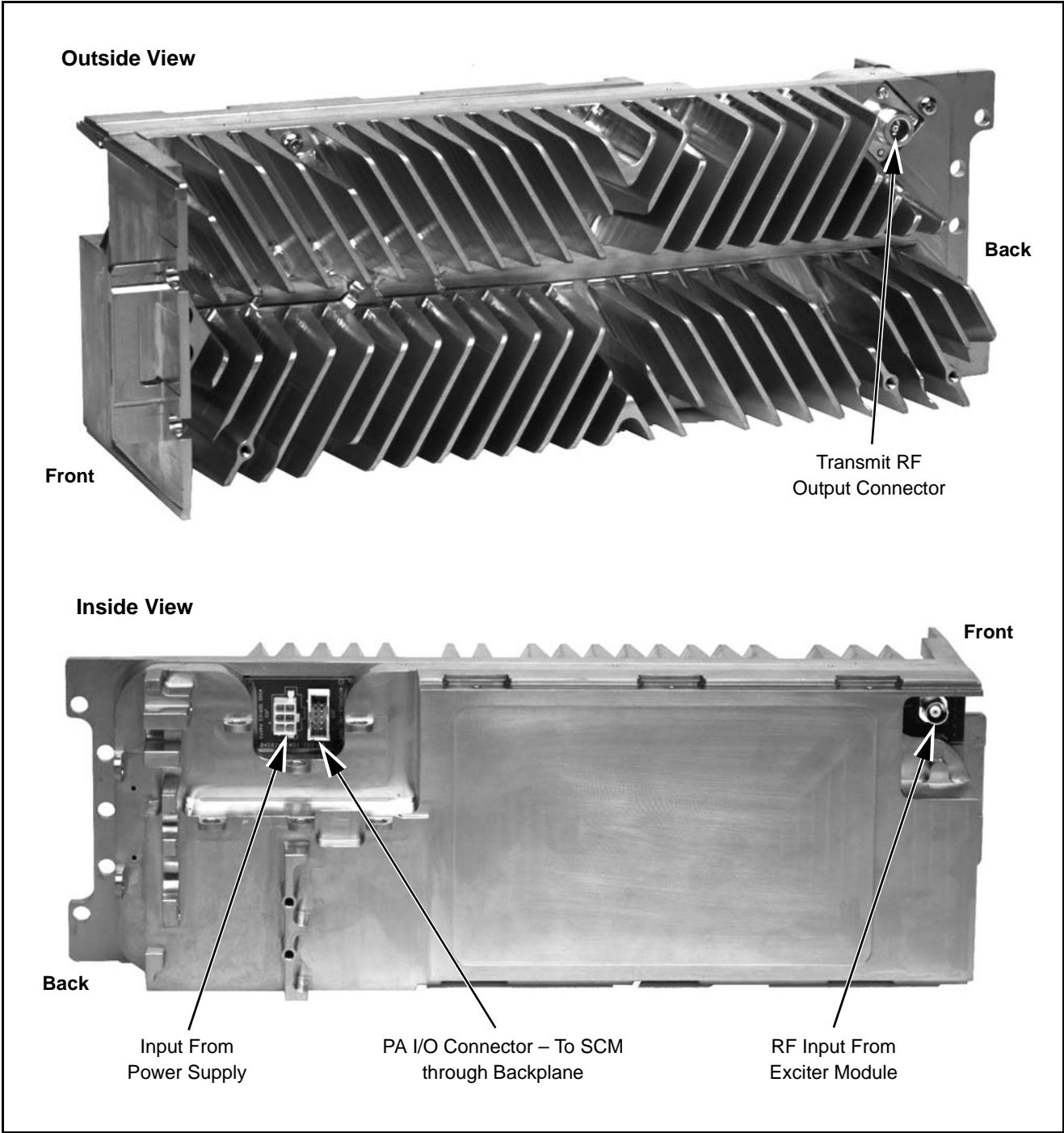


Figure 1. VHF 30 / 40 W Power Amplifier Module Inputs/Outputs

# 3

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the PA circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for the following functional theory of operation.

---

### RF Signal Path

A low-level modulated RF signal (approximately +13 dBm) from the Exciter Module enters the PA Input board via a coax cable. The signal is input to the IPA and amplified to approximately 0 to 10 W (depending on the dc power control voltage (V\_CNTL) from the PA output board). The IPA output is then fed to the Butterfly Module where final amplification occurs. The output of the Butterfly (40 W maximum) exits from the PA Output board via an N-type coax connector.

---

### Circulator

A double circulator is built into the CLN1227 Power Amplifier Module to provide isolation between the PA module and the transmit antenna.

---

### Heat Sink Temperature Sense

A thermistor mounted on the PA printed circuit board outputs a variable resistance proportional to the heat sink temperature. This signal is fed to the power control circuitry on the PA output board, which monitors the signal and reduces the PA output power if the PA temperature exceeds set limits.

---

### Output Power Control

A feedback and control loop configuration is used to regulate the PA output power. The Directional Coupler generates a dc voltage proportional to the PA Module output power. This voltage is fed to power control circuitry on the PA output board where it is compared to reference voltages to generate a dc power control voltage. The Station Control Module sends current and power limit signals to a D/A converter (via the SPI bus) to control the maximum current/control voltage levels. The control voltage is fed to the IPA module where it controls the IPA output, thus controlling the overall output from the PA Module.

---

## A/D Converter Circuitry

Analog signals from various strategic operating points throughout the PA module are fed to an A/D converter, which converts them to a digital signal and, upon request by the Station Control Module, outputs the signal to the Station Control Module via the SPI bus.

For example, the directional coupler generates a dc voltage proportional to the reflected power. This signal is converted to a digital signal and sent to the SCM. If the sense line indicates an impedance mismatch (high VSWR), the PA is either cut back in power or shut down completely.

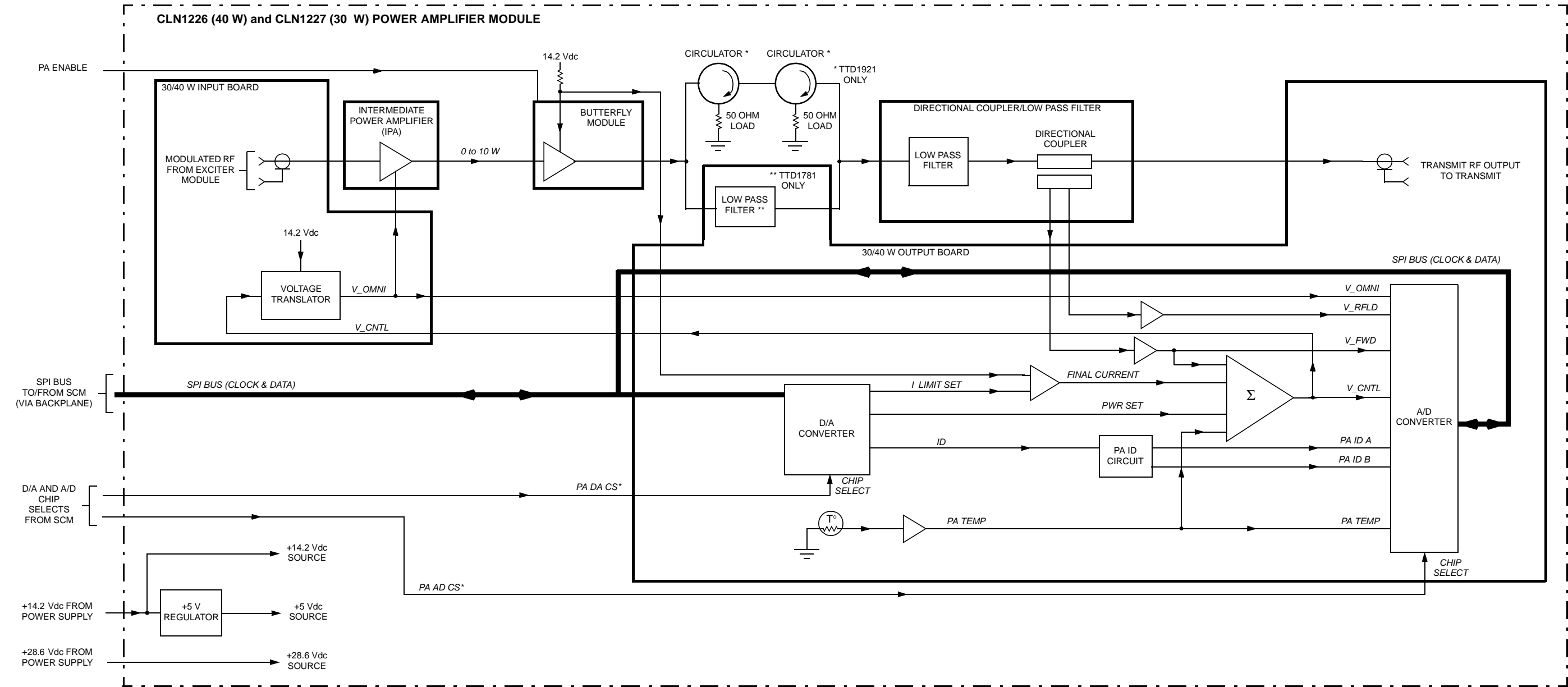


Figure 2. VHF 30/40 W Power Amplifiers Functional Block Diagram



**MOTOROLA**

# POWER AMPLIFIER MODULE

**MODELS CLN1224 (132 to 154 MHz), 100W  
CLN1225 (150 to 174 MHz), 100W**

## 1

### DESCRIPTION

The Models CLN1224, CLN1225 Power Amplifier Modules are described in this section. A general description, identification of inputs/outputs, functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The Power Amplifier Module (PA) accepts a low-level modulated RF signal from the Exciter Module and amplifies the signal for transmission via the site transmit antenna. The output power is continually monitored and regulated by a feedback and control loop, with a power output control voltage being generated by the transmitter control circuitry located on the PA Input/Output boards.

### Overview of Circuitry

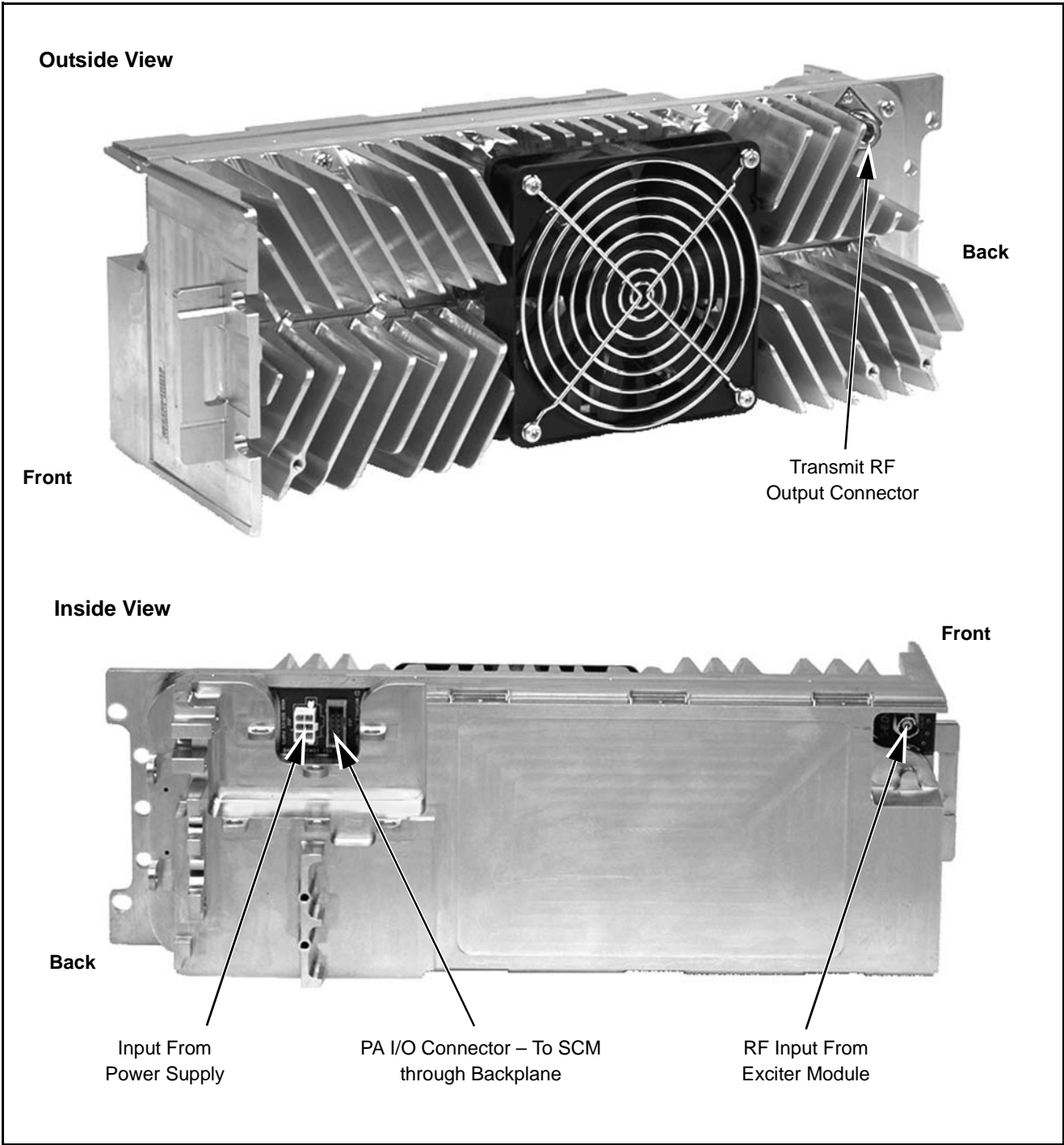
The PA contains the following circuitry:

- Final Device Module – a three stage amplifier which accepts output from the Exciter Module and provides final amplification up to 135 W. All the RF amplification transistors are included in this module
- Directional Coupler/Power Detector/Low Pass Filter – couples amplified RF signal to transmit antenna connector; also generates dc voltages proportional to forward and reflected power for use in TX power control loop; provides harmonic suppression for the station
- Single Circulator – provides isolation between Power Amplifier output and transmit antenna
- Temperature Sense Circuitry – provides variable resistance signal proportional to heat sink temperature; signal is monitored by the PA power control circuitry

2

IDENTIFICATION OF INPUTS/OUTPUTS

Figure 1 shows the PA Module input and output external connections.



**Figure 1. VHF 100 W Power Amplifier Module Inputs/Outputs**

## 3

# FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the PA circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for the following functional theory of operation.

---

### RF Signal Path

A low-level modulated RF signal (approximately +12 dBm) from the Exciter Module enters the PA Input board via a coax cable. The signal is input to the Final Module and amplified up to 135 W (depending on the dc power control voltage (V\_CNTL) from the PA output board). The output of the Final Module is fed to the circulator.

The output of the circulator exits from the PA Output board via an N-type coax connector.

---

### Circulator

A single circulator is built into the Power Amplifier Module to provide isolation between the PA module and the transmit antenna.

---

### Heat Sink Temperature Sense

A thermistor mounted on the PA printed circuit board outputs a variable resistance proportional to the heat sink temperature. This signal is fed to the power control circuitry on the PA output board, which monitors the signal and reduces the PA output power (and enables a fan) if the PA temperature exceeds set limits.

---

### Output Power Control

A feedback and control loop configuration is used to regulate the PA output power. The Directional Coupler generates a dc voltage proportional to the PA Module output power, which is a maximum of 100 W. This voltage is fed to power control circuitry on the PA output board where it is compared to reference voltages to generate a dc power control voltage. The Station Control Module sends current and power limit signals to a D/A converter (via the SPI bus) to control the maximum current/control voltage levels. The control voltage is fed to the Final Module where it controls the Final Module output, thus controlling the overall output from the PA Module.

---

## A/D Converter Circuitry

Analog signals from various strategic operating points throughout the PA module are fed to an A/D converter, which converts them to a digital signal and, upon request by the Station Control Module, outputs the signal to the Station Control Module via the SPI bus.

For example, the directional coupler generates a dc voltage proportional to the reflected power. This signal is converted to a digital signal and sent to the SCM. If the sense line indicates an impedance mismatch (high VSWR), the PA is either cut back in power or shut down completely.



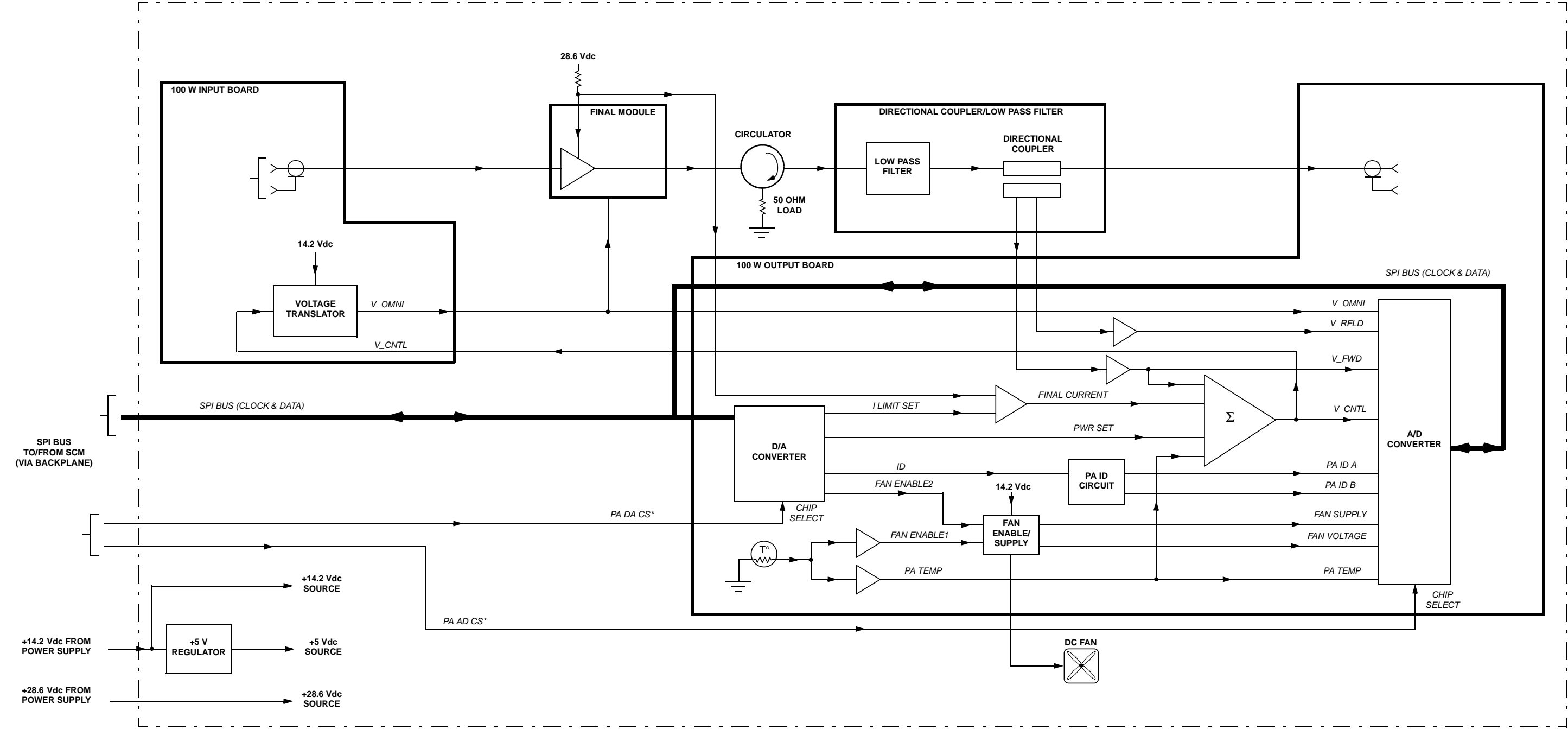


Figure 1. VHF 100 W Power Amplifiers Functional Block Diagram



# STATION CONTROL MODULE

## MODEL CLN1465

### 1

## DESCRIPTION

The CLN1465 Station Control Module (SCM) is described in this section. A general description, identification of controls, indicators, and inputs/outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The SCM serves as the main controller of the station. The SCM contains an MC68356 microprocessor which forms the heart of the module. This IC combines a 68302 Integrated Multiprotocol Processor (IMP) with a 56002 Digital Signal Processor (DSP) which, along with the support circuitry, provides signal processing and operational control over the other station modules.

The CLN1465 provides for Motorola Radio-Telephone Interconnect (MRTI) and 6809 trunking capabilities. In addition, the CLN1465 provides a Receiver Signal Strength Indication (RSSI) output and an external reference input for connection to a high stability oscillator.

---

## Overview of Circuitry

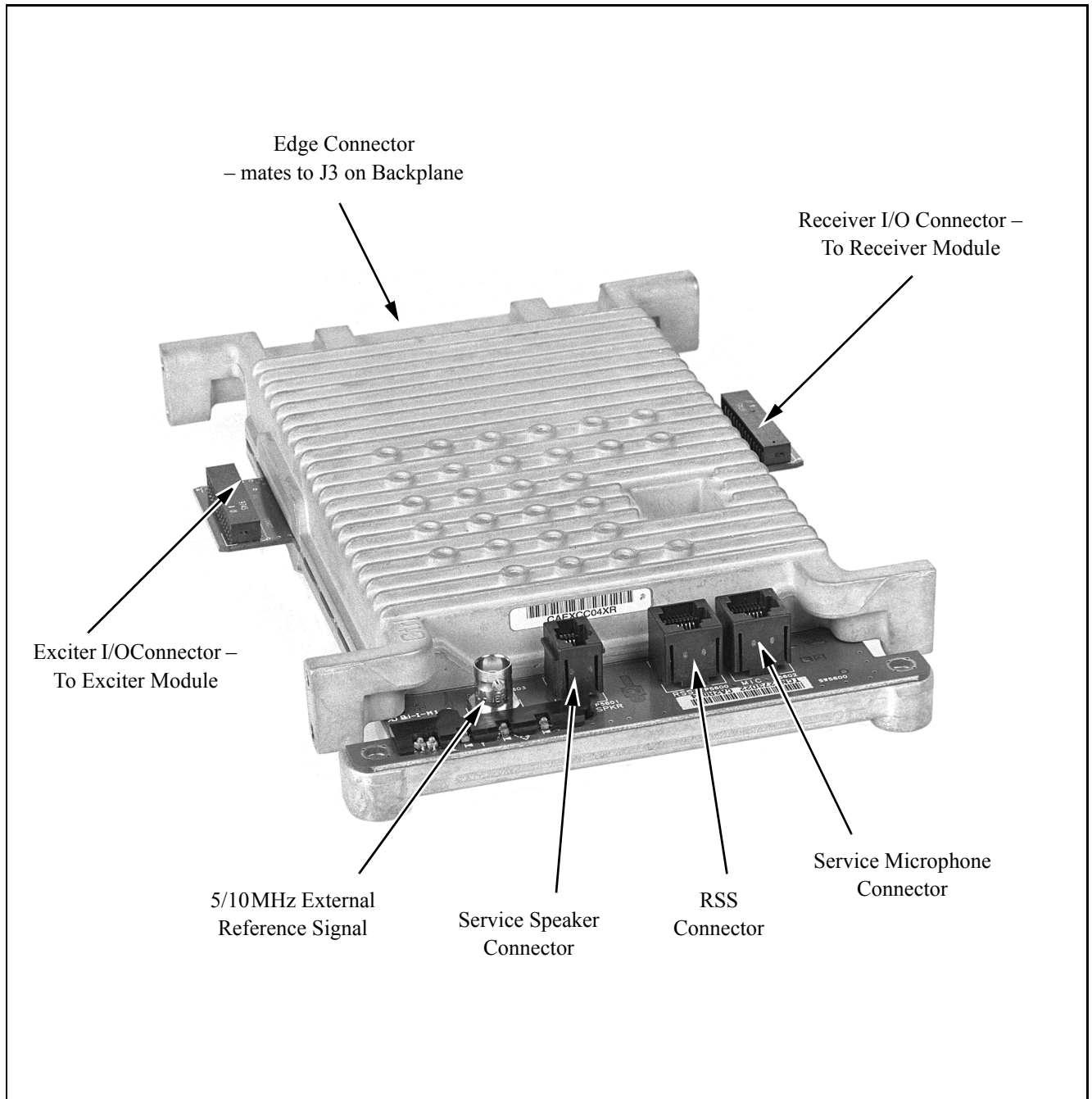
The SCM contains the following circuitry:

- Host Microprocessor – that part of the MC68356 which serves as the central controller for the station and the SCM
- Non-Volatile Memory – consists of Flash EPROM memory, containing both the system operating software and the station codeplug data
- SRAM Memory – Static RAM serves as short term storage for data
- Digital Signal Processing (DSP) and DSP ASIC Circuitry – that part of the MC68356 (and associated ASIC) which performs high-speed processing of all audio and signalling data signals
- Station Reference Circuitry – generates the 2.1 MHz reference signal used throughout the station
- Serial Peripheral Interface (SPI) Input/Output Circuitry – provides high-speed serial bus to pass control and diagnostic information between the Host microprocessor, the station modules (receiver, exciter, PA, etc.) and various serially-controlled devices on the SCM
- Serial Input/Output Circuitry – provides bus circuitry to buffer two of the Host microprocessor Serial Communication Interface (SCI) ports (SCC1 and SCC2) for communication with optional modules, and an external IBM-PC running Radio Service Software (RSS)
- Audio Processing Circuitry – routes the various audio input signals (such as microphone, wireline, and receiver audio) to output devices (such as external speaker and exciter modulation inputs) and converts (via various codecs) the audio signals between digital and analog formats for serial transmission to/from the DSP
- Parallel I/O Circuitry – provides the necessary logic interface for the Host microprocessor to send/receive miscellaneous control signals to/from various station modules and externally connected equipment, and to control the status LEDs on the front panel
- Supply Voltage Circuitry – contains filtering, voltage doubling and regulatory circuitry which accepts various input voltages from backplane regulators and the power supply, and generates the operating voltages required by the Receiver and Exciter modules, and the SCM

## 2

## INDICATORS AND INPUT/OUTPUT CONNECTIONS

Figure 1 shows the SCM indicators, and all input and output external connections.



**Figure 1. Station Control Module Indicators and Input/Output Connections**

# 3

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the SCM at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the SCM supply voltage circuitry. Refer to Figure 1 for a block diagram of the other sections of the SCM circuitry.

---

### Host Microprocessor

#### General

The SCM utilizes an MC68356 Microprocessor which combines microprocessor and DSP capabilities on a single device. The Host Microprocessor ( $\mu$ P) functions of the SCM are performed by an MC68302 Integrated Multiprotocol Processor (IMP) which is one part of the MC68356. This part serves as the main controller for the SCM (and station), controlling the operation of the station as determined by the station software and codeplug (both stored in a non-volatile Flash EPROM device).

The  $\mu$ P is equipped with a 23-line address bus; only 18 lines are required to access the non-volatile Flash memory, SRAM memory, and provide control (via memory mapping) for Parallel I/O circuitry in the SCM. The Host  $\mu$ P operates in MC68008 mode, providing an 8-bit data bus which (buffered for the Flash and SRAM memory) is used to transfer data to/from the SCM memory, as well as Parallel I/O circuitry. The Host  $\mu$ P also provides the signals controlling the demultiplexers used to route various audio inputs/outputs in the Audio Processing circuitry of the SCM.

#### Station Software/Codeplug Flash Memory

The station control software and the data which determines the station personality (i.e. codeplug) both reside in one 1 MB x 8 Flash EPROM. This device is accessed by the Host  $\mu$ P via the Host Address Bus and the (buffered) 8-line Host Master Data Bus.

Stations are shipped from the factory with generic default data programmed into the codeplug portion of the Flash. Field programming is performed during installation using the RSS to enter additional customer-specific data, such as site output power, time-out timer settings, etc.

#### SRAM Memory

Each SCM contains 256 Kbyte of SRAM which provides short-term storage for data generated/required during normal operation.

## Host $\mu$ P Clock Generation

The Host  $\mu$ P operates at a 20.4 MHz rate, generated internally from a reference clock. A high-stability VCO in the Station Reference circuitry generates the station master clock (16.8 MHz) which is divided by 14 (in the DSP ASIC) to 1.2 MHz and routed to the EXTAL pin of the Host  $\mu$ P. The Host  $\mu$ P multiplies this reference (under software control) by 17 to produce an internal system clock of 20.4 MHz.

## Address Decoding

Host  $\mu$ P read and write operations are performed using the Host Address and Data buses in conjunction with four programmable chip select lines from the internal MC68356 chip select generators, CS0 to CS3, which are used in the following manner.

- CS0 is used to control access to the Flash (EPROM) memory space. Since the Flash device stores station control software, CS0 is also enabled after a reset to access the boot ROM upon system start-up.
- CS1, CS2 are used to control access of up to two SRAM devices.
- CS3 is used to control access to the Parallel I/O circuitry (control signals and SPI bus chip selects for station modules and external options).

---

## Serial I/O Circuitry

The Serial I/O circuitry interfaces with two of the Serial Communications Interface (SCI) ports (SCC1 and SCC2) on the Host  $\mu$ P to provide general-purpose serial communications buses, as follows:

- SCC1 – this port is buffered to provide a high-speed Interprocessor Communications Bus, allowing the Host  $\mu$ P to communicate with optional modules (via the backplane)
- SCC2 – serves as a serial RSS port. An 8-pin Telco connector is provided on the front of the SCM to allow service personnel to connect a PC loaded with the Radio Service Software (RSS) to the station, and perform programming and maintenance tasks. EIA-232 Bus Receivers/Drivers interface the connector to the SCC2 port.

---

## SPI I/O Circuitry

The Serial Peripheral Interface (SPI) I/O circuitry provides a SPI bus which is used as a general-purpose communications bus to allow the Host  $\mu$ P to communicate with other modules in the station. The SPI I/O circuitry also includes an A/D converter which allows the Host  $\mu$ P to determine (via the SPI bus) the connected optional modules and other station characteristics.

The SCM is always configured as the SPI bus master, while other modules (Receiver, Exciter, PA, etc.) are configured as bus slaves. Two slave configurations are possible:

- Basic slave – these are SPI-compatible ICs, located on the slave modules (e.g., A/D and D/A converters, and frequency synthesizers).
- Intelligent slave – these are slave modules which contain a microprocessor having a local SPI bus (e.g., intelligent equipment connected to the station via the Systems connector on the backplane).

There are three SPI signals, as follows:

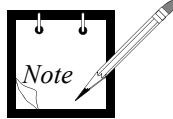
- SPI CLK – derived from the internal Host  $\mu$ P clock. With a Host  $\mu$ P clock frequency of 20.4 MHz, the minimum SPI CLK is approximately 319 KHz. It is used to shift serial data from the Host  $\mu$ P to a slave, and from the slave back to the Host  $\mu$ P.
- MOSI (Master Out Slave In) – provides the data path containing information from the master (SCM) to the slave (Receiver, Exciter, PA, etc.). This is an output from the Host  $\mu$ P.
- MISO (Master In Slave Out) – provides the data path containing information from the slave to the master. This is an input to the Host  $\mu$ P.

---

## Station Reference Circuitry

The Station Reference Circuitry incorporates a high-stability VCO (CMAC Oscillator Circuitry) to generate a stable 16.8 MHz signal which is fed to the DSP ASIC. The ASIC divides the signal by 8 and outputs a 2.1 MHz signal which is buffered and filtered by a splitter and output to the Exciter Module and Receiver Module as 2.1 MHz REF.

The CLN1465 SCM includes a phase-locked loop (PLL) IC. Higher stability is achieved by phase-locking the CMAC Oscillator Circuitry to a 5/10 MHz external reference source from an external high-stability oscillator, allowing the CMAC Oscillator Circuitry to be automatically adjusted to this source (referred to as “auto-netting”).



A BNC connector (located on the front of the CLN1465) is provided to allow the highly-stable external 5 / 10 MHz source to be input to the OSC<sub>IN</sub> input of the PLL to perform frequency netting. Refer to the Routine Maintenance section in this manual for recommended intervals and procedures for netting the station reference.

The Station Reference Circuitry may operate in one of three modes:

- Normal Mode – In this mode, the control voltage is turned off (via control voltage enable switch) and the high-stability VCO operates in an open loop mode; stability of the VCO in this mode is 2 PPM per year.
- Manual Netting Mode – Periodically, an external 5 / 10 MHz source is required to fine tune, or “net”, the 16.8 MHz reference signal. In this mode, the PLL compares the 5/10 MHz reference and a sample of the 16.8 MHz VCO output and generates up/down pulses. The Host  $\mu$ P reads the pulses (via SPI bus) and sends correction signals (via SPI bus) to the VCO to adjust the output frequency to 16.8 Mhz  $\pm$ 0.3 ppm.
- High-Stability Mode – For some systems, the free-running stability of the VCO is unacceptable for optimum system performance. Therefore, an external 5/10 MHz source is connected permanently to the BNC connector. In this mode, the PLL compares the 5/10 MHz reference and a sample of the 16.8 MHz VCO output and generates a dc correction voltage. The control voltage enable switch is closed, allowing the control voltage from the PLL to adjust the high-stability VCO frequency to 16.8 Mhz  $\pm$ 0.3 ppm. The VCO operates in this closed loop mode and is continually being frequency-controlled by the control voltage from the PLL.

---

## Digital Signal Processor (DSP) and DSP ASIC Circuitry

### General

The second half of the MC68356 contains a 56002 Digital Signal Processor (DSP). All station transmit and receive audio/data is processed by the DSP and related circuitry. This circuitry includes the DSP, the DSP ASIC, and the Audio Processing circuitry. All audio signals input to or output from the DSP ASIC are in digitized format. The digitized audio is transferred to/from various codec ICs in the Audio Processing circuitry along corresponding serial buses (dependent on the particular routing of an audio signal).



**Inputs** to the DSP circuitry are:

- Digitized receive signals from the Receiver Module
- Audio from handset or microphone connected to appropriate SCM connector (behind the station front panel)
- Digitized voice audio/data from Wireline Interface Board via PCM Codec Bus
- Auxiliary TX Audio from Systems connector on backplane
- MRTI TX Audio from Trunking/MRTI connector on backplane
- Trunk TX Data from Trunking/MRTI connector on backplane

**Outputs** from the DSP circuitry are:

- Digitized voice audio/data from DSP to Wireline Interface Board via PCM Codec Bus
- Digitized voice audio/data from DSP to Exciter Module (modulation signals) via Audio Processing circuitry
- Digitized voice audio from DSP to external speaker via Audio Processing circuitry; speaker is connected to appropriate SCM connector behind the station front panel
- Trunk RX Audio (voice and control channel) to Trunking/MRTI connector on backplane
- MRTI RX Audio to Trunking/MRTI connector on backplane

### **Digital Signal Processor (DSP)**

The DSP operates at a clock speed of 60 MHz with no wait states. The DSP accepts and transmits digitized audio to/from the various modules in the station. The DSP provides address and data buses to receive/transmit digitized audio (via the DSP ASIC) and to access the DSP program and signal processing algorithms contained in three 32K x 8 SRAM ICs. It also provides a serial bus (SSI) to interface directly with linear Codec #1.

## DSP ASIC

The DSP ASIC operates under control of the DSP to provide a number of functions, as follows:

- Interfaces with the DSP via the DSP address and data buses and interrupt request lines
- Accepts 16.8 MHz signal from Station Reference circuitry and outputs a 2.1 MHz reference signal used throughout the station, and a 1.2 MHz processor clock used by the MC68356 to generate the core clocks for the DSP and Host  $\mu$ P.
- Provides serial interfaces for linear Codec #5 and PCM codecs
- Provides serial interface for programming custom IC on Receiver Module, and accepts digitized data from custom IC via differential-to TTL converter circuitry
- Provides Receiver Signal Strength Indication (RSSI) data output

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## Audio Processing Circuitry

### General

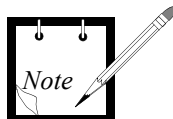
The Audio Processing circuitry interfaces external analog audio inputs and outputs with the DSP circuitry. The CLN1465 uses two linear codec ICs (referred to as Codec #1 and Codec #5) to handle wideband codec operation and the additional signal line requirements of trunking operation. Since audio signals input to or output from the DSP are in a digitized format, the codecs convert the audio signals between analog and digital formats as required.

Microphone and MRTI audio signals are digitized by Codec #2 (p/o Audio Processing Circuitry) before being sent to DSP ASIC via PCM Codec Bus

### Speaker Audio

Speaker audio (to external speaker) is provided by codec #2. This signal is shared with MRTI RX Audio. The MRTI level is set (via the RSS) to suit MRTI output requirements. The adjustment is accomplished using a digital potentiometer which is controlled by the Host  $\mu$ P (via the SPI bus).

When the station is configured for operation with a full-duplex MRTI unit (the default is half-duplex), MRTI TX Audio is not routed to the speaker to prevent echo problems on the phone line. However, this also prevents use of the local microphone input and external speaker for MRTI testing.



Since trunking and MRTI share the same backplane connector, they are mutually exclusive.

## Microphone

Microphone audio passes through preamp/bias generator circuitry to a switch which selects mic or MRTI TX Audio, and routes the result to Codec #2. A separate path from the preamp output routes mic audio to the MRTI RX Audio output. This allows mic audio to reach the MRTI output without appearing on the local speaker. Gain in the mic audio paths is chosen to match the required MRTI levels.

## Discriminator Audio

DISC RX Audio is generated by linear Codec #5. Normally it is a wideband RX audio signal, available on the backplane for the system connector, the TCC connector (as Trunk RX Data), and for any option cards. However, it has three other functions as well:

- Under the influence of the Audio Mode input on the system connector, the signal is changed to band-limited RX audio with optional de-emphasis and squelch.
- In line test mode, Line 1 input audio from the Wireline Interface Board (WIB) is routed to this output for level checking and test purposes.

## Auxiliary TX Audio

The system connector input, Aux TX Audio, provides a path for audio from external equipment to reach the transmitter without passing through the wireline. The Audio Mode input switches it between wideband audio which is only splatter-filtered, and audio which is band-limited and pre-emphasized before being splatter-filtered. In either case, the audio reaches the DSP via codec #1. In line test mode, this input is routed to the Line 2 output for level setting and test purposes. In addition, for special applications, the signal can be routed directly to the exciter (i.e., does not pass through the DSP). There is no adjustable gain required for this input.

## Wireline Interface Board Audio

Each of the wireline inputs/outputs has a programmable gain stage on the Wireline Interface Board (WIB). Digitized audio is carried to/from the DSP ASIC via the PCM Codec bus. When the line 1/2 pair carries narrow-band audio, the audio is converted to/from digital format by a PCM Codec on the WIB.

For the 8-wire model WIB, the line 3/4 pair are restricted to narrow-band audio, and are converted to/from digital format by a PCM Codec on the WIB.

## MRTI Audio

MRTI audio is handled by Codec #2. In most installations, the MRTI is a half duplex device. This allows MRTI TX Audio to be routed to the local speaker (and thus to the MRTI RX AUDIO line) without causing echo problems (since the MRTI RX AUDIO line is muted in the MRTI). Gain in the MRTI paths is set by station software.

Full duplex MRTI operation is available, with the limitation that MRTI TX Audio does is not heard from the local speaker.

## Trunking Audio

A trunking station can operate as either a control channel or a voice channel. In either case, wideband audio is routed to/from the Trunking Central Controller (TCC) as Trunk TX Data (through Codec #1) and Trunk RX Data (through Codec #5), providing paths for control and status tones. For voice channel operation, voice audio is routed to the WIB as described in the Wireline Audio section.

## Exciter Modulation Signals

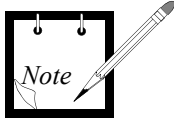
Digitized audio/data intended to be transmitted from the station is output from the DSP circuitry to Codec #1. The digitized signal is converted to analog, level shifted and amplified. The output is then fed to one of the inputs of a multiplexer switch. The output of the multiplexer is fed to two individual digitally-controlled potentiometers (each of which is adjusted by the Host  $\mu$ P via the SPI Bus) and output to the Exciter Module as modulation signals VCO MOD AUDIO and REF MOD AUDIO.

---

## Parallel I/O Circuitry

### General

The Parallel I/O circuitry allows the Host  $\mu$ P to generate SPI bus chip selects and to send/receive control signals to/from station modules and external options (via the backplane).



Refer to the Backplane section of this manual for complete details on the input/output signals which are routed to/from the backplane.

### Input Circuitry

A buffer is provided to route serial station information (SERIAL ID IN) to the Host  $\mu$ P from a serial ID device on the station backplane.

An octal buffer is used to allow various input control signals from optional station circuitry (connected to the backplane) to be accepted and sent to the Host  $\mu$ P. This includes input signals from MRTI and trunking equipment.

### Output Circuitry

Two 1-of-16 demultiplexers are used to provide various SPI bus chip selects and four octal D flip-flops provide control signals to be output to the SCM, the Receiver and Exciter modules, and station circuitry (via the backplane). Control of the demultiplexers and flip-flops comes via the Host Data bus and associated chip select signals from the Host  $\mu$ P.

### Front Panel LEDs

Four status LEDs are provided on the front panel to provide visual indications of various station operating conditions. The LEDs are driven, via software control, by five lines from an octal D flip-flop in the Parallel I/O circuitry.



The front panel **Station Status** indicator actually comprises two LEDs, one red and one green, which produce a bicolor effect to indicate different informational messages, depending on the particular LED(s) and duty cycle enabled. The resulting bicolor effect is achieved by locating the two LEDs adjacent to each other on the SCM board and combining the light sources through a single light pipe to the front panel.



Refer to the Station Operation section of this manual for complete details on the interpretation of the LEDs.

---

## Supply Voltage Circuitry

The SCM contains on-board regulator and filtering circuitry to generate the various operating voltages required by the SCM circuitry. The SCM routes +10 V and +8 V from two regulators on the backplane to the Receiver and Exciter modules.

+14.2 V and +5V from the power supply (via the backplane) are used as sources for the following supply voltage circuits:

- +15 V Regulator Circuitry – voltage doubler circuit accepts +14.2 V input and feeds +15 V regulator to provide +15 V for the Receiver and Exciter modules.
- +12 V Regulator Circuitry – accepts input from the +15 V regulator to generate the voltage required (under Host  $\mu$ P control) for powering the Flash memory device during programming and erasing cycles.
- +5 V Regulator Circuitry – provides VCCA (analog +5 V) for the Audio Processing circuitry in the SCM.
- Filtering Circuitry – filters the +14.2 V and +5 V from the power supply (via backplane) to provide +14.2 V and VCC (digital +5 V) for the SCM digital circuitry.

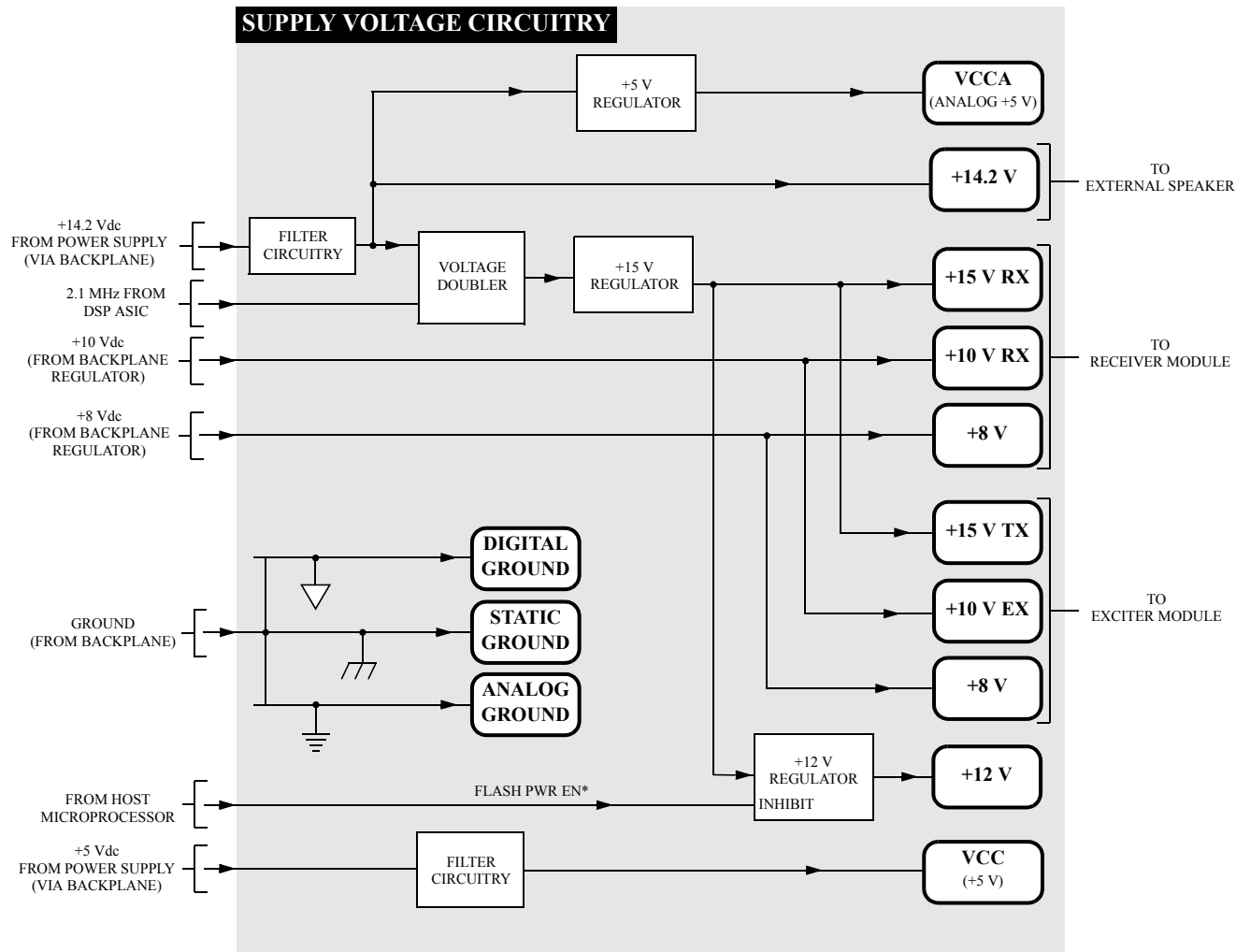
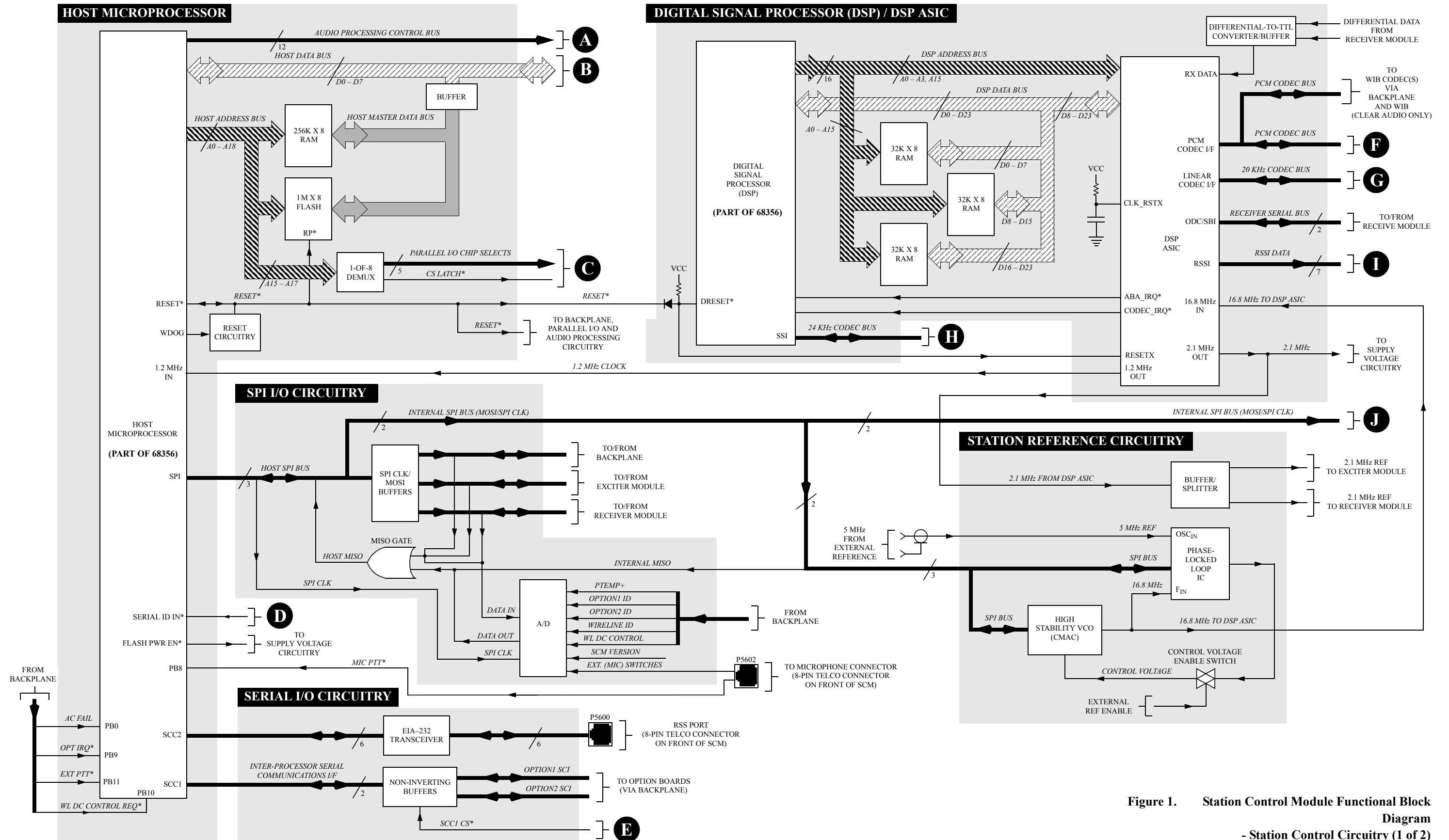


Figure 2. Station Control Module Functional Block Diagram - Supply Voltage Circuitry







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# 4 WIRE, EURO WIRELINE INTERFACE BOARD MODEL CLN1204

## 1

### DESCRIPTION

The Model CLN1204 Wireline Interface Board is described in this section. A general description, identification of jumpers, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

#### General Description

The Wireline Interface Board (WIB) serves as the interface between the customer telephone lines and the station equipment. Each WIB contains circuitry to interface with a variety of telephone line configurations and signal types.

The WIB is installed behind the front panel, above the Station Control Module within the option-card bracket, and is connected to a 96-pin Euro connector located on the backplane of the station. The phone line connections are routed from a wire-trap terminal block mounted on the rear of the backplane to the WIB connector.

#### Overview of Circuitry

The WIB contains the following circuitry:

- Audio and Data Circuits – the WIB provides inbound and outbound voice and data circuits which interface with the customer phone lines
- Line Impedance Selection – jumper fields provide impedance matching to satisfy several different wireline telecom specifications.

2

INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the location of the WIB jumpers and all input and output external connections.

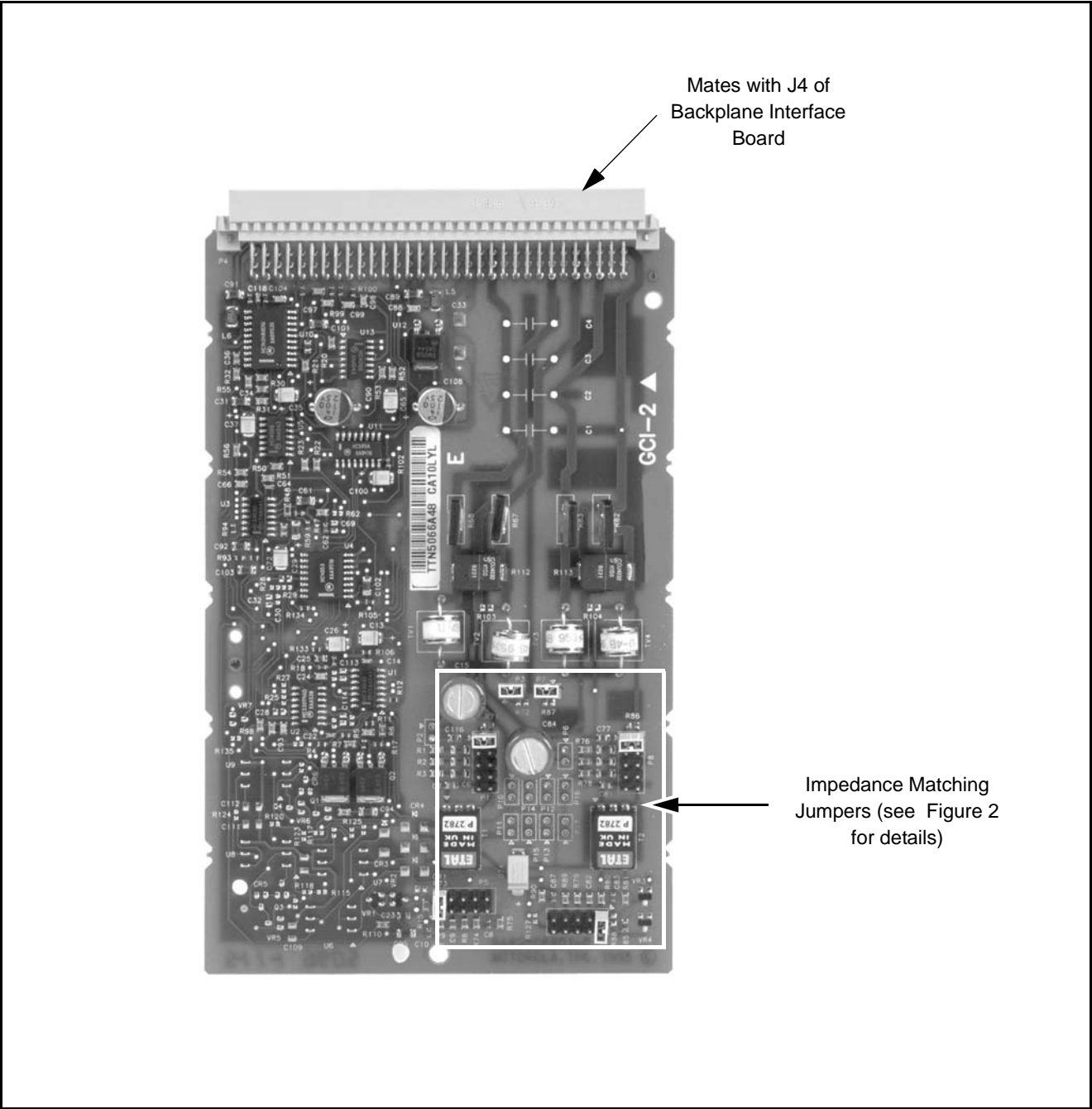


Figure 1. CLN1204 Wireline Interface Board Jumpers and Input/Output Connections

# 3

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the WIB circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 3 for a block diagram of the 2-wire voice signal path, and to Figure 4 for the 4-wire voice signal path.

---

### Functional Overview (Refer to Figures 3 & 4)

#### Introduction

As mentioned previously, the WIB serves as the interface between the customer analog telephone lines and the serial PCM data signals of the station equipment. In general, the WIB routes all voice and/or remote control signals between the station equipment and the landline equipment (e.g., a control center, modem, etc.).

As shown in the block diagrams in Figures 3 and 4, the WIB contains one 2-wire audio circuit and one 4-wire audio circuit. Also provided is impedance-matching jumper fields which are used to meet various wireline specifications.

#### Audio/Data Circuits

As shown in the block diagrams, each WIB contains a PCM Codec-filter, SPI latch and associated circuitry which can be configured to provide the following signal paths:

- 2-wire voice audio/data from landline to station, and from station to landline
- 4-wire voice audio/data from landline to station, and from station to landline

These audio signals may include Tone Remote Control signals

---

## Description of Audio/Data Signal Paths



For 2-wire and 4-wire configurations, phone line connections are made at the wire-trap terminal connector on the station backplane, with the required line impedance match being selected on the WIB. 2-wire audio connections are made at Line 2 Audio.



**Refer to Figure 2 for the correct settings of impedance matching jumpers, as determined by the country in which the station is being operated. Incorrect jumper settings may violate local telecommunications authority regulations and place the equipment in an unapproved status. Some countries also specify a maximum allowed line input level. Refer to the RSS Online Help, under Line Level.**

Coarse gain adjustments are provided by circuitry on the WIB for Landline-to-Station and Station-to-Landline audio paths. Additional fine level adjustments are performed in software in the Station Control Module.

### 2-Wire Voice Audio Path (Refer to Figure 3)

Voice audio signals sent to/from the station via 2-wire copper pair are processed by the 2-wire audio circuit on the WIB (Line 2 Audio). The audio transformer in this circuit may have both inbound and outbound audio signals present simultaneously. In this case, the outbound and inbound signals are mixed and routed via the inbound audio path to the SCM, where an adaptive cancellation routine in the DSP isolates the inbound audio. The 2-wire audio circuit operates as follows:

Landline-to-Station balanced audio is input to the primary of an audio transformer. The signal is induced into the transformer secondary and fed to a buffer. (Note that jumpers in parallel with the transformer primary and secondary provide for selectable impedance matching. Refer to Figure 2 for impedance matching information.)

The buffer sums the inbound and outbound signals and feeds this signal, via an analog switch (not shown), to pre-emphasis and gain adjust circuitry. To compensate for line losses, the gain adjust circuitry provides coarse adjustment for eight levels of gain adjust (5, 10, 15, 20, 25, 30, 35, and 40 dB) which is under the control of the SCM (via the SPI latch).

The output of the gain adjust circuitry is de-emphasized and then fed to an A/D converter in the PCM codec, which digitizes the audio signal into a PCM output. This output is fed serially to the DSP ASIC on the SCM, which provides a memory-mapped interface with the DSP and other SCM audio circuitry (refer to the Station Control Module section).

Station-to-Landline audio is input to the WIB as PCM data (WL 1/2 RXD) and fed to a D/A converter in the PCM codec, which takes the PCM data and converts it to an analog audio signal. The audio signal is fed to gain

adjust circuitry. The SCM controls the gain adjust circuitry (via the SPI latch) to provide four coarse levels of gain (0 dB, -6 dB, -12 dB, and -20 dB).

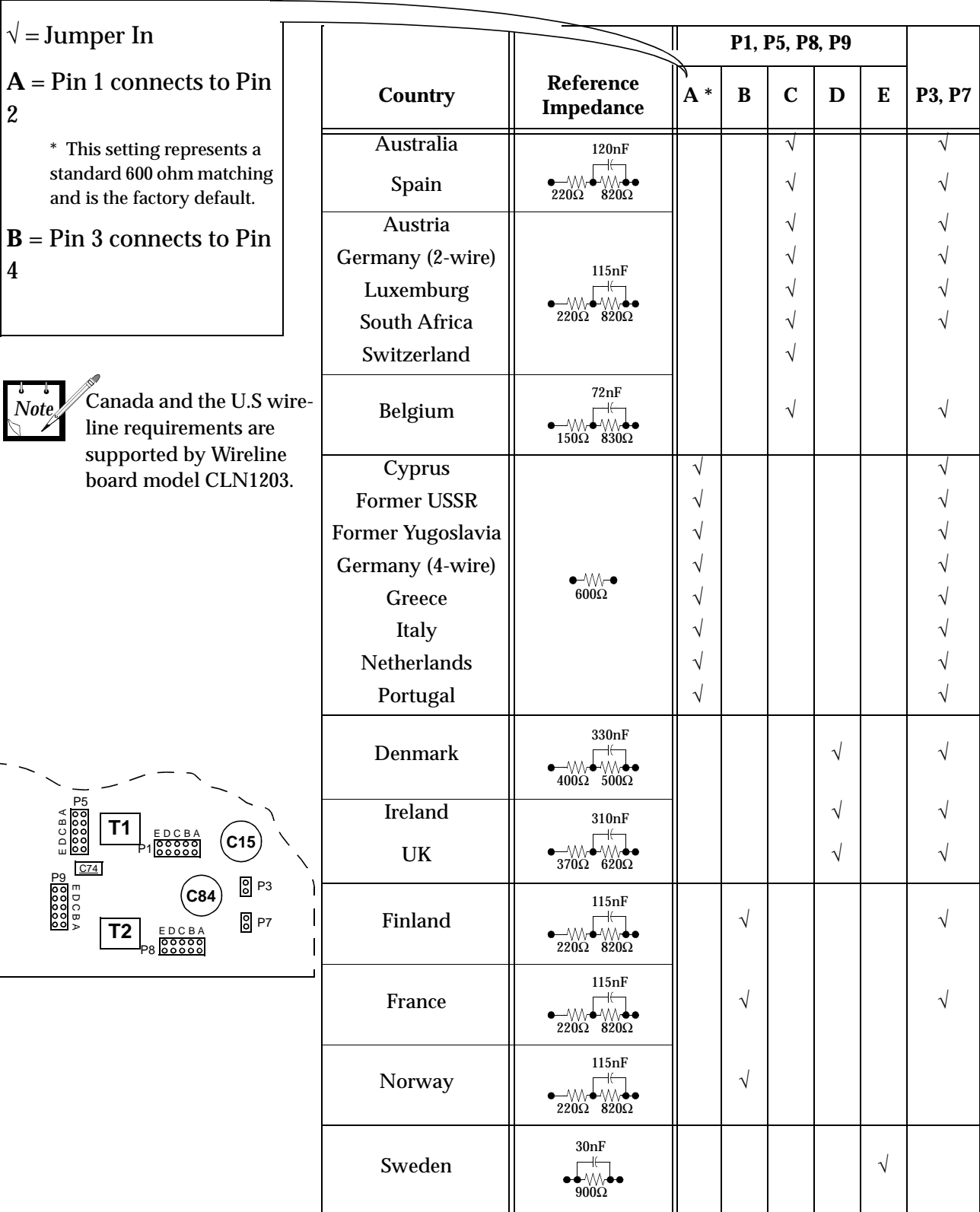
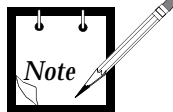


Figure 2. CLN1204 Wireline Interface Board Jumper Settings

The output of the gain adjust circuitry is fed through a 2-pole low-pass filter and into the inputs of two amplifiers. The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of the audio transformer. The audio signal is induced into the secondary and output to the landline system (via the wire-trap terminal connector) as balanced audio.

#### 4-Wire Voice Audio Path (Refer to Figure 4)



For 4-wire configurations, phone line connections are made at the wire-trap terminal connector on the station backplane. Landline-to-Station signals are connected at Line 1 Audio. Station-to-Landline signals are connected at Line 2 Audio.

Voice audio signals sent to/from the station via 4-wire copper pair are processed by the 4-wire audio path on the WIB (Line 1 Audio & Line 2 Audio). The 4-wire audio path operates as follows:

Landline-to-Station balanced audio (Line 1 Audio) is input to the primary of an audio transformer. The signal is induced into the transformer secondary and fed to a buffer. (Note that jumpers in parallel with the transformer primary and secondary provide for selectable impedance matching. Refer to Figure 2 for impedance matching information.)

The buffer feeds the audio signal to the pre-emphasis and gain adjust circuitry. To compensate for line losses, the gain adjust circuitry provides coarse adjustment for eight levels of gain adjust (5, 10, 15, 20, 25, 30, 35, and 40dB), which is under the control of the SCM (via the SPI latch).

The output of the gain adjust circuitry is de-emphasized and then fed to an A/D converter in the PCM codec, which digitizes the audio signal into a PCM output. This output is fed serially to the DSP ASIC on the SCM, which provides a memory-mapped interface with the DSP and other SCM audio circuitry (refer to the Station Control Module section).

Station-to-Landline audio is input to the WIB as PCM data (WL 1/2 RXD) and fed to a D/A converter in the PCM codec, which takes the PCM data and converts it to an analog audio signal. The audio signal is fed to the gain adjust circuitry. Under control of the SCM (via the SPI latch), the gain adjust circuitry provides four coarse levels of gain (0dB, -6dB, -12dB, and -20dB). The output of the gain adjust circuitry is fed through a 2-pole low-pass filter and into the inputs of two amplifiers (line drivers).

The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of an audio transformer. The audio signal is induced into the secondary and output to the landline system (via the wire-trap terminal connector on the backplane) as balanced audio.

The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of an audio trans-



former. The audio signal is induced into the secondary and output to the landline system (via the screw terminal connector) as balanced audio.

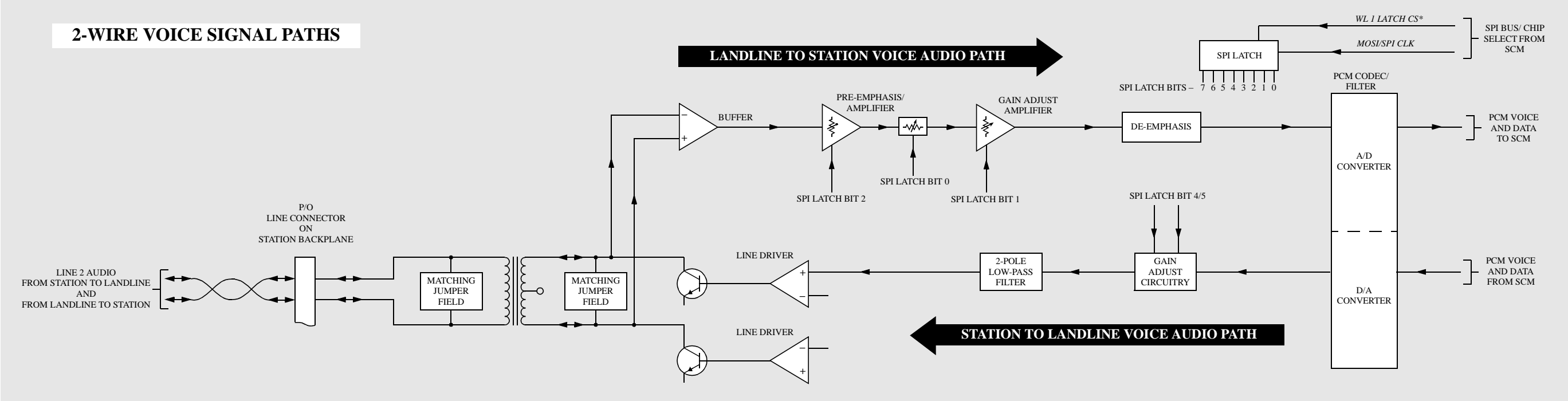


Figure 3. CLN1204 2-Wire Voice Audio Path Functional Block Diagram

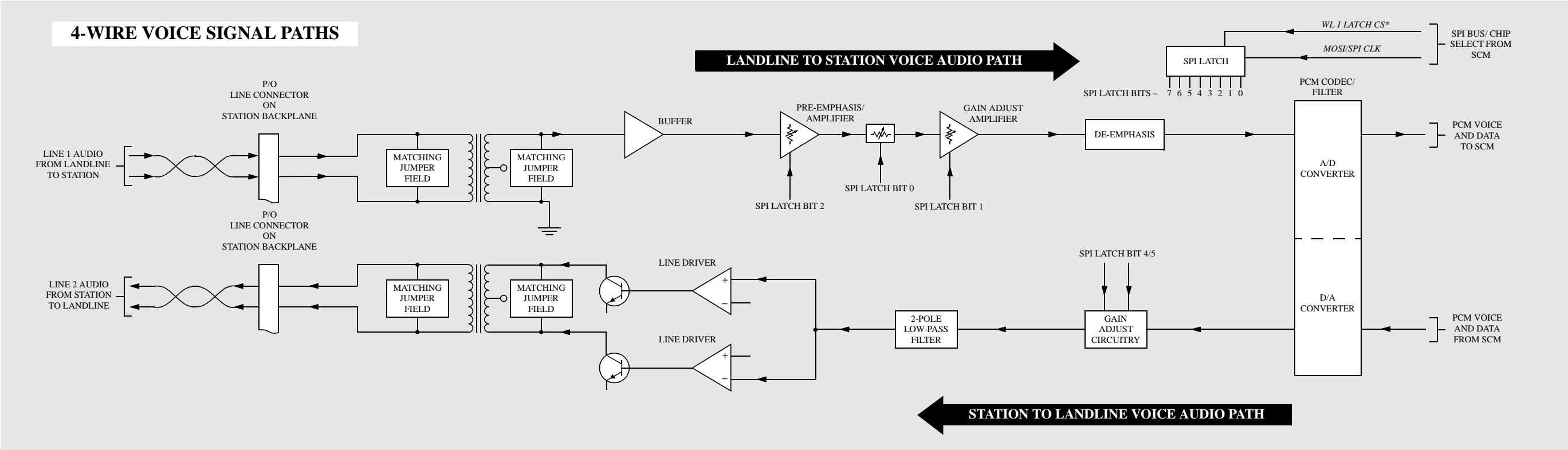


Figure 4. CLN1204 4-Wire Voice Audio Path Functional Block Diagram



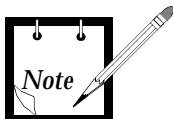
# 4 WIRE, WIRELINE INTERFACE BOARD

## MODEL CLN1203

### 1

## DESCRIPTION

The Model CLN1203 Wireline Interface Board is described in this section. A general description, identification of jumpers, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)



Some station operational features associated this board may not be supported by the MTR2000 station at this time. Refer to the ***Summary of Operational Features***, in the Description section, for a list of all currently available features.

## General Description

The Wireline Interface Board (WIB) serves as the interface between the customer telephone lines and the station equipment. Each WIB contains circuitry to interface with a 600  $\Omega$  impedance telephone line configuration with various signal types.

The WIB is installed behind the front panel, above the Station Control Module within the option-card bracket, and is connected to a 96-pin Euro connector located on the backplane of the station. The phone line connections are routed from a wire-trap terminal block mounted on the rear of the backplane to the WIB connector.

## Overview of Circuitry

The WIB contains the following circuitry:

- Audio and Data Circuits – the WIB provides a number of voice and data circuits which interface with the customer phone lines

2

INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the location of the WIB jumpers and all input and output external connections.

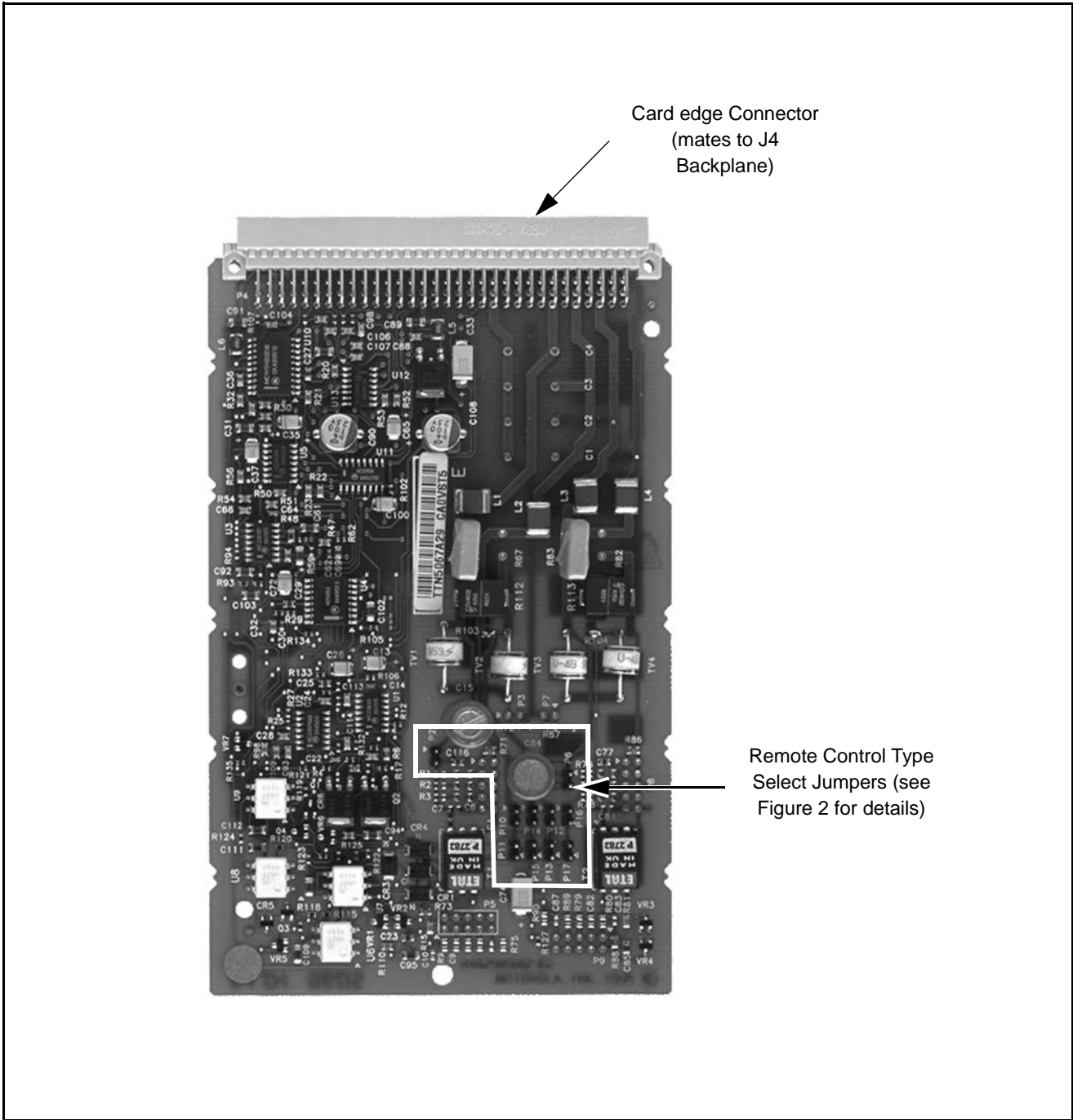


Figure 1. CLN1203 Wireline Interface Board Jumpers and Input/Output Connections

**3****FUNCTIONAL THEORY OF OPERATION**

The following theory of operation describes the operation of the WIB circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 3 for a block diagram of the 2-wire voice signal path, and to Figure 4 for the 4-wire voice signal path.

---

**Functional Overview**  
**(Refer to Figures 3 & 4)****Introduction**

As mentioned previously, the WIB serves as the interface between the customer analog telephone lines and the serial PCM data signals of the station equipment. In general, the WIB routes all voice and/or data signals between the station equipment and the landline equipment (e.g., a control center, modem, etc.).

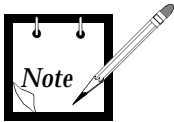
As shown in the block diagrams in Figures 3 and 4, the WIB contains one 2-wire audio circuit and one 4-wire audio circuit.

**Audio/Data Circuits**

As shown in the block diagrams, each WIB contains a PCM Codec-filter, SPI latch and associated circuitry which can be configured to provide the following signal paths:

- 2-wire voice audio/data from landline to station, and from station to landline
- 4-wire voice audio/data from landline to station, and from station to landline

Description of Audio/Data Signal Paths



For 2-wire and 4-wire configurations, phone line connections are made at the wire-trap terminal connector on the station backplane, providing a standard 600 Ω line matching impedance. 2-wire audio connections are made at Line 2 Audio.

Coarse gain adjustments are provided by circuitry on the WIB for Land-line-to-Station and Station-to-Landline audio paths. Additional fine level adjustments are performed in software in the Station Control Module.

Model CLN1203 WIB supports tone remote control of the station. Refer to Figure 2 for the jumper locations and correct settings for each type of remote control.

2-Wire Voice Audio Path (Refer to Figure 3)

Voice audio signals sent to/from the station via 2-wire copper pair are processed by the 2-wire audio circuit on the WIB (Line 2 Audio). The audio transformer in this circuit may have both inbound and outbound audio signals present simultaneously. In this case, the outbound and inbound signals are mixed and routed via the inbound audio path to the SCM, where an adaptive cancellation routine in the DSP isolates the inbound audio. The 2-wire audio circuit operates as follows:

Landline-to-Station balanced audio is input to the primary of an audio transformer (input has standard 600 Ω line matching impedance). The signal is induced into the transformer secondary and fed to a buffer.

The buffer sums the inbound and outbound signals and feeds this signal, via an analog switch (not shown), to pre-emphasis and gain adjust circuitry. To compensate for line losses, the gain adjust circuitry provides coarse

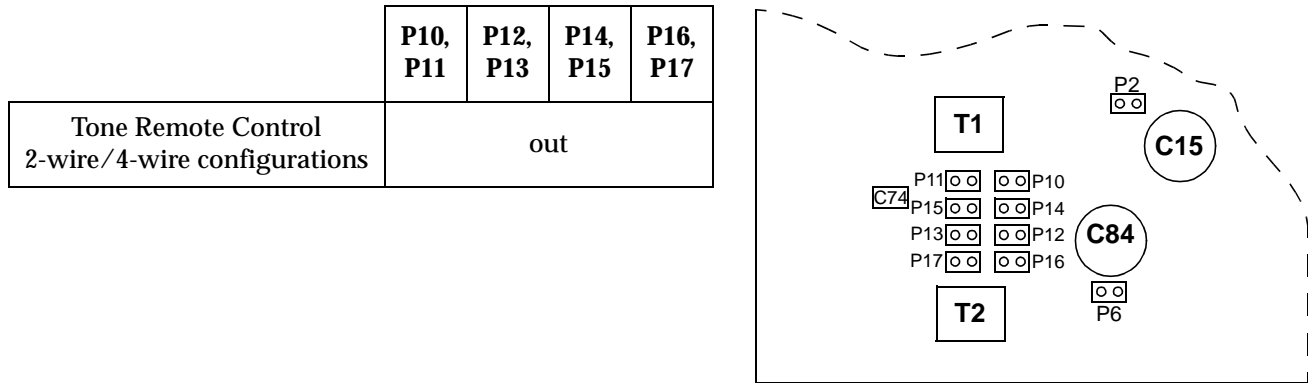


Figure 2. CLN1203 Wireline Interface Board Jumpers Settings

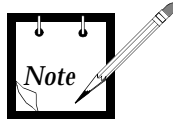
adjustment for eight levels of gain adjust (5, 10, 15, 20, 25, 30, 35, and 40dB), which is under the control of the SCM (via the SPI latch).

The output of the gain adjust circuitry is de-emphasized and then fed to an A/D converter in the PCM codec, which digitizes the audio signal into a PCM output. This output is fed serially to the DSP ASIC on the SCM, which provides a memory-mapped interface with the DSP and other SCM audio circuitry (refer to the Station Control Module section).

Station-to-Landline audio is input to the WIB as PCM data (WL 1/2 RXD) and fed to a D/A converter in the PCM codec, which takes the PCM data and converts it to an analog audio signal. The audio signal is fed to gain adjust circuitry. Under control of the SCM (via the SPI latch), the gain adjust circuitry provides four coarse levels of gain adjust (0dB, -6dB, -12dB, and -20dB).

The output of the gain adjust circuitry is fed through a 2-pole low-pass filter and into the inputs of two amplifiers. The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of the audio transformer. The audio signal is induced into the secondary and output to the landline system (via the wire-trap terminal connector) as balanced audio.

#### 4-Wire Voice Audio Data Path (Refer to Figure 4)



For 4-wire configurations, phone line connections are made at the wire-trap terminal connector on the station backplane. Landline-to-Station signals are connected at Line 1 Audio. Station-to-Landline signals are connected at Line 2 Audio.

For systems using tone remote control of the station, refer to Figure 2 for the jumper locations and correct settings for each type of remote control

Voice audio signals sent to/from the station via 4-wire copper pair are processed by the 4-wire audio path on the WIB (Line 1 Audio & Line 2 Audio). The 4-wire audio path operates as follows:

Landline-to-Station balanced audio (Line 1 Audio) is input to the primary of an audio transformer (input has standard 600  $\Omega$  line matching impedance). The signal is induced into the transformer secondary and fed to a buffer.

The buffer output feeds the audio signal to the pre-emphasis and gain adjust circuitry. To compensate for line losses, the gain adjust circuitry provides coarse adjustment for eight levels of gain adjust (5, 10, 15, 20, 25, 30, 35, and 40dB), which is under the control of the SCM (via the SPI latch).

The output of the gain adjust circuitry is de-emphasized and then fed to an A/D converter in the PCM codec, which digitizes the audio signal into a PCM output. This output is fed serially to the DSP ASIC on the SCM,

which provides a memory-mapped interface with the DSP and other SCM audio circuitry (refer to the Station Control Module section).

Station-to-Landline audio is input to the WIB as PCM data (WL 1/2 RXD) and fed to a D/A converter in the PCM codec, which takes the PCM data and converts it to an analog audio signal. The audio signal is fed to the gain adjust circuitry. Under control of the SCM (via the SPI latch), the gain adjust circuitry provides four coarse levels of gain adjustment (0dB, -6dB, -12dB, and -20dB). The output of the gain adjust circuitry is fed through a 2-pole low-pass filter and into the inputs of two amplifiers (line drivers).

The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of an audio transformer. The audio signal is induced into the secondary and output to the landline system (via the wire-trap terminal connector on the backplane) as balanced audio.



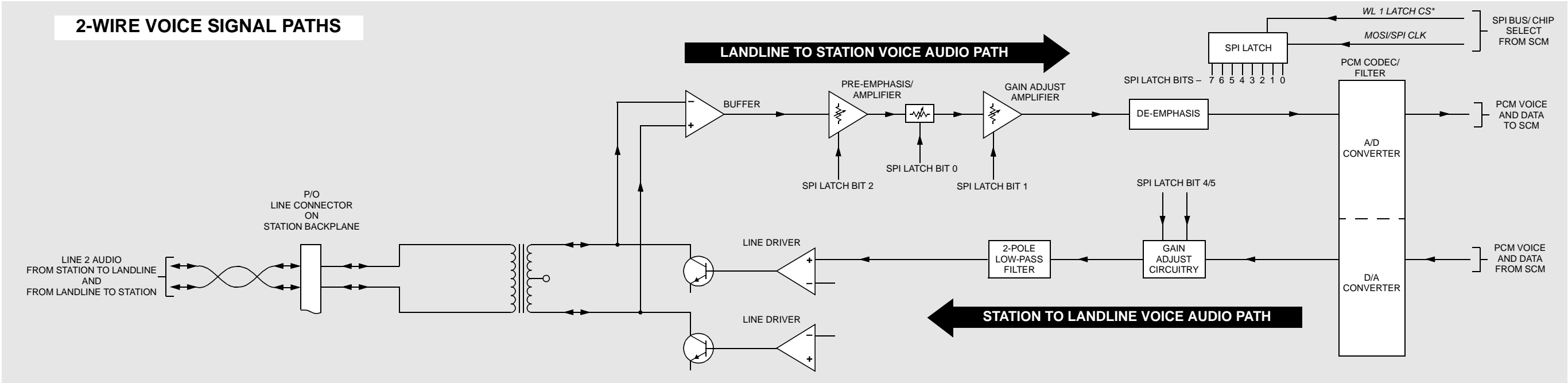


Figure 3. CLN1203; 2-Wire Voice Audio Path Functional Block Diagram

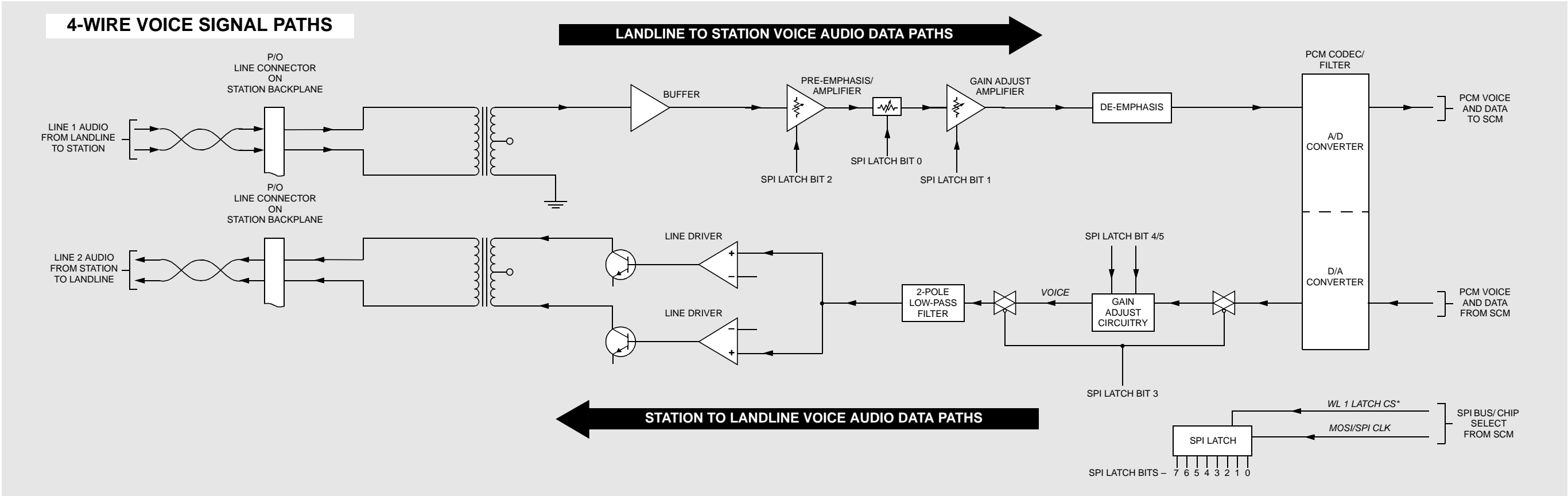


Figure 4. CLN1203; 4-Wire Voice Audio Data Path Functional Block Diagram



# 8 WIRE, WIRELINE INTERFACE BOARD

## MODEL CLN1205

### 1

## DESCRIPTION

The Model CLN1205 Wireline Interface Board (WIB) is described in this section. A general description, identification of jumpers, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The Wireline Interface Board (WIB) serves as the interface between the customer telephone lines and the station equipment. Each WIB contains circuitry to interface with a 600  $\Omega$  impedance telephone line configuration with various signal types.

The WIB is installed behind the front panel, above the Station Control Module within the option-card bracket, and is connected to a 96-pin Euro connector located on the backplane of the station. The phone line 1 and line 2 connections are routed from a wire-trap terminal block mounted on the rear of the backplane to the WIB connector. Phone line 3 and line 4 connections are routed from the system connector.

### Overview of Circuitry

The WIB contains the following circuitry:

- Audio and Data Circuits – the WIB provides a number of voice and data circuits which interface with the customer phone lines

2

INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the location of the WIB jumpers and all input and output external connections.

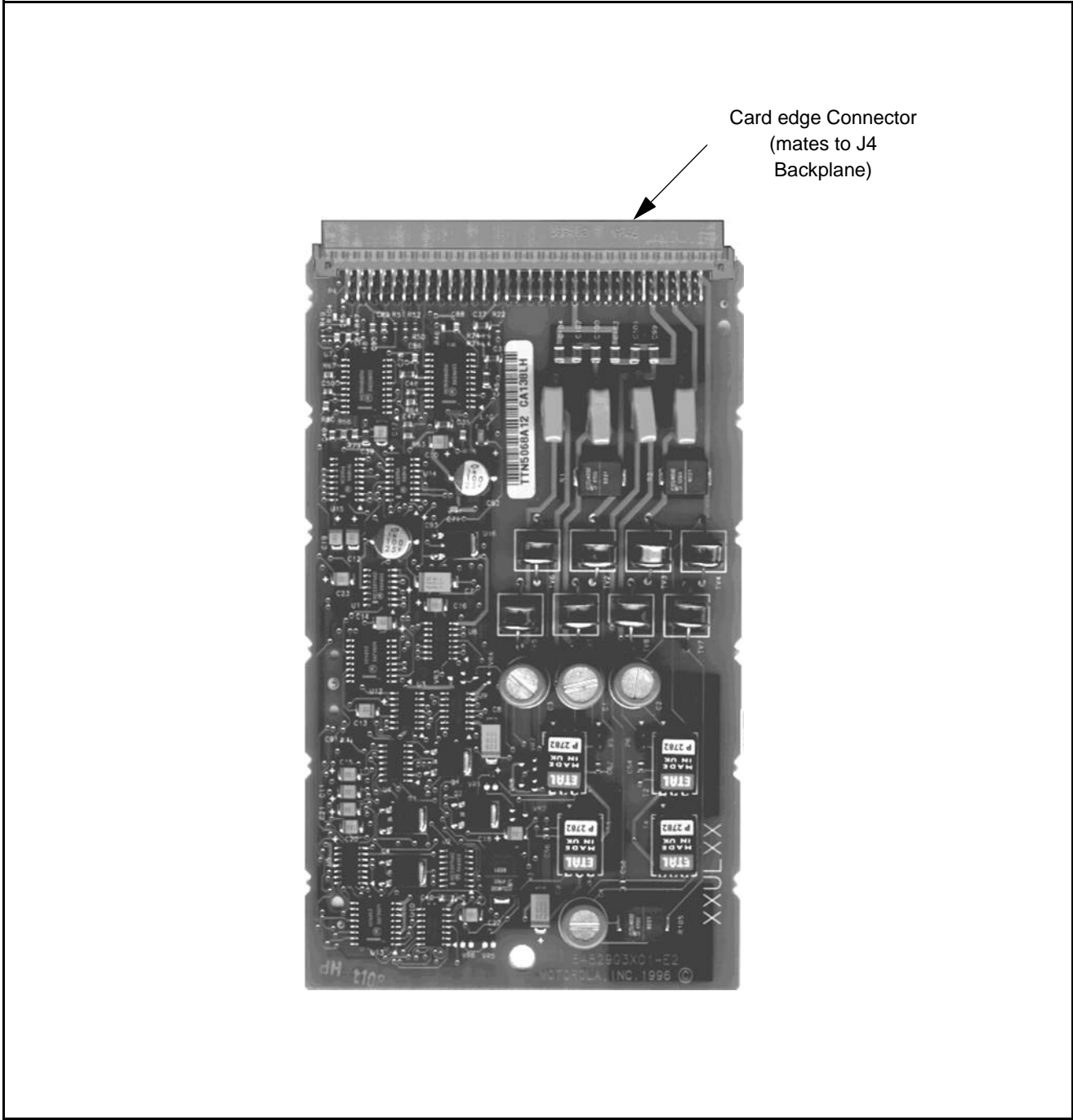


Figure 1. CLN1205 Wireline Interface Board Input/Output Connections

**3****FUNCTIONAL THEORY OF OPERATION**

The following theory of operation describes the operation of the WIB circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level.

The CLN1205 WIB can provide:

- 8-wire to support the Console Priority Interface (CPI) function,

The 8-wire capability is described in the following subsections. Refer to Figure 2 for a block diagram of the 8-wire voice signal paths.

- 4-wire, or
- 2-wire operation.

The 4-wire and 2-wire capability is described in the following subsections, and is identical to that provided by the 4-wire WIB (CLN1203), except that there is no circuitry to support DC Remote. The 4-wire WIB operation is the same as that described in the 4 WIRE, WIRELINE INTERFACE BOARD WITH DC REMOTE, MODEL CLN1203 section of this manual.

---

## Functional Overview

(Refer to Figure 2)

### Introduction

As mentioned previously, the WIB serves as the interface between the customer analog telephone lines and the serial PCM data signals of the station equipment. In general, the WIB routes all voice and/or data signals between the station equipment and the landline equipment (e.g., a control center, modem, etc.).

As shown in the block diagrams in Figure 2, the WIB contains one 8-wire audio circuit.

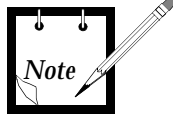
### Audio/Data Circuits

As shown in the block diagram of Figure 2, each WIB contains 2 PCM Co-dec-filters, 2 SPI latches and associated circuitry which can be configured to provide the following signal paths:

- 8-wire voice audio/data from landline to station, and from station to landline; to support CPI operation only.
- OR 4-wire full duplex operation on half of the board using lines 1 and 2. This mode of operation is identical to that described in the CLN1203 section.
- OR 2-wire half duplex operation using line 2.

---

## Description of Audio/Data Signal Paths



### 8-Wire Voice Audio Data Path (Refer to Figure 2, Lines 1 to 4)

For this 8-wire configuration:

- phone line 1 and line 2 connections are made at the wire-trap terminal connector on the station backplane, providing a standard 600  $\Omega$  line matching impedance.
- line 3 and line 4 connections are made at the system connector on the station backplane, providing a standard 600  $\Omega$  line matching impedance.

Coarse gain adjustments are provided by circuitry on the WIB for Landline-to-Station and Station-to-Landline audio paths. Additional fine level adjustments are performed in software within the Station Control Module.

8-wire operation is provided through two sets of circuitry; each set provides a 4-wire voice audio data path.

### 4-Wire Voice Audio Data Path (Refer to Figure 2, Lines 1 and 2)



For 4-wire configurations, phone line 1 and line 2 connections are made at the wire-trap terminal connector on the station backplane. Landline-to-Station signals are connected at Line 1 Audio. Station-to-Landline signals are connected at Line 2 Audio.

Voice audio signals sent to/from the station via 4-wire copper pair are processed by the 4-wire audio path on the WIB (Line 1 Audio & Line 2 Audio). The 4-wire audio path operates as follows:

Landline-to-Station balanced audio (Line 1 Audio) is input to the primary of an audio transformer (input has standard 600  $\Omega$  line matching impedance). The signal is induced into the transformer secondary and fed to a buffer.

Station-to-Landline audio is input to the WIB as PCM data (WL 1/2 RXD) and fed to a D/A converter in the PCM codec, which takes the PCM data and converts it to an analog audio signal. The audio signal is fed to the gain adjust circuitry. Under control of the SCM (via the SPI latch), the gain adjust circuitry provides four coarse levels of gain adjustment (0 dB, -6 dB, -12 dB, and -20 dB). The output of the gain adjust circuitry is fed through a 2-pole low-pass filter and into the inputs of two amplifiers (line drivers).

The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of an audio trans-

former. The audio signal is induced into the secondary and output to the landline system (via the wire-trap terminal connector on the backplane) as balanced audio.

## **2-Wire Voice Audio Path** **(Refer to Figure 3 of the CLN1203 section, Line 2)**

Voice audio signals sent to/from the station via 2-wire copper pair are processed by the 2-wire audio circuit on the WIB (Line 2 Audio). The audio transformer in this circuit may have both inbound and outbound audio signals present simultaneously. In this case, the outbound and inbound signals are mixed and routed via the inbound audio path to the SCM. The 2-wire audio circuit operates as follows.

Landline-to-Station balanced audio is input to the primary of an audio transformer (input has standard 600  $\Omega$  line matching impedance). The signal is induced into the transformer secondary and fed to a buffer.

The buffer sums the inbound and outbound signals and feeds this signal, via an analog switch (not shown), to pre-emphasis and gain adjust circuitry. To compensate for line losses, the gain adjust circuitry provides coarse adjustment for eight levels of gain adjust (5, 10, 15, 20, 25, 30, 35, and 40 dB), which is under the control of the SCM (via the SPI latch).

The output of the gain adjust circuitry is de-emphasized and then fed to an A/D converter in the PCM codec, which digitizes the audio signal into a PCM output. This output is fed serially to the DSP ASIC on the SCM, which provides a memory-mapped interface with the DSP and other SCM audio circuitry (refer to the Station Control Module section).

Station-to-Landline audio is input to the WIB as PCM data (WL 1/2 RXD) and fed to a D/A converter in the PCM codec, which takes the PCM data and converts it to an analog audio signal. The audio signal is fed to gain adjust circuitry. Under control of the SCM (via the SPI latch), the gain adjust circuitry provides four coarse levels of gain adjust (0 dB, -6 dB, -12 dB, and -20 dB).

The output of the gain adjust circuitry is fed through a 2-pole low-pass filter and into the inputs of two amplifiers. The outputs of the amplifiers are fed to two transistors which are connected in a push-pull configuration to drive the primary of the audio transformer. The audio signal is induced into the secondary and output to the landline system (via the wire-trap terminal connector) as balanced audio.

In a CPI system (trunked systems with console control), the 8-wire WIB is used to carry additional control signals remotely over lines. Usually lines 1 and 2 are connected to the console and lines 3 and 4 are connected to the Central Interconnect Terminal (CIT). The 8-wire version of WIB generally consists of a duplicated 4-wire WIB. Two SPI switches control Lines 1 through 4.

8-WIRE VOICE SIGNAL PATHS

Note: For 2-WIRE configurations see the CLN1203 WIB Functional Block Diagram, Figure 3.

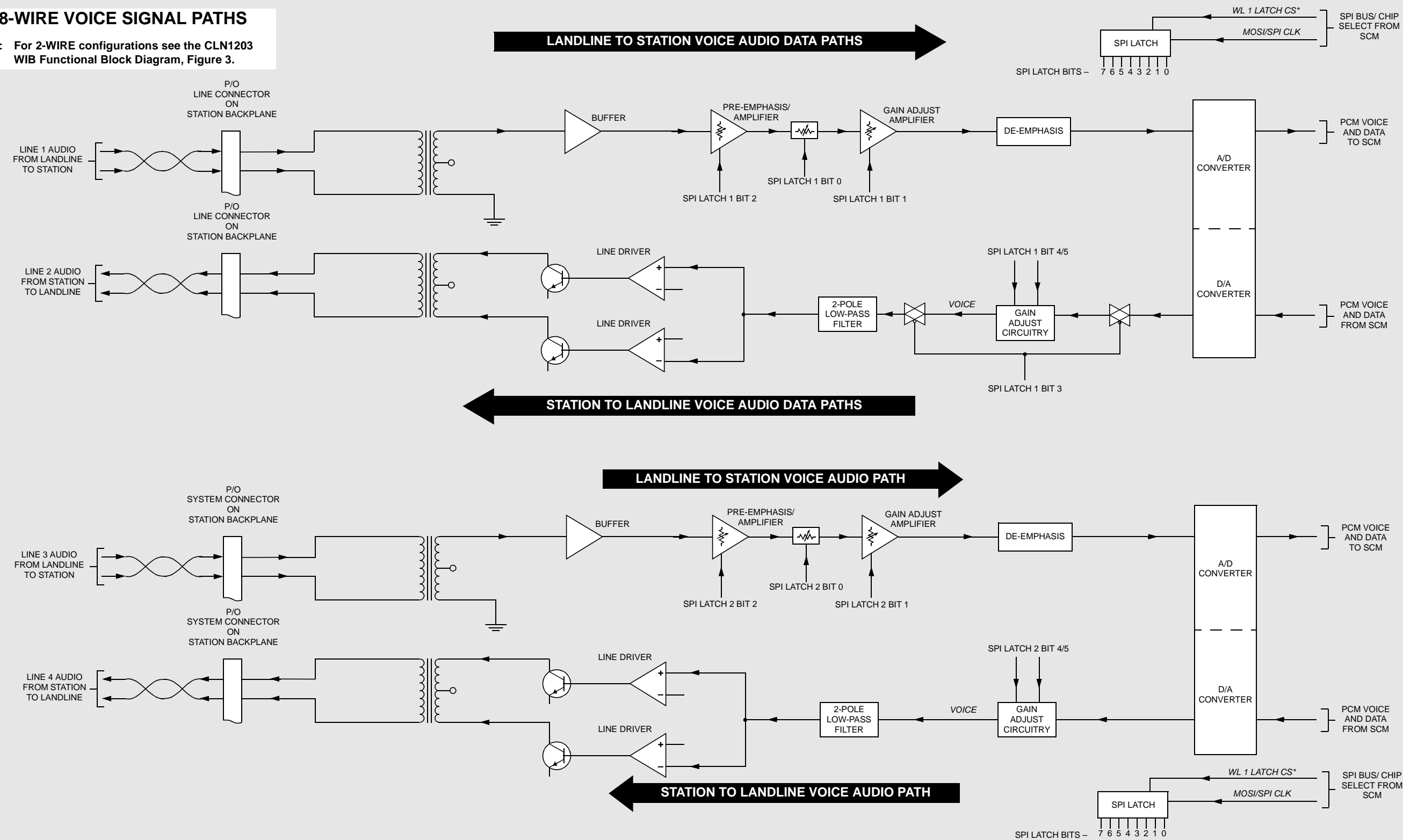


Figure 2. CLN1205 8-Wire Voice Audio Data Path Functional Block Diagram





# AUXILIARY I/O BOARD

## MODEL CLN1206

### 1

## DESCRIPTION

The Model CLN1206 Auxiliary I/O Board is described in this section. A general description, identification of jumpers, and inputs/outputs, functional block diagrams, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The Auxiliary I/O Board serves as the interface between a variety of auxiliary equipment external to the station (e.g., Trunking Controller) and the Station Control Module (SCM). The auxiliary equipment can be Motorola or non-Motorola equipment. If the Wild Card option is included with the station, then some System connector inputs and outputs can be configured through the RSS.

The Auxiliary I/O Board is installed behind the front panel, above the Station Control Module within the option-card bracket, and is connected to a 96-pin Euro connector (either J1 or J2) located on the backplane of the station. The auxiliary equipment connections are routed from the System connector (labeled **J5, SYSTEM**) to the Auxiliary I/O Board connector.

### Overview of Circuitry

The Auxiliary I/O Board contains the following circuitry:

- 11 general purpose inputs (GPIs) which interface with customer equipment.
- 11 general purpose outputs (GPOs) plus one dedicated relay driver, which interface with customer equipment.
- Jumper fields provide routing of signals to and from the SCM.

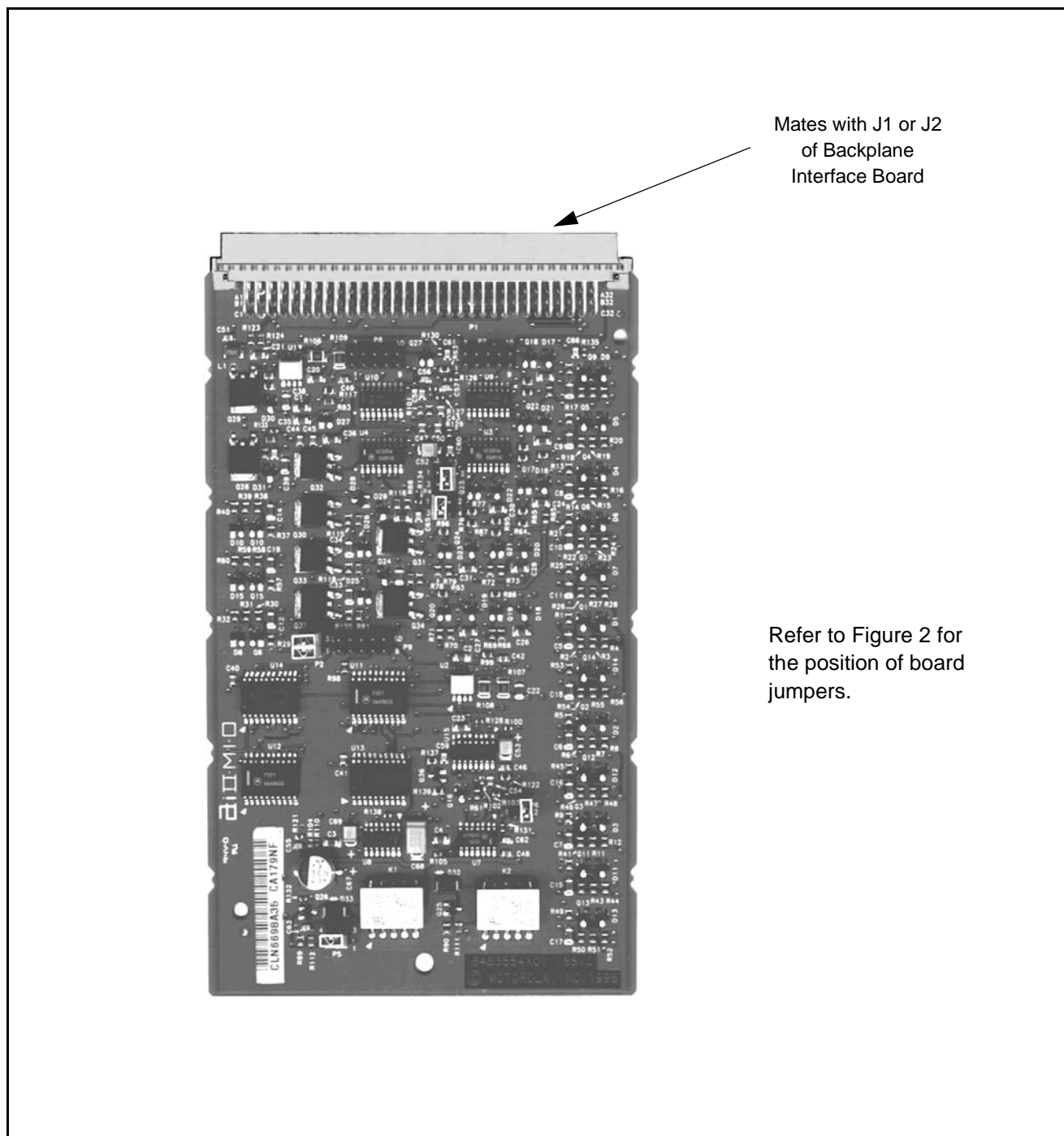


**Refer to the RSS Online Help for further detail on the GPIs, GPOs, and jumpers available on the Auxiliary I/O Board.**

## 2

## INPUT AND OUTPUT CONNECTIONS

Figure 1 shows the location of the Auxiliary I/O Board input and output external connections.



**Figure 1. CLN1206 Auxiliary I/O Board Input/Output Connections**

## 3

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the Auxiliary I/O Board circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 3 for a block diagram of the Auxiliary I/O Board.

---

### Functional Overview

#### Introduction

The Auxiliary I/O Board serves as the interface between the customer auxiliary equipment and the Station Control Module (SCM). In general, the Auxiliary I/O Board routes parallel input and output auxiliary equipment control signals between the SCM and the auxiliary equipment. There are 23 inputs and outputs available on the Auxiliary I/O Board, for connection with external equipment at any one time. There are 11 inputs and 12 outputs.

The SCM host processor reads and writes the auxiliary information with 16 bit data telegrams via the Serial Peripheral Interface (SPI). The hardware functionality of the Auxiliary I/O Board (e.g., Ext\_Failsoft, Rx\_Lock and Ext\_Alarms) is determined by the SCM software.

As shown in the block diagrams in Figures 3, the Auxiliary I/O Board contains signal buffer and latch circuits. Also provided are jumper fields which are used for various system configuration requirements.

## Input Circuits

As shown in the block diagrams, the Auxiliary I/O Board contains SPI Input Buffers and associated circuitry which provides an input signal path from auxiliary equipment to the station SCM.

The input circuitry comprises 16 general purpose inputs (GPI\_0 to GPI\_15) of which 11 are available; 3 of these 11 inputs are dedicated inputs and 8 are user programmable (see Table 1 or RSS Online Help for details):

- GPI\_0 to GPI\_13 are transistor buffered inputs.  
All transistor inputs can accept an open collector device from the auxiliary side. The impedance is 10 kOhm and if no open collector input drive is used, the input withstands a pull up to maximum 16 V.
- GPI\_14 and GPI\_15 are opto isolated inputs; rated at 2500Vrms isolation. Input voltage between 15 and 50V to activate input.

GPI\_14 can be configured as either an opto isolated or transistor input. This input can also be jumpered to the SPI Latch or to the EXT\_PTT SCM direct input (jumpers P2 and P9). When jumpered to the EXT\_PTT, GPI\_14 is used as fast External PTT control. The External PTT line has a direct path to the SCM in order to decrease reaction time by eliminating SPI processing delay.

**Table 1. General Purpose Inputs**

| GPI#   | Auxiliary I/O (P1) Pin # | Backplane System Connector (J5) Pin# | GPI Function   |
|--------|--------------------------|--------------------------------------|--|
| GPI_0  | B26                      | B7                                   | Dedicated to Ext_Repeat input                          |
| GPI_1  | C25                      | A8                                   | Not Supported (Do Not Use)                             |
| GPI_2  | C24                      | A9                                   | Not Supported (Do Not Use)                             |
| GPI_3  | C28                      | A5                                   | Wild Card input  |
| GPI_4  | A28                      | C5                                   | Wild Card input  |
| GPI_5  | B27                      | B6                                   | Not Supported (Do Not Use)                             |
| GPI_6  | C26                      | A7                                   | Dedicated to Ext_Failsoft input                        |
| GPI_7  | C11                      | A22                                  | Wild Card input  |
| GPI_8  | B28                      | B5                                   | Not Supported (Do Not Use)                             |
| GPI_9  | C6                       | A28                                  | Wild Card input  |
| GPI_10 | A24                      | C12                                  | Wild Card input  |
| GPI_11 | B23                      | B12                                  | Wild Card input  |
| GPI_12 | B22                      | B11                                  | Wild Card input  |
| GPI_13 | B24                      | B9                                   | Wild Card input  |
| GPI_14 | B7 or C5 + C7            | B26 or A29 + A26                     | Fast Ext_PTT input or Not Supported (jumper dependent) |
| GPI_15 | A26 + C27                | C7 + A6                              | Not Supported (Do Not Use)                             |

When data is routed from auxiliary equipment through the Auxiliary I/O Board to the SCM, it is stored in an SPI Input Buffer. At this time, an option interrupt request (OPT\_IRQ) is generated and sent to the SCM, indicating that data is available to be read. (During Reset and Initialization the IRQ is not sent to the SCM.) These inputs are then interrogated by the SCM applying OP1/2\_CS (Option Board 1 or 2 Chip Select), SPI\_Clock and serially reading via MISO (Master In / Slave Out). The IRQ also triggers the Latch Clock of the Input Buffers and sets the Comparator to the new status. The Comparators monitor old and new GPI status.

The minimum time within which GPI changes can be detected is 40 msec and the slowest slope that the signal can be is 1 V/sec.

Table 2 provides a description of the SPI Bus input circuitry signals.

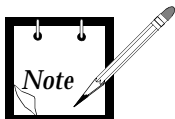
Table 3 provides a description of input circuitry for the Option Interrupt Request signal.

**Table 2. SPI Bus Input Circuitry Signals**

| Signal Name               | Function             | Auxiliary I/O Board Connector P1 | Description   | Signal Direction |
|---------------------------|----------------------|----------------------------------|---|------------------|
| MISO                      | Master In/ Slave Out | Pin B8                           | serial SPI Latch Data   | Output           |
| SPI_CLK                   | SPI Bit Clock        | Pin C8                           | A low to high transition shifts serial data bit out of the shift register | Input            |
| OP1/2_CS1<br>(see Note 1) | SPI Select Line      | Pin B11                          | A high to low transition activates the serial shift mode                  | Input            |

**Table 3. Option Interrupt Request Signal**

| Signal Name | Function  | Auxiliary I/O Board Connector P1 | Description<br>(see Note 2)   | Signal Direction |
|-------------|---|----------------------------------|---|------------------|
| Opt_IRQ*    | Interrupt when Status Change at GPI XX (active low) | Pin A25                          | Negative pulse with 350uS duration<br>30 mS delay after GPI Status change | Output           |



Note 1: OP1/2 represent two different signals routed to either:

- Option Slot 1 (P1/B11): that is, signal OP1\_CS1,
- or
- Option Slot 2 (which is also P1/B11): that is, signal OP2\_CS1.

Note 2: All signals are 5V TTL signals.

## Output Circuits

As shown in the block diagrams, the Auxiliary I/O Board contains SPI Output Latches and associated circuitry which provides an output signal path from the station SCM to auxiliary equipment.

The Latches are selected by using the OP1/2\_CS2 (Chip Select).

A serial SPI data block is routed from the Controller which contains the actual 16 Bit Output Pattern and is stored in the SPI Output Latches. After buffering by transistor stages the output information is made available for the auxiliary equipment.

The output circuitry comprises 16 general purpose outputs of which 12 are available; 7 of these 12 outputs are dedicated and 5 are user programmable (see Table 5 or the RSS Online Help for details):

- GPO\_0 to GPO\_2 are TTL outputs; maximum 40V, 50mA sink current. GPO\_8 to GPO\_13 are open collector transistor outputs; maximum 40V, 100mA sink current.
- GPO\_14 and GPO\_15) can be configured as dry (potential free) contact outputs (relay); contact rating is 250V, 1 A maximum.
- In addition there is a RF Relay Transistor Drive Stage provided which can be used for base station backup configurations; 40V, 100 to 200mA maximum sink current.

The Auxiliary I/O Board also provides some fast reacting outputs which are directly controlled by the SCM processor and which bypass the SPI Latches. This avoids the time consuming SPI write and store process. The fast reacting output functions are Fast Carrier Detect, AC Fail, and RdStat. They are jumper selectable and routed to the Output Transistors of GPO\_14 (see Table 7) and GPO\_15 (see Table 8).

The Initialization and Reset Control Circuit of this board provides a controlled startup and reset of the output registers during the powerup or reset process. This ensures that no erroneous data is seen by the auxiliary equipment before the Controller defines the outputs. This circuit also suppresses the Opt IRQs generated during reset and startup.

Table 2 provides a description of the SPI Bus input circuitry signals.

**Table 4. SPI Bus Output Circuitry Signals**

| Signal Name               | Function             | Auxiliary I/O Board Connector P1 | Description  | Signal Direction |
|---------------------------|----------------------|----------------------------------|--|------------------|
| MOSI                      | Master Out/ Slave In | Pin A7                           | serial SPI Latch Data  | Input            |
| SPI_CLK                   | SPI Bit Clock        | Pin C8                           | A low to high transition shifts serial data bit in to the shift register | Input            |
| OP1/2_CS1<br>(see Note 1) | SPI Select Line      | Pin A10                          | A high to low transition activates the serial shift mode                 | Input            |



Note 1: OP1/2 represent two different signals routed to either:

- Option Slot 1 (P1/A10): that is, signal OP1\_CS2, or
- Option Slot 2 (which is also P1/A10): that is, signal OP2\_CS2.



**Table 5. General Purpose Output Electrical Characteristics**

| Output   | Auxiliary I/O (P1) Pin # | Backplane System Connector (J5) Pin# | Output Type (see Note 1) | Maximum Sink Current (mA) | Maximum Voltage (V) | Output Function                                    | Jumper Settings (see Tables 6 & 7) (see Note 2) |
|----------|--------------------------|--------------------------------------|--------------------------|---------------------------|---------------------|--|---|
| GPO_0    | B25                      | A12                                  | LCO                      | 50                        | 40                  | Wild Card output                                   | -   |
| GPO_1    | C23                      | A10                                  | LCO                      | 50                        | 40                  | Dedicated to VSWR_Fail* output                     | -   |
| GPO_2    | C22                      | A11                                  | LCO                      | 50                        | 40                  | Wild Card output                                   | -   |
| GPO_3    | C6                       | A28                                  | LCO                      | 50                        | 40                  | Not Supported (Do Not Use)                         |   |
| GPO_4    | A24                      | C12                                  | LCO                      | 50                        | 40                  | Not Supported (Do Not Use)                         |   |
| GPO_5    | B23                      | B12                                  | LCO                      | 50                        | 40                  | Not Supported (Do Not Use)                         |   |
| GPO_6    | B22                      | B11                                  | LCO                      | 50                        | 40                  | Not Supported (Do Not Use)                         |   |
| GPO_7    | B24                      | B9                                   | LCO                      | 50                        | 40                  | Not Supported (Do Not Use)                         |   |
| GPO_8    | C32                      | A1                                   | OCO                      | 100                       | 40                  | Wild Card output                                   | -   |
| GPO_9    | B32                      | B1                                   | OCO                      | 100                       | 40                  | Dedicated to Rx_Lock output                        | -   |
| GPO_10   | A32                      | C1                                   | OCO                      | 100                       | 40                  | Dedicated to Tx_Lock output                        | -   |
| GPO_11   | C31                      | A2                                   | OCO                      | 100                       | 40                  | Dedicated to PA_Fail output                        | -   |
| GPO_12   | A29                      | C4                                   | OCO                      | 100                       | 40                  | Dedicated to FailSoft output                       | -   |
| GPO_13   | B31                      | B2                                   | OCO                      | 100                       | 40                  | Wild Card output                                   | -   |
| GPO_14   | C4 / B4                  | A30/B29                              | RC                       | Contact rating = 1 A      | -                   | AC_Fail output or Not supported (jumper dependent) | P5 (2/4) or (1/2)                               |
| GPO_15   | A30 / B30                | C3 / B3                              | RC                       | Contact rating = 1 A      | -                   | Wild Card output or RdStat (jumper dependent)      | P3 (2/4) P4 (1/3) or P4 (2/4)                   |
| GPO_15   | B12 (see Note 3)         | B21 (see Note 3)                     | OCO                      | 100                       | 40                  | Wild Card output or RdStat (jumper dependent)      | P3 (3/4)  |
| RF Relay | B5                       | C9                                   | OCO                      | 200                       | 40                  | Dedicated to RF Relay driver                       | -   |

\* = Active Low



Note 1: The output types are:

LCO = Loaded Collector Output (RL = 10 kOhm pulled up to +5Vdc)

OCO = Open Collector Output (reverse diode protected)

RC = Relay Contact (dry: both Output Pins potential free)

Note 2: These alternate jumper settings also put different functions on the GPO (see Tables 7 and 8)

Note 3: Only available in Option slot 1.

Auxiliary I/O Configuration Jumpers

Jumpers are provided to route inputs and outputs in a specific direction to and from the SCM; the SCM determines the functionality of the inputs and outputs.

The board jumpers are shown in Figure 2.

GPI\_14 is a special input which can be jumpered to be a transistor input or opto isolated.

In addition it can be dedicated to the Ext\_PTT\* Line routed to the SCM. This function is a fast external PTT\* (an active low function).

The board jumper settings for P2, P9, P6 are provided in Table 6. Settings for P5 are provided in Table 7. Settings for P3, P4 are provided in Table 8.

P7 and P8 are not used.

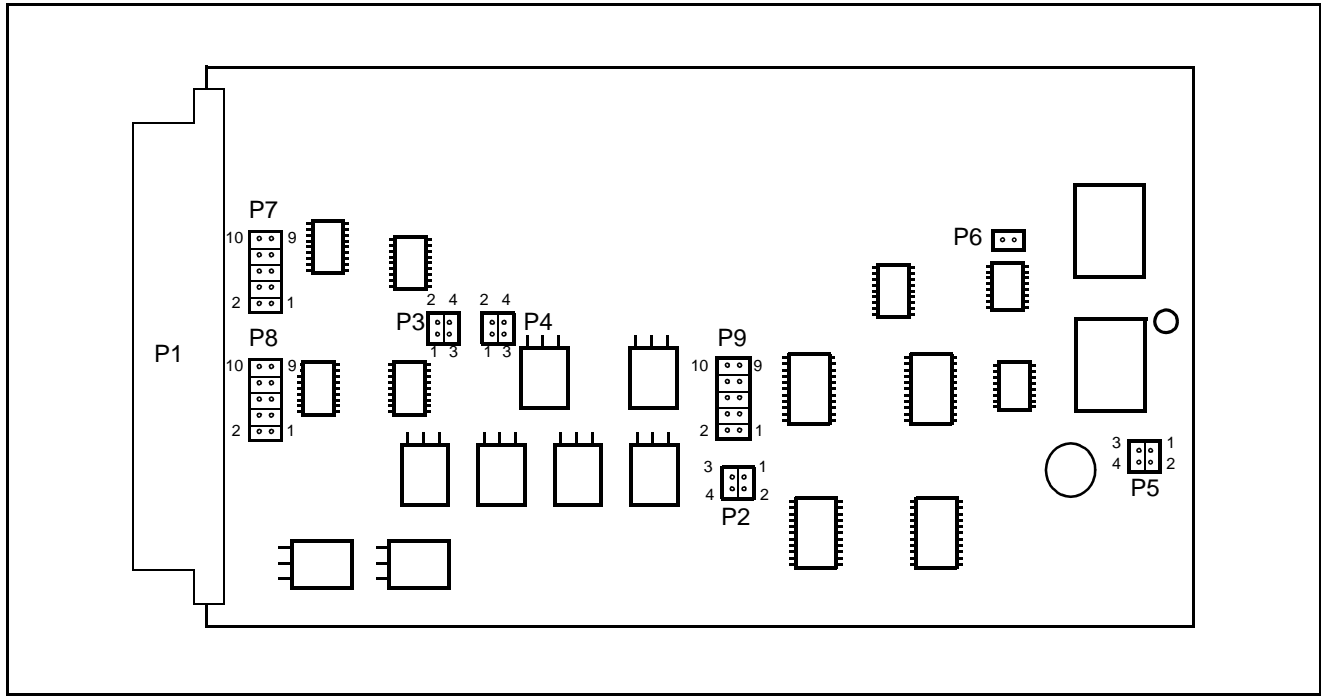


Figure 2. CLN1206 Auxiliary I/O Board Jumpers

Table 6. Configuring Input GPI\_14 Function

| Function on GPI_14                 | Input Type                 | System Connector Input Pins | Auxiliary I/O Board Jumpers |               |     |
|------------------------------------|----------------------------|-----------------------------|-----------------------------|---------------|-----|
|                                    |                            |                             | P2                          | P9            | P6  |
| Fast External PTT*<br>(See Note 1) | via Optocoupler (E/M sub). | A29 Opto +<br>A26 Opto –    | 3 - 4, 1 - 2                |               | In  |
|                                    | via Transistor             | B26                         |                             | 9 - 10, 7 - 8 | In  |
| Fast External PTT<br>(See Note 2)  | via Optocoupler (E/M sub)  | A29 Opto +<br>A26 Opto –    | 3 - 4, 1 - 2                |               | Out |
|                                    | via Transistor             | B26                         |                             | 9 - 10, 7 - 8 | Out |

Table 7. Configuring Output GPO\_14 Function

| Function on GPO_14                      | Output Type       | System Connector Output Pins | Auxiliary I/O Board Jumper P5 |
|---|-------------------|------------------------------|-------------------------------|
| AC Fail                                 | via Relay Closure | B29, A30                     | 2 - 4                         |
| SPI Latch for Bit 14 (software defined) | via Relay Closure | B29, A30                     | 1 - 2                         |

Table 8. Configuring Output GPO\_15 Function

| Function on GPO_15                      | Output Type                       | System Connector Output Pins | Auxiliary I/O Board Jumpers |       |
|---|-----------------------------------|------------------------------|-----------------------------|-------|
|   |                                   |                              | P3                          | P4    |
| Fast Carrier Detect                     | via Relay Closure                 | C3, B3                       | 2 - 4                       | 2 - 4 |
|   | via Open Collector                | B21 (see Note 4)             | 3 - 4                       | 2 - 4 |
| RdStat                                  | via Relay Closure<br>(see Note 3) | C3, B3                       | 2 - 4                       | 1 - 3 |
|   | via Open Collector                | B21 (see Note 4)             | 3, 4                        | 1, 3  |
| SPI Latch for Bit 15 (software defined) | via Relay Closure                 | C3, B3                       | 1 - 2                       |       |
|   | via Open Collector                | B21 (see Note 4)             | 1 - 3                       |       |



The shaded areas indicate default manufacturing settings.

Note 1: This is an active low; that is, no current to the Opto Input.

Note 2: This configuration, with P6 out (PTT when current to the Opto Input) represents the E Signal of 4 wire E&M Trunk Type I Phone Signalling. The opposite direction of the E&M is covered in Note 3.

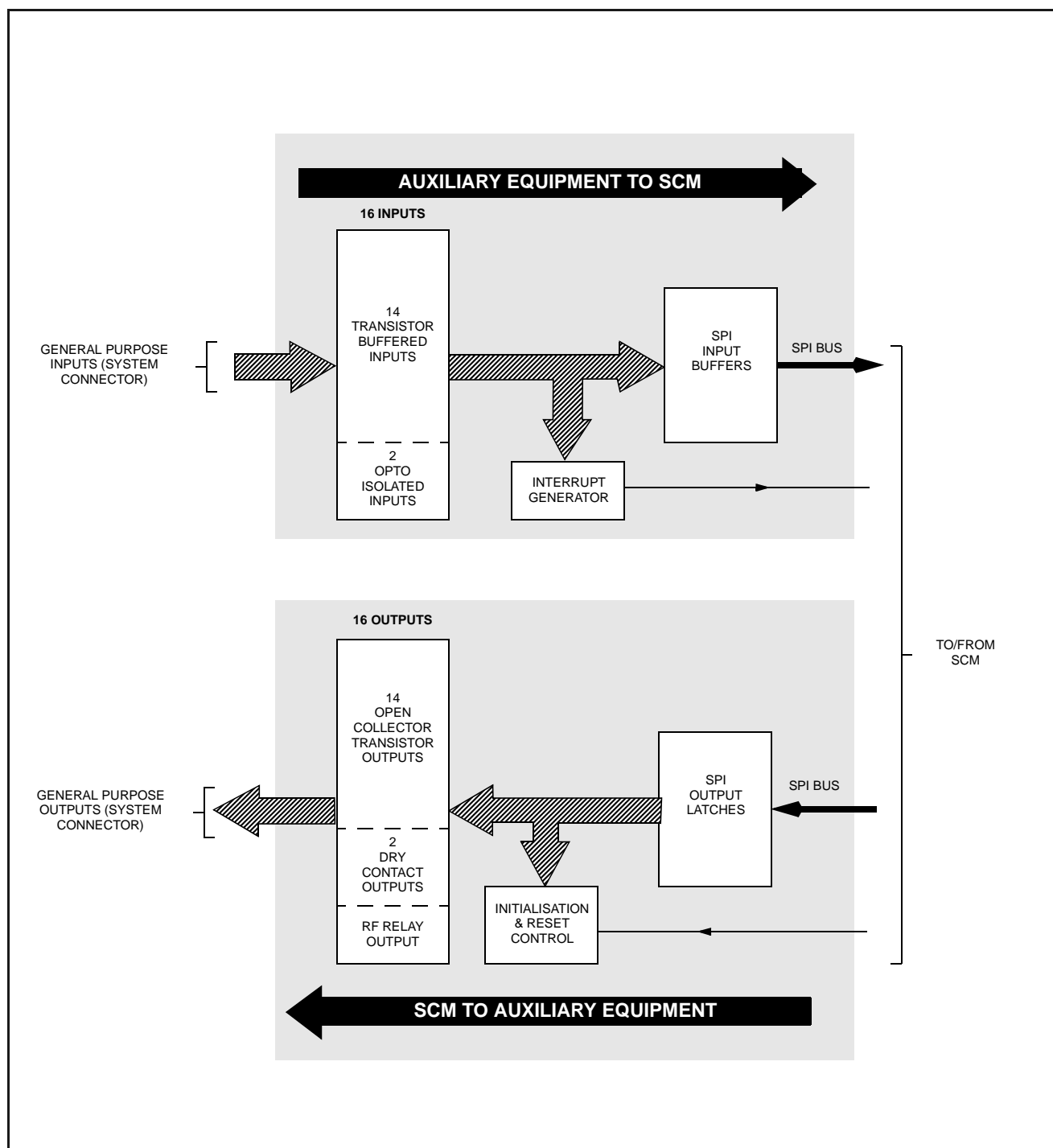


**In this configuration the second remaining unused input type must be jumpered to the SPI Buffer. The Buffer Input should never be left floating; otherwise the IRQ Generator will not function properly (i.e., use either P2-1&2 or P9-7&8).**

Note 3: This configuration represents the M Signal of 4 wire E&M Trunk Type I Phone Signalling. The opposite direction of the E&M is covered in Note 2.

Note 4: Indicates that the configuration is only available when the board is plugged into Option slot 1.

Note 5: See also Table 5 for detailed information.



**Figure 3. CLN1206 – Auxiliary I/O Board Functional Block Diagram**



# BACKPLANE INTERCONNECT BOARD

## MODEL CLN1202

### 1

## DESCRIPTION

The CLN1202 Backplane Interconnect Board provides the electrical interconnections between the Station Control Module (SCM), the Power Supply, the Power Amplifier, and any optional plug-in modules of the station. The board also provides the connectors necessary to interface the station to phone lines, peripheral RF equipment, and other communications and maintenance equipment. This section provides a general description, identification of inputs/outputs, and a pin-out listing for all connectors, including information on signal names, functions, and levels.

### General Description

The Backplane Interconnect Board (mounted across the rear of the station) is constructed with connectors on both sides. The connectors on one side mate with various station plug-in modules (such as the SCM, Wireline Interface Board and Auxiliary I/O option board); the connectors on the other side allow interface connections between the station and the phone lines, Power Supply, PA control signals, antenna relay, and other communications and maintenance equipment.

A metal shield mounts over the rear of the backplane board to provide protection for the circuit board runners and connector solder pads, ESD protection, and EMI/RFI shielding, as shown in Figure

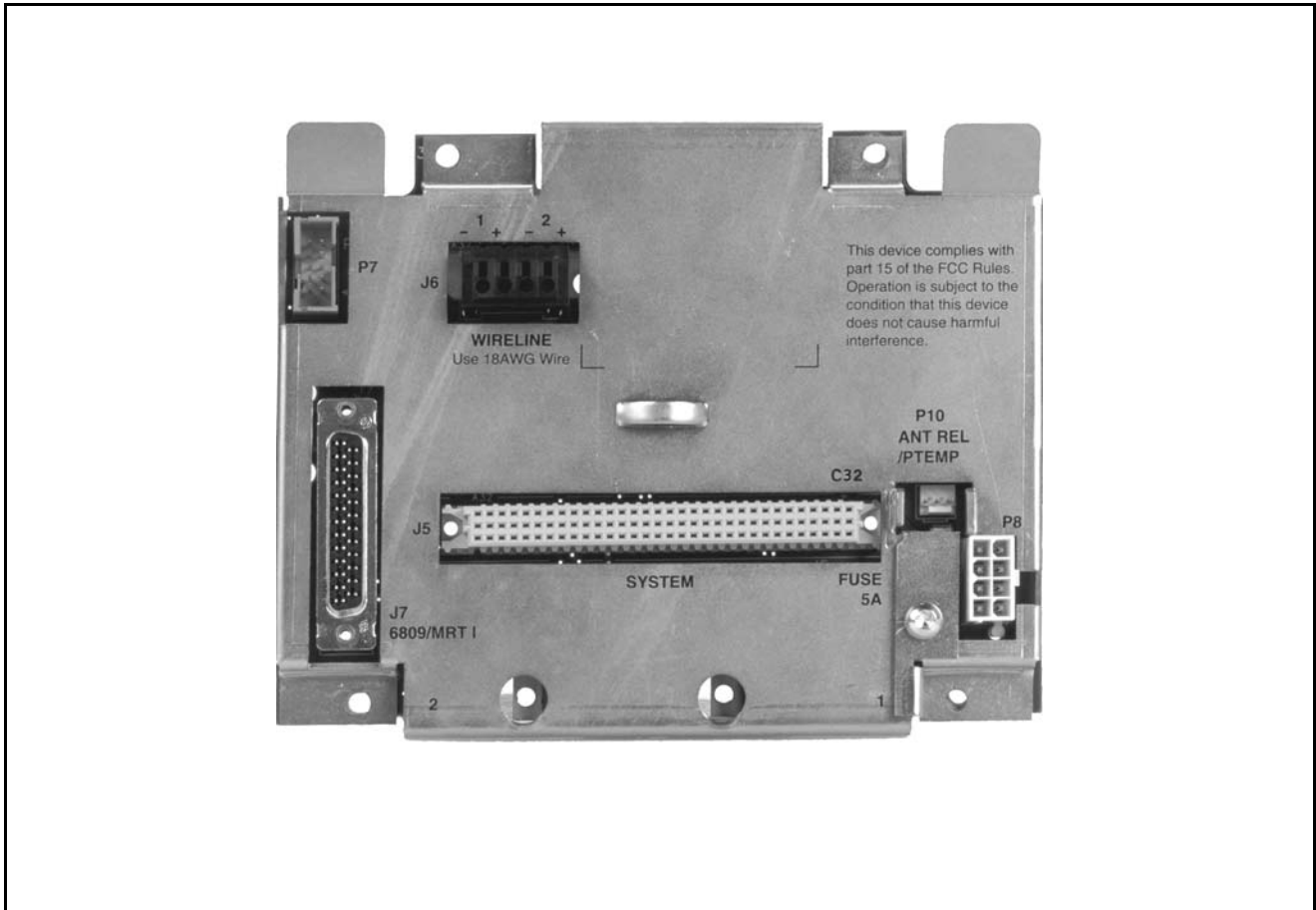
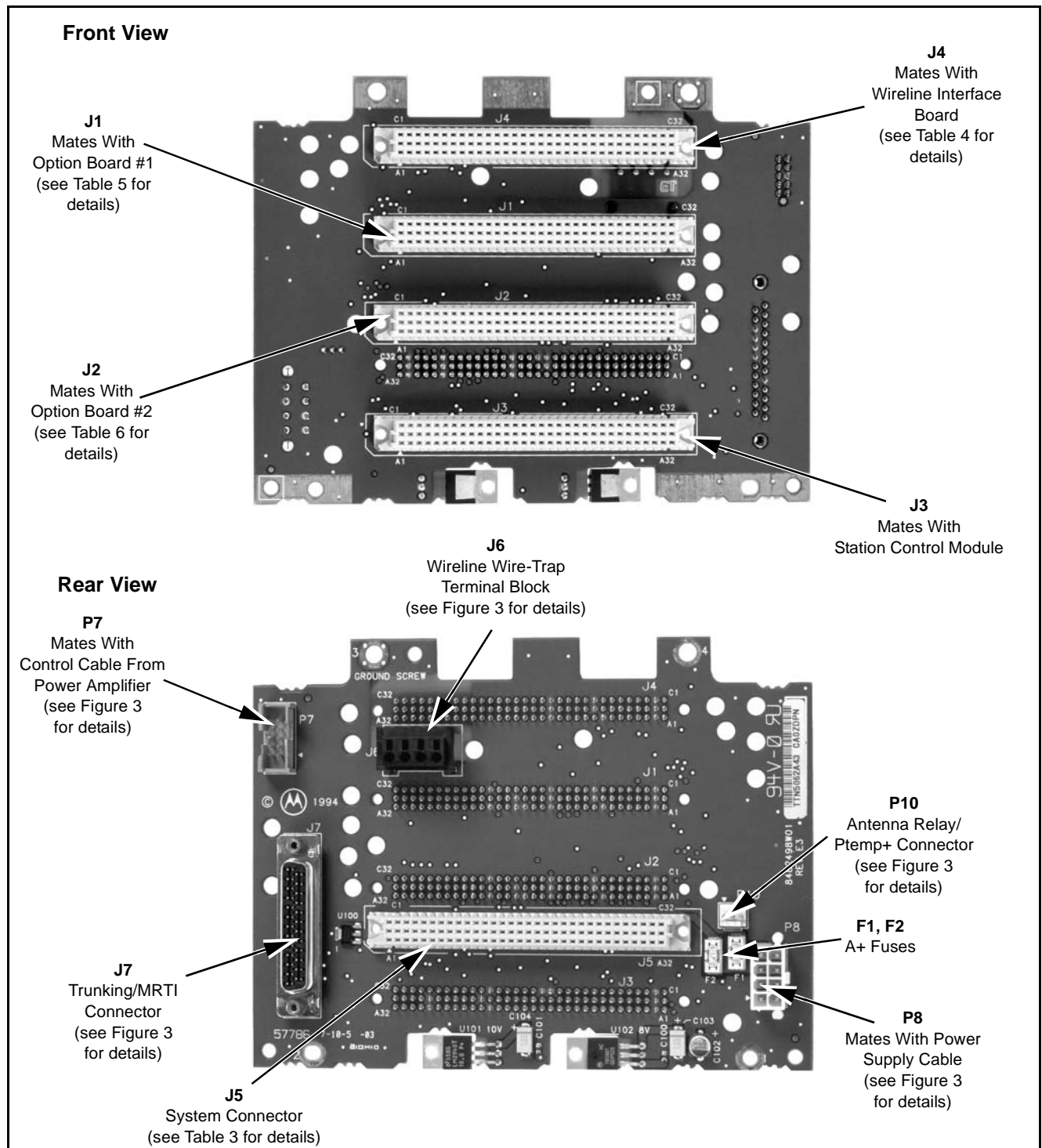


Figure 1. Backplane Interconnect Board

## 2

## LOCATION OF BACKPLANE CONNECTORS

Figure 2 shows the location of the connectors on each side of the Backplane Interconnect Board.



**Figure 2. Station Backplane Connector Locations (Front and Rear Views)**



## 3

## BACKPLANE CONNECTORS INFORMATION

Each connector on the backplane has been assigned a connector designation number. For rear connectors, the connector number is stamped into the metal shield covering the rear of the backplane board. Labels for connectors which accept the plug-in modules are viewable when the front panel is removed. Table 1 lists each connector and its assigned designation number. Table 2 provides a detailed description of all of the backplane signals, arranged in alphanumeric order. NOTE: An asterisk (\*) indicates an active low signal.

Figure 3 provides pin-out information for all non-Eurocard connectors located on the rear side of the backplane board. For the 96-pin Eurocard connectors, Tables 3 through 7 provide pinout information for each of these connectors. As shown, each connector pin is defined by signal name, input or output (with reference to connector), and the to/from location(s).

**Table 1. Assigned Connector Number Vs. Function/Location Information**

| Connector | Function/Location   |
|-----------|---|
| J1        | 96-pin Eurocard connector; accepts plug-in Option Board 1 (from front of station, behind front panel)   |
| J2        | 96-pin Eurocard connector; accepts plug-in Option Board 2 (from front of station, behind front panel)   |
| J3        | 96-pin Eurocard connector; accepts plug-in Station Control Module (from front of station, behind front panel)   |
| J4        | 96-pin Eurocard connector; accepts plug-in Wireline Interface Board (from front of station, behind front panel)   |
| J5        | 96-pin Eurocard connector; provides System connection to external communications equipment (on back of station)   |
| J6        | Wireline self-clamping terminals; accept customer phone line connections for 2-wire and 4-wire WIB configurations (on back of station)<br>Note: This wire-trap terminal block accepts between .052 sq mm (20 AWG) and 0.2 sq mm (24AWG) solid wire or stranded wire. A stripped wire of any of these sizes can serve as a removable release tool. |
| J7        | DB-25 connector; can be used for connection to trunking controller in wide-area trunking system, or to a Microprocessor Radio Telephone Interconnect (MRTI) (on back of station)  |
| P7        | 10-pin connector; provides for connection to Power Amplifier (PA); routes SPI bus and chip selects from Station Control Module to PA (on back of station)   |
| P8        | 8-pin connector; provides for connection to Power Supply module; routes dc supply voltages to station modules; routes AC Fail signal to Station Control Module (on back of station)   |
| P10       | Antenna Relay 3-pin connector; supplies control signals to antenna relay module; provides connection to a peripheral temperature sensing device such as found in an external circulator (on back of station)  |

**Table 2. Backplane Signal Descriptions**

| Signal Name               | Type    | Function/Signal Levels   |
|---------------------------|---------|--|
| 5 VDC                     | Power   | +5 Vdc from Power Supply (1.5 Amp maximum)   |
| 8 VDC                     | Power   | +8 Vdc from Regulator U102-3 (0.4 Amp maximum)   |
| 10 VDC EX                 | Power   | +10 Vdc from U101-3 to Exciter Module via SCM (0.3 Amp maximum)  |
| 10 VDC RX                 | Power   | +10 Vdc from U101-3 to Receiver Module via SCM (0.75 Amp maximum)  |
| 14.2 VDC                  | Power   | +14.2 Vdc from Power Supply (8 Amp maximum from 500 W power supply; 16.5 Amp maximum from 250 W power supply)  |
| 28.6 VDC                  | Power   | +28.6 Vdc from Power Supply directly to PA - 500 W power supply only (11.5 Amp maximum)  |
| AC Fail                   | Digital | AC status signal from power supply to SCM; Active high indicates AC Mains failure  |
| Antenna Relay             | Digital | Open-collector control signal from SCM to antenna relay; Low to energize relay   |
| Aux Carrier* or TSTAT     | Digital | From SCM to MRTI (Aux Carrier*) to indicate RF channel activity (i.e. PA is keyed or second receiver is unquelled); Active low (open-collector output)   |
|                           |         | From SCM to TCC ("Transmitter Status"); Active high to indicate station is transmitting at rated power with an acceptable level of reflected power; low for any other condition; To opto-isolated input in TCC |
| Aux TX Audio              | Analog  | To SCM; Accepts wideband or voice-band audio from second receiver (selected by Aux TX Audio Mode (WCI))  |
| Aux TX Audio Mode (WCI)   | Digital | To SCM; Wild-Card Input selects mode of Disc RX Audio output & Aux TX Audio input  |
| Carrier Detect Switch     | Digital | From SCM to indicate carrier present; TTL active high  |
| Carrier SQ Override (WCI) | Digital | Wild-Card Input disables carrier squelch gating qualifier; TTL active high   |
| Chassis GND               | Power   | Station ground   |
| Cntrl 14.2 VDC            | Analog  | +14.2 Vdc from Power Supply to Systems connector J5 (0.75 Amp maximum)   |
| Coded WL RX Audio         | Analog  | Wideband (coded) audio to WIB; 5 Vdc maximum level   |
| Disc RX Audio             | Analog  | Discriminator audio output from SCM; can be switched (by Aux TX Audio Mode) to be either buffered disc audio or de-emphasized RX audio (300 to 3 KHz)  |
| Ext Code Detect           | Digital | To SCM from external CIU; indicates code detect to reduce station turn-on delay; TTL active high   |
| Ext Failsoft (WCI)        | Digital | Wild-Card Input for wide-area trunking systems; TTL active high  |
| Ext PTT*                  | Digital | Interrupt request to SCM to key transmitter; TTL active low  |
| Ext Repeat* (WCI)         | Digital | Wild-Card Input controls audio routing in wide-area trunking systems; TTL active low   |
| Ext SPI CS1*              | Digital | From SCM to Systems connector; SPI bus chip select; TTL active low   |
| Ext SPI CS2*              | Digital | From SCM to Systems connector; SPI bus chip select; TTL active low   |
| Failsoft OUTPUT (WCO)     | Digital | Wild-Card Output; active during failsoft to signal console in coded systems; TTL active low  |

**Table 2. Backplane Signal Descriptions (Continued)**

| Signal Name                | Type    | Function/Signal Levels  |
|----------------------------|---------|---|
| GND                        | Power   | Station ground  |
| GPI_0 to GPI_15 (WCI)      | Digital | General Purpose Inputs from external equipment (into the station at the System connector, through the Auxiliary I/O board, to the SCM).   |
| GPO_0 to GPO_15 (WCO)      | Digital | General Purpose Outputs to external equipment (from the SCM, through the Auxiliary I/O board, to the System connector).   |
| GPIO_0 and GPIO_1          | Digital | General Purpose Inputs and Outputs, to and from the SCM.  |
| Line 1+                    | Analog  | 4-wire Phone Line (differential) inputs for clear audio and 12 kbps coded data; 300 to 3400 Hz (clear), or 30 to 6000 Hz (coded); 600Ω typical impedance (country-specific)   |
| Line 1-                    |         |   |
| Line 2+                    | Analog  | 2-wire Phone Line (differential) inputs/outputs or, 4-wire Phone Line outputs for clear audio and 12 kbps coded data; 300 to 3400 Hz (clear), or 30 to 6000 Hz (coded); 600Ω typical impedance (country-specific)   |
| Line 2-                    |         |   |
| Line 3+                    | Analog  | Second Phone Line (differential) input pair for clear audio (8-wire WIB only); 300 to 3400 Hz; 600Ω typical impedance (country-specific)  |
| Line 3-                    |         |   |
| Line 4+                    | Analog  | Second Phone Line (differential) output pair for clear audio (8-wire WIB only); 300 to 3400 Hz; 600Ω typical impedance (country-specific)   |
| Line 4-                    |         |   |
| MISO (Master In Slave Out) | Digital | SPI data from Slave devices to Master (SCM); standard TTL   |
| MOSI (Master Out Slave In) | Digital | SPI data from Master (SCM) to Slave devices; standard TTL   |
| MRTI RX Audio              | Analog  | From SCM; Station clear audio signals (RX, Wireline TX, or Mic) bound for landline via MRTI; MRTI accepts a 1.3 V <sub>pp</sub> ±8 dB input level (MRTI has an ALC)   |
| MRTI RX Carrier*           | Digital | From SCM to MRTI to indicate squelch status of station and control direction of audio between SCM and MRTI for half-duplex patch modes (when signal is active, MRTI PTT is forced inactive and MRTI TX Audio is muted); Active during clear/coded reception and coded Repeater hang time, but <i>not</i> clear Repeater hang time; Also active for any PTT with higher priority than MRTI (i.e. normally active during Wireline PTT to force MRTI to mute MRTI TX Audio and instead route WL TX Audio to landline; Active low (open-collector output) |
| MRTI TX Audio              | Analog  | To SCM; MRTI audio from landline to be transmitted by station, or routed to WIB; Consists of subscriber signaling (i.e. selective signalling), call alert tones, and regular voice audio; Audio levels: either 80 mV <sub>rms</sub> to 2 V <sub>rms</sub> open circuit, or 15 mV <sub>rms</sub> to 0.5 V <sub>rms</sub> into 600Ω; Nominal level is 165 mV <sub>rms</sub> for '#' tone pair into 600Ω (used to set 60% FSD)   |
| OP1 CS1*                   | Digital | From SCM to Option 1 module; SPI bus chip selects; TTL active low   |
| OP1 CS2*                   |         |   |
| OP1 CS3*                   |         |   |
| OP1 CS4*                   |         |   |
| OP2 CS1*                   | Digital | From SCM to Option 2 module; SPI bus chip selects; TTL active low   |
| OP2 CS2*                   |         |   |
| OP2 CS3*                   |         |   |
| Opt IRQ*                   | Digital | Interrupt request to SCM from Option cards; TTL active low  |

**Table 2. Backplane Signal Descriptions (Continued)**

| Signal Name                  | Type          | Function/Signal Levels  |
|------------------------------|---------------|---|
| Option1 ID                   | Analog        | Option 1 ID to SCM A/D; module ID determined by specific voltage; 0 to 5 Vdc  |
| Option2 ID                   | Analog        | Option 2 ID to SCM A/D; module ID determined by specific voltage; 0 to 5 Vdc  |
| PA A/D CS*                   | Digital       | From SCM; during SPI signalling, selects A/D converter in PA; TTL active low  |
| PA D/A CS*                   | Digital       | From SCM; during SPI signalling, selects D/A converter in PA; TTL active low  |
| PA Enable*                   | Digital       | From SCM; controls final module bias in low power PAs; TTL active low   |
| PA Fail (WCO)                | Digital       | Auxiliary I/O board output indicates a PA failure; active high  |
| PA Reset*                    | Digital       | Resets D/A converter in PA; TTL active low (not used)   |
| Patch Inhibit* or RSTAT      | Digital       | From SCM to MRTI to inhibit phone patch; Open-collector output (active low); While active, MRTI will not receive or place any calls   |
|                              |               | From SCM to TCC to indicate receiver status; Open-collector output to opto-isolated input in TCC; Low when receiver is squelched, high when receiver is unsquelched   |
| PL Detect Switch (WCO)       | Digital       | Wild-Card Output active when PL/DPL present; TTL active high  |
| PL Strip* or CCI             | Digital       | Relay-closure input from MRTI to SCM (PL Strip*); Active low inhibits station TX PL; Typically used when MRTI transmits signalling information  |
|                              |               | Logic input from TCC to provide Control Channel Indicate (CCI); Voice channel = high; Control channel = low; Driven by an opto-isolated open-collector with a $V_{ce_{sat}}$ of 1.0 V (maximum) @ a 2 mA load |
| Ptemp+                       | Analog        | Input to SCM from peripheral temperature sensing device on circulator   |
| Raw WL TX Audio              | Analog        | Wideband (coded) TX audio to SCM; 5 Vdc maximum level (if clipped)  |
| Rdstat-R2 Control            | Digital       | From SCM to control second receiver; TTL active high  |
| Repeater ON/OFF (WCI)        | Digital       | Wild-Card Input controls audio routing and repeater keyup; TTL  |
| Reset*                       | Digital       | System reset from SCM; TTL active low   |
| RF Relay Control In          | Digital       | From SCM to control external RF relay driver; TTL active high   |
| RF Relay Control Out         | Relay Closure | From Auxiliary I/O to System connector to control external RF relay driver; TTL active high   |
| RSSI                         | Analog        | From SCM; DC voltage proportional to the receive RF signal strength; 0 to 5 Vdc   |
| RX Inhibit-R2 Status         | Digital       | To SCM from second receiver to inhibit receiver audio to WIB  |
| RX Lock (WCO)                | Digital       | Wild-Card Output indicates RX synthesizer is locked; TTL active high  |
| RX PL Override (WCI)         | Digital       | Wild-Card Input disables PL gating qualifier; TTL active high   |
| SCI RX Option1               | Digital       | To SCM from Option 1 card; for interprocessor communications; standard TTL  |
| SCI RX Option2               | Digital       | To SCM from Option 2 card; for interprocessor communications; standard TTL  |
| SCI TX Option1               | Digital       | From SCM to Option 1 card; for interprocessor communications; standard TTL  |
| SCI TX Option2               | Digital       | From SCM to Option 2 card; for interprocessor communications; standard TTL  |
| SpectraTac Enc Disable (WCI) | Digital       | Wild-Card Input to disable SpectraTac status tone; TTL active high  |

**Table 2. Backplane Signal Descriptions (Continued)**

| Signal Name          | Type    | Function/Signal Levels  |
|----------------------|---------|---|
| Serial ID            | Digital | Serial ID data to SCM from backplane serial ID device   |
| SPI CLK              | Digital | SCM SPI bus clock; Low-to-high transition shifts data; 310 KHz (minimum); standard TTL  |
| Trunk Duplex Enable* | Digital | To SCM from TCC; active during full duplex phone calls to inhibit station repeat audio; TTL active low  |
| Trunk /MRTI PTT*     | Digital | To SCM from relay-closure (MRTI) or opto-isolated open-collector (TCC) to key transmitter; Active low   |
| Trunk Mute*          | Digital | Multi-purpose control signal to SCM from TCC; In some systems, active low mutes the repeat audio path and active high unmutes the audio path; Or, used by TCC to keep station out of failsoft by toggling this line periodically; Or, used to request a fast unmute of the Connect Tone (PL) decoder by receipt of a 1.6 ms pulse at start of voice calls; Driven by an opto-isolated open-collector with a $V_{e\text{-sat}}$ of 1.0 V (maximum) @ a 2 mA load |
| Trunk RX Audio       | Analog  | Buffered RX discriminator audio sent to TCC; For control channels, it contains Inbound Signaling Words (ISW) (1.4 Vpp minimum, on a quiescent dc bias of 4.05 V $\pm$ 1.5 Vdc); On voice channels, it contains connect and disconnect tones (0.7 to 2.0 Vpp, on a quiescent dc bias of 5 V $\pm$ 0.25 Vdc), and high-speed acknowledge tones (2.5 to 6.0 Vpp, on a quiescent dc bias of 5 V $\pm$ 0.25 Vdc)   |
| Trunk TX Data+       | Analog  | Outbound TX modulation from TCC; Contains all trunking transmit data, including 3600 bps control channel data (8.8 Vpp $\pm$ 0.4 V, 0 Vdc) and 300 or 150 bps voice channel data (2.8 Vpp $\pm$ 0.3 V, 0 Vdc)   |
| Trunk TX Data-       | Analog  | Trunking data signal ground   |
| Trunk TX Inhibit*    | Digital | To SCM; inhibits standby station; TTL active low  |
| TX Lock (WCO)        | Digital | Wild-Card Output indicates TX synthesizer is locked; TTL active high  |
| TX PL On/Off (WCI)   | Digital | Wild-Card Input To SCM; disables TX PL/DPL modulation; TTL active high  |
| V Control            | Analog  | PA control voltage (P7 pin 4 only); 0 to 10 Vdc   |
| Voltage Forward      | Analog  | DC voltage proportional to actual RF power output (P7 pin 1 only); 0 to 10 Vdc (Goes nowhere)   |
| VSWR Fail*           | Digital | VSWR failure indicated by active low.   |
| Wireline 1/2 FSYNC   | Codec   | From SCM to WIB codec; 8 KHz frame sync clock initiates sampling of PCM transmit data output  |
| Wireline 1/2 RXD     | Codec   | PCM receive data from SCM to WIB; standard TTL  |
| Wireline 1/2 TXD     | Codec   | PCM transmit data from WIB; standard TTL  |
| Wireline 3/4 FSYNC   | Codec   | From SCM to second WIB codec (8-wire WIB only); 8 KHz frame sync clock initiates sampling of PCM transmit data output   |
| Wireline 3/4 RXD     | Codec   | PCM receive data to WIB (8-wire WIB only); standard TTL   |
| Wireline 3/4 TXD     | Codec   | PCM transmit data from WIB (8-wire WIB only); standard TTL  |
| Wireline BCLK        | Codec   | From SCM to WIB codec; 256 KHz (average) bit clock serially shifts data into/out of codec   |
| Wireline ID          | Analog  | To SCM A/D from WIB; module ID determined by specific voltage; 0 to 5 Vdc   |

**Table 2. Backplane Signal Descriptions (Continued)**

| Signal Name         | Type    | Function/Signal Levels  |
|---------------------|---------|---|
| Wireline MCLK       | Codec   | From SCM to WIB codec; 256 KHz (average) master clock generates internal co-dec clock and sequencing signals; rising-edge aligned to frame sync clock |
| Wireline1 Latch CS* | Digital | Chip select for SPI latch on WIB; TTL active low  |
| Wireline2 Latch CS* | Digital | Chip select for SPI latch #2 on 8-wire WIB only; TTL active low   |
| WL DC Control       | Analog  | To SCM A/D from WIB which has DC remote control capability; voltage level corresponds to detected wireline current level                              |
| WL DC Control REQ*  | Digital | Interrupt request to SCM from WIB which has DC remote control capability; TTL active low when control current detected on wireline                    |

**In Tables 3 to 7...**

...the "To/From" column provides the source or destination of the signal as a connector number followed by a pin number. The first part (e.g. J3) represents the assigned connector number, followed by the specific connector pin number(s).

...symbols ' and " indicate pin assignment functions which are jumper configurable. This applies to some General Purpose Inputs (GPIs) and some General Purpose Outputs (GPOs).

...an asterisk (\*) indicates an active low signal.

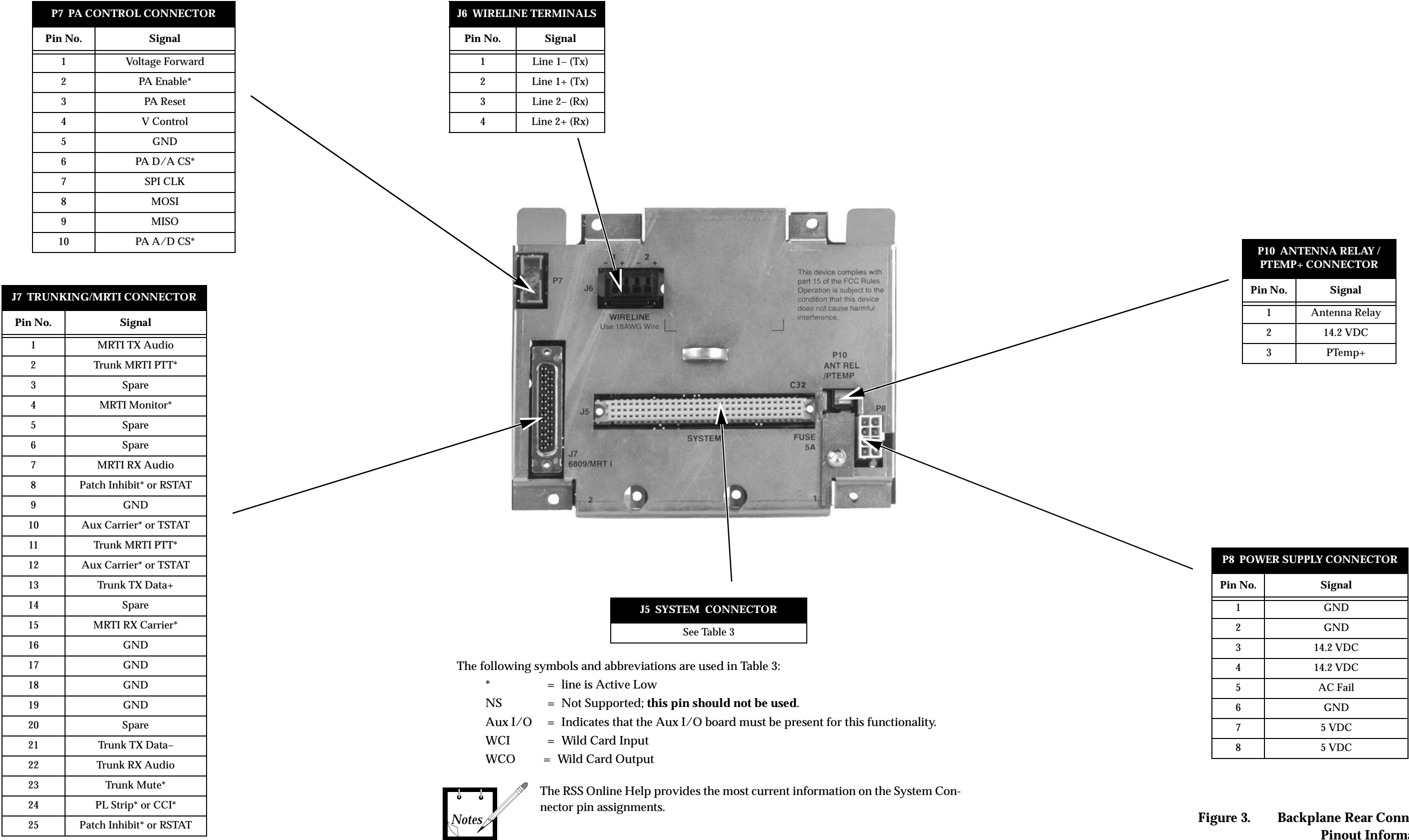


Figure 3. Backplane Rear Connector Pinout Information



| Table 3. J5 SYSTEM CONNECTOR  |                               |                  |                              |  |                            |                  |                        |  |                                 |                  |                        |   |
|---|-------------------------------|------------------|------------------------------|--|----------------------------|------------------|------------------------|--|---------------------------------|------------------|------------------------|---|
| Pin #   | Row A                         | Input/<br>Output | To/From                      | Signal Characteristics                                       | Row B                      | Input/<br>Output | To/From                | Signal Characteristics                                       | Row C                           | Input/<br>Output | To/From                | Signal Characteristics  |
| 1   | GPO_8 (WCO)                   | O                | J1-C32, J2-C32               | OCO, 100mA, 40V  | RX Lock (Aux I/O)          | O                | J1-B32, J2-B32         | OCO, 100mA, 40V; RX Lock, active high                        | TX Lock (Aux I/O)               | O                | J1-A32, J2-A32         | OCO, 100mA, 40V; TX Lock, active high                               |
| 2   | PA Fail (Aux I/O)             | O                | J1-C31, J2-C31               | OCO, 100mA, 40V, active low                                  | GPO_13 (WCO)               | O                | J1-B31, J2-B31         | OCO, 100mA, 40V  | RdStat-R2 Control               | O                | J1-A31, J2-A31, J3-A26 | TTL output, high when unsquelched                                   |
| 3   | SCI_CLKK1                     | O                | J1-C30, J2-C30, J3-C28       | Do not use.  | RdStat or GPO_15, Note 4   | O                | J1-B30, J2-B30         | One side of relay closure, see C3                            | RdStat or GPO_15, Note 4        | O                | J1-A30, J2-A30         | Other side of normally open relay, see B3                           |
| 4   | AC Fail                       | O                | P8-5, J1-C29, J2-C29, J3-C24 | TTL output, active high                                      | Carrier Detect Switch      | O                | J1-B29, J2-B29, J3-B24 | TTL output, active high                                      | Failsoft Output (Aux I/O)       | O                | J1-A29, J2-A29         | OCO, 100mA, 40V, active low   |
| 5   | GPI_3 (WCI)                   | I                | J1-C28, J2-C28               | Pulled up transistor input, 16V max                          | GPI_8 (NS)                 | I                | J1-B28, J2-B28         | Pulled up transistor input, 16V max                          | GPI_4 (WCI)                     | I                | J1-A28, J2-A28         | Pulled up transistor input, 16V max                                 |
| 6   | GPI_15 (–) (NS)               | I                | J1-C27, J2-C27               | –ve side opto-isolated input, see C7                         | GPI_5 (NS)                 | I                | J1-B27, J2-B27         |  | Not Supported                   | I                | J1-A27, J2-A27, J3-B26 |   |
| 7   | Ext Failsoft (Aux I/O)        | I                | J1-C26, J2-C26               | Pulled up transistor input, 16V max                          | Ext Repeat* (Aux I/O)      | I                | J1-B26, J2-B26         |  | GPI_15 (+) (NS)                 | I                | J1-A26, J2-A26         | +ve side opto-isolated input, see A6                                |
| 8   | GPI_1 (NS)                    | I                | J1-C25, J2-C25               |  | Trunk Duplex Enable*       | I                | J3-B25                 | TTL input  | Trunk TX Inhibit*               | I                | J3-A25                 | TTL input   |
| 9   | GPI_2 (NS)                    | I                | J1-C24, J2-C24               | Pulled up transistor input, 16V max                          | GPI_13 (WCI) or GPO_7 (NS) | I/O              | J1-B24, J2-B24         | Caution: See Auxiliary I/O section for jumpering information | RF Relay Control Out (Aux I/O)  | O                | J1-B5, J2-B5           | OCO, 200mA, 40V, active high  |
| 10  | VSWR_Fail* (Aux I/O)          | O                | J1-C23, J2-C23               | Pulled up transistor output (10kohms to +5Vdc), active low   | Spare 311                  | –                | N/C                    |  | Ext PTT Out (Aux I/O) *, Note 5 | I                | J1-A23, J2-A23, J3-A23 | TTL input   |
| 11  | GPO_2 (WCO)                   | O                | J1-C22, J2-C22               | Pulled up transistor output (10kohms to +5Vdc)               | GPI_12 (WCI) or GPO_6 (NS) | I/O              | J1-B22, J2-B22         | Caution: See Auxiliary I/O section for jumpering information | RSSI                            | O                | J1-A22, J2-A22, J3-A22 | RSS programmable sensitivity, Note 6                                |
| 12  | GPO_0 (WCO)                   | O                | J1-B25, J2-B25               |  | GPI_11 (WCI) or GPO_5 (NS) | I/O              | J1-B23, J2-B23         |  | GPI_10 (WCI) or GPO_4 (NS)      | I/O              | J1-A24, J2-A24         | Caution: See Auxiliary I/O section for jumpering information        |
| 13  | Antenna Relay                 | O                | P10-1, J3-C26                | OCO, 200mA, active low                                       | Spare 301                  | –                | N/C                    |  | Spare 304                       | –                | –                      |   |
| 14  | Not Supported                 | O                | J1-C18, J2-C18, J3-C19       |  | Not Supported              | I                | J1-B19, J2-B19, J3-B19 | TTL input  | Not Supported                   | O                | J1-A19, J2-A19, J3-A19 |   |
| 15  | Spare 310                     | –                | –                            |  | GND                        | –                | Station ground         |  | GND                             | –                | Station ground         |   |
| 16  | Spare 308                     | –                | –                            |  | Spare 300                  | –                | –                      |  | GND                             | –                | Station ground         |   |
| 17  | Aux TX Audio                  | I                | J1-C16, J2-C16, J3-C16       | RSS programmable input sensitivity                           | Spare 321                  | –                | –                      |  | Disc RX Audio                   | O                | J1-A16, J2-A16, J3-A16 | Discriminator audio, flat response; 80mV to 400mV for 60% deviation |
| 18  | Cntrl 14.2 VDC                | O                | P8 pins 3, 4 (thru F2)       | +14.2Vdc, Note 1   | Cntrl 14.2 VDC             | O                | P8 pins 3, 4 (thru F2) | +14.2Vdc, Note 1   | Cntrl 14.2 VDC                  | O                | P8 pins 3, 4 (thru F2) | +14.2Vdc, Note 1  |
| 19  | GND                           | –                | Station ground               |  | GND                        | –                | Station ground         |  | GND                             | –                | Station ground         |   |
| 20  | 5 VDC                         | O                | P8 pins 7, 8                 | +5.1 ± 0.25 Vdc  | 5 VDC                      | O                | P8 pins 7, 8           | +5.1 ± 0.25 Vdc  | 5 VDC                           | O                | P8 pins 7, 8           | +5.1 ± 0.25 Vdc   |
| 21  | Not Supported                 | O                | J3-C12                       |  | RdStat or GPO_15, Note 4   | O                | J1-B12                 | OCO, 100mA, 40V  | Not Supported                   | O                | J3-A12                 |   |
| 22  | GPI_7 (WCI)                   | I                | J1-C11, J2-C11               | Pulled up transistor input, 16V max.                         | Spare 322                  | –                | –                      |  | Spare 302                       | –                | –                      |   |
| 23  | Spare 323                     | –                | –                            |  | Spare 325                  | –                | –                      |  | Spare 324                       | –                | –                      |   |
| 24  | Spare 320                     | –                | –                            |  | Spare 309                  | –                | –                      |  | GPIO_0 (CNTR I/O)               | I/O              | J1-A9, J2-A9, J3-A17   | TTL input/output  |
| 25  | Spare 903                     | –                | –                            |  | Spare 902                  | –                | –                      |  | Spare 317                       | –                | –                      |   |
| 26  | Ext PTT or GPI_14 (–), Note 1 | I                | J1-C7, J2-C7                 | –ve side opto-isolated input, see A29                        | Ext PTT or GPI_14, Note 2  | I                | J1-B7, J2-B7           | Pulled up transistor input, 16V max, see A29                 | Spare 901                       | –                | –                      |   |
| 27  | GND                           | –                | Station ground               |  | GND                        | –                | Station ground         |  | GND                             | –                | Station ground         |   |
| 28  | GPI_9 (WCI) or GPO_3 (NS)     | I/O              | J1-C6, J2-C6                 | Caution: See Auxiliary I/O section for jumpering information | Line 4+                    | O                | J4-C10                 | Wireline output, balanced (+)                                | Line 3+                         | I                | J4-C12                 | Wireline input, balanced (+)  |
| 29  | Ext PTT or GPI_14 (–), Note 2 | I                | J1-C5, J2-C5                 | +ve. side opto-isolated input, see A26                       | AC Fail or GPO_14, Note 3  | O                | J1-B4, J2-B4           | Other side of relay closure, see A30                         | GPIO_1 (CNTR I/O)               | I/O              | J1-A4, J2-A4, J3-A13   | TTL input/output  |
| 30  | AC Fail or GPO_14, Note 3     | O                | J1-C4, J2-C4                 | One side of normally open relay, see B29                     | Line 4–                    | O                | J4-A9                  | Wireline output, balanced (–)                                | Line 3–                         | I                | J4-A11                 | Wireline input, balanced (+)  |
| 31  | GND                           | –                | Station ground               |  | GND                        | –                | Station ground         |  | GND                             | –                | Station ground         |   |
| 32  | Cntrl 14.2 VDC                | O                | P8 pins 3, 4 (thru F2)       | +14.2Vdc, Note 1   | Cntrl 14.2 VDC             | O                | P8 pins 3, 4 (thru F2) | +14.2Vdc, Note 1   | Cntrl 14.2 VDC                  | O                | P8 pins 3, 4 (thru F2) | +14.2Vdc, Note 1  |
| <div><div>Note 1:</div><div>For dc-only 250W power supplies, this voltage is equal to the input supply voltage.</div></div> <div><div>Note 2:</div><div>This pin can be jumpered for Ext PTT (supported) or GPI_14 (not supported). See Aux I/O jumpers P2 and P9.</div></div> <div><div>Note 3:</div><div>This pin can be jumpered for AC Fail (supported) or GPO_14 (not supported). See Aux I/O jumper P5.</div></div> <div><div>Note 4:</div><div>This pin can be jumpered for RdStat (supported) or GPO_15 (supported). See Aux I/O jumpers P3 and P4.</div></div> <div><div>Note 5:</div><div>Ext PTT signal output, taken from Ext PTT input. The output signal can be inverted, depending on jumper settings. See jumpers P2, P6, P9.</div></div> <div><div>Note 6:</div><div>For R03.01 (host software) and earlier, the fixed sensitivity is @ 172 mVrms for 60% system deviation. RSS programmable for pre-emphasized or flat response. DC offset +2.4V. High impedance input.</div></div> |                               |                  |                              |  |                            |                  |                        |  |                                 |                  |                        |   |

| Table 4. J4 WIRELINE CONNECTOR |                    |              |                              |                     |              |                              |                     |              |                           |
|--------------------------------|--------------------|--------------|------------------------------|---------------------|--------------|------------------------------|---------------------|--------------|---------------------------|
| Pin #                          | Row A              | Input/Output | To/From                      | Row B               | Input/Output | To/From                      | Row C               | Input/Output | To/From                   |
| 1                              | Wireline MCLK      | I            | J3-B6                        | Spare 5             | –            | –                            | Wireline BCLK       | I            | J3-C5                     |
| 2                              | GND                | –            | Station ground               | GND                 | –            | Station ground               | GND                 | –            | Station ground            |
| 3                              | 5 VDC              | I            | P8 pins 7, 8                 | 5 VDC               | I            | P8 pins 7, 8                 | 5 VDC               | I            | P8 pins 7, 8              |
| 4                              | GPIO_1 (CNTR I/O)  | I/O          | J1-A4, J2-A4, J5-C29, J3-A13 | Wireline 3/4 TXD    | O            | J3-B4                        | Wireline 3/4 RXD    | I            | J3-C4                     |
| 5                              | Wireline 1/2 TXD   | O            | J3-A5                        | Wireline 1/2 RXD    | I            | J3-B5                        | Spare 45            | –            | –                         |
| 6                              | Wireline 3/4 FSYNC | I            | J3-A6                        | Wireline2 Latch CS* | I            | J3-B7                        | Wireline 1/2 FSYNC  | I            | J3-C6                     |
| 7                              | MOSI               | I            | P7-8, J1-A7, J2-A7, J3-A7    | Spare 18            | –            | –                            | Wireline1 Latch CS* | I            | J3-C7                     |
| 8                              | GND                | –            | Station ground               | MISO                | O            | J1-B8, J2-B8, J3-B8, P7-9    | SPI CLK             | I            | P7-7, J1-C8, J2-C8, J3-C8 |
| 9                              | Line 4–            | O            | J5-B30                       | GND                 | –            | Station ground               | GND                 | –            | Station ground            |
| 10                             | Spare 28           | –            | –                            | Spare 37            | –            | –                            | Line 4+             | O            | J5-B28                    |
| 11                             | Line 3–            | I            | J5-C30                       | Spare 19            | –            | –                            | Spare 10            | –            | –                         |
| 12                             | Spare 1            | –            | –                            | Spare 38            | –            | –                            | Line 3+             | I            | J5-C28                    |
| 13                             | WL DC Control      | O            | J3-A27                       | WL DC Control REQ*  | O            | J3-B27                       | Spare 46            | –            | –                         |
| 14                             | GND                | –            | Station ground               | GND                 | –            | Station ground               | GND                 | –            | Station ground            |
| 15                             | 14.2 VDC           | I            | P8 pins 3, 4 (thru F1)       | 14.2 VDC            | I            | P8 pins 3, 4 (thru F1)       | 14.2 VDC            | I            | P8 pins 3, 4 (thru F1)    |
| 16                             | Spare 2            | –            | –                            | Reset*              | I            | J1-B16, J2-B16, J3-B16, P7-3 | Spare 47            | –            | –                         |
| 17                             | Spare 29           | –            | –                            | Spare 6             | –            | –                            | Spare 24            | –            | –                         |
| 18                             | Spare 15           | –            | –                            | Spare 20            | –            | –                            | Spare 25            | –            | –                         |
| 19                             | Spare 30           | –            | –                            | Spare 39            | –            | –                            | Wireline ID         | O            | J3-C22                    |
| 20                             | Spare 16           | –            | –                            | Coded WL RX Audio   | I            | J1-B20, J2-B20, J3-B20       | Raw WL TX Audio     | O            | J1-C20, J2-C20, J3-C20    |
| 21                             | Chassis GND        | –            | –                            | Chassis GND         | –            | –                            | Chassis GND         | –            | –                         |
| 22                             | Spare 31           | –            | –                            | Spare 40            | –            | –                            | Spare 27            | –            | –                         |
| 23                             | Spare 3            | –            | –                            | Spare 7             | –            | –                            | Spare 11            | –            | –                         |
| 24                             | Spare 32           | –            | –                            | Spare 41            | –            | –                            | Spare 48            | –            | –                         |
| 25                             | Spare 17           | –            | –                            | Spare 21            | –            | –                            | Spare 49            | –            | –                         |
| 26                             | Line 2+            | I/O          | J6-4                         | Line 2+             | I/O          | J6-4                         | Line 2+             | I/O          | J6-4                      |
| 27                             | Spare 4            | –            | –                            | Spare 8             | –            | –                            | Spare 12            | –            | –                         |
| 28                             | Line 2–            | I/O          | J6-3                         | Spare 22            | –            | –                            | Spare 50            | –            | –                         |
| 29                             | Spare 34           | –            | –                            | Spare 43            | –            | –                            | Spare 26            | –            | –                         |
| 30                             | Line 1+            | I            | J6- 2                        | Line 1+             | I            | J6-2                         | Line 1+             | I            | J6-2                      |
| 31                             | Spare 36           | –            | –                            | Spare 23            | –            | –                            | Spare 51            | –            | –                         |
| 32                             | Line 1–            | I            | J6-1                         | Spare 9             | –            | –                            | Spare 13            | –            | –                         |

| Table 5. J1 OPTION1 CONNECTOR |                          |                  |                              |                        |                  |                           |                       |                  |                             |
|-------------------------------|--------------------------|------------------|------------------------------|------------------------|------------------|---------------------------|-----------------------|------------------|-----------------------------|
| Pin No.                       | Row A                    | Input/<br>Output | To/From                      | Row B                  | Input/<br>Output | To/From                   | Row C                 | Input/<br>Output | To/From                     |
| 1                             | Spare                    | –                | –                            | Spare A12              | –                | J2-B1                     | Spare A1              | –                | –                           |
| 2                             | GND                      | –                | Station ground               | GND                    | –                | Station ground            | GND                   | –                | Station ground              |
| 3                             | 5 VDC                    | I                | P8 pins 7, 8                 | 5 VDC                  | I                | P8 pins 7, 8              | 5 VDC                 | I                | P8 pins 7, 8                |
| 4                             | GPIO_1 (CNTR I/O)        | I/O              | J2-A4, J3-A13, J4-A4, J5-C29 | GPO_14' (WCO)          | O                | J2-B4, J5-B29             | GPO_14 (WCO)          | O                | J2-C4, J3-A30               |
| 5                             | Spare                    | –                | J2-A5                        | RF Relay Control Out   | O                | J2-B5, J5-C9              | GPI_14' (WCI)         | I                | J2-C5, J5-A29               |
| 6                             | Spare                    | –                | J2-A6                        | RF Relay Control In    | I                | J2-B6, J3-A24             | GPI_9 or GPO_3 (WCIO) | I/O              | J2-C6, J5-A28               |
| 7                             | MOSI                     | I                | P7-8, J2-A7, J3-A7, J4-A7    | GPI_14 (WCI)           | I                | J2-B7, J5-B26             | GPI_14'' (WCI)        | I                | J2-C7, J5-A26               |
| 8                             | GND                      | –                | Station ground               | MISO                   | O                | P7-9, J2-B8, J3-B8, J4-B8 | SPI CLK               | I                | P7-7, J2-C8, J3-C8, J4-C8   |
| 9                             | GPIO_0 (CNTR I/O)        | I/O              | J2-A9, J3-A17, J5-C24        | GND                    | –                | Station ground            | GND                   | –                | Station ground              |
| 10                            | OP1 CS2*                 | I                | J3-A10                       | OP1 CS4*               | I                | J3-B10                    | OP1 CS3*              | I                | J3-C10                      |
| 11                            | Secure Control2          | –                | N/C                          | OP1 CS1*               | I                | J3-B11                    | GPI_7 (WCI)           | I                | J2-C11, J5-A22              |
| 12                            | SCI RX Option1           | O                | J3-A9                        | GPO_15'' (WCO)         | O                | J5-B21                    | Spare A11             | –                | J2-C12                      |
| 13                            | Spare                    | –                | –                            | Spare A18              | –                | J2-B13                    | SCI TX Option1        | I                | J3-B9                       |
| 14                            | GND                      | –                | Station ground               | GND                    | –                | Station ground            | GND                   | –                | Station ground              |
| 15                            | 14.2 VDC                 | I                | P8 pins 3, 4 (thru F1)       | 14.2 VDC               | I                | P8 pins 3, 4 (thru F1)    | 14.2 VDC              | I                | P8 pins 3, 4 (thru F1)      |
| 16                            | Disc RX Audio            | I                | J2-A16, J3-A16, J5-C17       | Reset*                 | I                | J2-B16, J3-B16, J4-B16    | Aux TX Audio          | I                | J2-C16, J3-C16, J5-A17      |
| 17                            | GND                      | –                | Station ground               | Decrypted RX Audio     | I                | J2-B17, J3-B17            | Clear TX Audio        | I                | J2-C17, J3-C17              |
| 18                            | GND                      | –                | Station ground               | GND                    | –                | Station ground            | TX Code Detect*       | I                | J2-C18, J3-C19, J5-A14      |
| 19                            | RX Code Detect* (Future) | I                | J2-A19, J3-A19, J5-C14       | Ext Code Detect        | I                | J2-B19, J3-B19, J5-B14    | Option1 ID            | O                | J3-C18                      |
| 20                            | Coded Mod Audio          | I                | J2-A20, J3-A20               | Coded WL RX Audio      | I                | J2-B20, J3-B20, J4-B20    | Raw WL TX Audio       | I                | J2-C20, J3-C20, J4-C20      |
| 21                            | GND                      | –                | Station ground               | Secure RX Audio        | I                | J2-B21, J3-B21            | GND                   | –                | Station ground              |
| 22                            | RSSI                     | I                | J2-A22, J3-A22, J5-C11       | GPI_12 or GPO_6 (WCIO) | I/O              | J2-B22, J5-B11            | GPO_2 (WCO)           | O                | J2-C22, J5-A11              |
| 23                            | Ext PTT*                 | I                | J2-A23, J3-A23, J5-C10       | GPI_11 or GPO_5 (WCIO) | I/O              | J2-B23, J5-B12            | VSWR FAIL* (WCO)      | O                | J2-C23, J5-A10              |
| 24                            | GPI_10 or GPO_4 (WCIO)   | I/O              | J2-A24, J5-C12               | GPI_13 or GPO_7 (WCIO) | I/O              | J2-B24, J5-B9             | GPI_2 (WCI)           | I                | J2-C24, J5-A9               |
| 25                            | Opt_IRQ*                 | O                | J2-A25, J3-C23               | GPO_0 (WCO)            | O                | J2-B25, J5-A12            | GPI_1 (WCI)           | I                | J2-C25, J5-A8               |
| 26                            | GPI_15 (WCI)             | I                | J2-A26, J5-C7                | Ext Repeat* (WCI)      | I                | J2-B26, J5-B7             | Ext Failsoft (WCI)    | I                | J2-C26, J5-A7               |
| 27                            | RX Inhibit-R2 Status     | I                | J2-A27, J3-B26, J5-C6        | GPI_5 (WCI)            | I                | J2-B27, J5-B6             | GPI_15' (WCI)         | I                | J2-C27, J5-A6               |
| 28                            | GPI_4 (WCI)              | I                | J2-A28, J5-C5                | GPI_8 (WCI)            | I                | J2-B28, J5-B5             | GPI_3 (WCI)           | I                | J2-C28, J5-A5               |
| 29                            | Failsoft OUTPUT (WCO)    | O                | J2-A29, J5-C4                | Carrier Detect Switch  | I                | J2-B29, J3-B24, J5-B4     | AC Fail               | I                | P8-5, J2-C29, J3-C24, J5-A4 |
| 30                            | GPO_15 (WCO)             | O                | J2-A30, J5-C3                | GPO_15' (WCO)          | O                | J2-B30, J5-B3             | SCI_CLKK1             | O                | J2-C30, J5-A3, J3-C28       |
| 31                            | Rdstat-R2 Control        | I                | J2-A31, J5-C2, J3-A26        | GPO_13 (WCO)           | O                | J2-B31, J5-B2             | PA Fail (WCO)         | O                | J2-C31, J5-A2               |
| 32                            | TX Lock (WCO)            | O                | J2-A32, J5-C1                | RX Lock (WCO)          | O                | J2-B32, J5-B1             | GPO_8 (WCO)           | O                | J2-C32, J5-A1               |

| Table 6. J2 OPTION2 CONNECTOR |                             |                  |                              |                        |                  |                           |                        |                  |                             |
|-------------------------------|-----------------------------|------------------|------------------------------|------------------------|------------------|---------------------------|------------------------|------------------|-----------------------------|
| Pin No.                       | Row A                       | Input/<br>Output | To/From                      | Row B                  | Input/<br>Output | To/From                   | Row C                  | Input/<br>Output | To/From                     |
| 1                             | Spare A14                   | –                | –                            | Spare A12              | –                | J1-B1                     | Spare A15              | –                | –                           |
| 2                             | GND                         | –                | Station ground               | GND                    | –                | Station ground            | GND                    | –                | Station ground              |
| 3                             | 5 VDC                       | I                | P8 pins 7, 8                 | 5 VDC                  | I                | P8 pins 7, 8              | 5 VDC                  | I                | P8 pins 7, 8                |
| 4                             | GPIO_1 (CNTR I/O)           | I/O              | J1-A4, J3-A13, J4-A4, J5-C29 | GPO_14' (WCO)          | O                | J1-B4, J5-B29             | GPO_14 (WCO)           | O                | J1-C4, J3-A3                |
| 5                             | Spare A16                   | –                | J1-A5                        | RF Relay Control Out   | O                | J1-B5, J5-C9              | GPI_14' (WCI)          | I                | J1-C5, J5-A29               |
| 6                             | Spare A19                   | –                | J1-A6                        | RF Relay Control In    | I                | J1-B6, J3-A24             | GPI_19 or GPO_3 (WCIO) | I/O              | J1-C6, J5-A28               |
| 7                             | MOSI                        | I                | P7-8, J1-A7, J3-A7, J4-A7    | GPI_14 (WCI)           | I                | J1-B7, J5-B26             | GPI_14'' (WCI)         | I                | J1-C7, J5-A26               |
| 8                             | GND                         | –                | Station ground               | MISO                   | O                | P7-9, J1-B8, J3-B8, J4-B8 | SPI CLK                | I                | P7-7, J1-C8, J3-C8, J4-C8   |
| 9                             | GPIO_0 (CNTR I/O)           | I/O              | J1-A9, J3-A17, J5-C24        | GND                    | –                | Station ground            | GND                    | –                | Station ground              |
| 10                            | OP2 CS2*                    | I                | J3-A11                       | N/C                    | –                | –                         | OP2 CS3*               | I                | J3-C11                      |
| 11                            | Secure Control2             | –                | N/C                          | OP2 CS1*               | I                | J3-B12                    | GPI_7 (WCI)            | I                | J1-C11, J5-A22              |
| 12                            | SCI RX Option2              | O                | J3-C9                        | N/C                    | –                | –                         | Spare A11              | –                | J1-C12                      |
| 13                            | Spare A17                   | –                | –                            | Spare A18              | –                | J1-B13                    | SCI TX Option2         | I                | J3-A8                       |
| 14                            | GND                         | –                | Station ground               | GND                    | –                | Station ground            | GND                    | –                | Station ground              |
| 15                            | 14.2 VDC                    | I                | P8 pins 3, 4 (thru F1)       | 14.2 VDC               | I                | P8 pins 3, 4 (thru F1)    | 14.2 VDC               | I                | P8 pins 3, 4 (thru F1)      |
| 16                            | Disc RX Audio               | I                | J1-A16, J3-A16, J5-C17       | Reset*                 | –                | J1-B16, J3-B16, J4-B16    | Aux TX Audio           | I                | J1-C16, J3-C16, J5-A17      |
| 17                            | GND                         | –                | Station ground               | Decrypted RX Audio     | I                | J1-B17, J3-B17            | Clear TX Audio         | I                | J1-C17, J3-C17              |
| 18                            | GND                         | –                | Station ground               | GND                    | –                | Station ground            | TX Code Detect*        | I                | J1-C18, J3-C18, J5-A14      |
| 19                            | RX Code Detect*<br>(Future) | I                | J1-A19, J3-A19, J5-C14       | Ext Code Detect        | I                | J1-B19, J3-B19, J5-B14    | Option2 ID             | O                | J3-B18                      |
| 20                            | Coded Mod Audio             | I                | J1-A20, J3-A20               | Coded WL RX Audio      | I                | J1-B20, J3-B20, J4-B20    | Raw WL TX Audio        | I                | J1-C20, J3-C20, J4-C20      |
| 21                            | GND                         | –                | Station ground               | Secure RX Audio        | I                | J1-B21, J3-B21            | GND                    | –                | Station ground              |
| 22                            | RSSI                        | I                | J1-A22, J3-A22, J5-C11       | GPI_12 or GPO_6 (WCIO) | I/O              | J1-B22, J5-B11            | GPO_2 (WCO)            | O                | J1-C22, J5-A11              |
| 23                            | Ext PTT*                    | I                | J1-A23, J3-A23, J5-C10       | GPI_11 or GPO_5 (WCIO) | I/O              | J1-B23, J5-B12            | VSWR FAIL* (WCO)       | O                | J1-C23, J5-A10              |
| 24                            | GPI_10 or GPO_4<br>(WCIO)   | I/O              | J1-A24, J5-C12               | GPI_13 or GPO_7 (WCIO) | I/O              | J1-B24, J5-B9             | GPI_2 (WCI)            | I                | J1-C24, J5-A9               |
| 25                            | OPT_IRQ*                    | O                | J1-A25, J3-C23               | GPO_0 (WCO)            | O                | J1-B25, J5-A12            | GPI_1 (WCI)            | I                | J1-C25, J5-A8               |
| 26                            | GPI_15 (WCI)                | I                | J1-A26, J5-C7                | Ext Repeat* (WCI)      | I                | J1-B26, J5-B7             | Ext Failsoft (WCI)     | I                | J1-C26, J5-A7               |
| 27                            | RX Inhibit-R2 Status        | I                | J1-A27, J3-B26, J5-C6        | GPI_5 (WCI)            | I                | J1-B27, J5-B6             | GPI_15' (WCI)          | I                | J1-C27, J5-A6               |
| 28                            | GPI_4 (WCI)                 | I                | J1-A28, J5-C5                | GPI_8 (WCI)            | I                | J1-B28, J5-B5             | GPI_3 (WCI)            | I                | J1-C28, J5-A5               |
| 29                            | Failsoft OUTPUT (WCO)       | O                | J1-A29, J5-C4                | Carrier Detect Switch  | I                | J1-B29, J3-B24, J5-B4     | AC Fail                | I                | P8-5, J1-C29, J3-C24, J5-A4 |
| 30                            | GPO_15 (WCO)                | O                | J1-A30, J5-C3                | GPO_15' (WCO)          | O                | J1-B30, J5-B3             | SCI_CLKK1              | O                | J1-C30, J5-A3, J3-C28       |
| 31                            | Rdstat-R2 Control           | I                | J1-A31, J5-C2, J3-A26        | PL Detect Switch (WCO) | O                | J1-B31, J5-B2             | PA Fail (WCO)          | O                | J1-C31, J5-A2               |
| 32                            | TX Lock (WCO)               | O                | J1-A32, J5-C1                | RX Lock (WCO)          | O                | J1-B32, J5-B1             | GPO_8 (WCO)            | O                | J2-C32, J5-A1               |

| Table 7. J3 CONTROLLER CONNECTOR |                         |              |                           |                       |              |                              |                       |              |                             |
|----------------------------------|-------------------------|--------------|---------------------------|-----------------------|--------------|------------------------------|-----------------------|--------------|-----------------------------|
| Pin #                            | Row A                   | Input/Output | To/From                   | Row B                 | Input/Output | To/From                      | Row C                 | Input/Output | To/From                     |
| 1                                | 14.2 VDC                | I            | P8 pins 3, 4 (thru F1)    | 14.2 VDC              | I            | P8 pins 3, 4 (thru F1)       | 14.2 VDC              | I            | P8 pins 3, 4 (thru F1)      |
| 2                                | GND                     | –            | Station ground            | GND                   | –            | Station ground               | GND                   | –            | Station ground              |
| 3                                | 5 VDC                   | I            | P8 pins 7, 8              | 5 VDC                 | I            | P8 pins 7, 8                 | 5 VDC                 | I            | P8 pins 7, 8                |
| 4                                | 8 VDC                   | I            | U102-3                    | Wireline 3/4 TXD      | I            | J4-B4                        | Wireline 3/4 RXD      | O            | J4-C4                       |
| 5                                | Wireline 1/2 TXD        | I            | J4-A5                     | Wireline 1/2 RXD      | O            | J4-B5                        | Wireline BCLK         | O            | J4-C1                       |
| 6                                | Wireline 3/4 FSYNC      | O            | J4-A6                     | Wireline MCLK         | O            | J4-A1                        | Wireline 1/2 FSYNC    | O            | J4-C6                       |
| 7                                | MOSI                    | O            | P7-8, J1-A7, J2-A7, J4-A7 | Wireline2 Latch CS*   | O            | J4-B6                        | Wireline1 Latch CS*   | O            | J4-C7                       |
| 8                                | SCI TX Option2          | O            | J2-C13                    | MISO                  | I            | P7-9, J1-B8, J2-B8, J4-B8    | SPI CLK               | O            | P7-7, J1-C8, J2-C8, J4-C8   |
| 9                                | SCI RX Option1          | I            | J1-A12                    | SCI TX Option1        | O            | J1-C13                       | SCI RX Option2        | I            | J2-A12                      |
| 10                               | OP1 CS2*                | O            | J1-A10                    | OP1 CS4*              | O            | J1-B10                       | OP1 CS3*              | O            | J1-C10                      |
| 11                               | OP2 CS2*                | O            | J2-A10                    | OP1 CS1*              | O            | J1-B11                       | OP2 CS3*              | O            | J2-C10                      |
| 12                               | Ext SPI CS1*            | O            | J5-C21                    | OP2 CS1*              | O            | J2-B11                       | Ext SPI CS2*          | O            | J5-A21                      |
| 13                               | GPIO_1 (CNTR I/O)       | I/O          | J1-A4, J2-A4, J5-C29      | PA D/A CS*            | O            | P7-6                         | PA A/D CS*            | O            | P7-10                       |
| 14                               | 10 VDC EX               | I            | Regulator U101-3          | 10 VDC EX             | I            | Regulator U101-3             | GND                   | –            | Station ground              |
| 15                               | 10 VDC RX               | I            | Regulator U101-3          | 10 VDC RX             | I            | Regulator U101-3             | GND                   | –            | Station ground              |
| 16                               | Disc RX Audio           | O            | J1-A16, J2-A16, J5-C17    | Reset*                | O            | J1-B16, J2-B16, J4-B16, P7-3 | Aux TX Audio          | I            | J1-C16, J2-C16, J5-A17      |
| 17                               | GPIO_0 (CNTR I/O)       | I/O          | J1-A9, J2-A9, J5-C24      | Decrypted RX Audio    | I            | J1-B17, J2-B17               | Clear TX Audio        | O            | J1-C17, J2-C17              |
| 18                               | Ptemp+                  | I            | P10-3                     | Option2 ID            | I            | J2-C19                       | Option1 ID            | I            | J1-C19                      |
| 19                               | RX Code Detect*         | O            | J1-A19, J2-A19, J5-C14    | Ext Code Detect       | I            | J1-B19, J2-B19, J5-B14       | TX Code Detect*       | O            | J1-C18, J2-C18, J5-A14      |
| 20                               | Coded Mod Audio         | I            | J1-A20, J2-A20            | Coded WL RX Audio     | O            | J1-B20, J2-B20, J4-B20       | Raw WL TX Audio       | I            | J1-C20, J2-C20, J4-C20      |
| 21                               | GND                     | –            | Station ground            | Secure RX Audio       | I            | J1-B21, J2-B21               | GND                   | –            | Station ground              |
| 22                               | RSSI                    | O            | J1-A22, J2-A22, J5-C11    | GND                   | –            | Station ground               | Wireline ID           | I            | J4-C19                      |
| 23                               | Ext PTT*                | I            | J1-A23, J2-A23, J5-C10    | N/C                   | –            |                              | Opt IRQ*              | O            | J1-A25, J2-A25              |
| 24                               | RF Relay Control        | O            | J1-B6, J2-B6              | Carrier Detect Switch | O            | J1-B29, J2-B29, J5-B4        | AC Fail               | I            | P8-5, J1-C29, J2-C29, J5-A4 |
| 25                               | Trunk TX Inhibit*       | I            | J5-C8                     | Trunk Duplex Enable*  | I            | J5-B8                        | Serial ID             | I            | U100-2                      |
| 26                               | Rdstat-R2 Control       | O            | J1-A31, J2-A31, J5-C2     | RX Inhibit-R2 Status  | I            | J1-A27, J2-A27, J5-C6        | Antenna Relay         | O            | P10-1, J5-A13               |
| 27                               | WL DC Control           | I            | J4-A13                    | WL DC Control REQ*    | I            | J4-B13                       | PA Enable*            | O            | P7-2                        |
| 28                               | GND                     | –            | Station ground            | GND                   | –            | Station ground               | SCI_CLCK1             | O            | J1-C30, J5-A3, J2-C30       |
| 29                               | Trunk RX Audio          | O            | J7-22                     | Trunk TX Data+        | I            | J7-13                        | Trunk TX Data–        | I            | J7-21                       |
| 30                               | MRTI RX Audio           | O            | J7-7                      | MRTI TX Audio         | I            | J7-1                         | Aux Carrier* or TSTAT | O            | J7-12, J7-10                |
| 31                               | Trunk Mute*             | I            | J7-23                     | MRTI RX Carrier*      | O            | J7-15                        | PL Strip* or CCI      | I            | J7-24                       |
| 32                               | Patch Inhibit* or RSTAT | O            | J7-25                     | MRTI Monitor*         | I            | J7-4                         | Trunk MRTI PTT*       | I            | J7-2, J7-11                 |



# POWER SUPPLY MODULE

500 W, 50/60 Hz,

MODEL CLN1220 (85 to 264 Vac Input)

MODEL DLN6458 (180 to 264 Vac Input)

## 1

### DESCRIPTION

The CLN1220 and DLN6458 Power Supply Modules are described in this section. These Power Supplies are used on high power (i.e., >75 W) stations. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

The DLN6458 Power Supply Module is provided with stations delivered in Europe (after January 1, 2001). It operates in conjunction with the Power Factor Correction Choke (DLN6456).



**If a station with a CLN1220 Power Supply module is connected to a choke, the station equipment may be damaged. Do NOT connect a station with a CLN1220 Power Supply module to a Power Factor Correction Choke.**

There is one choke for each station mounted in a rack or cabinet. Each station is connected to a choke. The choke is connected to the ac power source with the interconnect cable supplied as part of the choke FRU (DLN6456).

### General Description

The CLN1220 Power Supply Module accepts an ac input (85 to 264 Vac, 50/60 Hz) and generates three output dc voltages to power the station modules: +5.1 Vdc, +14.2 Vdc, and +28.6 Vdc.

The DLN6458 Power Supply Module accepts an ac input (180 to 264 Vac, 50/60 Hz) and generates three output dc voltages to power the station modules: +5.1 Vdc, +14.2 Vdc, and +28.6 Vdc.

The power supply is a high-frequency switched mode design, utilizing Pulse Width Modulation (PWM) control, all contained in a metal heat-sink, mounted on the left-hand side of the station. The design provides for output over-voltage/over-current protection.

The ac input connection is made at the rear of the station via an IEC-type connector keyed to accept only high temperature type mating connectors. Also provided is a Battery Backup connection. Power supply cooling, when necessary, is provided by an external fan (located near the middle of the heatsink) which provides forced air across the power supply heatsink fins.



An external battery charger system is required to support the battery backup feature.

## 2

## PERFORMANCE SPECIFICATIONS

Table 1 shows the electrical performance specifications for Model CLN1220 & DLN6458 Power Supply Modules.

**Table 1. CLN1220/DLN6458 Power Supply Module Performance Specifications**

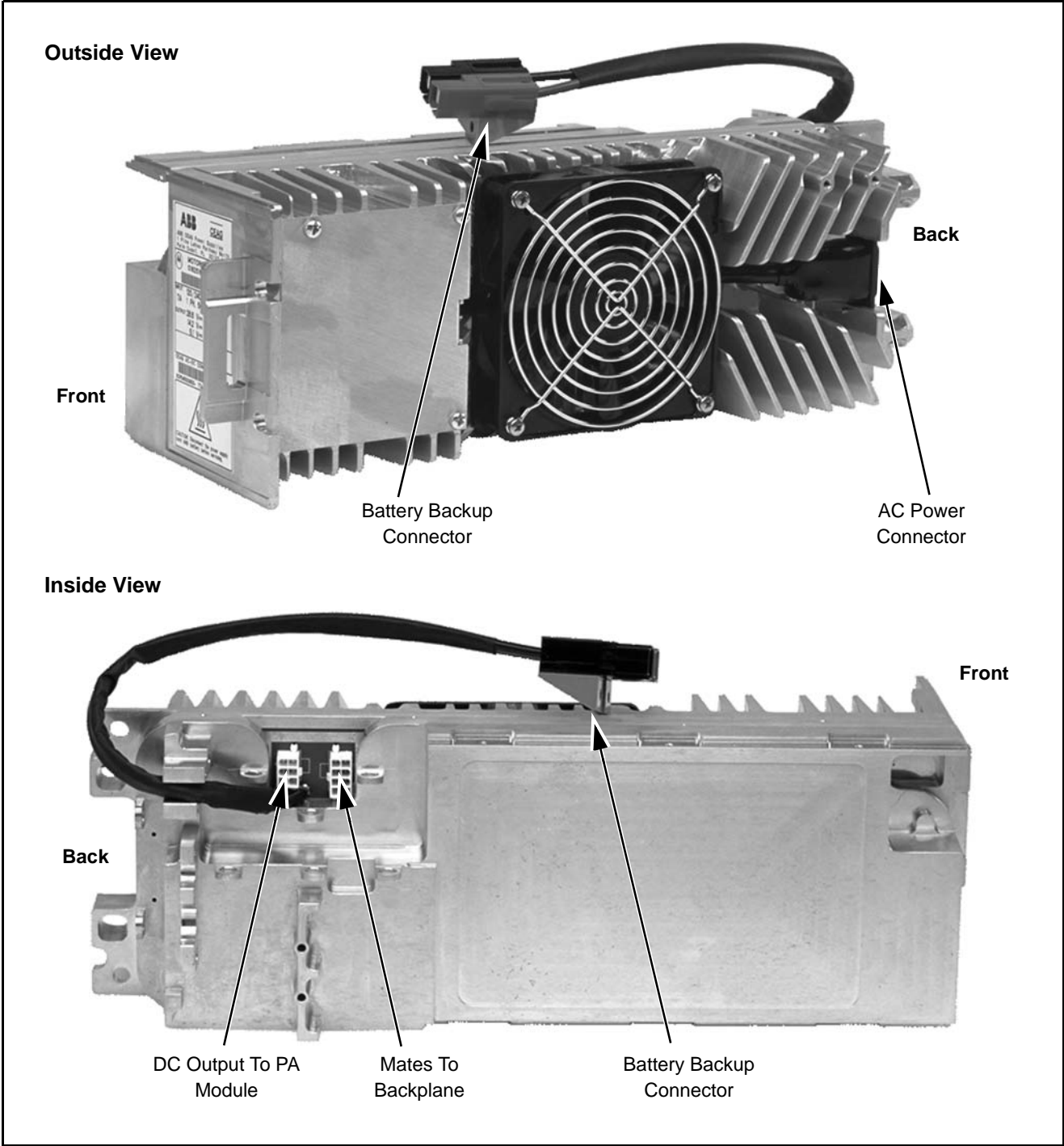
| Parameter                   | Specification  |                |
|-----------------------------|--|----------------|
|                             | CLN1220  | DLN6458        |
| Input Voltage Range         | 85 to 264 Vac  | 180 to 264 Vac |
| Operating Temperature       | -30° to +60° C (-22° to +140° F)   |                |
| Input Frequency Range       | 47 to 63 Hz  |                |
| Steady State Output Voltage | 28.6 V @ 13 A,<br>14.2 V @ 8 A,<br>5.1 V @ 2 A   |                |
| Output Power (Rated)        | 500 W  |                |
| Load Transient              | 28.6 Vdc output $\leq \pm 4\%$ of steady state value   |                |
| Output Ripple:              | +28.6 Vdc 50 mV p-p, @ 25° C (77° F)<br>+14.2 Vdc 50 mV p-p, @ 25° C (77° F)<br>+5.1 Vdc 100 mV p-p, @ 25° C (77° F) |                |
| Efficiency                  | Greater than 75% (full load)   |                |



3

IDENTIFICATION OF INPUTS/OUTPUTS

Figure 1 shows the Model CLN1220 and DLN6458 Power Supply Module input and output external connections.



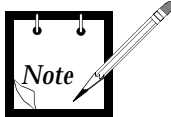
**Figure 1.     Model CLN1220/DLN6458 Power Supply Module Input/Output Connections**

# 4

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the power supply module.

### Supply Circuitry



#### Output Over-Current Protection

An over-current condition on either the 28.6 Vdc or 14.2 Vdc outputs causes the total supply to shutdown and try to restart. If the over-current continues to exist, the power supply will 'hiccup' until the overload condition is removed, and will not be damaged by the overload. The 28.6 Vdc output is protected by a primary current sense method such that its current limit point varies depending on the load on the other outputs at the time. The trip point for the 14.2 Vdc and 5.1 Vdc outputs is greater than 115% of the maximum current specified for the outputs. The power supply recovers automatically after the removal of the overload condition.

#### Over-Voltage Detection and Shutdown

The 28.6 V and 14.2 V dc outputs are protected from continuous over-voltages by detection circuits that cause the supply to shutdown and then try to restart itself. If the over-voltage condition continues to occur, the supply goes into a 'hiccup' mode of shutting down and trying to restart. If the over-voltage condition is removed, the supply automatically recovers. In addition, the 14.2 Vdc output is protected by a crowbar circuit if failure of any part would cause the 28.6 Vdc output to connect directly to the 14.2 Vdc output. In addition, the 5.1 Vdc output is protected by an over-voltage detect circuit that shuts down both series regulators at the same time. The trip point of the over-voltage detection circuit is less than 30.5 Vdc for 28.6 Vdc, less than 16.8 Vdc for 14.2 Vdc, and less than 6.0 Vdc for 5.1 Vdc.

#### AC Fail Detect

An AC Fail detect signal is provided to indicate (when used with battery backup option) that the power supply is operating from an external dc source rather than the ac mains. This signal is an open collector output capable of sinking 1 mA, and is routed to the Station Control Module. The active-low state indicates ac operation. For the nominal 120 Vac operation, the signal is active-high impedance (indicating an ac mains failure) when

the ac voltage is less than 85 Vrms, but more than the minimum voltage that guarantees that all outputs will be in regulation at full load. For the nominal 240 Vac operation, the detect point is less than 170 Vrms but more than the minimum ac input voltage that guarantees that all outputs be in regulation at full load.

### **Fan Control Line**

The supply incorporates temperature sense/fan enable circuitry for controlling a 12Vdc fan mounted on the surface of the heatsink assembly. The power supply circuitry senses the internal temperature of the power supply. When the internal temperature exceeds +60°C ( $\pm 5^\circ\text{C}$ ), +12 V is enabled at J1-1 to turn on the fan. The +12 V fan supply is derived from the +14.2 V output. Power to the fan is off when the temperature is below the set limit. The fan turns for approximately 10 seconds when power is first applied as a diagnostic indicator that the fan is functional.

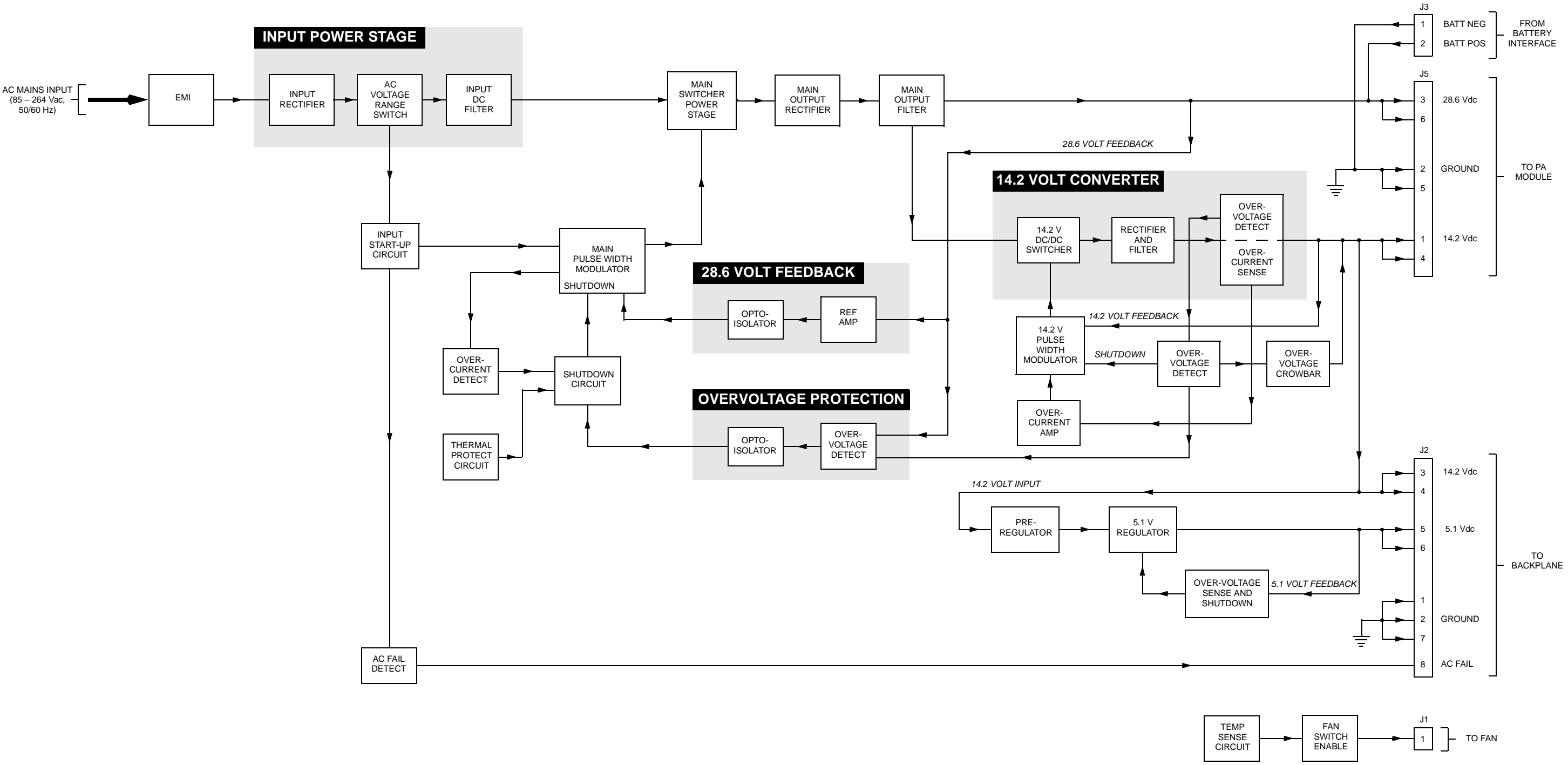


Figure 2. CLN1220/DLN6458 – 500 W Power Supply Functional Block Diagram



# AC/DC POWER SUPPLY MODULE

**MODEL DLN6622**  
**(500 W, 50/60 Hz, 85 to 264 Vac Input**  
**or 21.6 to 32 Vdc Input)**

## 1

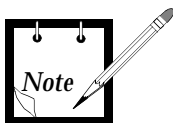
## DESCRIPTION

The DLN6622 Power Supply Module is described in this section. This Power Supply is used on high power (i.e., >75 W) stations. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

The DLN6622 Power Supply Module has built in power factor correction and includes a connection for battery backup that also serves as the DC input when the supply is used in dc only input mode.

### General Description

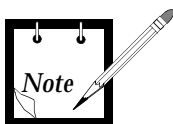
The DLN6622 Power Supply Module accepts an ac or a dc input (ac input = 85 to 264 Vac, 50/60 Hz, dc input = 21.6 to 32 Vdc) and generates three output dc voltages to power the station modules: +5.1 Vdc, +14.2 Vdc, and +28.6 Vdc.



When used in dc input mode the 28.6 Vdc output is determined by the dc input minus 0.5 Vdc.

The power supply is a high-frequency switched mode design, all contained in a metal heat-sink, mounted on the left-hand side of the station. The design provides for output over-voltage/over-current protection.

The ac input connection is made at the rear of the station via an IEC-type connector keyed to accept only high temperature type mating connectors. Also provided is a Battery Backup connection (see dc mode above). Power supply cooling, when necessary, is provided by an external fan (located near the middle of the heatsink) which provides forced air across the power supply heatsink fins.



An external battery charger system is required to support the battery backup feature.

## 2

## PERFORMANCE SPECIFICATIONS

Table 1 shows the electrical performance specifications for Model DLN6622 Power Supply Module

**Table 1. DLN6622 Power Supply Module AC Performance Specifications**

| Parameter   | Specification   |
|---|---|
| Input Voltage Range                               | 85 to 264 Vac   |
| Operating Temperature                             | –30° to +60° C (–22° to +140° F)  |
| Input Frequency Range                             | 47 to 63 Hz   |
| Steady State Output Voltage                       | 28.6 V @ 13 A,<br>14.2 V @ 8 A,<br>5.1 V @ 2 A  |
| Output Power (Rated)                              | 500 W   |
| Load Transient                                    | 28.6 Vdc output $\leq \pm 4\%$ of steady state value                                    |
| Output Ripple: +28.6 Vdc<br>+14.2 Vdc<br>+5.1 Vdc | 50 mV p-p, @ 25° C (77° F)<br>50 mV p-p, @ 25° C (77° F)<br>100 mV p-p, @ 25° C (77° F) |
| Efficiency  | Greater than 75% (full load)  |

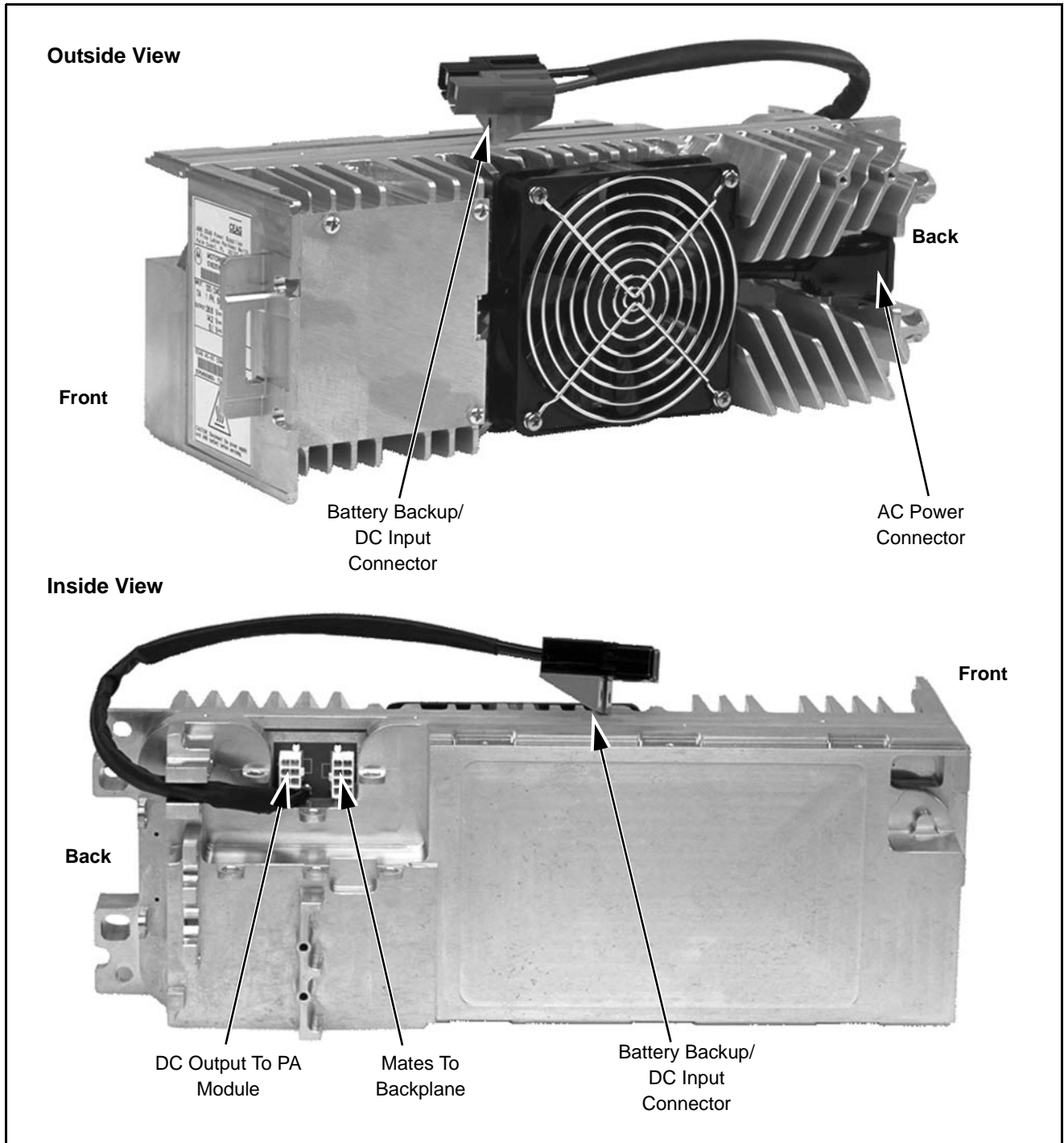
**Table 2. DLN6622 Power Supply Module DC Performance Specifications**

| Parameter   | Specification   |
|---|---|
| Operating Temperature                             | –30° to +60° C (–22° to +140° F)  |
| Input Voltage Range                               | 21.6 to 32 Vdc  |
| Steady State Output Voltage                       | 28.6 V @ 13 A, Input voltage dependant<br>14.2 V @ 8 A, Regulated<br>5.1 V @ 2 A, Regulated |
| Output Power (Rated)                              | 500 W   |
| Output Ripple: +28.6 Vdc<br>+14.2 Vdc<br>+5.1 Vdc | 50 mV p-p, @ 25° C (77° F)<br>50 mV p-p, @ 25° C (77° F)<br>100 mV p-p, @ 25° C (77° F)     |
| Efficiency  | Greater than 85% (full load)  |

### 3

## IDENTIFICATION OF INPUTS/OUTPUTS

Figure 1 shows the Model DLN6622 Power Supply Module input and output external connections.



**Figure 1. Model DLN6622 Power Supply Module Input/Output Connections**

## 4

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the power supply module.

---

### Supply Circuitry

#### Output Over-Current Protection

An over-current condition on either the 28.6 Vdc or 14.2 Vdc outputs causes the total supply to shutdown and try to restart. If the over-current continues to exist, the power supply will 'hiccup' until the overload condition is removed, and will not be damaged by the overload. The 28.6 Vdc output is protected by a primary current sense method such that its current limit point varies depending on the load on the other outputs at the time. The trip point for the 14.2 Vdc and 5.1 Vdc outputs is greater than 115% of the maximum current specified for the outputs. The power supply recovers automatically after the removal of the overload condition.

#### Over-Voltage Detection and Shutdown

The 28.6 V and 14.2 V dc outputs are protected from continuous over-voltages by detection circuits that cause the supply to shutdown and then try to restart itself. If the over-voltage condition continues to occur, the supply goes into a 'hiccup' mode of shutting down and trying to restart. If the over-voltage condition is removed, the supply automatically recovers. In addition, the 14.2 Vdc and the 5 Vdc outputs are protected by crowbar circuits.

#### AC Fail Detect

An AC Fail detect signal is provided to indicate (when used with battery backup option) that the power supply is operating from an external dc source rather than the ac mains. This signal is a TTL compatible output capable of sinking 1 mA, and is routed to the Station Control Module. The active-low state indicates ac operation. For the nominal 120 Vac operation, the signal is active-high impedance (indicating an ac mains failure) when the ac voltage is less than 85 Vrms, but more than the minimum voltage that guarantees that all outputs will be in regulation at full load. For the nominal 240 Vac operation, the detect point is less than 170 Vrms but more than the minimum ac input voltage that guarantees that all outputs be in regulation at full load.



## Fan Control Line

The supply incorporates temperature sense/fan enable circuitry for controlling a 12Vdc fan mounted on the surface of the heatsink assembly. The power supply circuitry senses the internal temperature of the power supply. When the internal temperature exceeds  $+60^{\circ}\text{C}$  ( $\pm 5^{\circ}\text{C}$ ), +12 V is enabled at J1-1 to turn on the fan. The +12 V fan supply is derived from the +14.2 V output. Power to the fan is off when the temperature is below the set limit. The fan turns for approximately 5 seconds when power is first applied as a diagnostic indicator that the fan is functional.

## Overtemperature Protection

The power supply will turn off all outputs when an operational ambient temperature of  $+80^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ ) has been reached with the supply operating at any input within its operating input voltage range (dc and ac).

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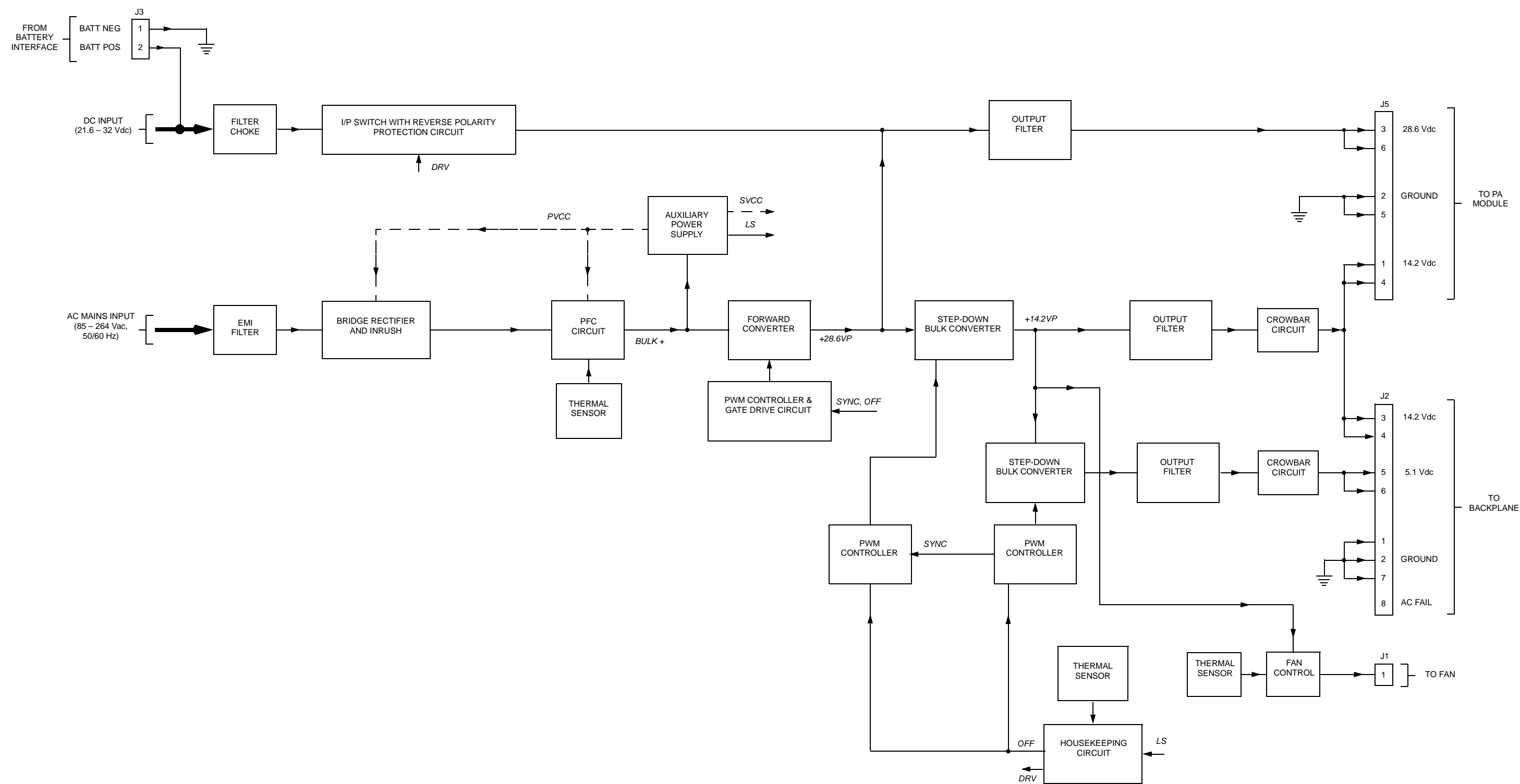


Figure 1. DLN6622 – 500 W Power Supply Functional Block Diagram



# POWER SUPPLY MODULE

MODEL CLN1221

(250 W, 50/60 Hz, 85 to 264 Vac Input)

## 1

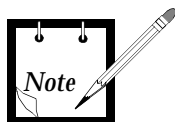
### DESCRIPTION

The CLN1221 Power Supply Module is described in this section. This Power Supply is used on low power (i.e., 30/40 W) stations. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

#### General Description

The CLN1221 Power Supply Module accepts an ac input (85 to 264 Vac, 50/60 Hz) and generates two output dc voltages to power the station modules: +5.1 Vdc and +14.2 Vdc. The power supply is a high-frequency switched mode design, utilizing Pulse Width Modulation (PWM) control, all contained in a metal heatsink, mounted on the left-hand side of the station. The design provides for over-voltage/over-current protection.

The ac input connection is made at the rear of the station via an IEC-type connector keyed to accept only high temperature type mating connectors. Also provided is a Battery Backup connection. Power supply cooling is provided by natural convection via the heatsink which is coplanar with the power supply circuit board assembly.



An external battery charger system is required to support the battery backup feature.

**2****PERFORMANCE SPECIFICATIONS**

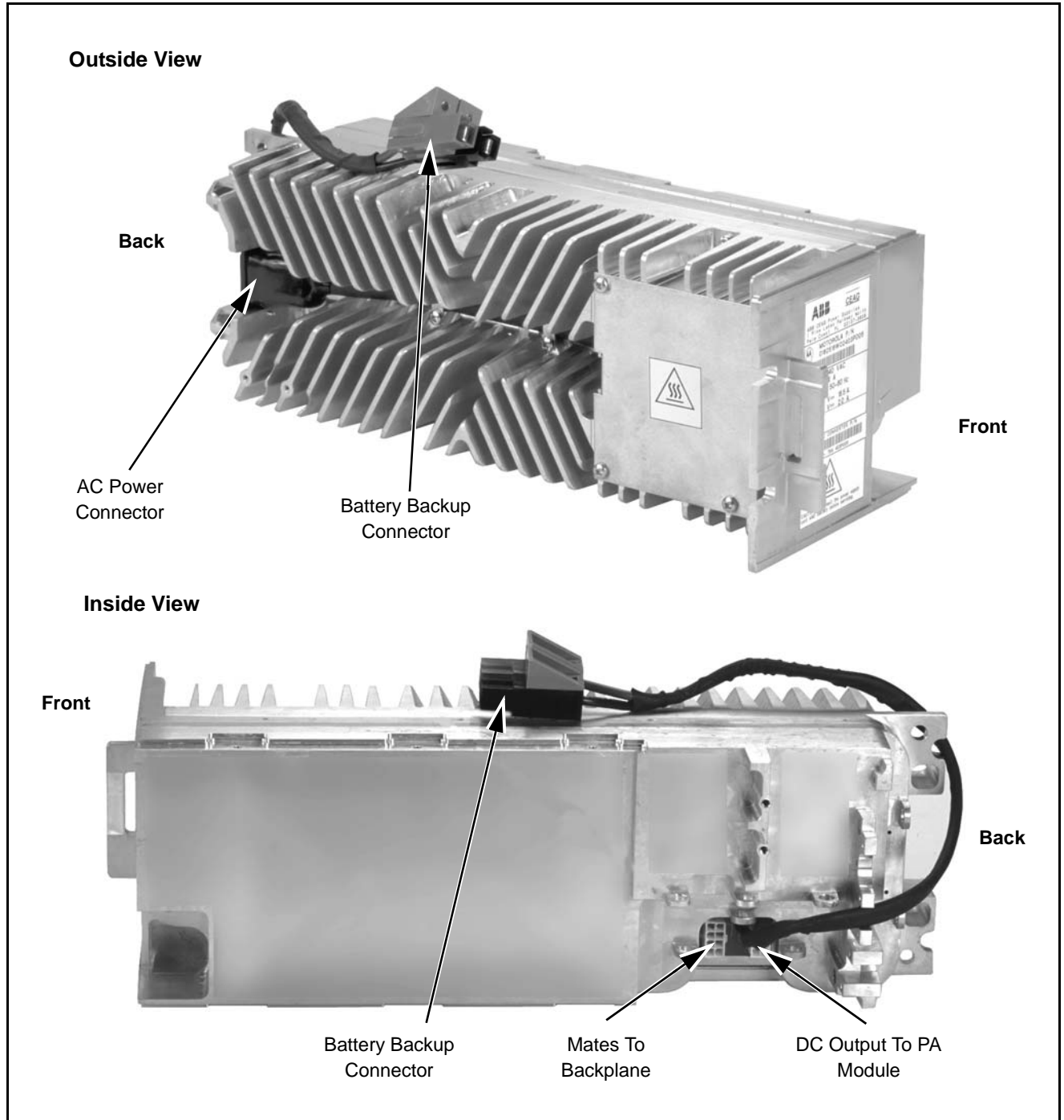
Table 1 shows the electrical performance specifications for the Model CLN1221 Power Supply Module.

**Table 1. CLN1221 Power Supply Module Performance Specifications**

| Parameter                   |           | Specification  |
|-----------------------------|-----------|--|
| Operating Temperature       |           | –30° to +60° C (–22° to +140° F)                       |
| Input Voltage Range         |           | 85 to 264 Vac  |
| Input Frequency Range       |           | 47 to 63 Hz  |
| Steady State Output Voltage |           | 14.2 V @ 16.5 A,<br>5.1 V @ 2 A                        |
| Output Power (Rated)        |           | 250 W  |
| Load Transient              |           | 14.2 Vdc output $\leq \pm 2.5\%$ of steady state value |
| Output Ripple               | +14.2 Vdc | 50 mV p-p, @ 25° C (77° F)                             |
|                             | +5.1 Vdc  | 100 mV p-p, @ 25° C (77° F)                            |
| Efficiency                  |           | Greater than 75% (full load)                           |

**3****IDENTIFICATION OF INPUTS/OUTPUTS**

Figure 1 shows the model CLN1221 Power Supply Module input and output external connections.



**Figure 1. Model CLN1221 Power Supply Module Input/Output Connections**

## 4

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the power supply module.

---

### Supply Circuitry



#### Output Over-Current Protection

An over-current condition on the 14.2 Vdc output causes the total supply to shutdown and try to restart. If the over-current continues to exist, the power supply will 'hiccup' until the overload condition is removed, and will not be damaged by the overload. The 14.2 Vdc output goes into the hiccup mode when its output current is greater than 18 A. The trip point for the 5.1 Vdc output is greater than 115% of the maximum current specified for the output. The power supply recovers automatically after the removal of the overload condition.

#### Over-Voltage Detection and Shutdown

The 14.2 Vdc output is protected from continuous over-voltages by detection circuits that cause the supply to shutdown and then try to restart itself. If the over-voltage condition continues to occur, the supply goes into a 'hiccup' mode of shutting down and trying to restart. If the over-voltage condition is removed, the supply automatically recovers. In addition, the 5.1 Vdc output is protected by an over-voltage detect circuit that shuts down both series regulators at the same time. The trip point of the over-voltage detection circuit is less than 16.8 Vdc for 14.2 Vdc, and less than 6.0 Vdc for 5.1 Vdc.

#### AC Fail Detect

An AC Fail detect signal is provided to indicate (when used with battery backup option) that the power supply is operating from an external dc source rather than the ac mains. This signal is an open collector output capable of sinking 1mA, and is routed to the Station Control Module. The active low state indicates ac operation. For the nominal 120 V ac operation, the signal is active-high impedance (indicating an ac mains failure) when the ac voltage is less than 85 Vrms, but more than the minimum voltage that guarantees that all outputs will be in regulation at full load. For the nominal 240 Vac operation, the detect point is less than 170 Vrms but more than the minimum ac input voltage that guarantees that all outputs be in regulation at full load.

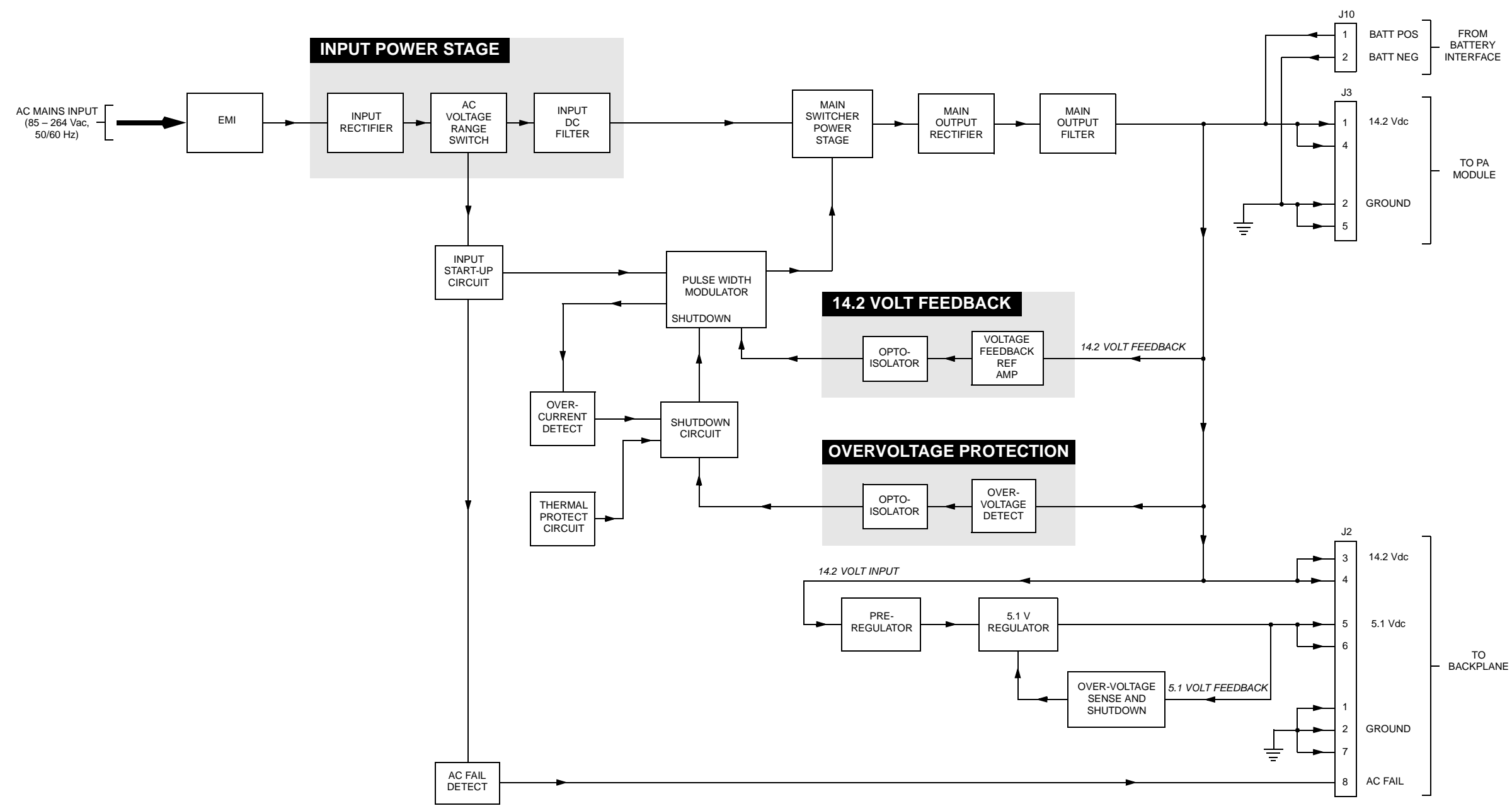


Figure 2. CLN1221 – 250 W Power Supply Functional Block Diagram





# POWER SUPPLY MODULE

MODEL DLN6624

(250 W, 50/60 Hz, 85 to 264 Vac Input  
or 10.8 to 16 Vdc Input)

## 1

### DESCRIPTION

The DLN6624 Power Supply Module is described in this section. This Power Supply is used on low power (i.e., 30/40 W) stations. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

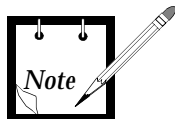
#### General Description

The DLN6624 Power Supply Module accepts an ac or a dc input (85 to 264 Vac, 50/60 Hz, dc input = 10.8 to 16 Vdc) and generates two output dc voltages to power the station modules: +5.1 Vdc and +14.2 Vdc.

When used in dc input mode the 14.2 Vdc output is determined by the dc input minus 0.5 Vdc.

The power supply is a high-frequency switched mode design, all contained in a metal heatsink, mounted on the left-hand side of the station. The design provides for over-voltage/over-current protection.

The ac input connection is made at the rear of the station via an IEC-type connector keyed to accept only high temperature type mating connectors. Also provided is a Battery Backup connection (see dc mode above). Power supply cooling is provided by natural convection via the heatsink which is coplanar with the power supply circuit board assembly.



An external battery charger system is required to support the battery backup feature.

## 2

## PERFORMANCE SPECIFICATIONS

Table 1 shows the electrical performance specifications for the Model DLN6624 Power Supply Module.

**Table 1. DLN6624 Power Supply Module AC Performance Specifications**

| Parameter                   | Specification   |
|-----------------------------|---|
| Operating Temperature       | –30° to +60° C (–22° to +140° F)                          |
| Input Voltage Range         | 85 to 264 Vac   |
| Input Frequency Range       | 47 to 63 Hz   |
| Steady State Output Voltage | 14.2 V @ 16.5 A,<br>5.1 V @ 2 A                           |
| Output Power (Rated)        | 250 W   |
| Load Transient              | 14.2 Vdc output $\leq \pm 2.5\%$ of steady state value    |
| Output Ripple               | +14.2 Vdc<br>+5.1 Vdc                                     |
|                             | 50 mV p-p, @ 25° C (77° F)<br>100 mV p-p, @ 25° C (77° F) |
| Efficiency                  | Greater than 75% (full load)                              |

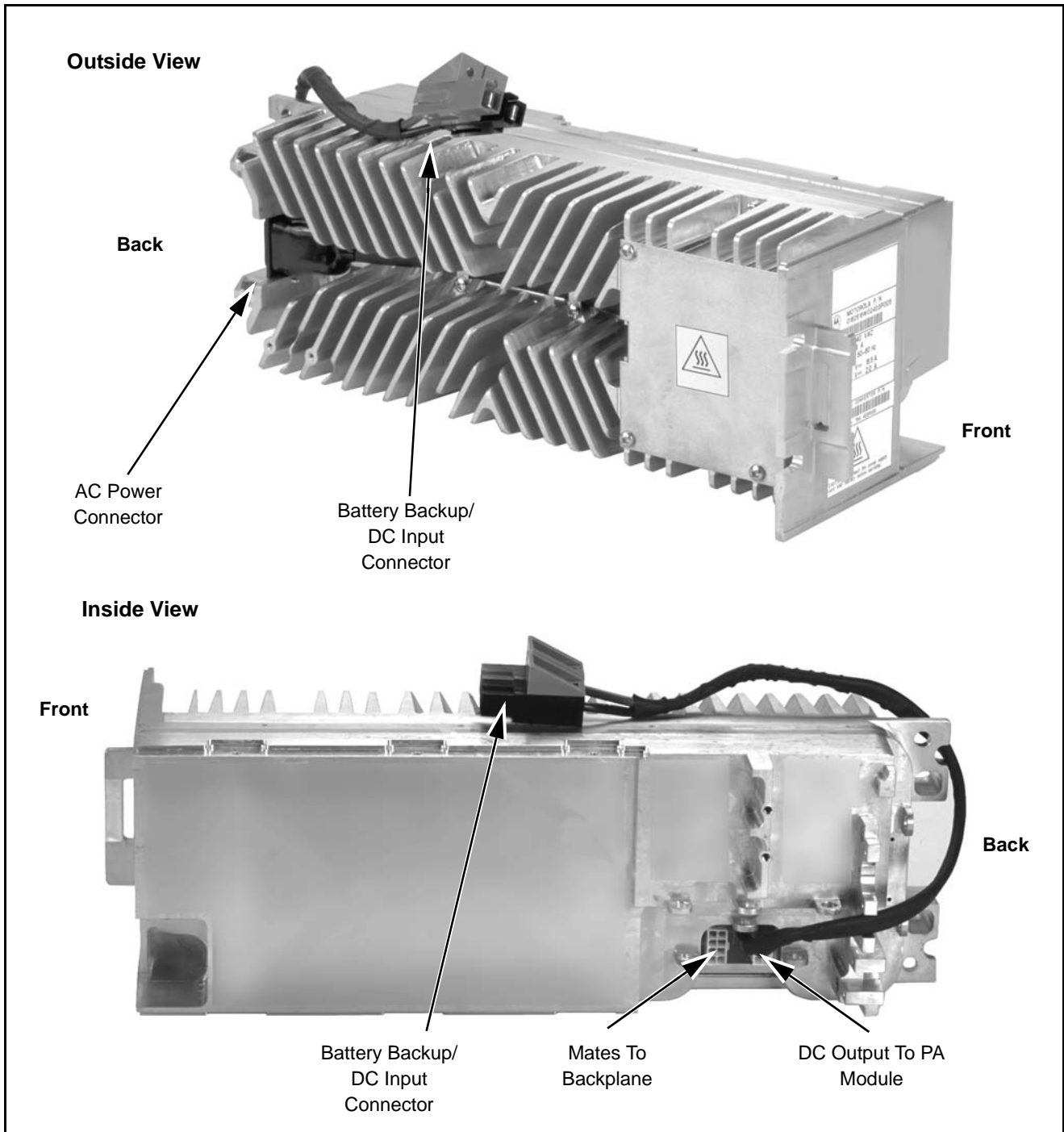
**Table 2. DLN6624 Power Supply Module DC Performance Specifications**

| Parameter                   | Specification  |
|-----------------------------|--|
| Operating Temperature       | –30° to +60° C (–22° to +140° F)   |
| Input Voltage Range         | 10.8 to 16 Vdc   |
| Steady State Output Voltage | 10.8V to 16V @ 16.5 A, Input voltage dependant<br>5.1 V $\pm 3\%$ @ 2 A, Regulated |
| Output Power (Rated)        | 250 W  |
| Output Ripple:              | +14.2 Vdc<br>+5.1 Vdc  |
|                             | 50 mV p-p, @ 25° C (77° F)<br>100 mV p-p, @ 25° C (77° F)                          |
| Efficiency                  | Greater than 85% (full load)   |

### 3

## IDENTIFICATION OF INPUTS/OUTPUTS

Figure 1 shows the model DLN6624 Power Supply Module input and output external connections.



**Figure 1. Model DLN6624 Power Supply Module Input/Output Connections**

## 4

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the power supply module.

---

### Supply Circuitry



#### Output Over-Current Protection

An over-current condition on the 14.2 Vdc output causes the total supply to shutdown and try to restart. If the over-current continues to exist, the power supply will 'hiccup' until the overload condition is removed, and will not be damaged by the overload. The 14.2 Vdc output goes into the hiccup mode when its output current is greater than 18 A. The trip point for the 5.1 Vdc output is greater than 115% of the maximum current specified for the output. The power supply recovers automatically after the removal of the overload condition.

#### Over-Voltage Detection and Shutdown

The 14.2 Vdc output is protected from continuous over-voltages by detection circuits that cause the supply to shutdown and then try to restart itself. If the over-voltage condition continues to occur, the supply goes into a 'hiccup' mode of shutting down and trying to restart. If the over-voltage condition is removed, the supply automatically recovers. In addition, the 5 Vdc output is protected by a crowbar circuit.

#### AC Fail Detect

An AC Fail detect signal is provided to indicate (when used with battery backup option) that the power supply is operating from an external dc source rather than the ac mains. This signal is a TTL compatible output capable of sinking 1mA, and is routed to the Station Control Module. The active low state indicates ac operation. For the nominal 120 V ac operation, the signal is active-high impedance (indicating an ac mains failure) when the ac voltage is less than 85 Vrms, but more than the minimum voltage that guarantees that all outputs will be in regulation at full load. For the nominal 240 Vac operation, the detect point is less than 170 Vrms but more than the minimum ac input voltage that guarantees that all outputs be in regulation at full load.

## **Overtemperature Protection**

The power supply will turn off all outputs when an operational ambient temperature of  $+80^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ ) has been reached with the supply operating at any input within its operating input voltage range (dc and ac).

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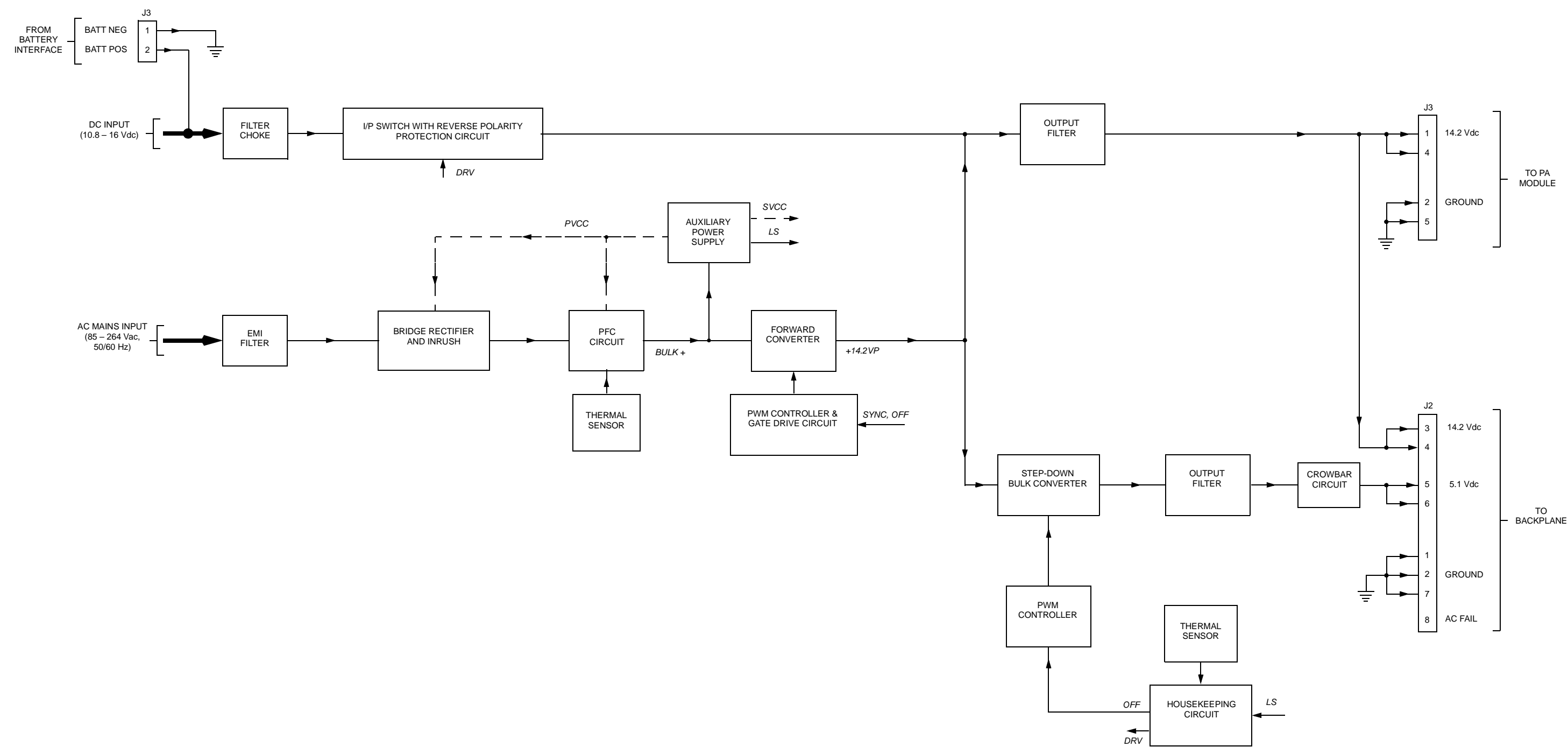


Figure 1. DLN6624 – 250 W Power Supply  
Functional Block Diagram



# POWER SUPPLY MODULE; DC-Only

## MODEL CLN1222

(500 W, 21 to 32 Vdc Input)

### 1

## DESCRIPTION

The CLN1222 Power Supply Module is described in this section. This Power Supply is used on high power (i.e., >75 W) stations. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The CLN1222 Power Supply Module accepts a dc input (21 to 32 Vdc) and generates three output dc voltages to power the station modules: +5.1 Vdc, +14.2 Vdc, and +28.6 Vdc (input voltage dependent). The power supply is a high-frequency switched mode design, utilizing Pulse Width Modulation (PWM) control, all contained in a metal heat-sink, mounted on the left-hand side of the station. The design provides for input reverse-voltage protection, and output over-voltage/over-current protection.

The dc input connection is made at the rear of the station via an AMP Power Lock connector. Power supply cooling is provided by natural convection via the heatsink which is coplanar with the power supply circuit board assembly.



**2****PERFORMANCE SPECIFICATIONS**

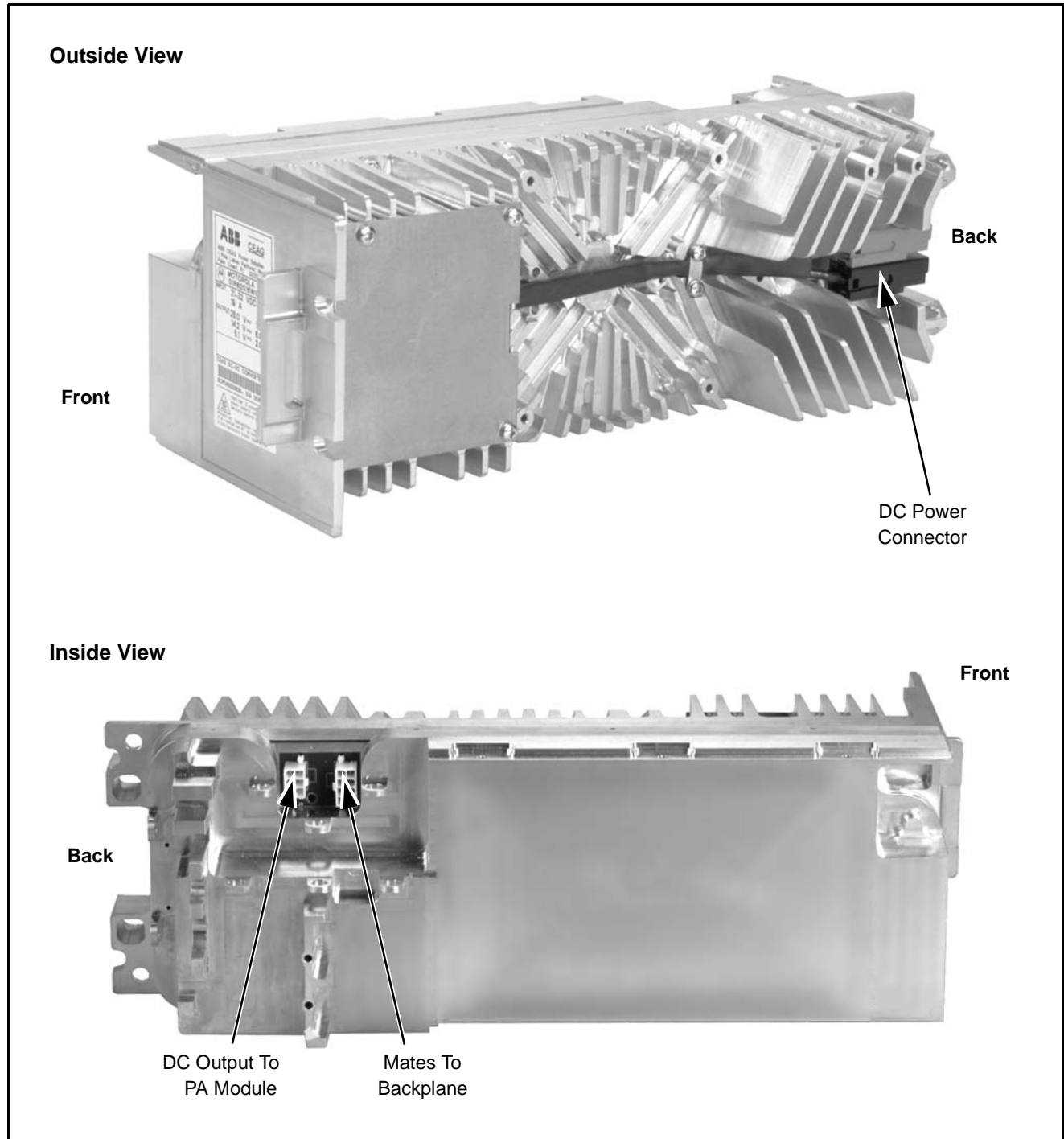
Table 1 shows the electrical performance specifications for the Model CLN1222 Power Supply Module.

**Table 1. CLN1222 Power Supply Module Performance Specifications**

| Parameter   | Specification   |
|---|---|
| Operating Temperature                             | –30° to +60° C (–22° to +140° F)  |
| Input Voltage Range                               | 21 to 32 Vdc  |
| Input AC Ripple                                   | 100 / 120 Hz and harmonics<br>10 kHz to 10 MHz  |
| Steady State Output Voltage                       | Input voltage dependent<br>28.6 V @ 13 A,<br>14.2 V @ 8 A,<br>5.1 V @ 2 A               |
| Output Power (Rated)                              | 500 W   |
| Output Ripple: +28.6 Vdc<br>+14.2 Vdc<br>+5.1 Vdc | 50 mV p-p, @ 25° C (77° F)<br>50 mV p-p, @ 25° C (77° F)<br>100 mV p-p, @ 25° C (77° F) |
| Efficiency  | Greater than 90% (full load)  |

**3****IDENTIFICATION OF INPUTS/OUTPUTS**

Figure 1 shows the model CLN1222 Power Supply Module input and output external connections.



**Figure 1. Model CLN1222 Power Supply Module Input/Output Connections**

## 4

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the power supply module.

---

### Supply Circuitry

#### Input Reverse-Voltage Protection

The Power Supply Module includes protection from input dc voltage with reverse-polarity.

The power supply is protected from damage and ensures that no reverse polarity voltages are supplied to the station modules. If a reverse-voltage is present, the in-line fuse will blow. This fuse is in line with the input power cable and not part of the station.



#### Output Over-Current Protection

An over-current condition on the 28.6 Vdc output is limited by an external in-line fuse or the external power supply. This fuse is in-line with the input power cable and not part of the station.

The trip point for the 14.2 Vdc and 5.1 Vdc outputs is greater than 115% of the maximum current specified for the outputs. The power supply recovers automatically after the removal of the overload condition.

#### Over-Voltage Detection and Shutdown

The 14.2 Vdc and 5.1 Vdc outputs are protected from continuous over-voltages by detection circuits that cause the supply to shutdown and then try to restart itself.

Also, the 14.2 Vdc output is protected by a crowbar circuit if failure of any part causes the 28.6 Vdc output to connect directly to the 14.2 Vdc output. The trip point of the over-voltage detection circuit is less than 16.8 Vdc for 14.2 Vdc, and less than 6.0 Vdc for 5.1 Vdc.

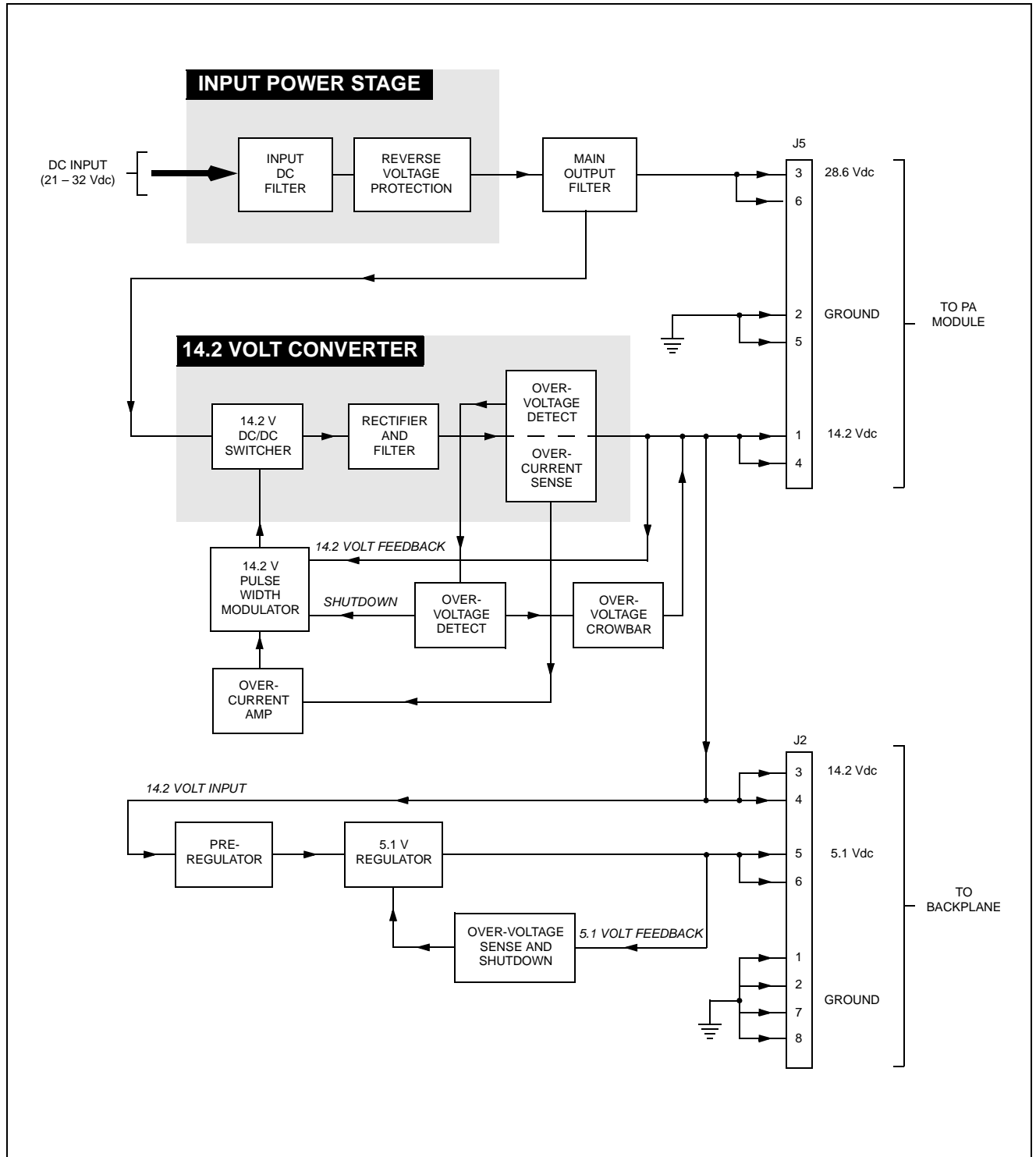


Figure 2. CLN1222 – 500 W DC-Only Power Supply Functional Block Diagram



# POWER SUPPLY MODULE; DC-Only

MODEL CLN1223  
(250 W, 10.8 to 16 Vdc Input)

## 1

### DESCRIPTION

The CLN1223 Power Supply Module is described in this section. This Power Supply is used on low power (i.e., 30/40 W) stations. A general description, identification of inputs and outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

#### General Description

The CLN1223 Power Supply Module accepts a dc input (10.8 to 16 Vdc) and generates two output dc voltages to power the station modules: +5.1 Vdc and +14.2 Vdc. The power supply is contained in a metal heat-sink, mounted on the left-hand side of the station. The design provides for input reverse-voltage protection, and output over-voltage/over-current protection.

The dc input connection is made at the rear of the station via an AMP Power Lock connector. Power supply cooling is provided by natural convection via the heatsink which is coplanar with the power supply circuit board assembly.

**2****PERFORMANCE SPECIFICATIONS**

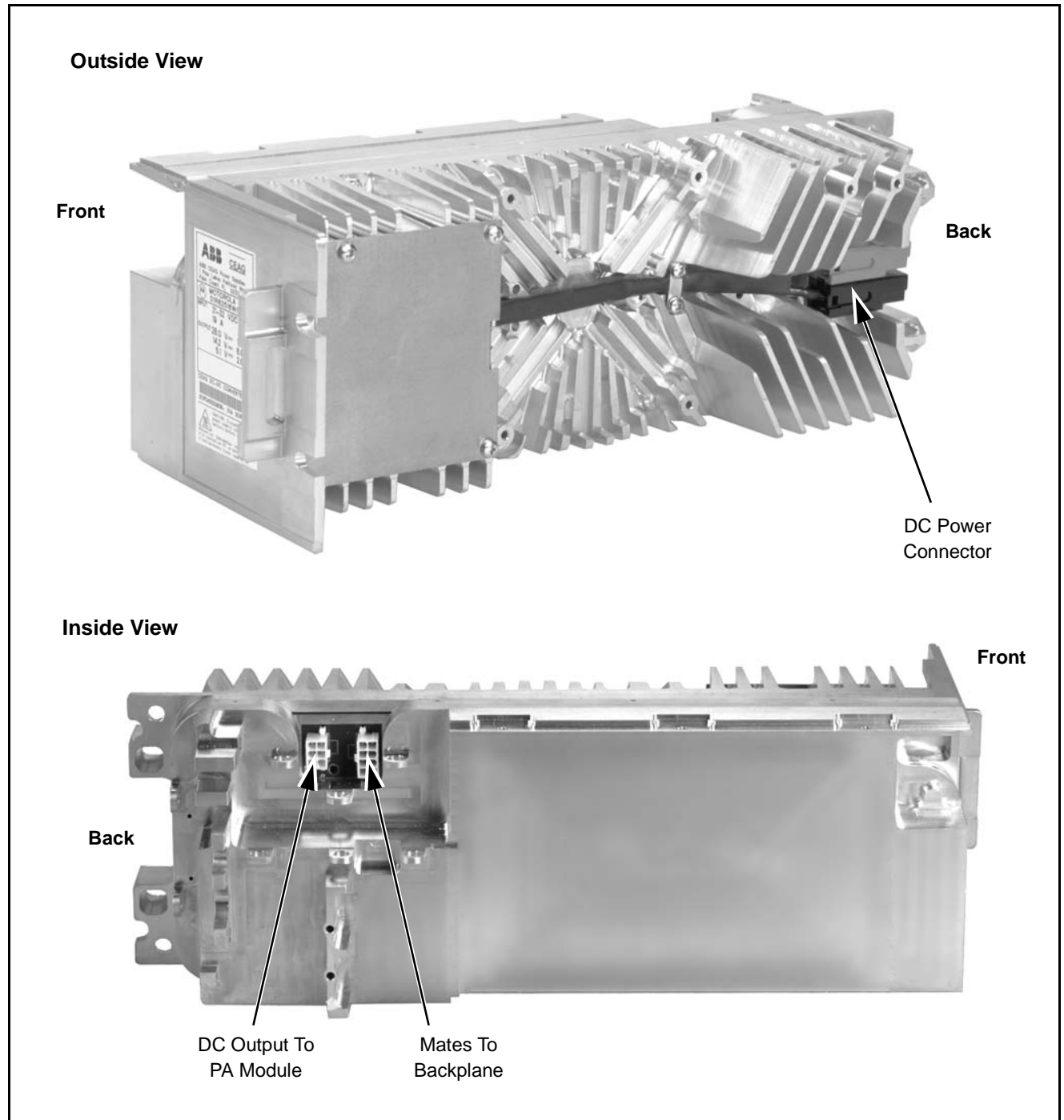
Table 1 shows the electrical performance specifications for the Model CLN1223 Power Supply Module.

**Table 1. CLN1223 DC-Only Power Supply Module Performance Specifications**

| Parameter                            | Specification  |
|--------------------------------------|--|
| Operating Temperature                | –30° to +60° C (–22° to +140° F)                               |
| Input Voltage Range                  | 10.8 to 16 Vdc   |
| Input AC Ripple                      | 100 / 120 Hz and harmonics<br>10 kHz to 10 MHz                 |
| Steady State Output Voltage          | Input dependent:<br>10.8V to 16V @ 16.5 A,<br>5.1 V ± 3% @ 2 A |
| Output Power (Rated)                 | 250 W  |
| Output Ripple: +14.2 Vdc<br>+5.1 Vdc | 50 mV p-p, @ 25° C (77° F)<br>100 mV p-p, @ 25° C (77° F)      |
| Efficiency                           | Greater than 90% (full load)                                   |

**3****IDENTIFICATION OF INPUTS/OUTPUTS**

Figure 1 shows the model CLN1223 Power Supply Module input and output external connections.



**Figure 1. Model CLN1223 DC-Only Power Supply Module Input/Output Connections**

## 4

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the power supply circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the power supply module.

---

### Supply Circuitry

#### Input Reverse-Voltage Protection

The Power Supply Module includes protection from input dc voltage with reverse-polarity.

The power supply is protected from damage and ensures that no reverse polarity voltages are supplied to the station modules. If a reverse-voltage is present, the in-line fuse will blow. This fuse is in line with the input power cable and not part of the station.



#### Output Over-Current Protection

An over-current condition on the 14.2 Vdc output is limited by an external in-line fuse or by the external power source. This fuse is in-line with the input power cable and not part of the station.

The 5.1Vdc regulator is protected by internal current limiting. The trip point for the 5.1 Vdc output is greater than 115% of the maximum current specified for the outputs. The 5.1Vdc recovers automatically after the removal of the overload condition.

#### Over-Voltage Detection and Shutdown

The 5.1 Vdc output is protected from continuous over-voltages by detection circuits that cause the supply to shutdown and then try to restart itself.



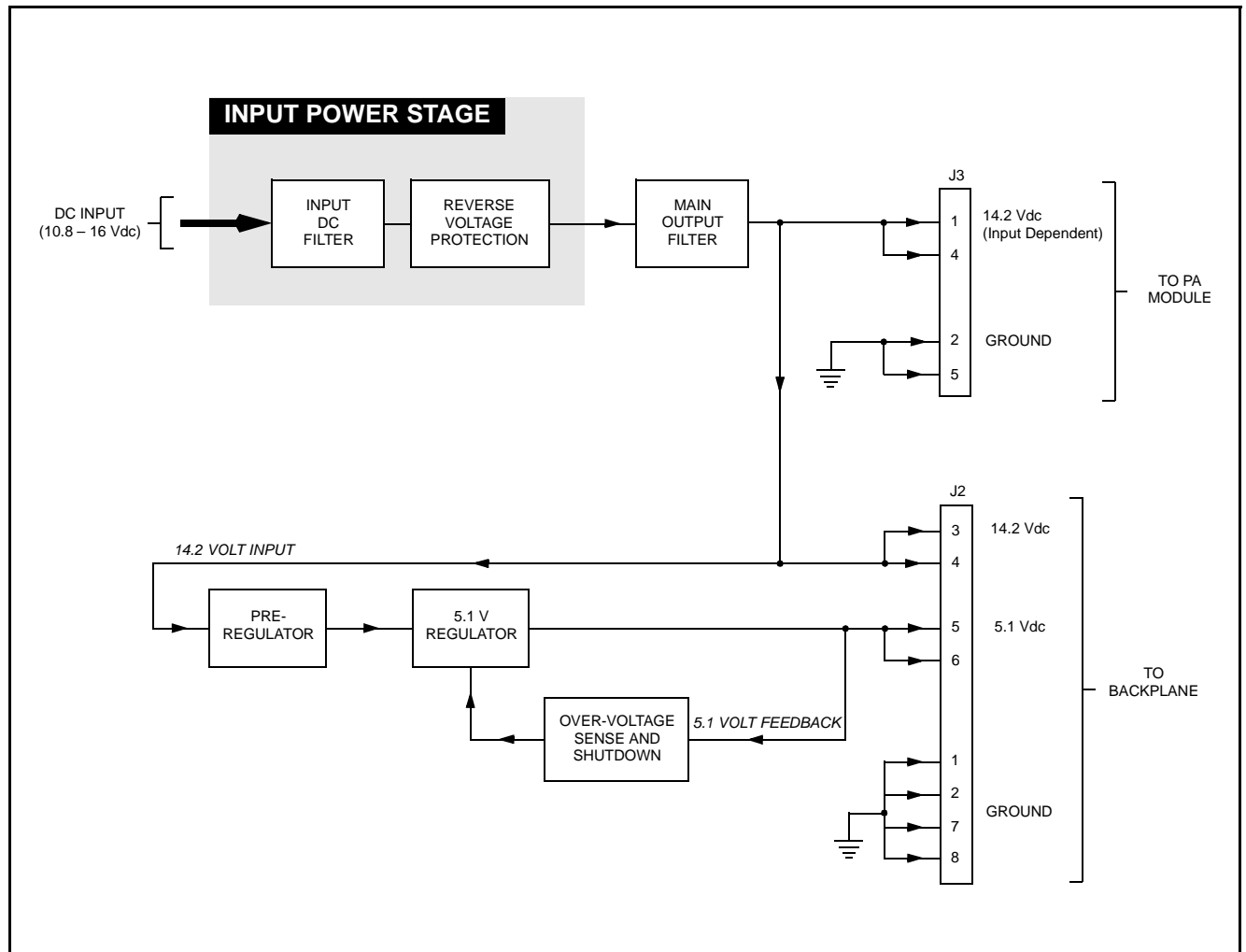


Figure 2. CLN1223 – 250 W DC-Only Power Supply Functional Block Diagram

## 1

### DESCRIPTION

The Motorola MTR2000 Satellite Receiver provides satellite receiver functionality in a reliable, software-controlled design. The innovative modular design and microprocessor-controlled Station Control Module (SCM) allows for superior station flexibility and simplified system upgrades. By eliminating “dead zones” in a communications system, the Satellite Receiver improves coverage on a particular receive frequency when used in a receiver voting system.

### General Mechanical Design

All elements of the satellite receiver are designed for EIA 48.3 cm (19") rack mounting, using the same mechanical parts as the MTR2000 Base Station/ Repeater. This allows the equipment to be mounted in standard telephone-style equipment racks or various sizes of Motorola cabinets. Figure 1 shows a typical satellite receiver.



**Figure 1. Typical MTR2000 Satellite Receiver**

---

## Overview of Circuitry

The satellite receiver contains the following circuitry:

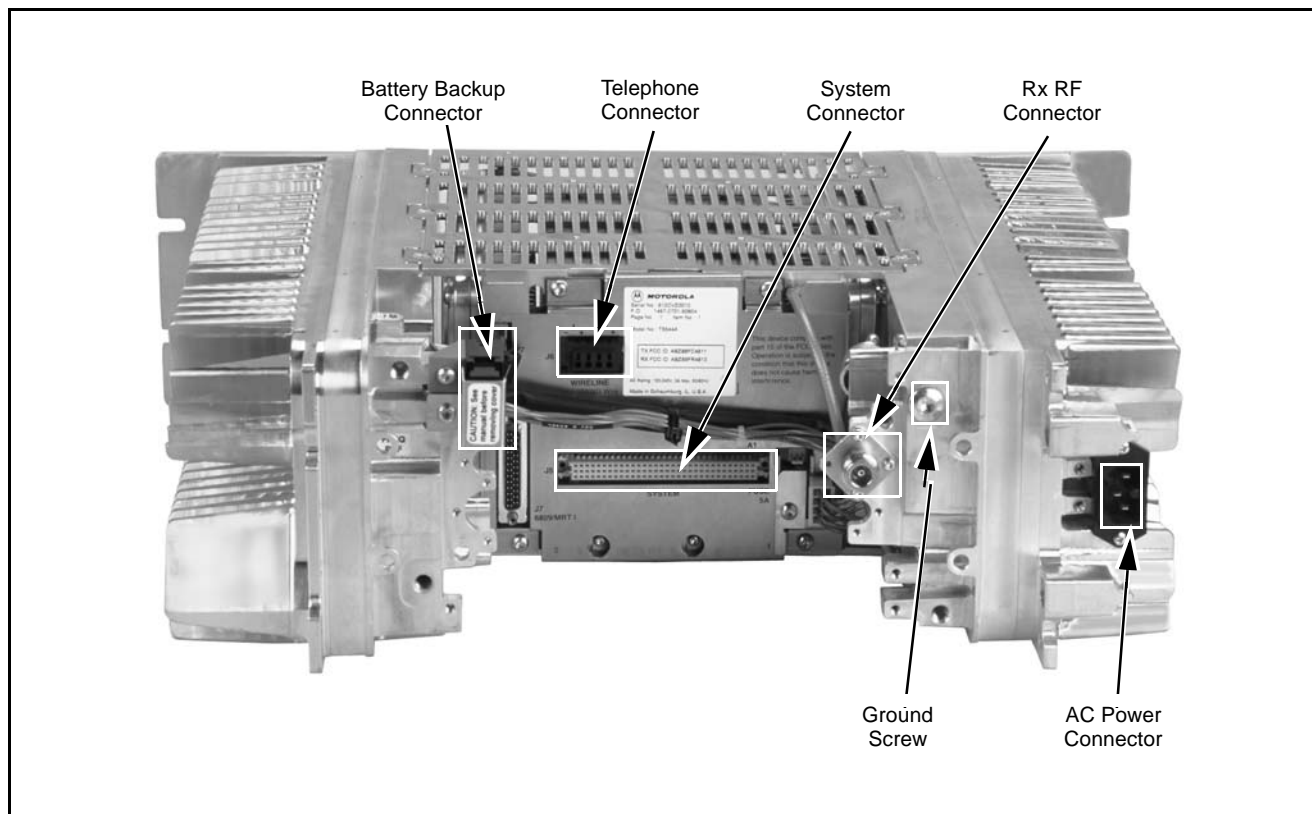
- Receiver Module
- Station Control Module
- Power Supply Module (250 W)
- Backplane Board
- Wireline Interface Board
- Auxiliary I/O Board (optional)

For detailed information on these modules, refer to the previous sections of this manual.

## 2

## INPUT AND OUTPUT CONNECTIONS

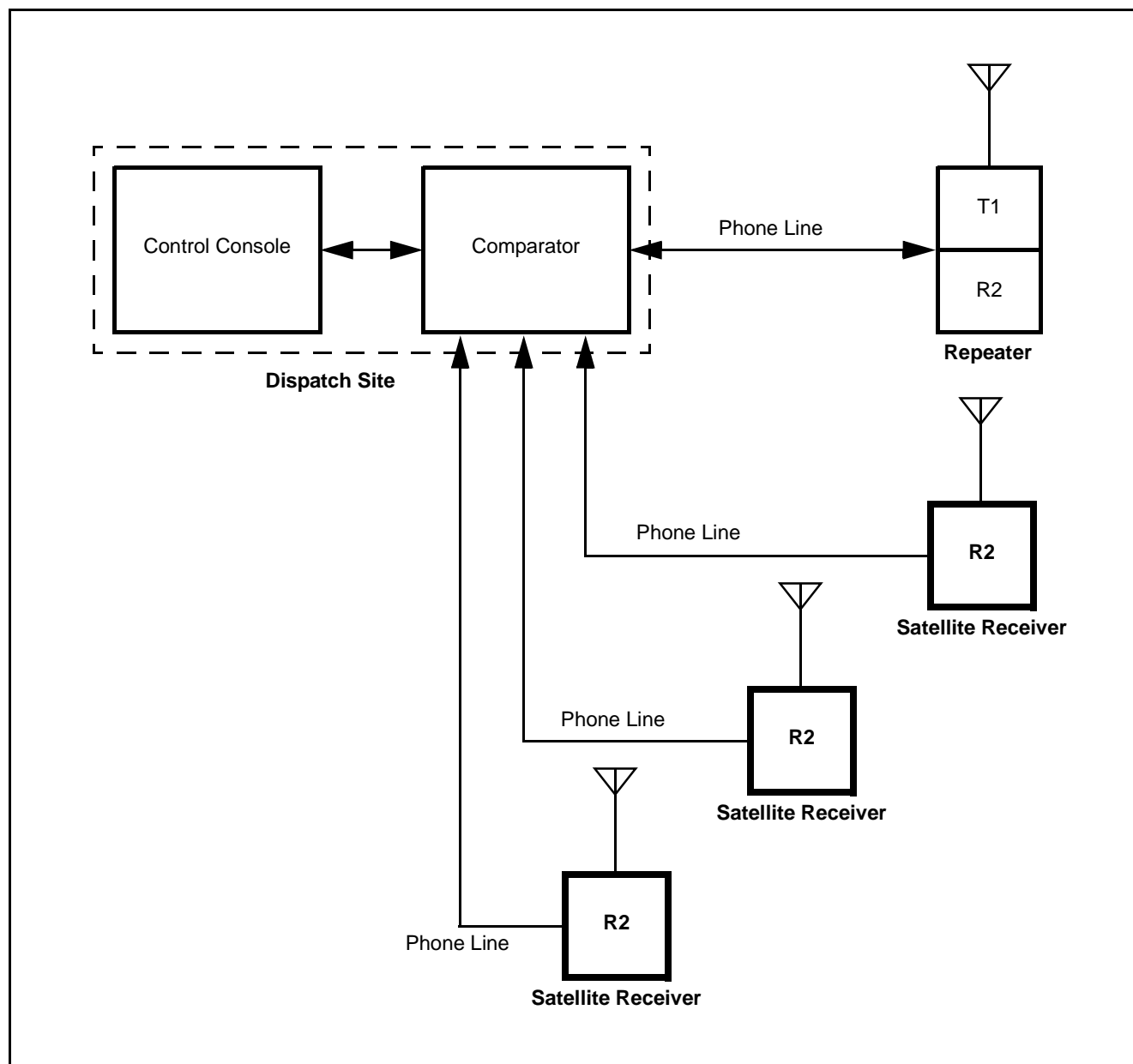
Figure 2 shows the satellite receiver input and output external connections.



**Figure 2. Satellite Receiver Input/Output Connections**

## Satellite Receiver Configuration

Typically, the Satellite Receiver connects to either a Spectra-TAC™ comparator or, through a Digital Voice Modem (DVM), to a DigiTAC™ comparator. In the case of a *Spectra-TAC* system, the only external connection required is audio output from the receiver's Wireline Interface Board (WIB) which is connected, by dedicated telephone line, to the *Spectra-TAC* comparator. In the case of a *DigiTAC* system, the RX Code Detect\* signal is connected to the DVM as well as the wireline audio connections. The DVM is then connected, by dedicated telephone line, to the DigiTAC comparator. Figure 2 shows a typical voting system and the connections of the Satellite Receivers.



**Figure 3. Satellite Receiver Connections Within a Voting System**

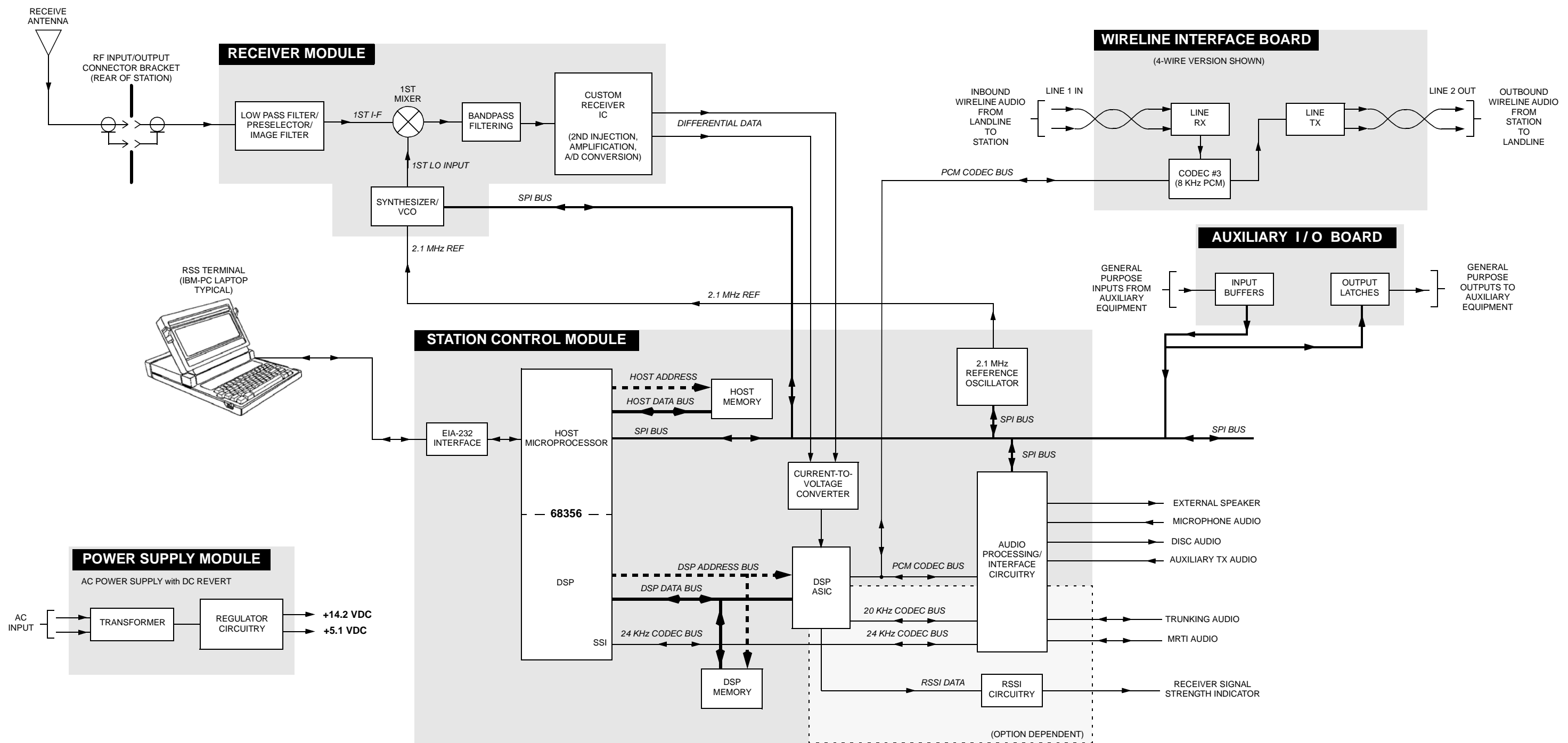


Figure 5. MTR2000 Satellite Receiver Functional Block Diagram



# ANTENNA RELAY MODULE

Model CLN6680

## 1

### DESCRIPTION

Model CLN6680 provides an Antenna Relay module for use with the MTR2000 station. This section provides a general description, option complement, identification of inputs/outputs, and functional theory of operation. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

#### General Description

This Antenna Relay module allows a single antenna to be used for both transmit and receive functions (base station applications only). The Antenna Relay is controlled by a signal from the Station Control Module to connect the antenna to either the Power Amplifier Module (transmit) or Receiver Module (receive). The Antenna Relay module is mounted on a flange provided on the rear of the Power Supply Module.

2

INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the Antenna Relay module input and output connections.

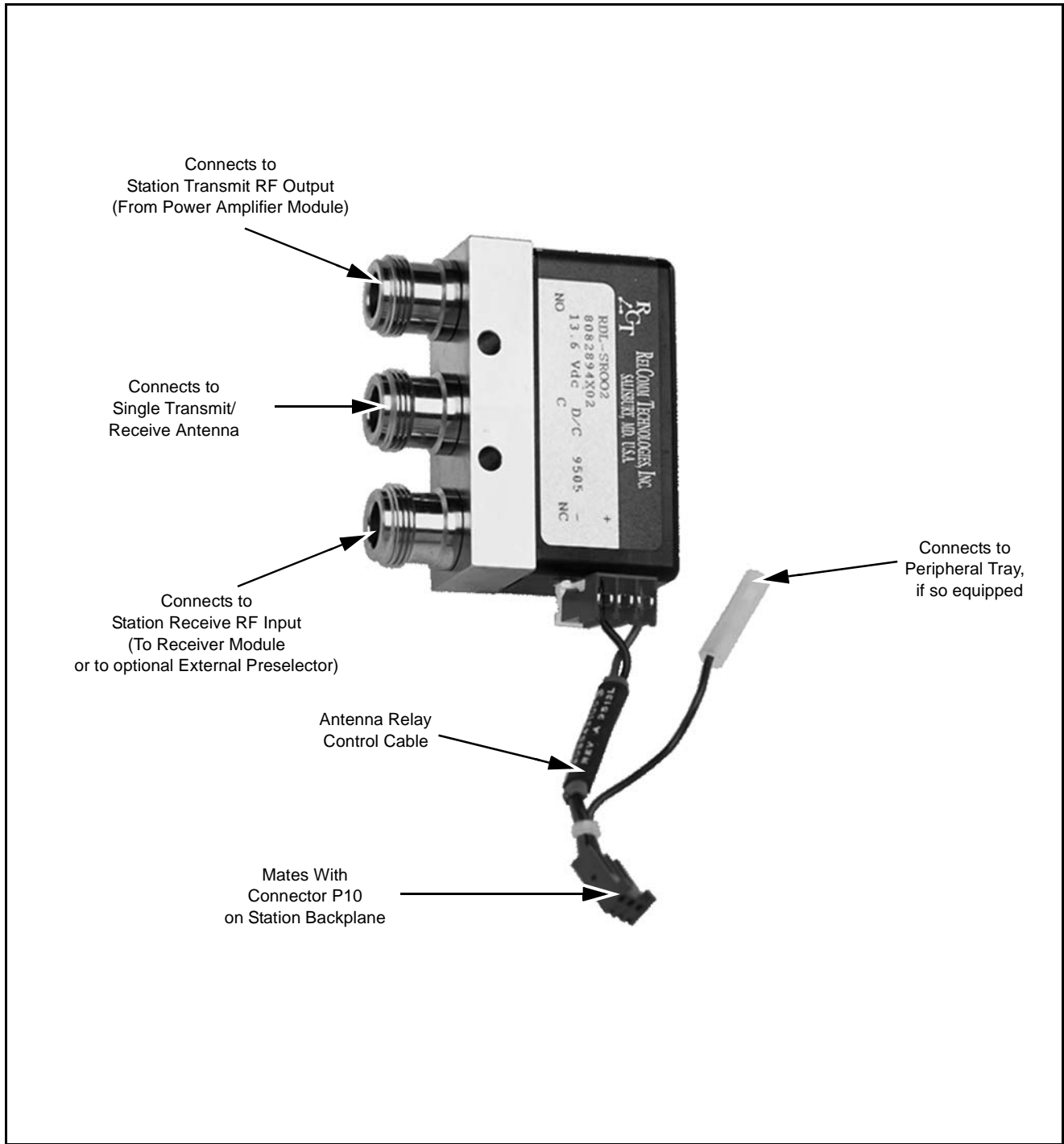


Figure 1. Typical Antenna Relay Module – Inputs/Outputs

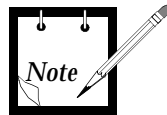


## Cables

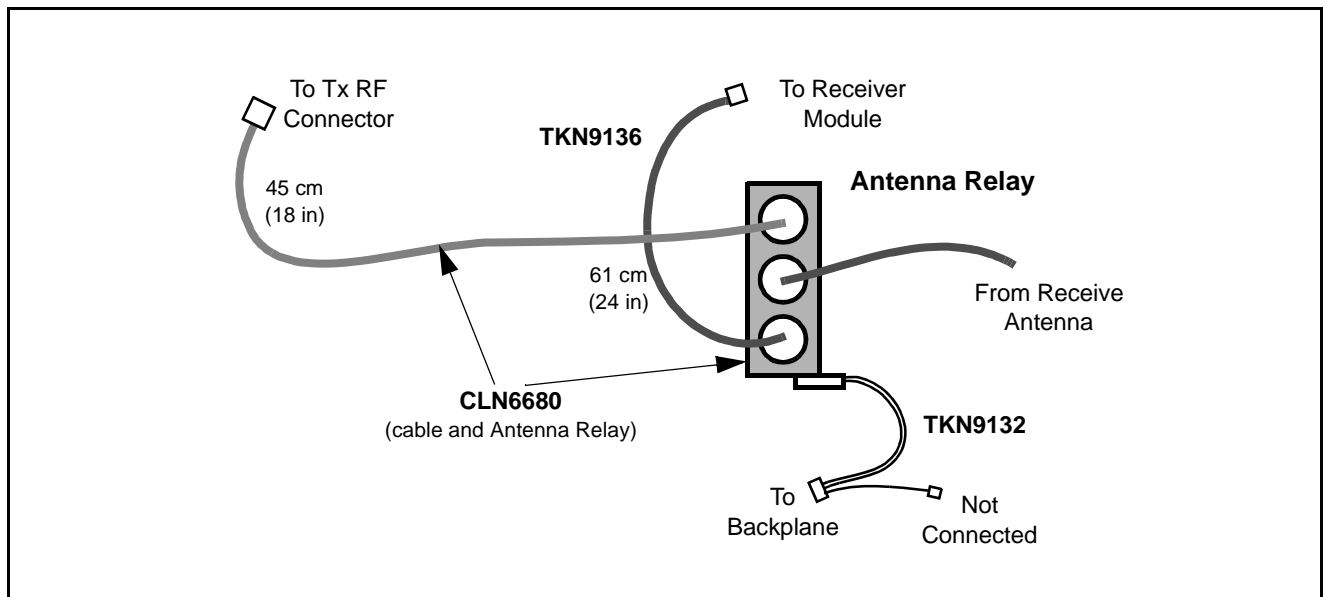
The set of cables used to connect an Antenna Relay to the MTR2000 station depends on what ancillary equipment is connected to the station.

A station can be configured with the following ancillary equipment:

- an Antenna Relay only.  
Figure 2 shows the kits required when only an Antenna Relay is installed on a station.
- an Antenna Relay and an External Preselector.  
Figure 3 shows the kits required when an Antenna Relay and an External Preselector are installed on a station.
- an Antenna Relay and an External Double Circulator.  
Figure 4 shows the kits required when an Antenna Relay and External Double Circulator are installed on a station.
- an Antenna Relay, an External Preselector, and an External Double Circulator.  
Figure 5 shows the kits required when an Antenna Relay, External Preselector, and External Double Circulator are installed on a station.



Some of the ancillary equipment listed above is not available on all stations. For example, an External Preselector is not available for 800 or 900MHz stations.



**Figure 2. Antenna Relay Only – Cable Kits**

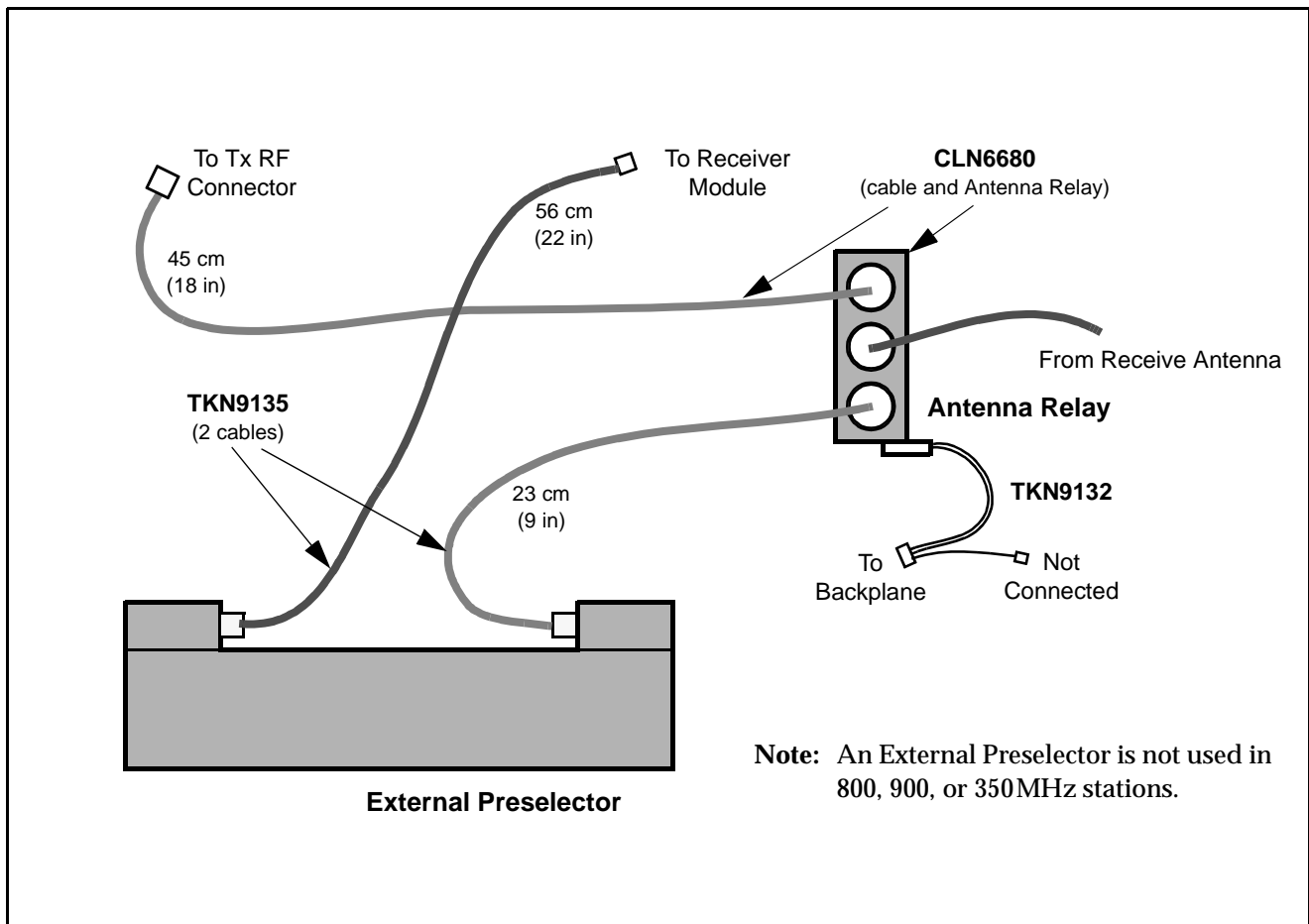
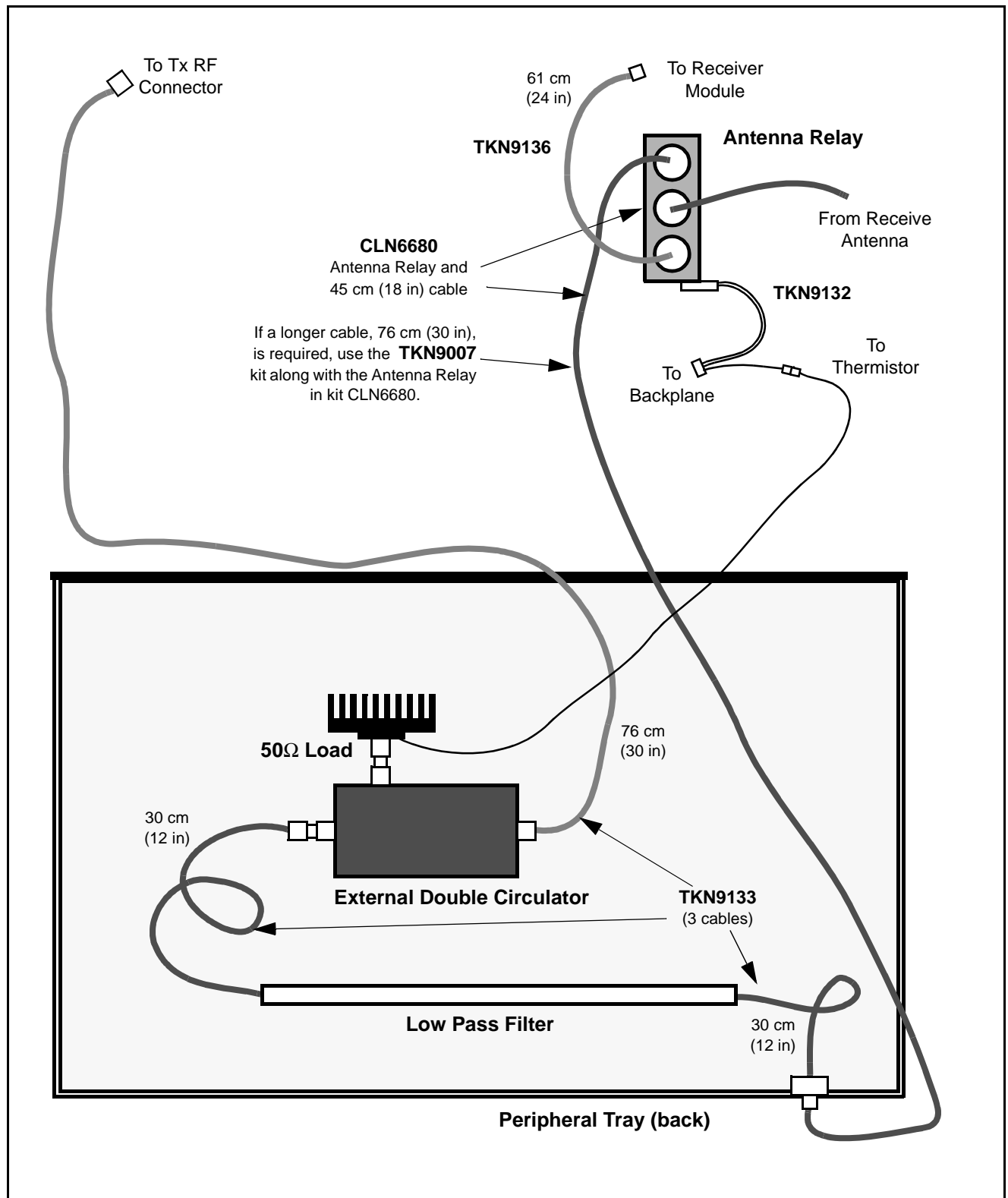


Figure 3. Antenna Relay and External Preselector – Cable Kits



**Figure 4. Antenna Relay and External Double Circulator- Cable Kits**

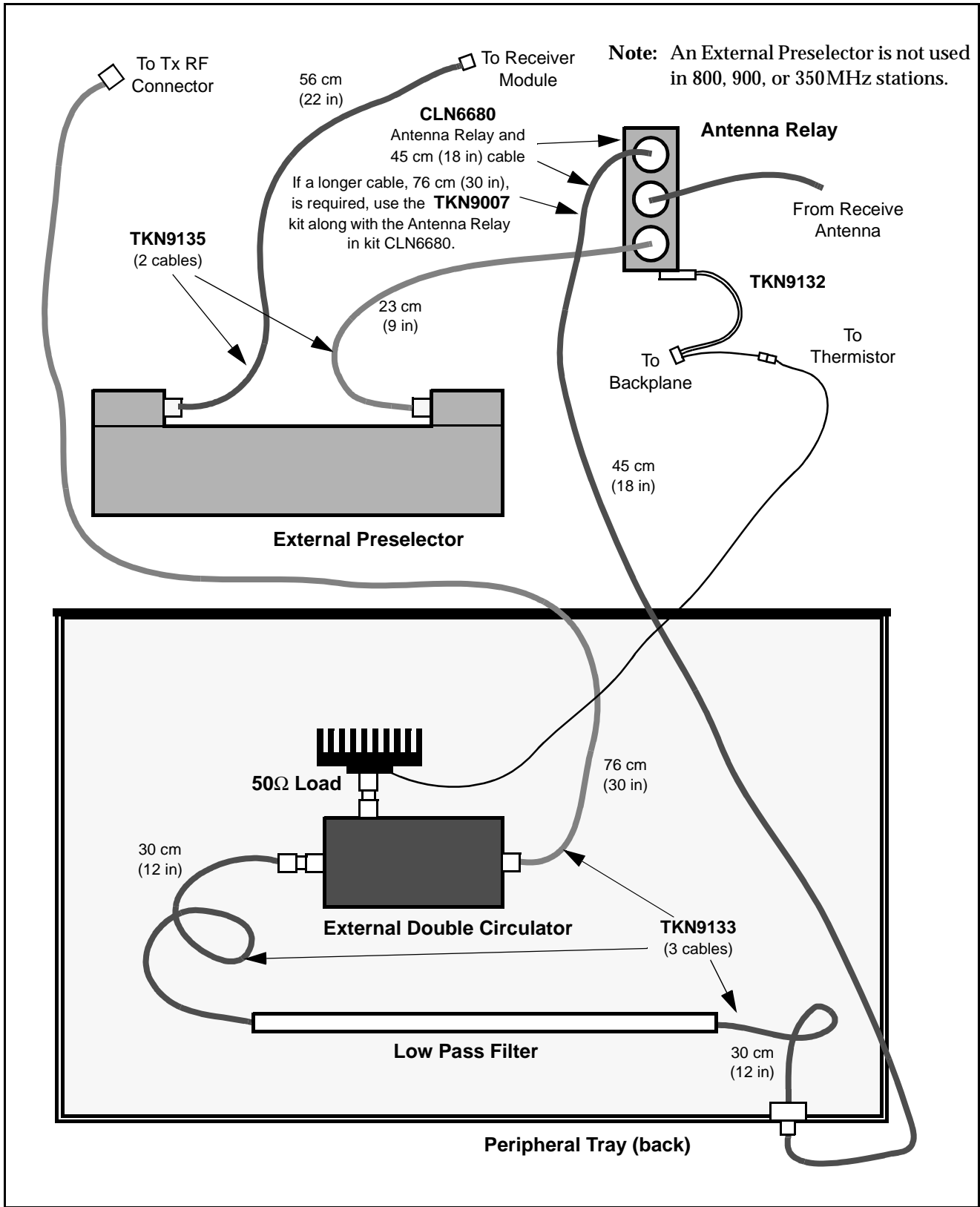


Figure 5. Antenna Relay, External Preselector, and External Double Circulator- Cable Kits

## 3

## OPTION COMPLEMENT

Table 1 shows the contents for the Option X371AG Antenna Relay module.

## Option Complement Chart

Table 1. Antenna Relay Option X371AG Complement

| Description          | Motorola Part No. |
|----------------------|-------------------|
| Antenna Relay Module | 8082894X02        |
| Control Cable        | 0112004B03        |
| Mounting Screws (2)  | 0312016A26        |

## 4

## PERFORMANCE SPECIFICATIONS

Table 2 shows the electrical performance specifications for the Antenna Relay used in Model CLN6680.

## Performance Specifications

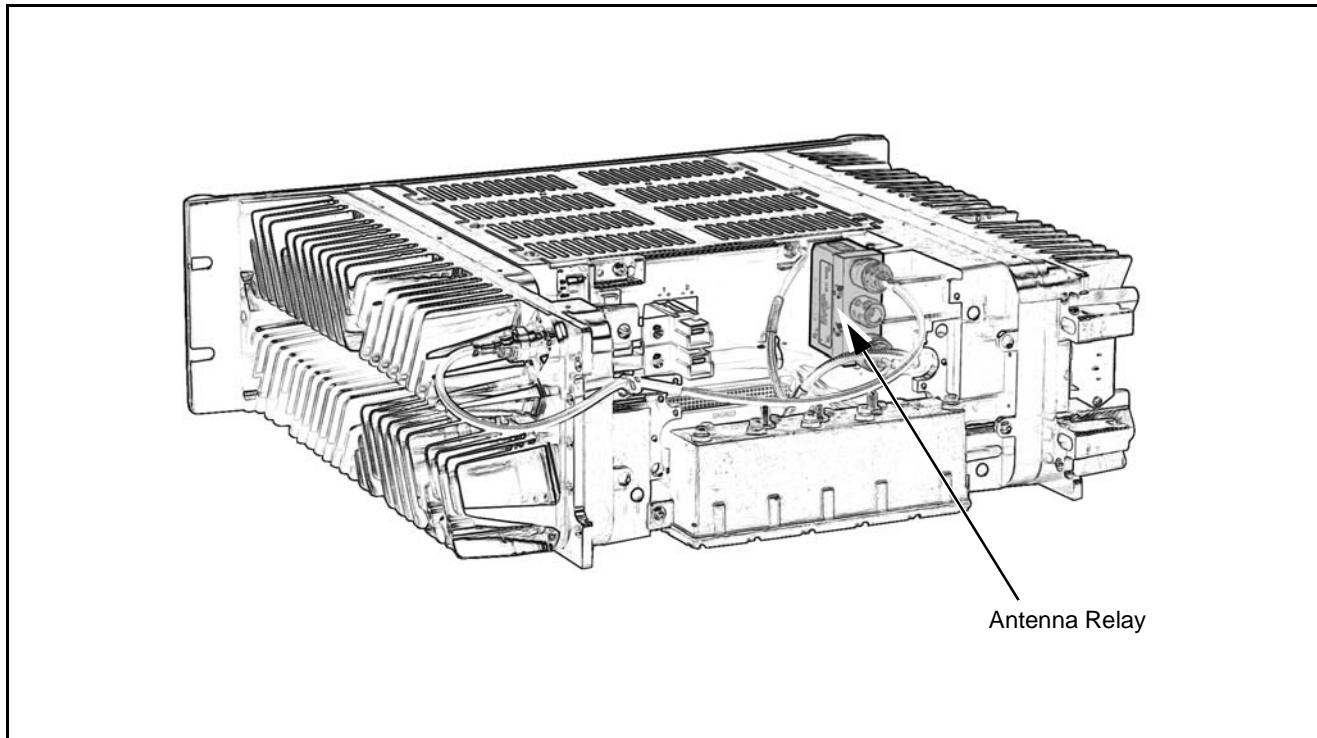
Table 2. Performance Specifications for Antenna Relay

| Parameter   | Specifications   |
|---|--|
| Operating Frequency   | DC to 4 GHz @ 20° C  |
| Maximum Input Power   | 500 W @ 1 GHz  |
| Coil Specifications:<br>Pull-in voltage<br>Drop-out voltage<br>Resistance     | 9.5 Vdc maximum<br>≥ 2 Vdc<br>100 Ω ±10% @ 20° C                                       |
| Contact Specifications:<br>Type<br>Actuation<br>Pull-in time<br>Drop-out time | SPDT<br>Failsafe (break before make)<br>20 ms maximum @ 20° C<br>10 ms maximum @ 20° C |
| Insertion Loss  | 0.3 dB maximum   |
| Isolation   | 70 dB minimum  |
| VSWR Maximum  | 1.3:1  |
| Temperature Range   | -30° C to +80° C   |
| Terminations  | Female N-Type  |
| Input and Output Impedance  | 50 Ohms  |

## 5

## MOUNTING LOCATION

The Antenna Relay Module is installed on a flange on the rear of the Power Supply Module. Stations equipped with the Antenna Relay module option are shipped with the antenna relay module installed as shown in Figure 6, allowing the RF cables to be routed out from the back of the cabinet or rack.



**Figure 6. Mounting Position for Antenna Relay Module**

## 6

## FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the Antenna Relay Module at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 7 for a block and interconnect diagram of the Antenna Relay Module.

The Antenna Relay Module contains a relay with a set of normally open and normally closed contacts. The relay coil is controlled by the Antenna Relay signal from the Station Control Module to connect either the Receiver Module or the Power Amplifier Module to a single transmit/receive antenna.



With the relay de-energized, the antenna is connected to the Receiver Module. To connect the antenna to the Power Amplifier Module, the Station Control Module must energize the relay (one side of which is connected to +14.2 Vdc) by grounding the Antenna Relay signal.

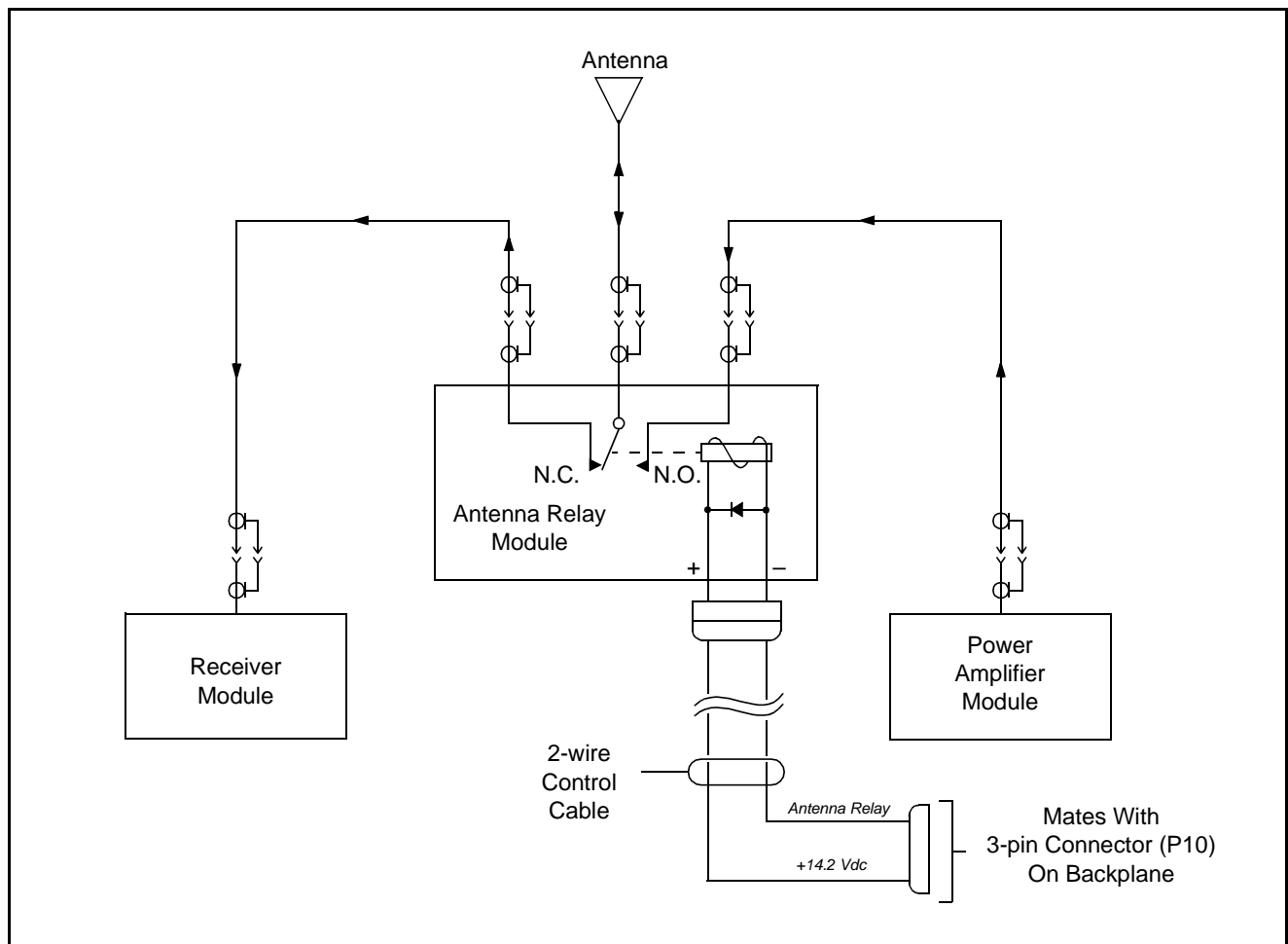


Figure 7. Functional Block and Interconnect Diagram for Antenna Relay Module



**MOTOROLA**

# VHF EXTERNAL PRESELECTOR MODULE

**Model CLN1216 (132 to 154 MHz)**

**Model CLN1217 (150 to 174 MHz)**

## 1

### DESCRIPTION

The VHF External Preselector, Models CLN1216, CLN1217, provide 5 poles of bandpass filtering for the station receive RF input signal. The filter assembly is mounted at the rear of the station. It includes mini-UHF connectors for input from the receive antenna and output to the Receiver module.

The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The external Preselector assembly is a 5-pole bandpass filter equipped with tuning slugs to adjust the passband corresponding to the operating frequency(s) of the station.

If the external Preselector option is being added to a station:

1. Attach the Preselector to the station according the mounting position and cable connection information provided in this section.
2. Tune the preselector assembly by following the *Preselector Field Tuning Procedures*, located in the Troubleshooting section of this manual.



2

INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the VHF External Preselector input and output connections and the tuning cavities and tuning screws.

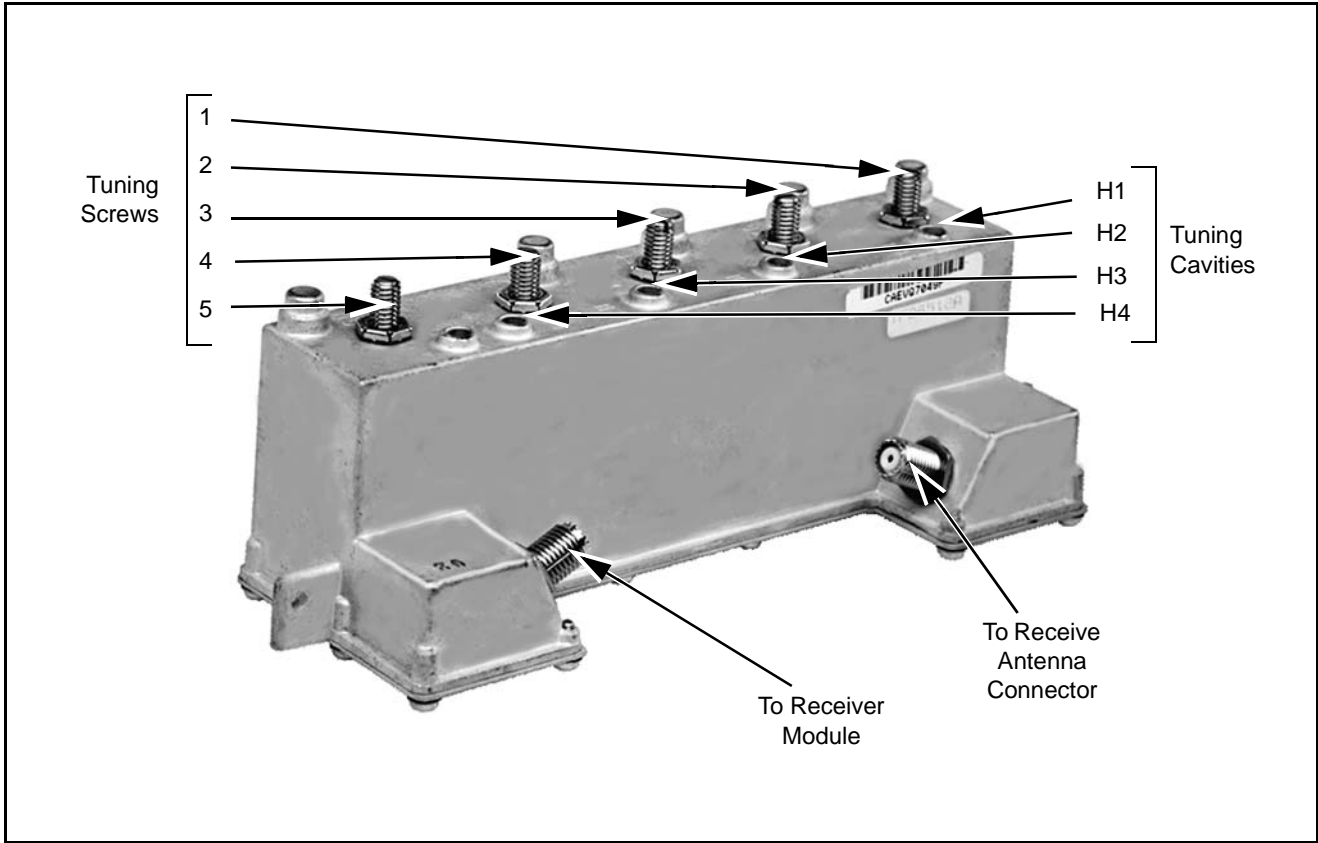


Figure 1. VHF External Preselector – Input/Output Connectors and Tuning Screws/Cavities

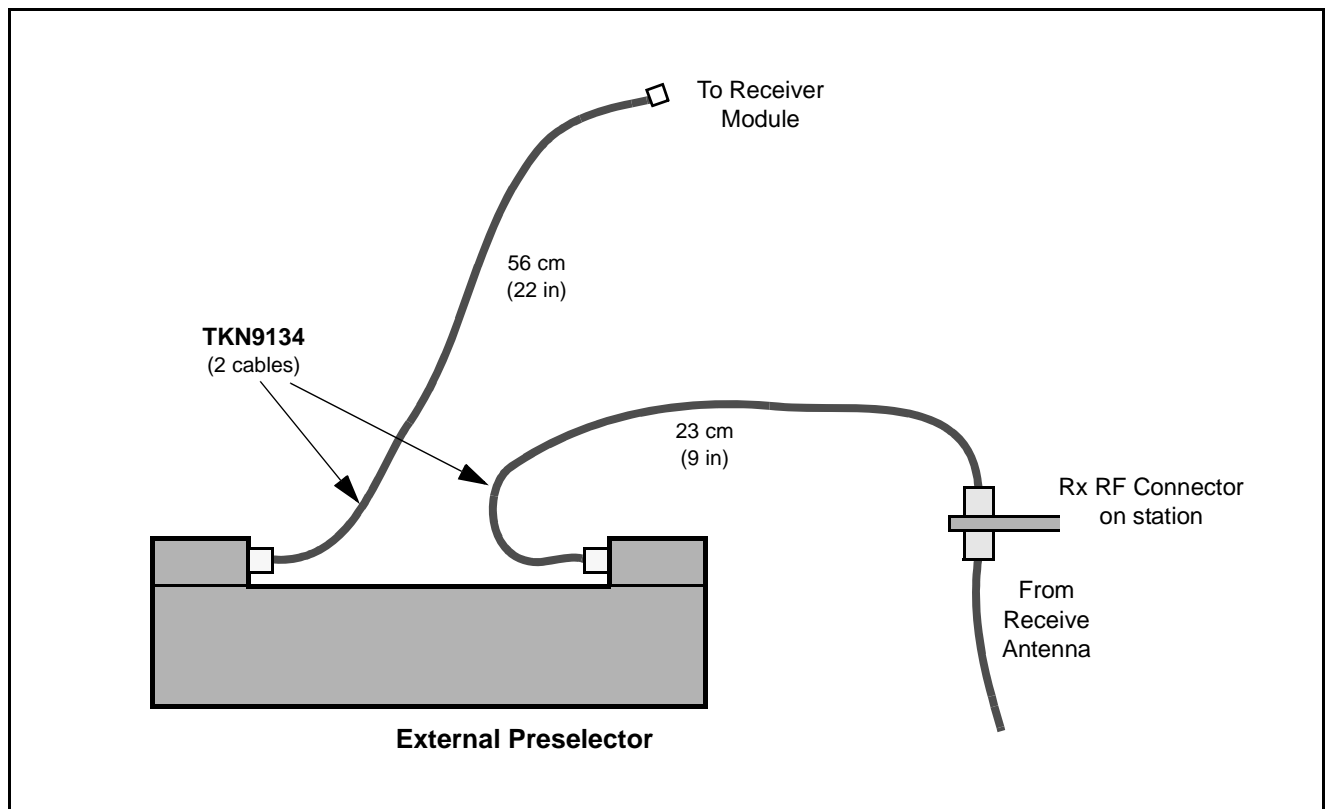
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## Cables

The set of cables used to connect an External Preselector to the MTR2000 station depends on what ancillary equipment is connected to the station.

A station can be configured with the following ancillary equipment:

- an External Preselector only.  
Figure 2 shows the kit required when only an External Preselector is installed on a station.
- an External Preselector and an Antenna Relay.  
See the Antenna Relay, Cables section for details.
- an External Preselector and an External Double Circulator.  
See the External Double Circulator, Cables section for details.
- an External Preselector, an Antenna Relay, and an External Double Circulator.  
See the Antenna Relay, Cables section for details.



**Figure 2. External Preselector Only – Cable Kit**

3

OPTIONS COMPLEMENT

Table 1 shows the constants for the VHF External Preselector options.

Option Complement Chart

Table 1. VHF External Preselector Option Complement

| Option | Application                       | Option Contents      |  |
|--------|-----------------------------------|----------------------|--|
| X265AA | MTR2000 Station<br>132 to 154 MHz | TLE6511A<br>TRN7799A | VHF Preselector assembly<br>VHF/UHF Tuning Kit |
| X265AB | MTR2000 Station<br>150 to 174 MHz | TLE6512A<br>TRN7799A | VHF Preselector assembly<br>VHF/UHF Tuning Kit |

4

MOUNTING LOCATION

The External Preselector is installed at the rear of the station. Stations equipped with the External Preselector option are shipped with the External Preselector installed as shown in Figure 3.

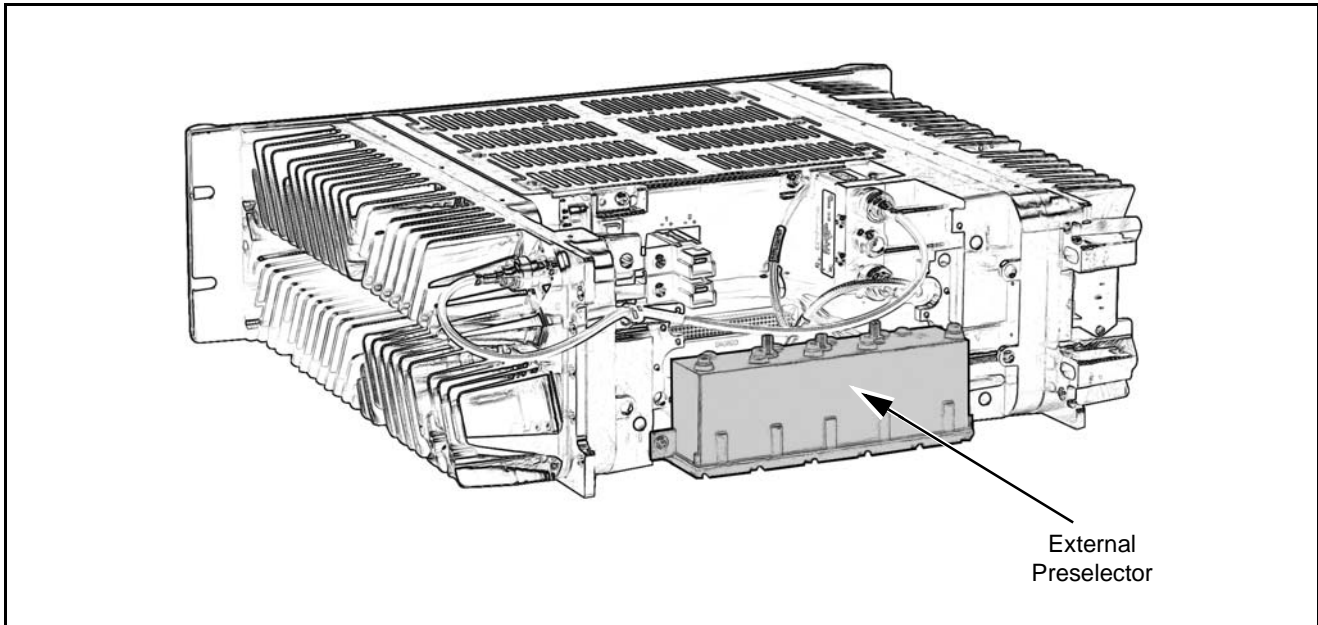


Figure 3. Mounting Position for External Preselector



# VHF EXTERNAL DOUBLE CIRCULATOR MODULE

**Model CLN1207 (132 to 146 MHz)**

**Model CLN1208 (144 to 160 MHz)**

**Model CLN1209 (158 to 174 MHz)**

## 1

## DESCRIPTION

The VHF External Double Circulator Module, models CLN1207, CLN1208, CLN1209, provides an additional 45 dB (minimum) of isolation between the Power Amplifier Module and the transmit antenna.

This section provides a general description, option matrix chart, identification of inputs/outputs, and functional theory of operation. The information provided is sufficient to give service personnel a functional understanding of the module, allow maintenance and troubleshooting to the module level. (Refer also to the Maintenance and Troubleshooting section of this manual for detailed troubleshooting procedures for all modules in the station.)

### General Description

The double circulator assembly consists of two RF circulators (contained in a single housing, a 50Ω load with heat sink and Low Pass Filter, all mounted in the peripheral tray. The RF output from the Power Amplifier module connects to the input of the assembly, while the output connects to an external low pass filter. The low pass filter provides harmonic suppression for the MTR2000 station. The output of the filter connects to the transmit antenna (directly, via antenna relay module, or via duplexer).



The double circulator model is typically used in high density radio site applications where other co-located transmitters near the frequency of the station can cause intermodulation products. The addition of the double circulator improves transmitter intermodulation by 45 dB.

2

INPUTS AND OUTPUT CONNECTIONS

Figure 1 shows the VHF External Double Circulator input and output connections.

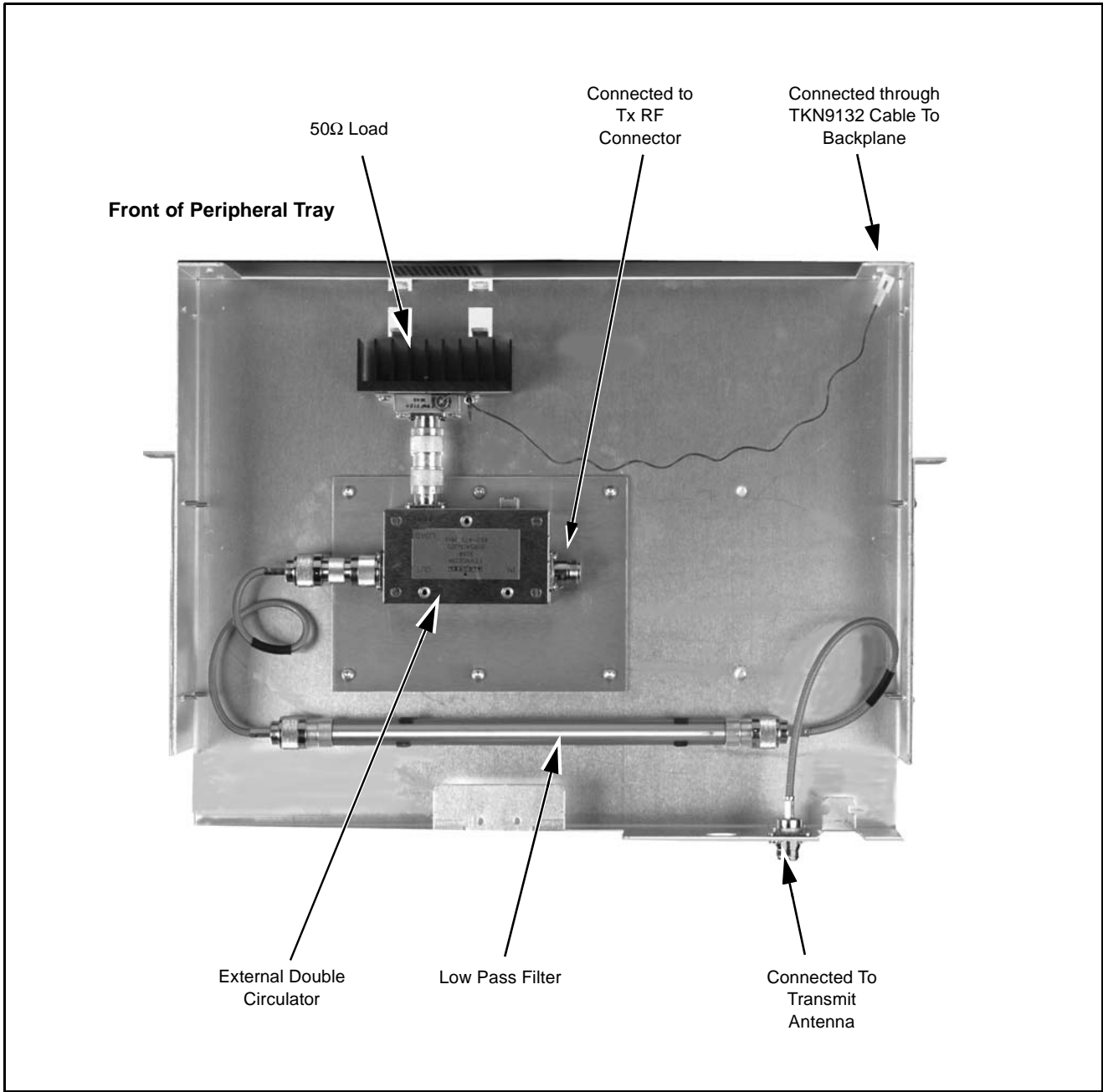


Figure 1. VHF External Double Circulator Mounted in Peripheral Tray – Inputs/Outputs

---

## Cables

The set of cables used to connect an External Double Circulator to the MTR2000 station depends on what ancillary equipment is connected to the station.

A station can be configured with the following ancillary equipment:

- an External Double Circulator only.  
Figure 2 shows the kits required to install this equipment on a station.
- an External Double Circulator and an External Preselector.  
Figure 3 shows the kits required to install this equipment on a station.
- an External Double Circulator and an Antenna Relay.  
See the Antenna Relay, Cables section for details.
- an External Double Circulator, an Antenna Relay, and an External Preselector.  
See the Antenna Relay, Cables section for details.
- an External Double Circulator and a Duplexer.  
See the Duplexer, Cables section for details.

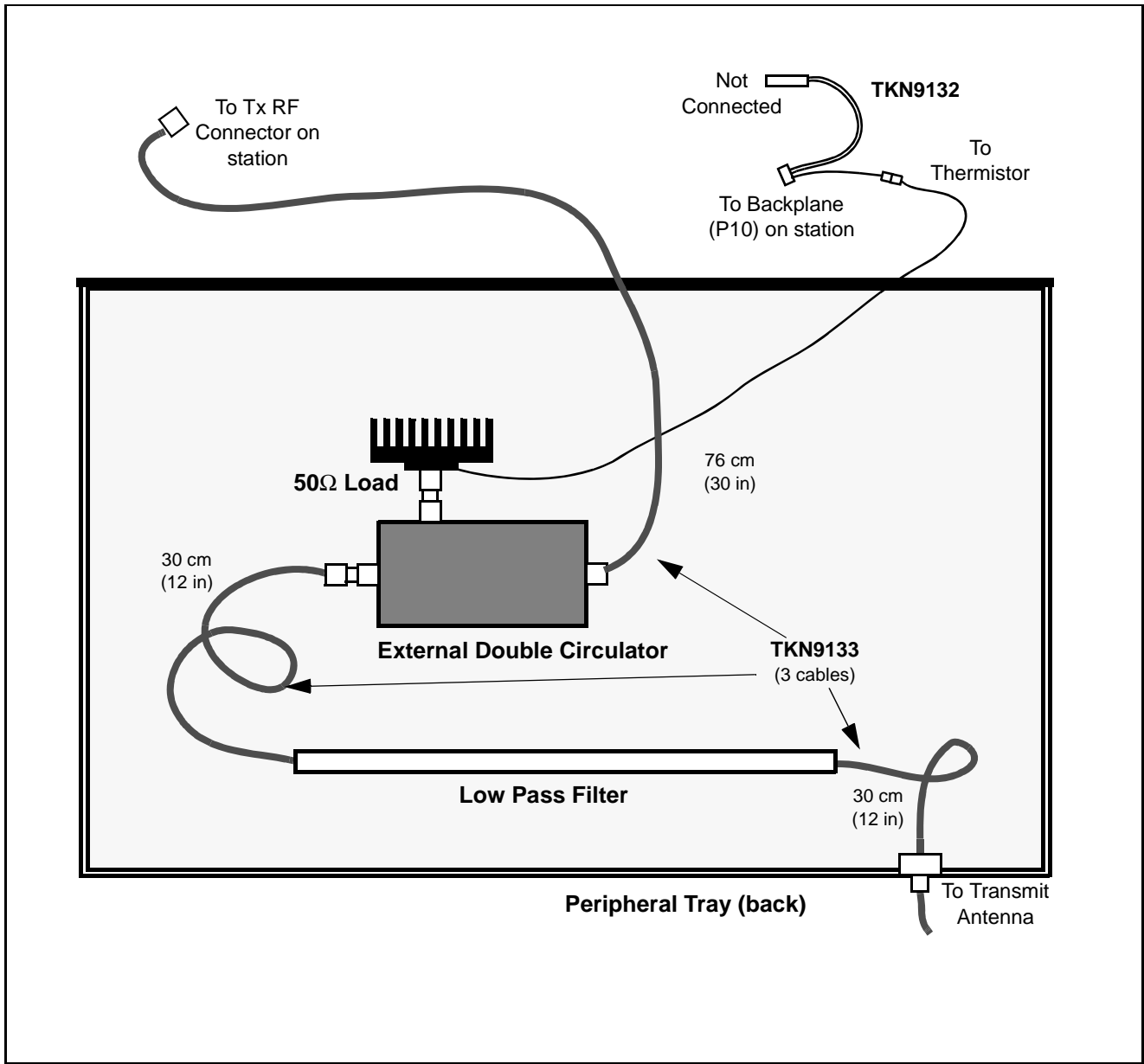
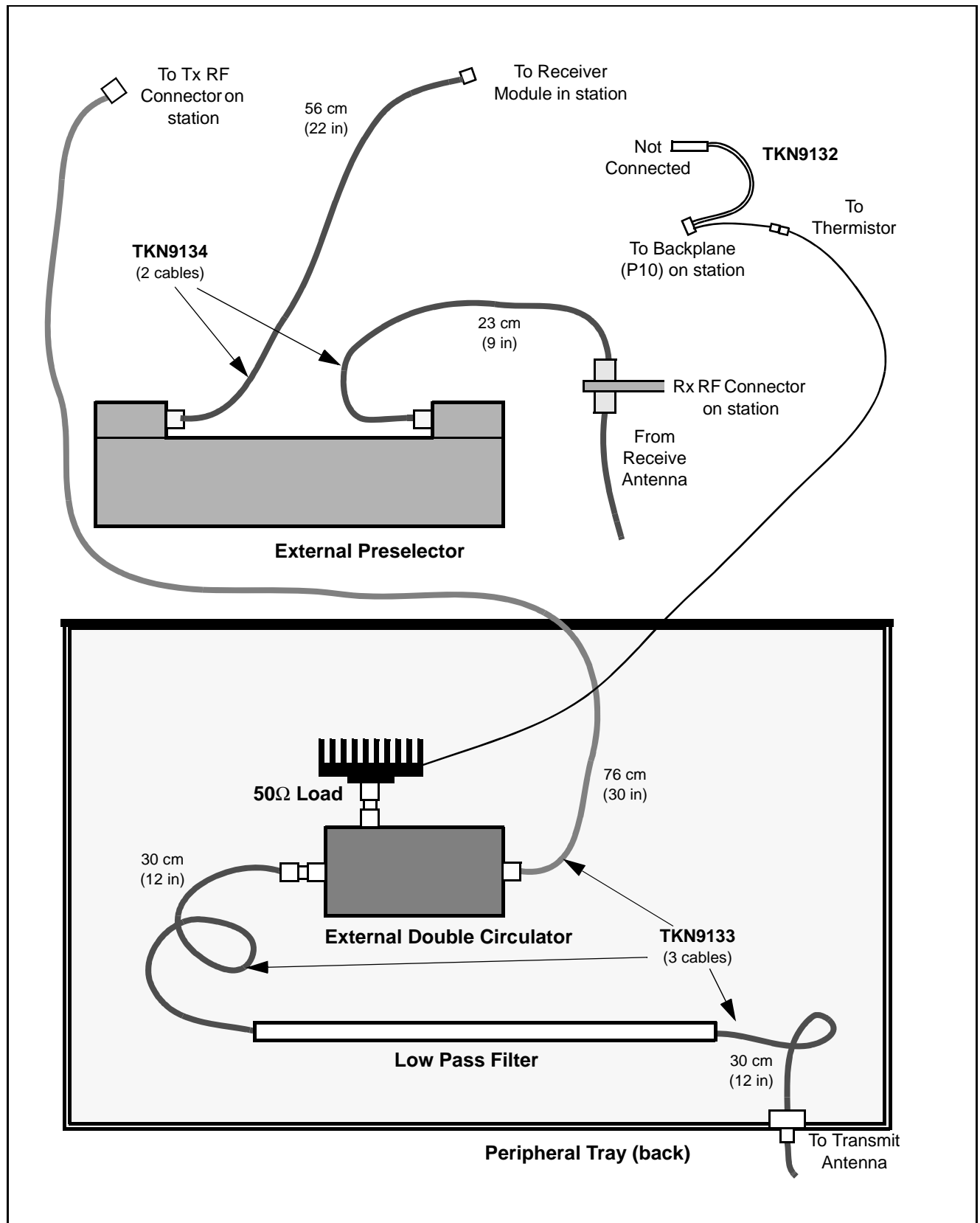


Figure 2. External Double Circulator Only – Cable Kits



**Figure 3. External Double Circulator and External Preselector- Cable Kits**



3

OPTIONS COMPLEMENT

Table 1 shows the contents of the Double Circulator options.

Option Complement Chart

Table 1. VHF External Double Circulator Options Complement

| Option                        | Application                       | Option Contents                              |   |
|-------------------------------|-----------------------------------|--|---|
| X676 AS<br>X676 AT<br>X676 AU | MTR2000 Station<br>132 to 174 MHz | TYD4010A<br>TRN7751A<br>TKN9133A<br>TLN3391A | Low Pass Filter<br>Peripheral Mounting Tray<br>Cables (peripheral tray)<br>50Ω Load (head sink mounted) |
| X676 AS                       | MTR2000 Station<br>132 to 146 MHz | TYD4001A                                     | Double Circulator assembly  |
| X676 AT                       | MTR2000 Station<br>144 to 160 MHz | TYD4002A                                     | Double Circulator assembly  |
| X676 AU                       | MTR2000 Station<br>158 to 174 MHz | TYD4003A                                     | Double Circulator assembly  |

# 4

## PERFORMANCE SPECIFICATIONS

Table 2 shows the electrical performance specifications for the external Dual Circulators used in Models CLN1207, CLN1208, and CLN1209.

### Performance Specifications

**Table 2. Performance Specifications for VHF External Double Circulator**

| Parameter  | Specifications                                     |
|--|--|
| Operating Frequency<br>CLN1207<br>CLN1208<br>CLN1209 | 132 to 146 MHz<br>144 to 160 MHz<br>158 to 174 MHz |
| Maximum RF Input Power                               | 400 W  |
| Insertion Loss                                       | 1.2 dB maximum                                     |
| Isolation  | 45 dB  |
| Operating Temperature Range                          | -20° C to +70° C                                   |
| Terminations   | Female N-Type                                      |
| Input / Output Return Loss                           | 19.1 dB minimum                                    |
| Input and Output Impedance                           | 50 Ohms  |
| Thermistor Value                                     | 20 k $\Omega$ @ 25° C<br>2.6 k $\Omega$ @ 80° C    |

5

FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the Dual Circulator Assembly at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the double circulator in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 4 for a block and interconnect diagram of the Double Circulator assembly.

Functional Operation

The double circulator assembly accepts transmit RF output power from the Power Amplifier module and provides 45 dB of isolation between the Power Amplifier module and the transmit antenna. The assembly consists of two circulators in a single case, each with a 50Ω load. Each circulator allows forward RF energy to pass through to the output, while routing any reflected RF energy to the corresponding 50Ω load.

Most of the reflected energy is absorbed by the 50Ω load (heat sink) mounted) connected to the second circulator. A thermistor mounted on the head sink provides a variable resistance signal proportional to the heat sink temperature. This signal is routed to the Station Control Module via the Temp Sense cable and backplane. If the heat sink temperature exceeds a preset threshold, the Station Control Module enables PA cutback mode.

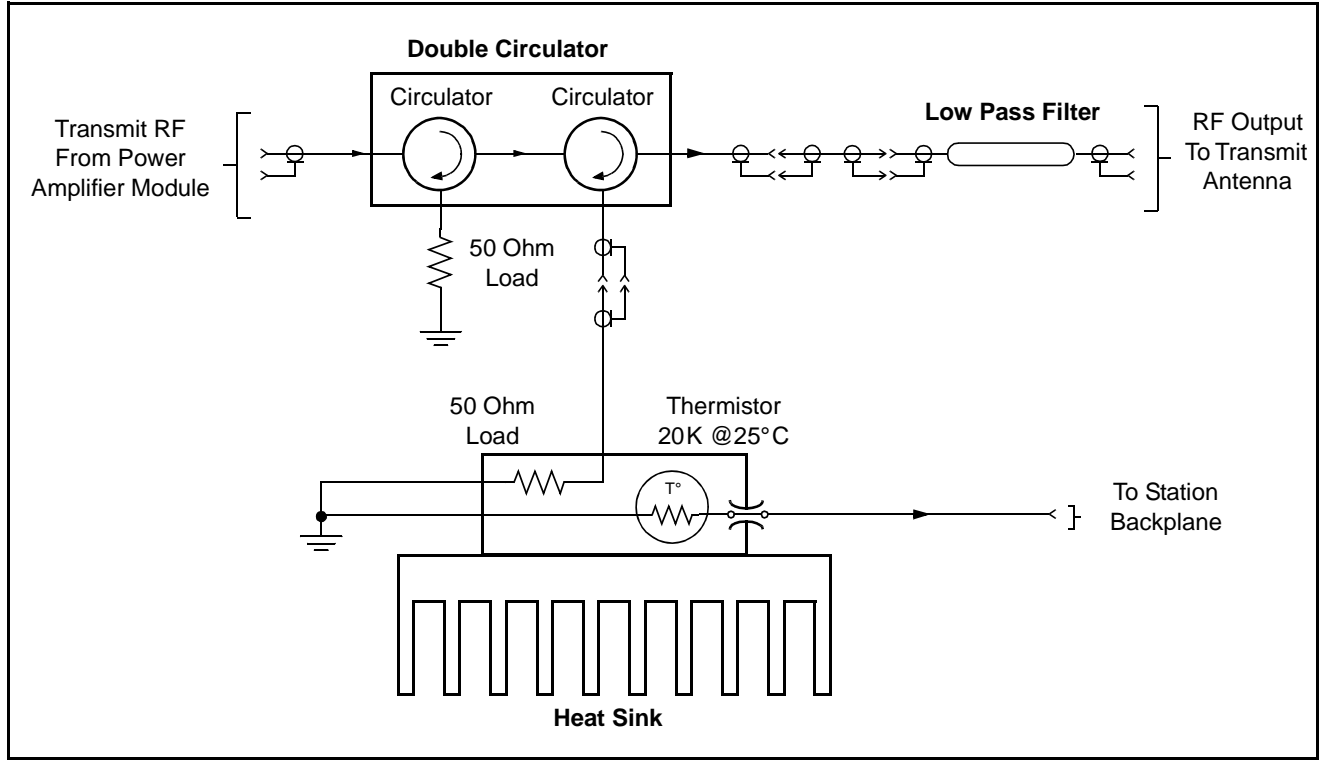


Figure 4. Functional Block and Interconnect Diagram for External Double Circulator Module



# VHF DUPLEXER MODULE

Model TYD4031 (132 to 146 MHz)

Model TYD4032 (144 to 160 MHz)

Model TYD4033 (158 to 174 MHz)

## 1

## DESCRIPTION

Kits TYD4031/32/33 provide band-dependent duplexer modules for use with MTR2000 VHF stations. This section provides a general description, identification of adjustments and inputs/outputs, performance specifications, and typical connection. While the duplexer module is considered non-repairable, tuning screws are provided for field tuning should replacement become necessary due to module failure, or if retuning is necessary due to a change in operating channels. A single channel field tuning procedure is provided in this section.

### General Description

The duplexer module (shown in Figure 1) allows a transmit and receive channel pair to share a common Tx/Rx antenna. Each duplexer module consists of six resonant cavities (three for transmit and three for receive) contained in a temperature-compensated copper enclosure designed to mount in a standard EIA 48.26 cm (19") equipment rack.

Each set of three cavities is designed and tuned to pass the respective transmit or receive channel frequency (or bandwidths) while providing maximum Tx noise suppression at the Rx frequency and maximum Rx isolation at the Tx frequency.

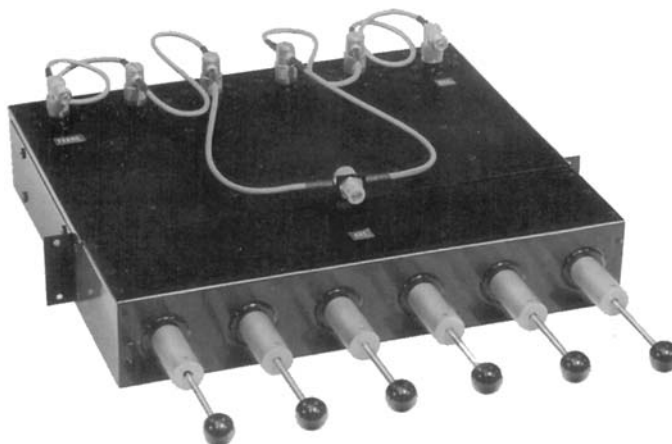


Figure 1. Typical VHF Duplexer Module

2

ADJUSTMENT SCREWS & INPUT/OUTPUT CONNECTORS

Figure 2 shows the position of the adjustment screws and input/output rf connectors for the VHF Duplexer module.

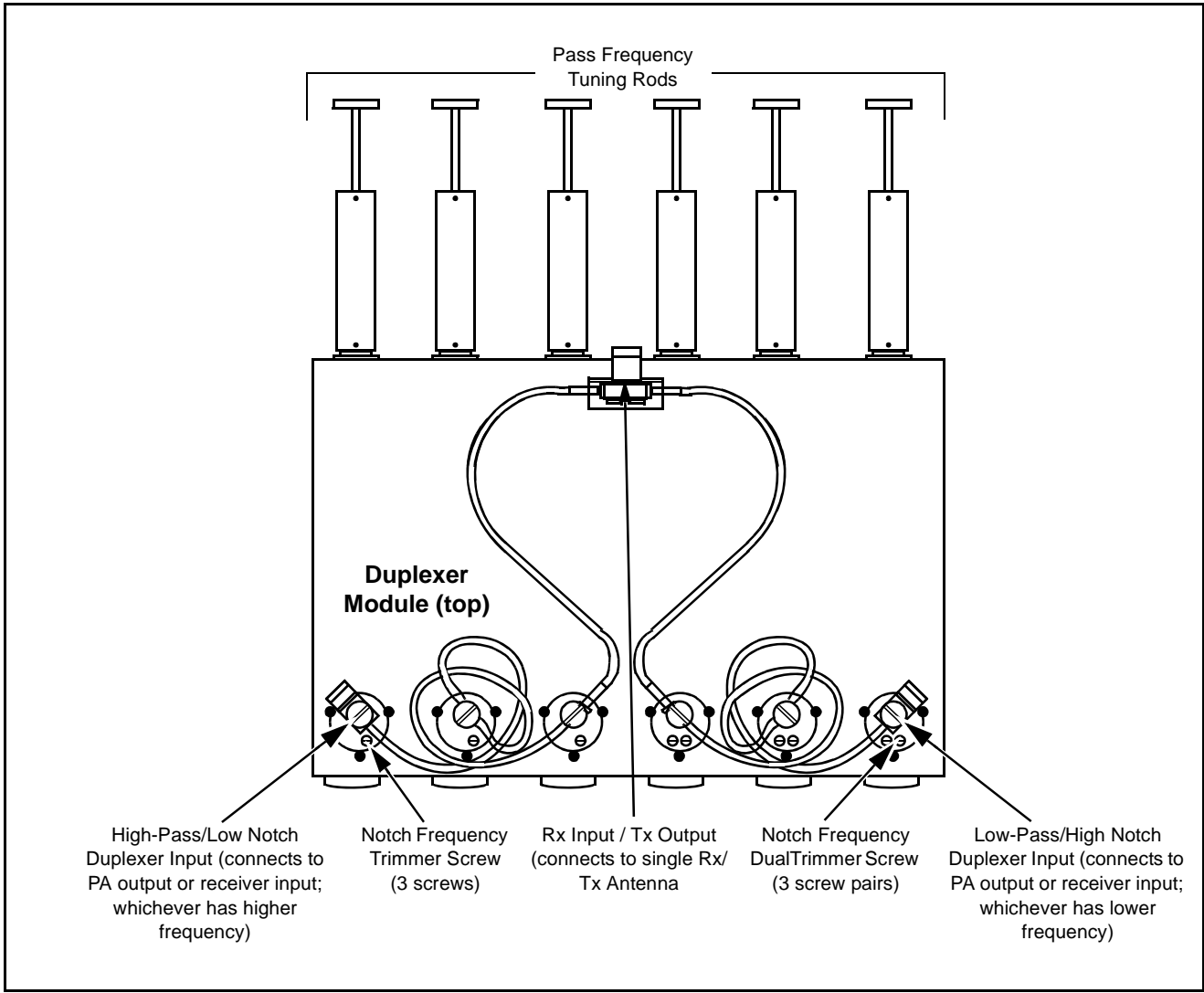


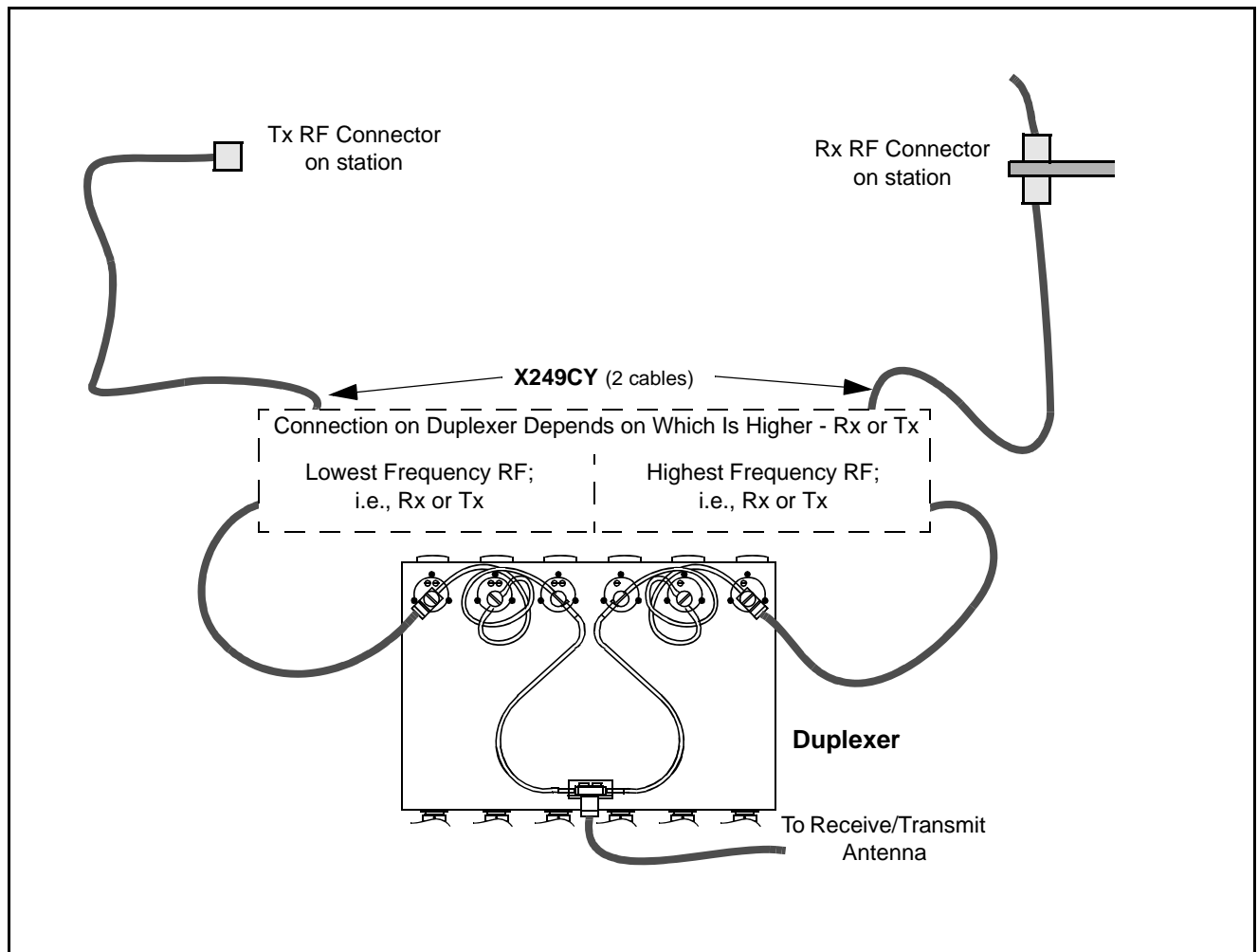
Figure 2. VHF Duplexer Module – Adjustment Screws and Input/Output Connectors

## Cables

The set of cables used to connect a Duplexer to the MTR2000 station depends on what ancillary equipment is connected to the station.

A station can be configured with the following ancillary equipment:

- a Duplexer only.  
Figure 3 shows the kits required to install this equipment on a station.
- an External Double Circulator and a Duplexer.  
Figure 4 shows the kits required to install this equipment on a station.
- an External Preselector and a Duplexer.  
Figure 5 shows the kits required to install this equipment on a station.
- an External Double Circulator, an External Preselector and a Duplexer.  
Figure 6 shows the kits required to install this equipment on a station.



**Figure 3. Duplexer Only – Cable Kits**

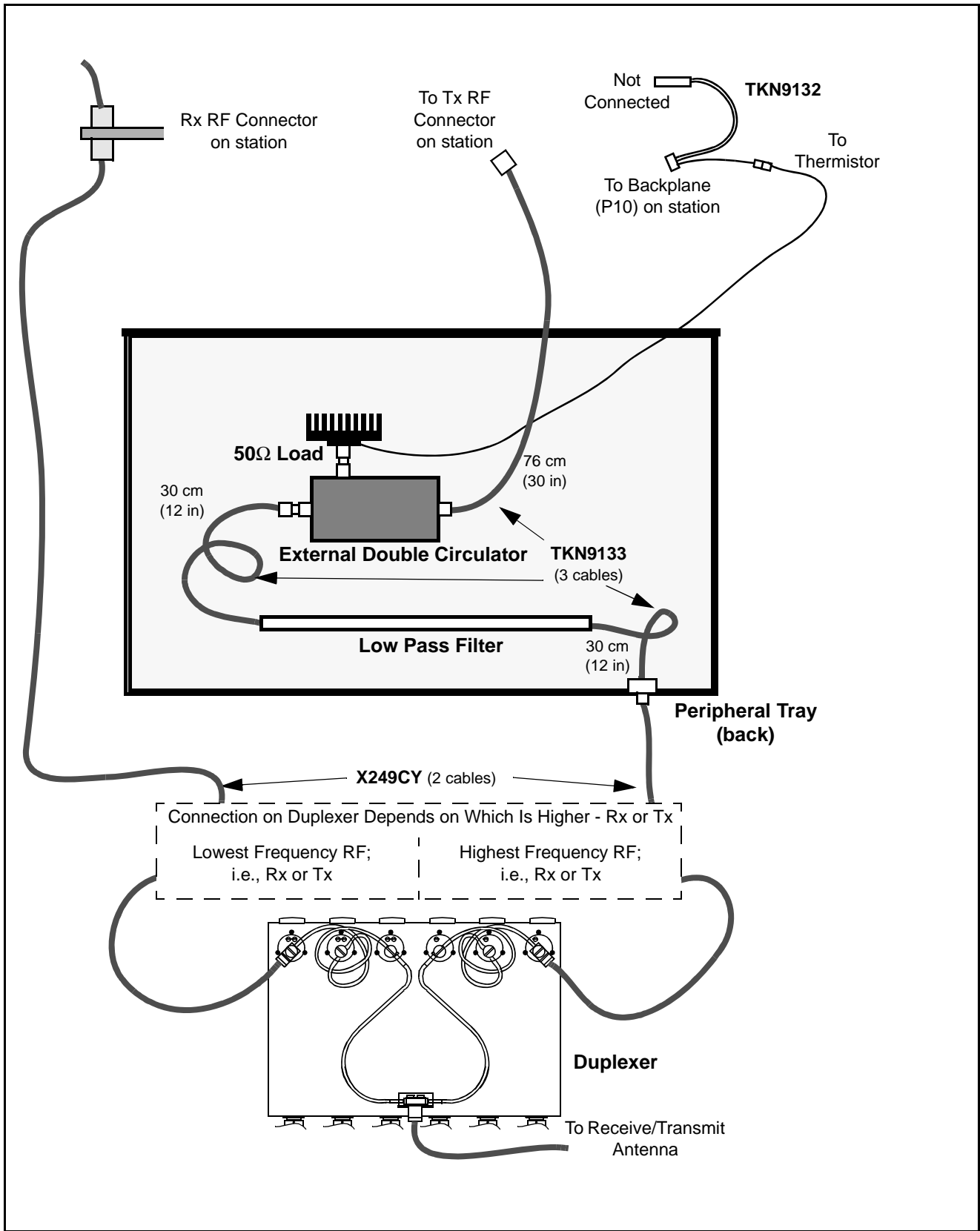
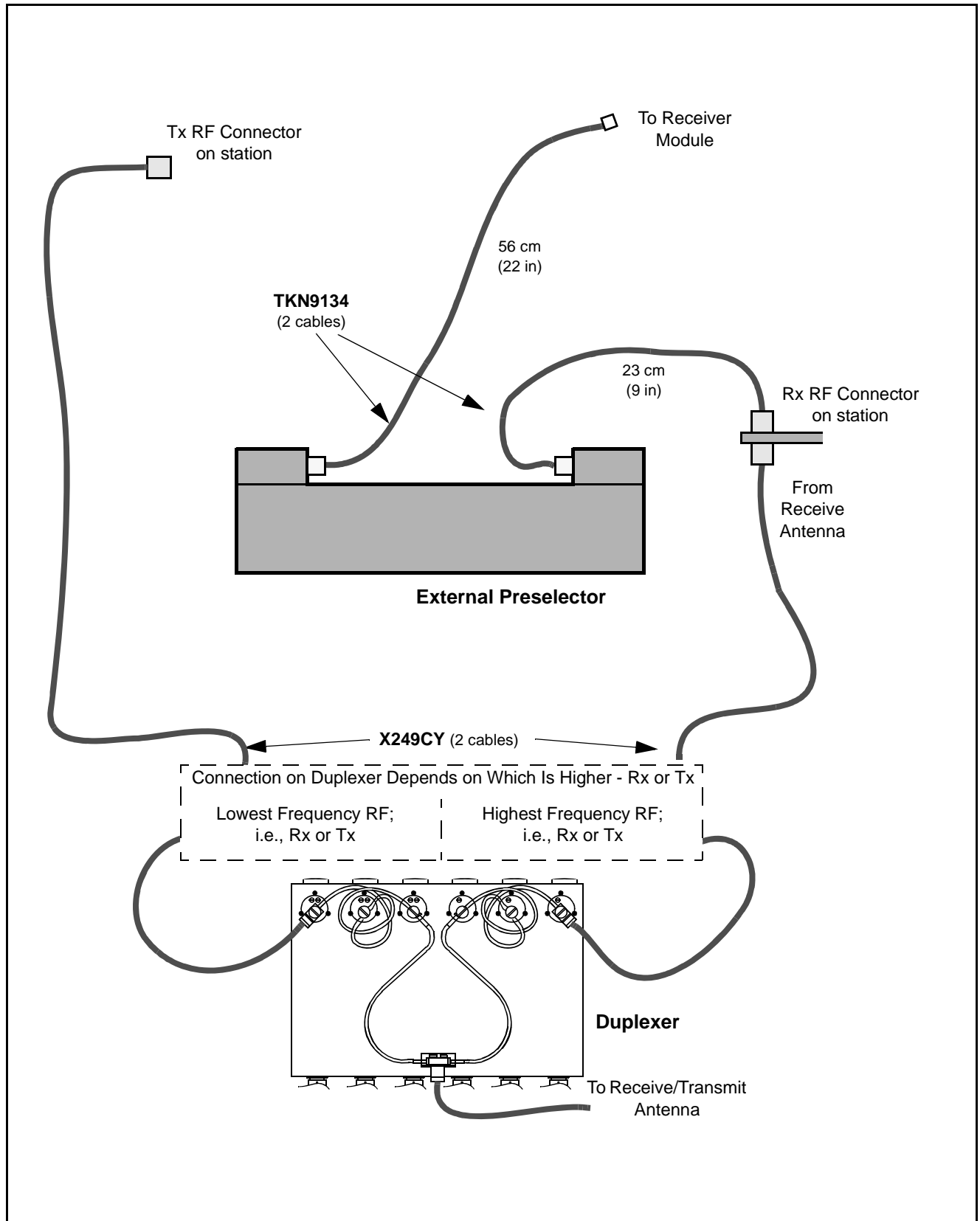


Figure 4. Duplexer and External Double Circulator- Cable Kits



**Figure 5. Duplexer and External Preselector- Cable Kits**



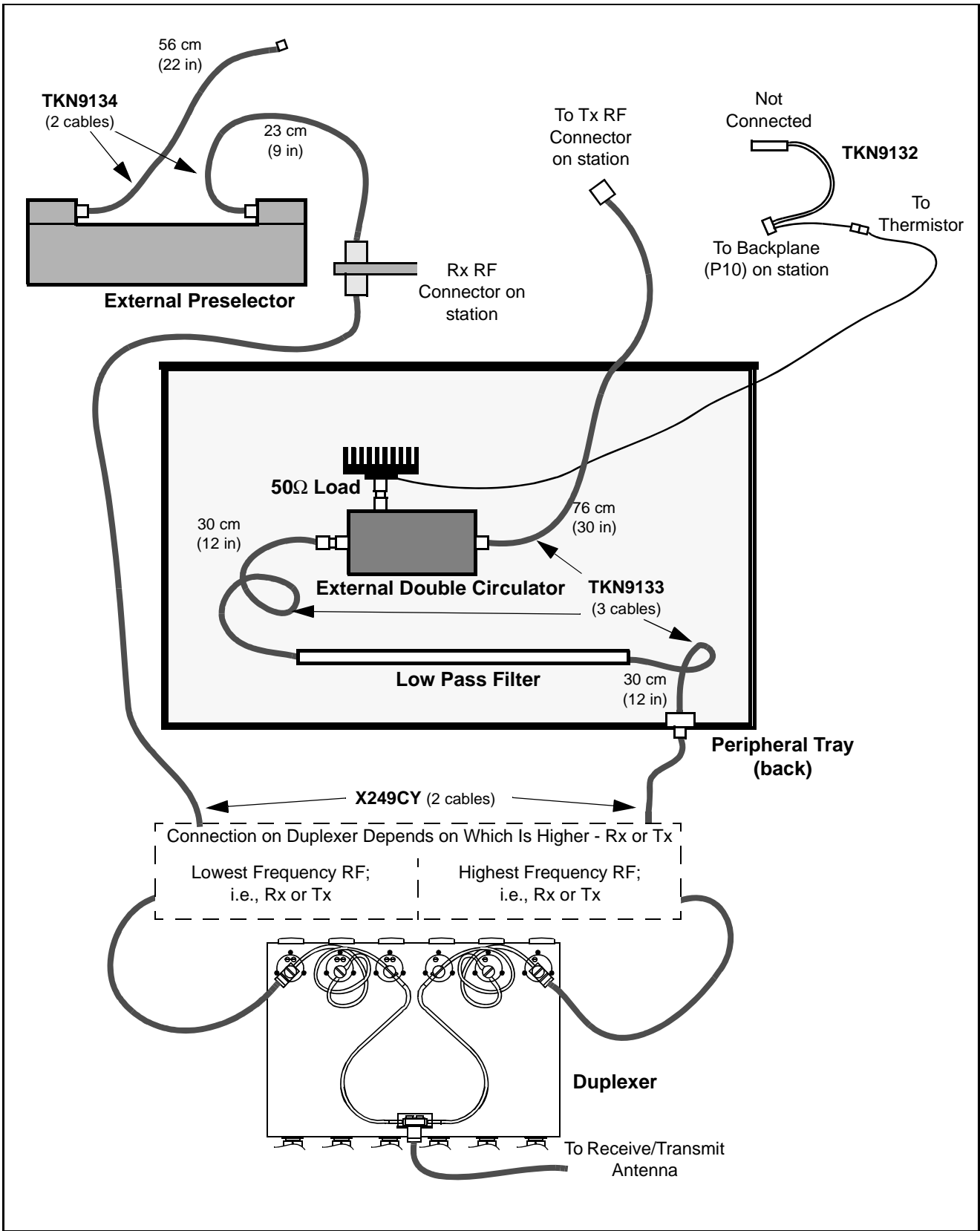


Figure 6. Duplexer, External Preselector, and External Double Circulator- Cable Kits

## 3

## PERFORMANCE SPECIFICATIONS

Table 1 shows the electrical performance specifications for the VHF Duplexer module.

## Performance Specifications

**Table 1. Performance Specifications for VHF Duplexer Module**

| Parameter  | Specifications  |
|--|---|
| Operating Frequency<br>TYD4031<br>TYD4032<br>TYD4033 | 132 to 146 MHz<br>144 to 160 MHz<br>158 to 174 MHz  |
| Insertion Loss<br>(Transmitter to Antenna)           | 1.3 dB maximum  |
| Insertion Loss<br>(Antenna to Receiver)              | 1.3 dB maximum  |
| Frequency Bandwidth<br>vs<br>Frequency Separation    | Tx-to-Rx Bandwidth<br>Spacing (maximum)<br>1.5 MHz200 kHz<br>2.5 MHz600 kHz<br>3.5 MHz800 kHz<br>4.5 MHz<br>and above1000 kHz |
| Tx Noise Suppression at Rx<br>Frequency              | 75 dB minimum   |
| Rx Isolation at Tx Frequency                         | 75 dB minimum   |
| Frequency Separation<br>(Minimum)                    | 1.5 MHz   |
| Return Loss  | 14 dB minimum   |
| Maximum Input Power                                  | 150 W   |
| Temperature Range                                    | -30°C (-22°F) to +60°C (140°F)  |
| Size   | 43.2 cm wide (17") x 54.6 cm<br>deep (21.5") x 7.6 cm high (3")<br>EIA Rack Mountable   |
| Weight   | 10 kg. (22 lbs.)  |
| Terminations   | Female N-Type   |
| Input and Output Impedance                           | 50 Ohms   |

*Specifications subject to change without notice.*

4

TYPICAL INTERCONNECTION

The duplexer module is typically mounted in the same rack or cabinet as the station and peripheral tray (if equipped). Figure 7 provides a simplified interconnect diagram showing the receiver and transmitter paths to a single Rx/Tx antenna.

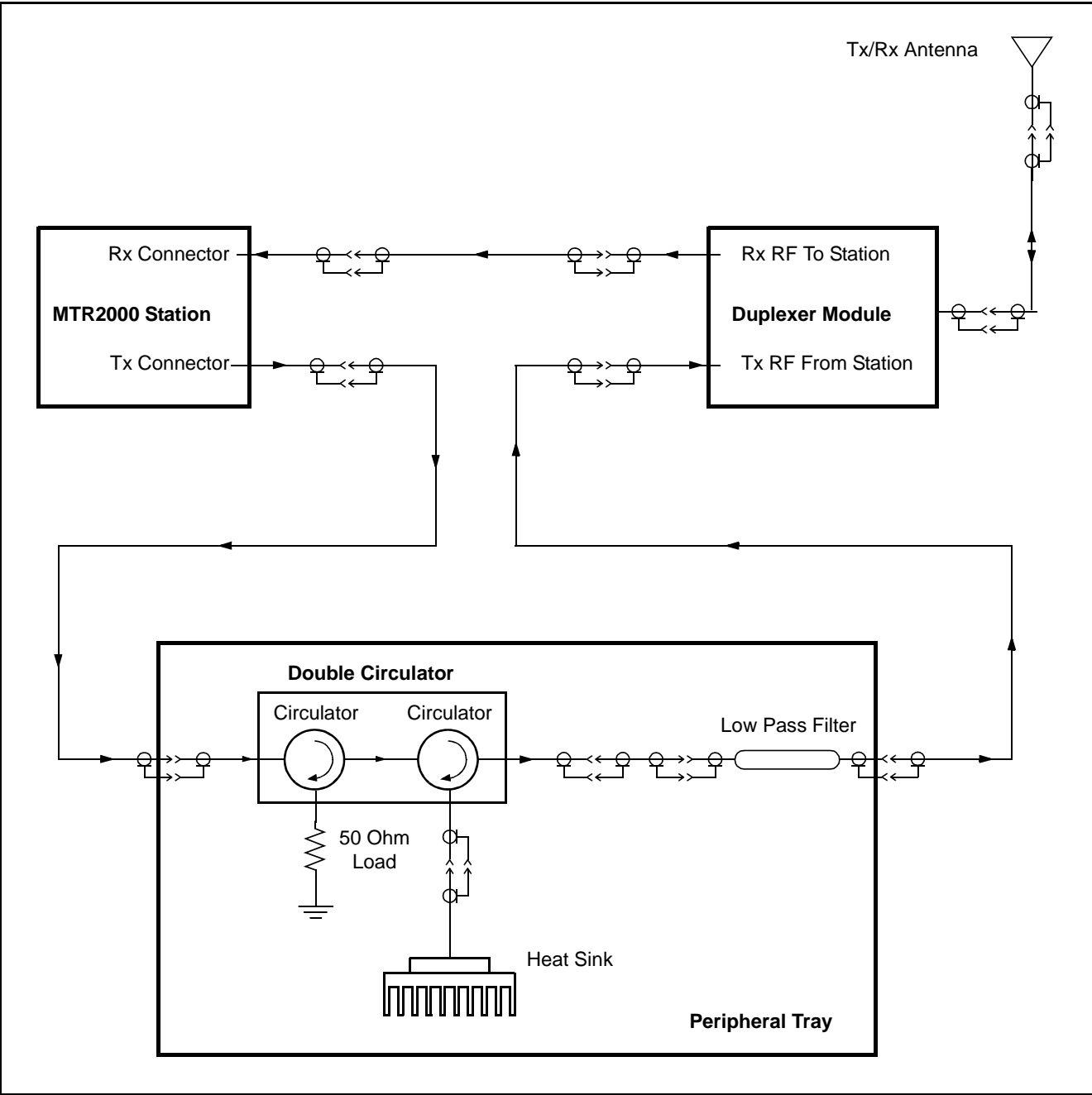


Figure 7. Typical Duplexer Interconnect Diagram

## 5

## FIELD TUNING PROCEDURE

Duplexer modules shipped with stations are tuned at the factory. If a duplexer must be replaced in the field, the unit must be installed and tuned specifically to the transmit and receive frequency pair for the particular station.

---

**Field Tuning Overview**

The duplexer module is comprised of three low-pass/high-notch cavities and three high-pass/low-notch cavities. Each set of three cavities provides bandpass filtering for either the transmit rf signal or the receive rf signal. In general, the duplexer must be tuned so that the transmit cavity set passes the transmit signal and rejects the receive signal; concurrently, the receive cavity set must be tuned to pass the receive signal and reject the transmit signal.

**This tuning procedure is valid for channels with a bandwidth of 200kHz or less. If bandwidth is more than 200kHz, the duplexer must be tuned by the service depot.**

Tuning is performed by injecting rf signals and making tuning adjustments (using the tuning rods and trimmer screws) while monitoring for maximum or minimum readings on the rf millivoltmeter. Field tuning the duplexer module requires the following general adjustments:

- Tune high-pass/low-notch cavities for maximum pass and reject response
- Tune low-pass/high-notch cavities for maximum pass and reject response
- Check high-pass/low-notch and low-pass/high-notch cavities for insertion loss
- Check high-pass/low-notch and low-pass/high-notch cavities for isolation

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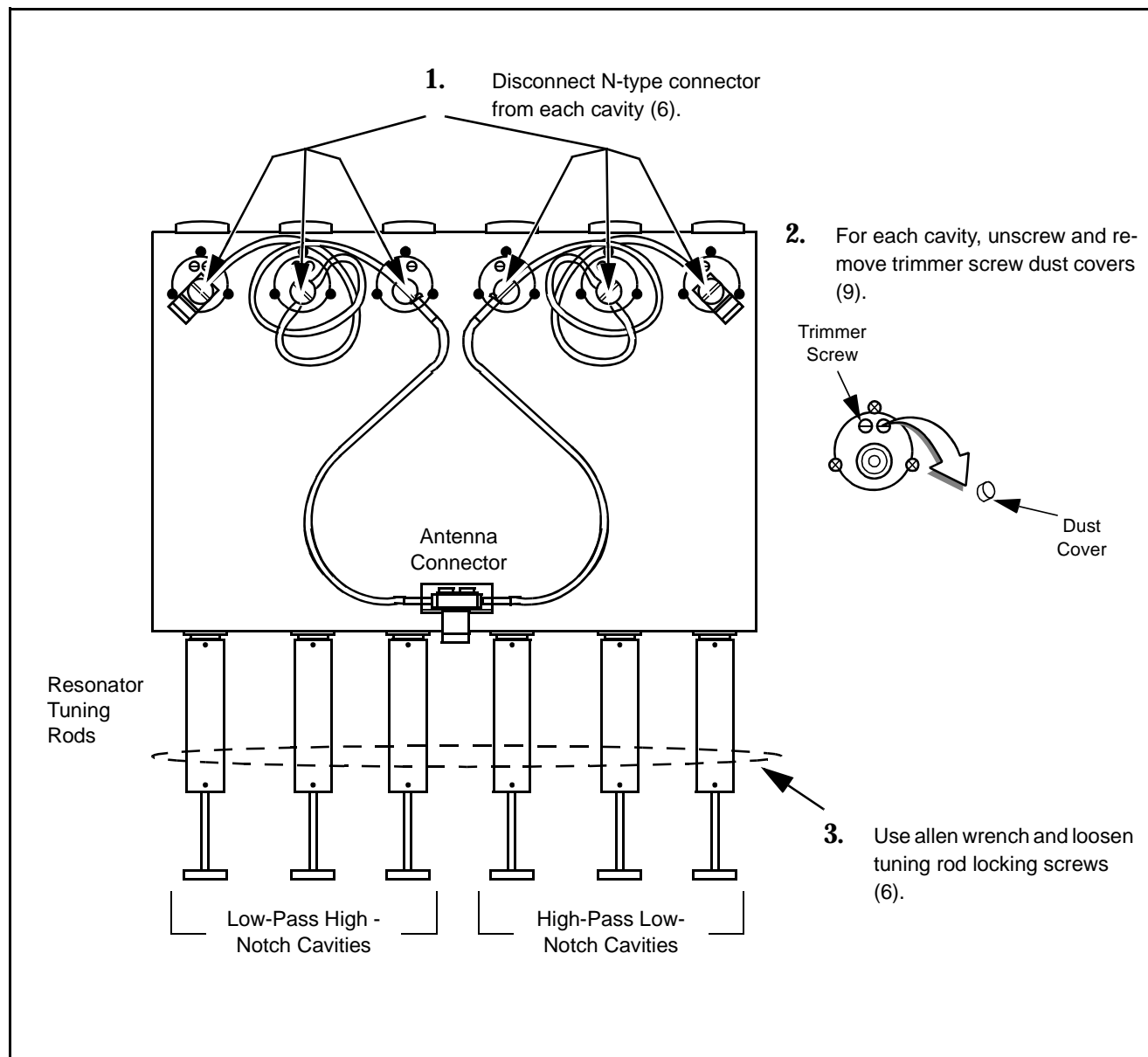
## Required Test Equipment

Field tuning of the duplexer module requires the following test equipment:

- Motorola R2001/R2600 Communications Analyzer (or equivalent)
- RF Millivoltmeter (Boonton 92E or equivalent)
- RF Signal Generator (HP8565 or equivalent)
- 50 $\Omega$  N-type terminator
- Male-to-Females N-Type "T" connector (UG-107B/U or equivalent)
- Slotted screwdriver
- 2.4 mm (3/32") allen wrench
- Tuning tool (thin blade)
- N-to-N bullet connector (UG29A/U or equivalent)
- N-to-BNC Adapter (UG349A/U)
- N-to-N Connector (UG57B/U)

## Setting Up for Tuning Duplexer

Perform the preliminary tasks shown in Figure 8 to prepare the duplexer module for tuning.



**Figure 8. Preliminary Tasks Prior to Tuning Duplexer**

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## Duplexer Tuning Procedure

The duplexer field tuning procedures are provided in Figure 9. The procedures are most easily performed with the duplexer module removed from the station rack or cabinet. Be sure to make note of the transmit and receive frequencies for the particular station before beginning.

If the duplexer module is tuned according to instructions and does not meet specifications for return loss, insertion loss, and/or isolation, you must return the duplexer for repair.

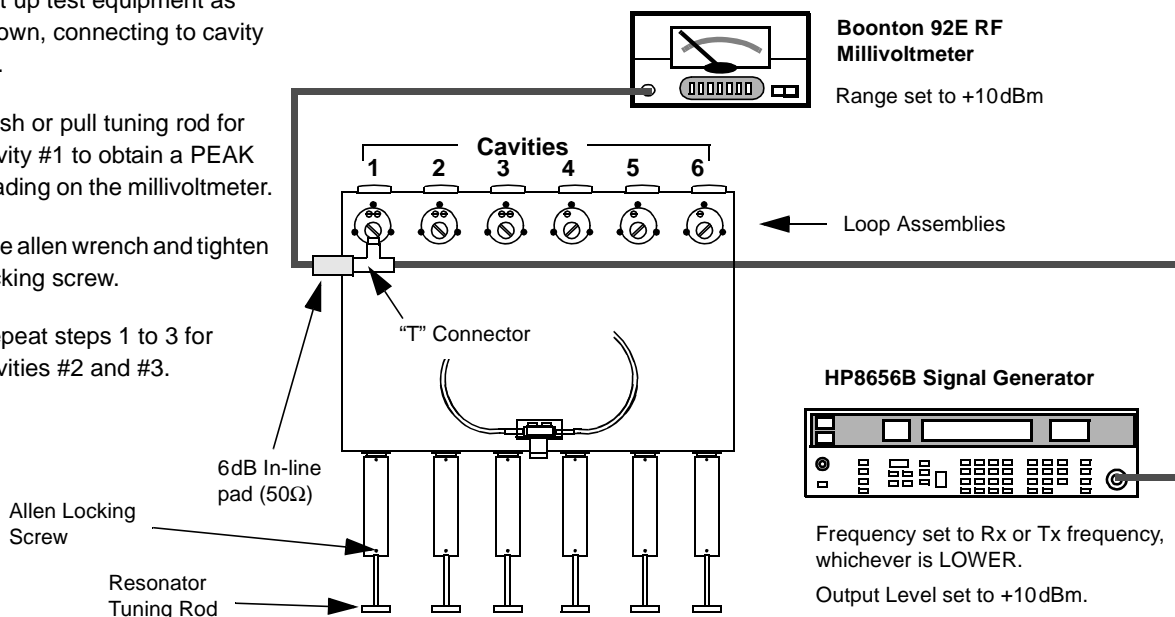
The notch (reject) frequency will maintain its spacing to the pass frequency when the pass adjustment of a cavity is moved several MHz. For example, a system operating at 135 and 138MHz, which is moved to 138 and 141MHz will require a minimum of readjustment if the pass adjustment is made first. It is therefore recommended that the pass adjustments be made first and that the procedure provided in Figure 9 be followed.

## 1. To Start

Remove cables from the duplexer, noting the position of each cable. Each cable is unique and must be returned to the original position when tuning is complete.

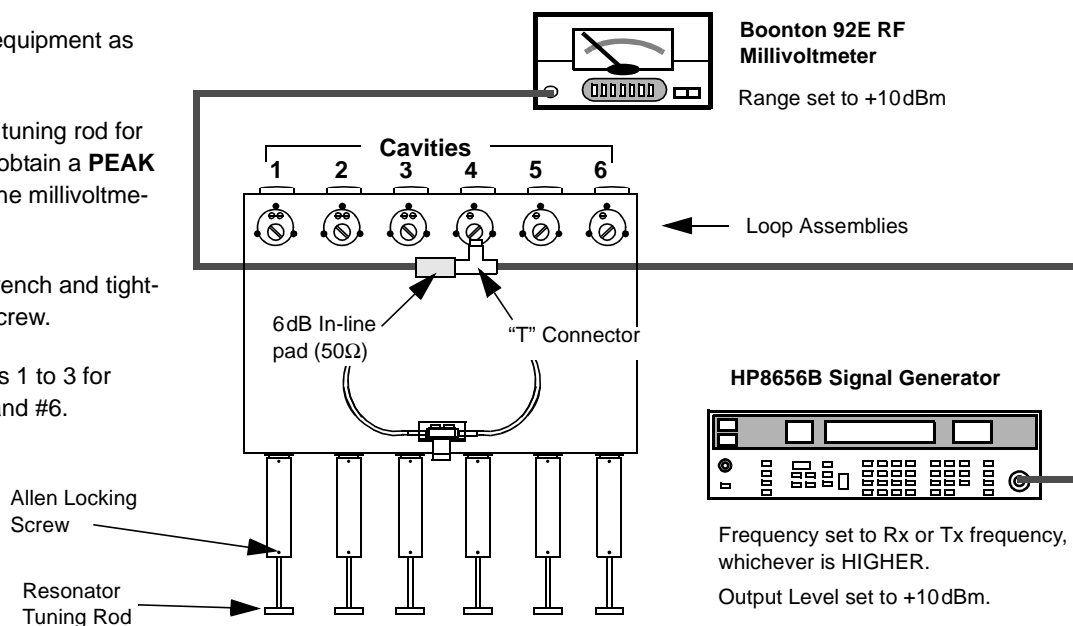
## 2. Tuning Low Pass Resonators

1. Set up test equipment as shown, connecting to cavity #1.
2. Push or pull tuning rod for cavity #1 to obtain a **PEAK** reading on the millivoltmeter.
3. Use allen wrench and tighten locking screw.
4. Repeat steps 1 to 3 for cavities #2 and #3.



## 3. Tuning High Pass Resonators

1. Set up test equipment as shown.
2. Push or pull tuning rod for cavity #4 to obtain a **PEAK** reading on the millivoltmeter.
3. Use allen wrench and tighten locking screw.
4. Repeat steps 1 to 3 for cavities #5 and #6.

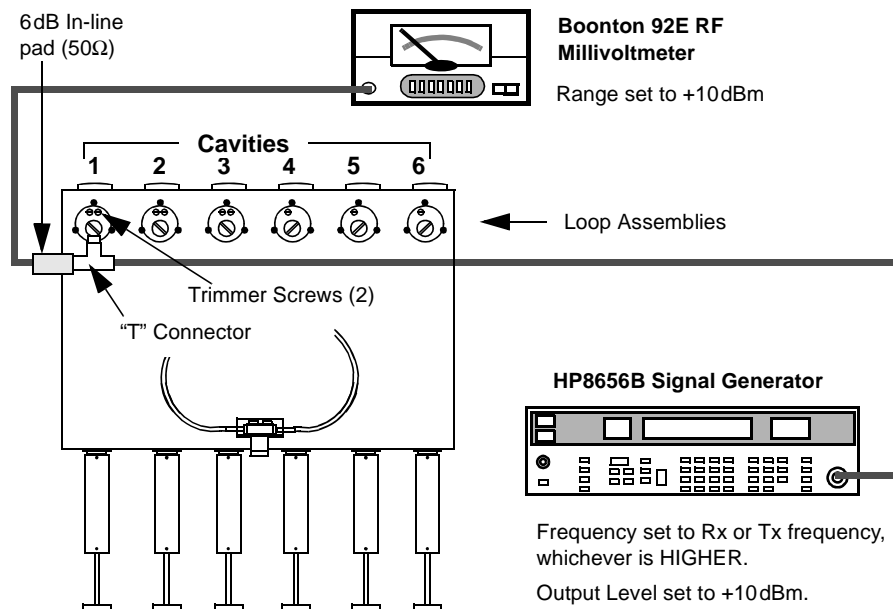


**Figure 9. VHF Duplexer Field Tuning Procedure**



## 4. Tuning High Notch Loop Assemblies

1. Set up test equipment as shown, connecting to cavity #1.
2. Use tuning tool to adjust trimmer screws for cavity #1 to obtain minimum reading on millivoltmeter. (Adjust trimmer screws equally to obtain minimum. Reduce the range on the millivoltmeter as necessary to reach true minimum reading.)
3. Repeat steps 1 and 2 for cavities #2 and #3.



## 5. Tuning Low Notch Loop Assemblies

1. Set up test equipment as shown.
2. Use tuning tool to adjust trimmer screw for cavity #4 to obtain minimum reading on millivoltmeter. (Adjust trimmer screw to obtain minimum. Reduce the range on the millivoltmeter as necessary to reach true minimum reading.)
3. Repeat steps 1 and 2 for cavities #5 and #6.
4. **Reconnect the cables on the duplexer. Make sure that the cables are returned to their original position on the Duplexer.**

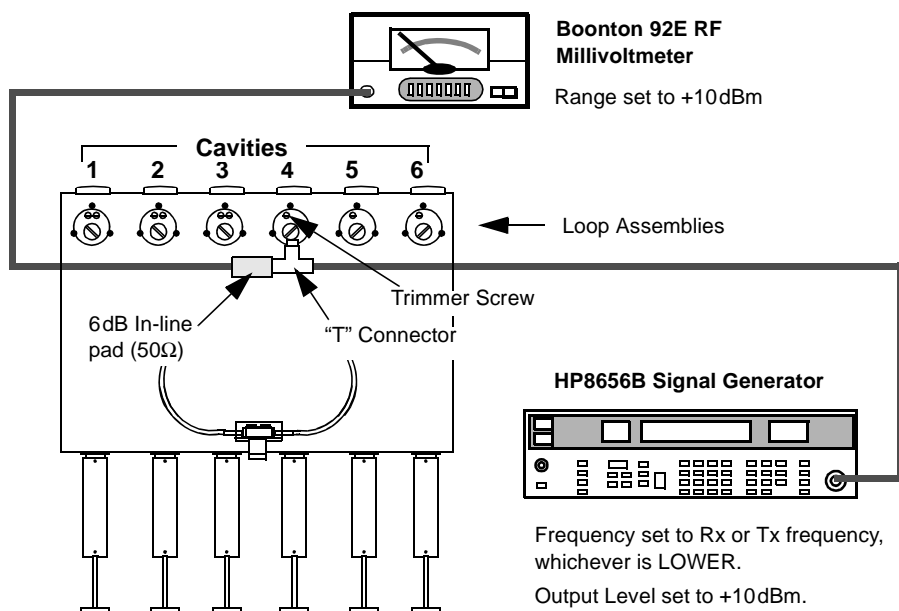
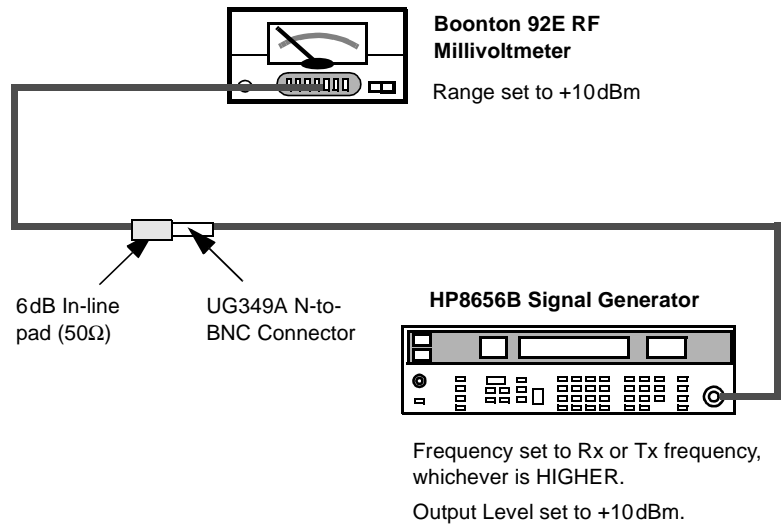


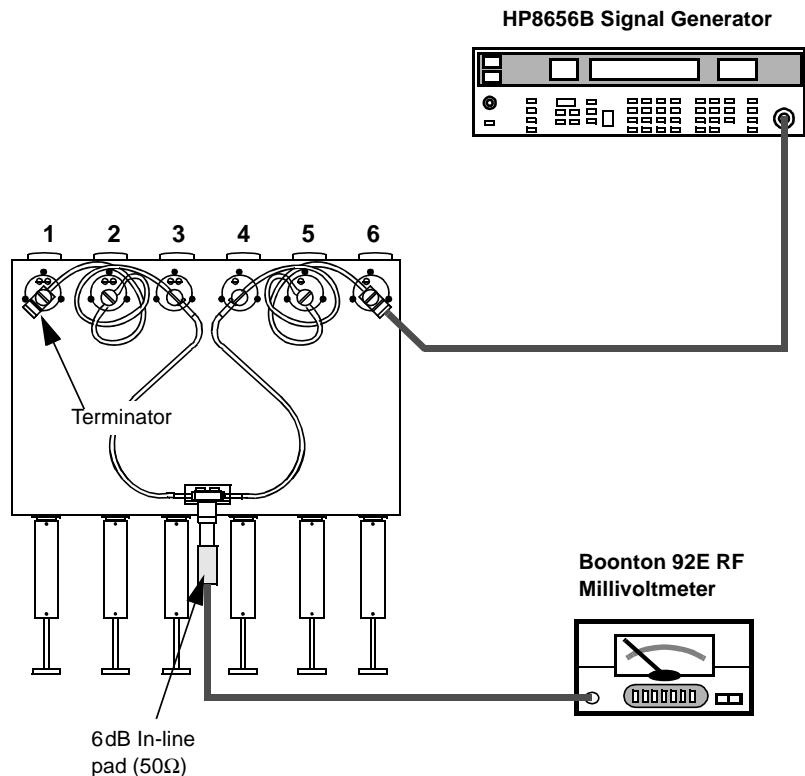
Figure 9. VHF Duplexer Field Tuning Procedure (Continued)

## 6. Verifying Insertion Loss

1. Connect test equipment as shown.
2. Observe and note the level in dBm as shown on the millivoltmeter.



3. Connect the duplexer cable assembly and test equipment to the duplexer as shown.
4. Observe and note the level in dBm as shown on the millivoltmeter.
5. Subtract the absolute number noted in Step 2 from the number noted in Step 4. The difference should be less than 1.3 dB to meet specification for Insertion Loss.
6. Repeat Steps 1 to 5 for Low-Pass/High Notch cavities with the following exceptions:
  - a) Set Frequency Generator for Rx or Tx frequency, whichever is LOWER
  - b) Connect Signal Generator to Low Pass duplexer input (cavity #1)
  - c) Connect terminator to cavity #6.



**Figure 9. VHF Duplexer Field Tuning Procedure (Continued)**

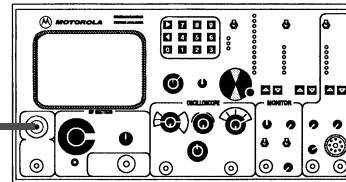
## 7. Verifying Isolation

1. Connect test equipment as shown.
2. Observe and note the level in dBm as shown on the R2001 display.

Monitor Function.

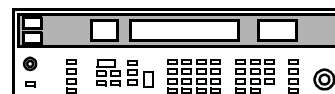
Center frequency set to Tx or Rx frequency, whichever is LOWER  
Attenuator set to -50 dBm

**R2001 Communications**



UG29A/U Bullet Connector

**HP8656B Signal Generator**



Frequency set to Rx or Tx frequency, whichever is LOWER.

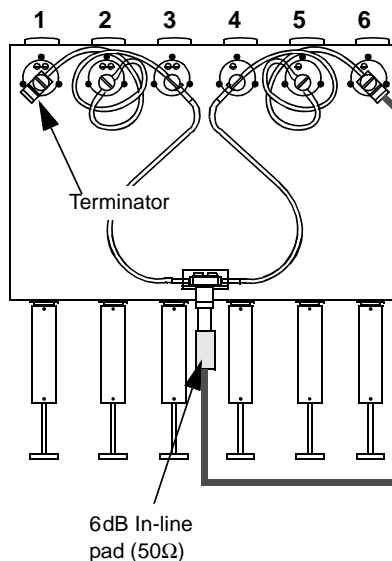
Output Level set to +10 dBm.

3. Connect the test equipment to the duplexer as shown.
4. Observe and note the level in dBm as shown on the R2001 display. (If no number is displayed, consider isolation to be greater than 105 dB, which exceeds the specification.)

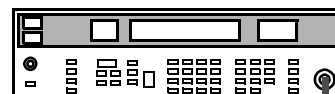
5. Subtract the absolute number noted in Step 4 from the number noted in Step 2. The difference should be higher than 75 dB to meet specification for Isolation.

6. Repeat Steps 1-5 for Low- Pass/ High Notch cavities with the following exceptions:

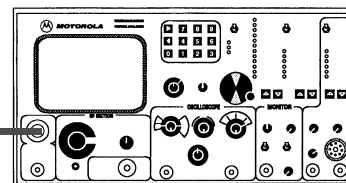
- a) Set Frequency Generator and R2001 for Rx or Tx frequency, whichever is HIGHER
- b) Connect Signal Generator to Low Pass duplexer input (cavity #1)
- c) Connect terminator to cavity #6.



**HP8656B Signal Generator**



**R2001 Communications**

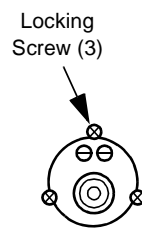


Attenuator set to 0 dBm

**Figure 9. VHF Duplexer Field Tuning Procedure (Continued)**

## 8. Post-Tuning Checks

1. Make sure all locking screws are tight. Reinstall dust covers on all trimmer capacitors.



2. Make sure all tuning rod locking screws (6) are tight.

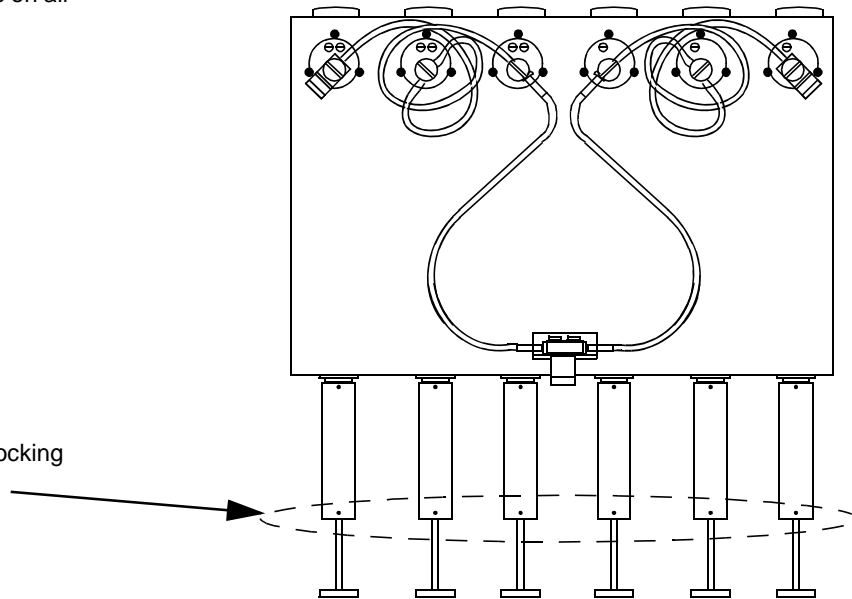


Figure 9. VHF Duplexer Field Tuning Procedure (Continued)



# ZETRON REPEATER PANEL

Model TDN9946

## 1

## DESCRIPTION

The MTR2000 is capable of Multi Coded Squelch through the Zetron Model 38 Repeater Panel, model TDN9946. The Model 38 Repeater Panel interconnects to the MTR2000 and provides 38 PL tones and 22 DPL tones standard. This section provides a general description, cable connection, and option information.

Refer to the ZETRON Repeater Panel Instruction Manual (supplied with the panel) for panel specifications, operation, installation, programming, and repair information.

### General Description

The Zetron panel, shown in Figure 1, is a community repeater panel. The Zetron panel can be mounted in a cabinet or rack and is 4.3 cm (1.7 in.) high.

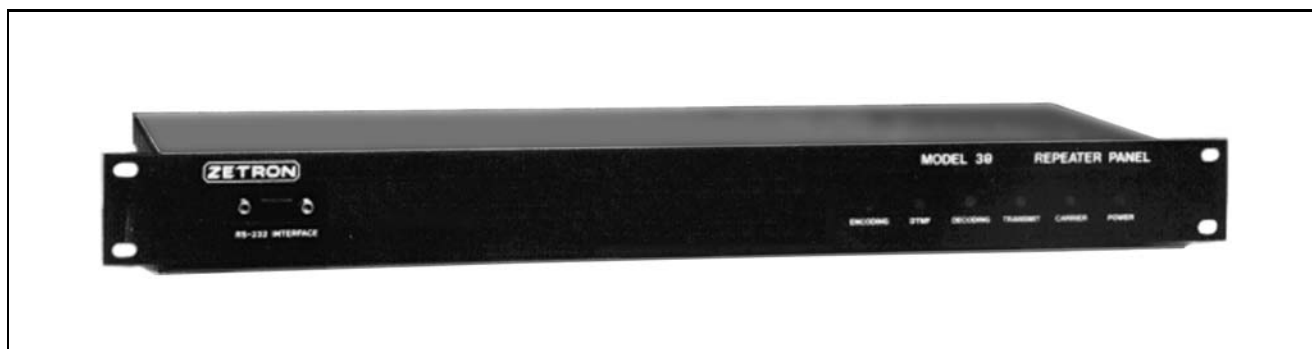


Figure 1. Zetron Repeater Tone Panel

## Cable

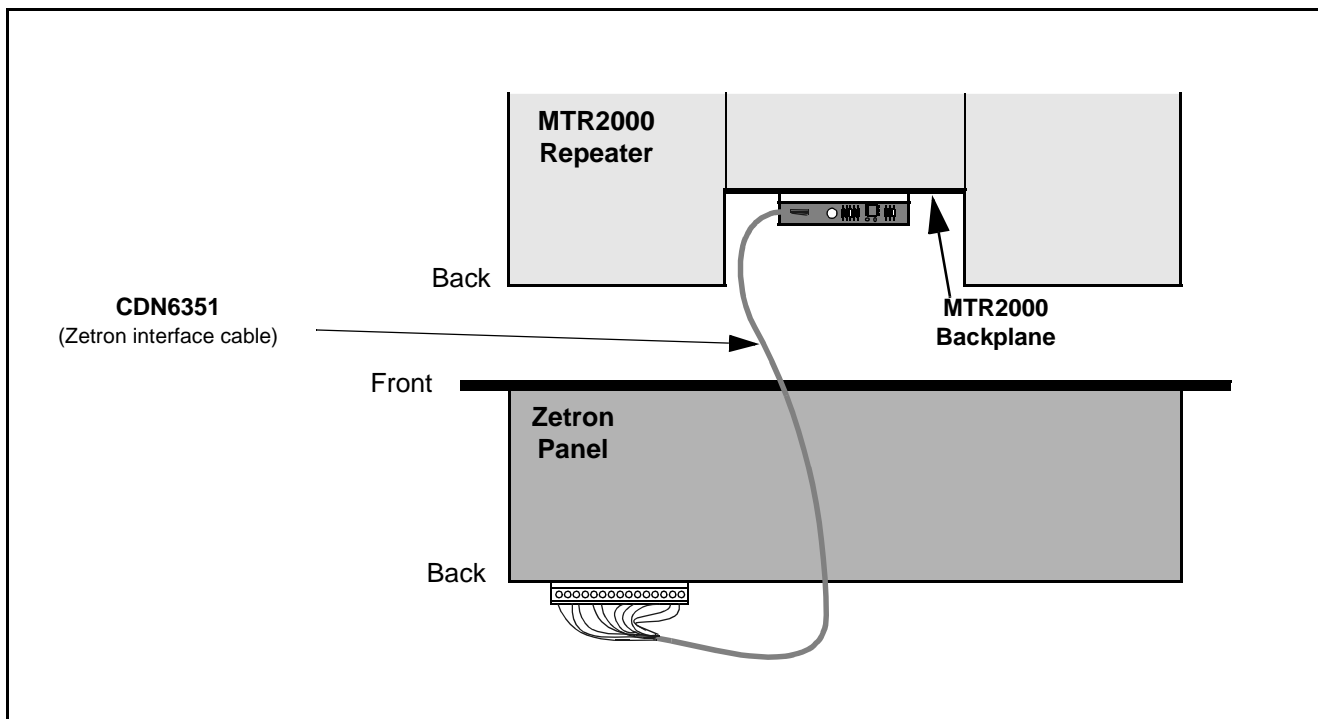
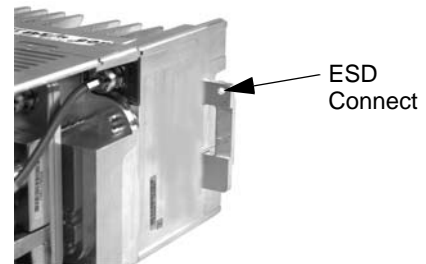
An interface cable, model CDN6351 is required to interface the Zetron Model 38 Repeater panel to the MTR2000. This cable is not an option to the MTR2000 station; it must be ordered as a separate item.

To connect the Zetron panel to the MTR2000 repeater:

1. On the MTR2000 backplane, remove the screw centered under the System (J5) connector. Remove the connector strain relief / fuse access plate.
2. Connect the Zetron interface cable to the System (J5) connector on the MTR2000 Backplane. See Figure 2.



**When installing the Zetron panel, ensure that an Electro-Static Discharge (ESD) cable is connected (via banana plug) to the hole in the front-right handle of the station. Otherwise, the MTR2000 and Zetron panel may be damaged.**



**Figure 2. MTR2000 to Zetron Panel – Cable Connection**

3. The component side of the Zetron interface circuit board should be facing up when connected to the MTR2000.  
If the components are facing down, this is an older version of the MTR2000 that does not support connection to the Zetron panel.
4. Re-install the connector strain relief / fuse access plate.
5. Configure the MTR2000 Radio Service Software (RSS) for operation with the Zetron panel. See the RSS Online Help for details.
6. Connect the interface cable to the Zetron panel.
7. Configure the Zetron panel as indicated in the Zetron Instruction manual.
8. Follow the initial power up and adjustment instructions in the Zetron panel Instruction manual.

## 2

## OPTION INFORMATION

The Zetron Model 38 Repeater Panel **is not an option** to the MTR2000; it must be ordered as a separate item. The interface cable (between the Zetron panel and the MTR2000 repeater) must also be ordered as a separate item.

The Zetron Selective Calling option, E380, replaces 38 PL tones and 22 DPL tones with 50 PL tones and 18 DPL tones. If this option is required, it must be ordered as a sub-item to the Model 38 Repeater Panel (model, TDN9946).