MOTOROLA

QUANTAR™

Satellite Receiver

For Analog/*ASTRO* and Analog/*SECURENET* Systems

VHF 132–174 MHz
UHF 403-520 MHz
800 MHz 806-825 MHz

Instruction Manual

68P81087E25-O

COMPUTER SOFTWARE COPYRIGHTS

COMMERCIAL WARRANTY
(STANDARD)

Motorola radio communications products are warranted to be free from defects in material and workmanship for a period of ONE (1) YEAR, (except for crystals and channel elements which are warranted for a period of ten (10) years) from the date of shipment. Parts, including crystals and channel elements, will be replaced free of charge for the full warranty period but the labor to replace defective parts will only be provided for One Hundred-Twenty (120) days from the date of shipment. Thereafter purchaser must pay for the labor involved in repairing the product or replacing the parts at the prevailing rates together with any transportation charges to or from the place where warranty service is provided. This express warranty is extended by Motorola Communications and Electronics, Inc., 1301 E. Algonquin Road, Schaumburg, Illinois 60196, to the original purchaser only, and only to those purchasing for purpose of leasing or solely for commercial, industrial, or governmental use.

THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED WHICH ARE SPECIFICALLY EXCLUDED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

In the event of a defect, malfunction or failure to conform to specifications established be seller, or if appropriate, to specifications accepted by Seller in writing, during the period shown, Motorola, at its option, will either repair or replace the product or refund the purchase price thereof, and such action on the part of Motorola shall be the full extent of Motorola's liability hereunder.

This warranty is void if:

a. the product is used in other than its normal and customary manner;

b. the product has been subject to misuse, accident, neglect or damage;

c. unauthorized alterations or repairs have been made, or unapproved parts used in the equipment.

This warranty extends only to individual products, batteries are excluded. Because each radio system is unique, Motorola disclaims liability for range, coverage, or operation of the system as a whole under this warranty except by a separate written agreement signed by an officer of Motorola.

LICENSED PROGRAMS — Motorola software provided in connection with this order is warranted to be free from reproducible defects for a period of one (1) year. All material and labor to repair any such defects will be provided free of charge for the full warranty period, and SUBJECT TO THE DISCLAIMER IN BOLD FACE TYPE.

Non-Motorola manufactured products are excluded from this warranty, but subject to the warranty provided by their manufacturers, a copy of which will be supplied to you on specific written request.

In order to obtain performance of this warranty, purchaser must contact its Motorola salesperson or Motorola at the address first above shown, attention Quality Assurance Department.

This warranty applies only within the United States.

EPS-30831-O

FCC INTERFERENCE WARNING

The FCC Requires that manuals pertaining to Class A and Class B computing devices must contain warnings about possible interference with local residential radio and TV reception. This warning reads as follows:

NOTE: This 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 the instruction manual, may cause harmful interference to radio communications.

MOTOROLA

instruction manual revision

GENERAL:

This revision outlines changes that have occurred since the printing of your instruction manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

68P81085E50–A	*Quantar* VHF Digital–Capable Station Functional Manual
68P81091E30–O	*Quantar* 800 MHz Digital–Capable Station Functional Manual
68P81090E75–O	*Quantar* 900 MHz Digital–Capable Station Functional Manual
68P81087E25–O	*Quantar* Satellite Receiver Functional Manual

REVISION DETAILS:

The stations described in the above listed manuals are shipped with a 110 V ac line cord. Please add the following note pertaining to making 220 V ac input power connections (p/o Installation sections of the above listed manuals):

(Note that if you wish to connect to a 220 V ac outlet, you must obtain a line cord employing "HAR" flexible cord with fittings approved by a safety testing agency in the end use country.)

MOTOROLA
Land Mobile Products Sector

QUANTAR™
Satellite Receiver
for Analog/*ASTRO* and Analog/*SECURENET* Systems
VHF 132–174 MHz
UHF 403–520 MHz
800 MHz 806–825 MHz

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STATION POWER SUPPLY MODULES

ANCILLARY EQUIPMENT

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

The following equipment ordering scenario is used by the sales representative to equip a *Quantar* satellite receiver with the proper hardware and firmware for specific system types and customer–defined options and features. The scenario is described here to explain the process and to show the structure and contents of the various options and models.

1 The sales model is T5367A.

NOTE: *The Sales Model includes only a TRN7479A Base Station Chassis and a TRN7480A Interconnect Board (backplane). Equipping the chassis with the proper modules is accomplished by ordering additional options, as described in the following steps.*

2 A System Family Option must be selected as follows:

System Type	Family Option
Conventional *ASTRO*/Analog	X599

3 The frequency option must be selected as follows:

Frequency Range	Option
VHF Range 1 (132–154 MHz)	X319AA
VHF Range 2 (150–174 MHz)	X319AB
UHF Range 1 (403–433 MHz)	X320AA
UHF Range 2 (438–470 MHz)	X320AB
UHF Range 3 (470–494 MHz)	X320AC
UHF Range 4 (494–520 MHz)	X320AD
800 MHz (806–825 MHz)	X600AA

(Continued)

4 If no other options are selected, Motorola's Order Processing appends the appropriate standard options (based on frequency band) to complete the satellite receiver equipment list. The tables below show the completed equipment lists for the seven available options.
If additional options are desired, they must be added to the initial order form. Step 5 lists the available options and the impact each has on the standard equipment configuration.

OPTION X319AA SELECTED IN STEP 3
(VHF Range 1)

	Option/ Kit	Description
Option from Initial Sales Order	**X319AA**	VHF High Band Range 1 Satellite Receiver
	TRD6361B	Receiver Board (VHF HI-Band Range 1)
	TFD6511A	Preselector Module (VHF HI-Band Range 1)
	TRN7482B	Receiver Module Hardware
	TKN8752A	Preselector Input RF Cable
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AJ	Blank Panels
	TRN7695A	Single slot wide blank panel
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

OPTION X319AB SELECTED IN STEP 3
(VHF Range 2)

	Option/ Kit	Description
Option from Initial Sales Order	**X319AB**	VHF High Band Range 2 Satellite Receiver
	TRD6362B	Receiver Board (VHF HI-Band Range 2)
	TFD6512A	Preselector Module (VHF HI-Band Range 2)
	TRN7482B	Receiver Module Hardware
	TKN8752A	Preselector Input RF Cable
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AJ	Blank Panels
	TRN7695A	Single slot wide blank panel
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

OPTION X600AA SELECTED IN STEP 3
(800 MHz)

	Option/ Kit	Description
Option from Initial Sales Order	**X600AA**	800 MHz Satellite Receiver
	TRF6551B	Receiver Board (800 MHz)
	TRN7638A	Receiver Module Hardware
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AK	Blank Panels
	TRN7695A	Single slot wide blank panel (2)
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

(Continued)

OPTION X320AA SELECTED IN STEP 3
(UHF Range 1)

	Option/ Kit	Description
Option from Initial Sales Order	**X320AA**	UHF Range 1 Satellite Receiver
	TRE6281C	Receiver Board (UHF Range 1)
	TLE5991A	Preselector Module (UHF Range 1)
	TRN7482B	Receiver Module Hardware
	TRN7799A	VHF/UHF Tuning Kit
	TKN8752A	Preselector Input RF Cable
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AJ	Blank Panels
	TRN7695A	Single slot wide blank panel
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

OPTION X320AB SELECTED IN STEP 3
(UHF Range 2)

	Option/ Kit	Description
Option from Initial Sales Order	**X320AB**	UHF Range 2 Satellite Receiver
	TRE6282C	Receiver Board (UHF Range 1)
	TLE5992A	Preselector Module (UHF Range 1)
	TRN7482B	Receiver Module Hardware
	TRN7799A	VHF/UHF Tuning Kit
	TKN8752A	Preselector Input RF Cable
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AJ	Blank Panels
	TRN7695A	Single slot wide blank panel
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

OPTION X320AC SELECTED IN STEP 3
(UHF Range 3)

	Option/ Kit	Description
Option from Initial Sales Order	**X320AC**	UHF Range 3 Satellite Receiver
	TRE6283C	Receiver Board (UHF Range 3)
	TLE5993A	Preselector Module (UHF Range 3 & 4)
	TRN7482B	Receiver Module Hardware
	TRN7799A	VHF/UHF Tuning Kit
	TKN8752A	Preselector Input RF Cable
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AJ	Blank Panels
	TRN7695A	Single slot wide blank panel
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

OPTION X320AD SELECTED IN STEP 3
(UHF Range 4)

	Option/ Kit	Description
Option from Initial Sales Order	**X320AD**	UHF Range 4 Satellite Receiver
	TRE6284C	Receiver Board (UHF Range 4)
	TLE5993A	Preselector Module (UHF Range 3 & 4)
	TRN7482B	Receiver Module Hardware
	TRN7799A	VHF/UHF Tuning Kit
	TKN8752A	Preselector Input RF Cable
Options/Kits Internally Added by Motorola Order Processing	**X43AB**	Power Supply Assembly
	TPN6186A	265W Power Supply (AC Input; w/o battery chrg)
	X621AB	Station Control Module (SCM); standard
	TRN7475A	Station Control Module
	TRN7476A	SCM Hardware
	X216AA	Wireline Interface Module (WIM) (4-wire)
	TRN7477A	Wireline Interface Board
	TKN8731A	WIM Cable
	X142AA	Duplex Interface Assembly
	TRN7494A	Duplex Interface (includes ant. connector bracket, N-connectors,and rf cables)
	X249AK	Cabling, Satellite Receiver
	TKN8753A	Receiver mini-UHF to N-type coax cable
	X163AJ	Blank Panels
	TRN7695A	Single slot wide blank panel
	TRN7696A	Dual slot wide blank panel
	TRN7984A	Triple slot wide blank panel
	X187AA	Domestic Power Cable
	TRN7663A	Line Cord
	X430AA	12" x 20" Cabinet
	THN6700A	12" Cabinet
	X362AA	Packing

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

AVAILABLE OPTIONS FOR *QUANTAR* SATELLITE RECEIVER (VHF, UHF, and 800 MHz)

Option Category	Option	and Complement
Power Supply	**X30AB**	**265W Power Supply with Battery Charger**
	TPN6187A	265W Power Supply Assembly with Battery Charger
	TKN8732A	Battery Charger Cable Kit
	TKN8786A	Battery Temperature Sensor
	TRN5155A	10' Extension Cable w/connectors and fuse block
	X121AA	**12/24V DC Input 210W Power Supply**
	TRN7802A	210W Power Supply Assembly (12/24 V DC Input)
	TKN8732A	Battery Charger Cable Kit
	TRN5155A	10' Extension Cable w/connectors and fuse block
	X113AA	**48/60V DC Input 210W Power Supply**
	TRN7803A	210W Power Supply Assembly (48/60 V DC Input)
	TKN8732A	Battery Charger Cable Kit
	TRN5155A	10' Extension Cable w/connectors and fuse block
Modem	**X437AA**	**Add *ASTRO* Modem**
	TRN7668A	*ASTRO* Modem Card
Miscellaneous	HSN1000	External Speaker
	TRN7738A	External Speaker Hardware (bracket and cable)
	HMN1001A	Test Microphone
	Note that the external speaker and microphone are not options and must be ordered as line items on the STIC-1 order form.	

FOREWORD

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.

Service and Replacement Modules

Motorola System Support Center
1335-A Basswood Drive
Schaumburg, IL 60173

1-800-448-3245
FAX 708-576-2172

For complete information on ordering FRU replacement modules, or instructions on how to return faulty modules for repair, contact the System Support Center (see sidebar).

The following FRU replacement modules are available:

Receiver Module (VHF Range 1)	TLN3250A
Receiver Module (VHF Range 2)	TLN3251A
Receiver Module (UHF Range 1)	TLN3313A
Receiver Module (UHF Range 2)	TLN3314A
Receiver Module (UHF Range 3)	TLN3373A
Receiver Module (UHF Range 4)	TLN3374A
Receiver Module (800 MHz)	TLN3315A
Station Control Module	TLN3256A
4-Wire Wireline Interface Module	TLN3257A
Power Supply Module (265W AC)	TLN3261A
Power Supply Module (265W AC w/charger)	TLN3262A
Power Supply Module (210W 12/24 V dc input)	TLN3377A
Power Supply Module (210W 48/60V dc input)	TLN3378A
ASTRO Modem Card	TLN3265A

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.

GENERAL SAFETY INFORMATION

- ▶ 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.

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

PERFORMANCE SPECIFICATIONS

General

Specification	VHF	UHF	800 MHz
Number of Channels	4	4	4
Channel Spacing	30 kHz, 25 kHz, 12.5 kHz	30 kHz, 25 kHz, 12.5 kHz	30 kHz, 25 kHz, 12.5 kHz
Frequency Generation	Synthesized	Synthesized	Synthesized
Power Supply Type	Switching	Switching	Switching
Power Supply Input Voltage	90-280 V ac	90-280 V ac	90-280 V ac
Power Supply Input Frequency	47-63 Hz	47-63 Hz	47-63 Hz
Battery Revert	12V dc	12V dc	12V dc
Temperature Range (ambient)	−30° C to +60° C	−30° C to +60° C	−30° C to +60° C

Receiver

Specification	VHF	UHF	800 MHz
Frequency Range	132-154 MHz (R1) 150-174 MHz (R2)	403-433 MHz (R1) 438-470 MHz (R2) 470-494 MHz (R3) 494-520 MHz (R4)	806-825 MHz
Selectivity	90 db (30 kHz) 85 dB (25 kHz) 80 dB (12.5 kHz)	85 dB (30/25 kHz) 75 dB (12.5 kHz)	80 dB (30/25 kHz) 70 dB (12.5 kHz)
Sensitivity (12 dB SINAD)	0.25 μV	0.35 μV	0.30 μV
Sensitivity (20 dB Quieting)	0.35 μV	0.5 μV	0.42 μV
Off Channel Acceptance	±2 kHz minimum (12.5/25/30 kHz channel)	±2 kHz minimum (12.5/25/30 kHz channel)	±2 kHz minimum (12.5/25/30 kHz channel)
Frequency Stability	1 ppm	1 ppm	1 ppm
Intermodulation	85 dB (25/30 kHz) 80 db (12.5 kHz)	85 dB (25/30 kHz) 75 db (12.5 kHz)	80 dB (25/30 kHz) 70 db (12.5 kHz)
Spurious and Image Rejection	100 dB	100 dB	100 dB
Audio Response (Analog Mode)	+1, −3 dB from 6 dB per octave de-emphasis; 300-3000 Hz referenced to 1000 Hz at line input		
Audio Distortion	Less than 3% @ 1000 Hz		
Wireline Output	-20 dBm to 0 dBm @ 60% Rated System Deviation, 1 kHz		
FM Hum and Noise (300 to 3000 kHz bandwidth)	50 dB nominal (25/30 kHz) 45 dB nominal (12.5 kHz)	50 dB nominal (25/30 kHz) 45 dB nominal (12.5 kHz)	45 dB nominal (25/30 kHz) 40 dB nominal (12.5 kHz)
RF Input Impedance	50 Ohms		
FCC Designation (FCC Rule Part 15)	ABZ89FR3776	ABZ89FR4796	ABZ89FR5757

Specifications subject to change without notice

MOTOROLA

User Questionnaire

To the User of this Instruction Manual:

Motorola is engaged in a continuing program of improving its instruction literature. We believe that you can aid us in this program, so that we in turn can better help you operate and service our equipment. Please help us by answering the following questions. Whenever possible, please give complete model number of equipment and part number of diagram, parts list, and/or instruction section. ***This information is important!***

SCHEMATIC DIAGRAMS (Depot manuals only), CABLING DIAGRAMS AND FLOW CHARTS

- ❑ Are accurate and easy to follow
- ❑ Contain minor errors
- ❑ Contain major errors
- ❑ Are difficult to follow

If you have checked any box except the first, please tell us what diagram(s) (or portions thereof) were at fault, or enter other comments.

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68P81086E92-O

TEXT

- ❑ Easy to follow – helps to operate and/or service equipment
- ❑ Would like more information on –

____

____

- ❑ Some instruction sections are too long or superfluous such as –

____

____

- ❑ Other comments

____

____

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(continued on reverse side)

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- ❑ Contain major errors

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- ❑ Some are superfluous such as –

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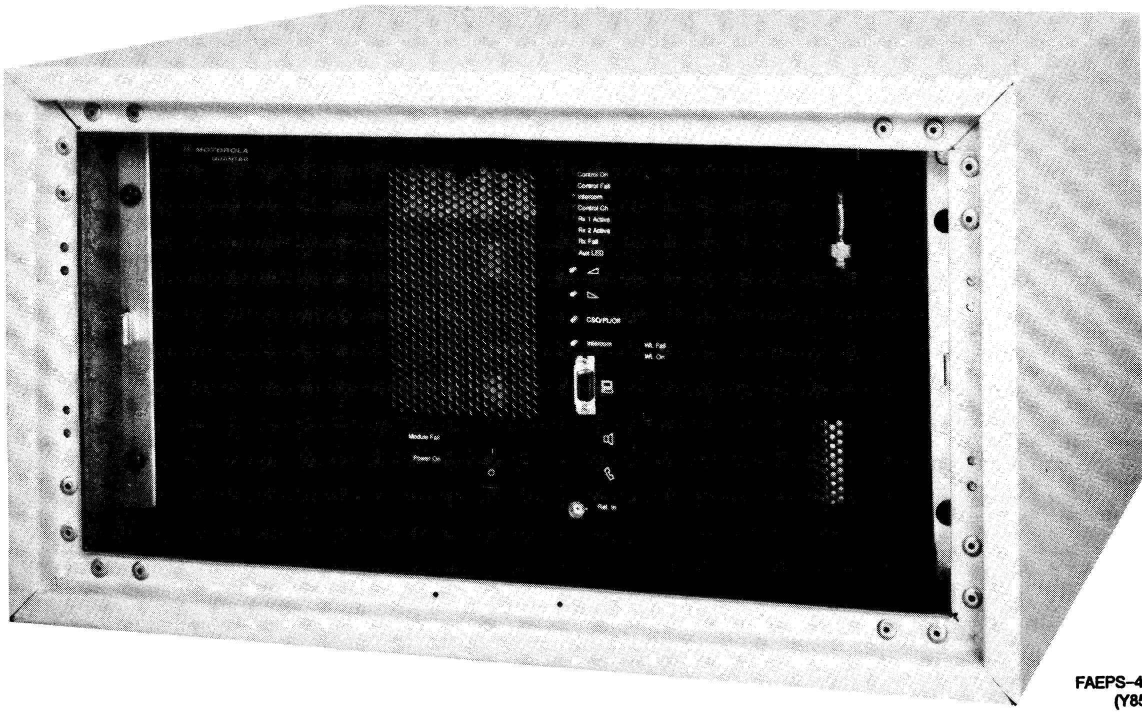

FAEPS–48715–O
(Y851)

Figure 1. *Quantar* Satellite Receiver in 12" Cabinet (800 MHz Model Shown)

1 INTRODUCTION

An important design goal in any rf communications system is to ensure that mobile and portable radios within the coverage area can both transmit and receive signals to/from the base station(s). Low–powered portables may have difficulty in some locations transmitting to the base station. Additionally, obstacles such as high–rise buildings, large hills or mountains, densely wooded areas, and other obstructions can make the subscriber–to–base station rf link difficult or unreliable. These areas of inadequate rf coverage are referred to as "dead spots".

"Dead spots" in rf coverage can be virtually eliminated by implementing a voting receiver system, where satellite receivers are placed strategically throughout the coverage area. Transmissions from subscribers (unable to reach the base station) are received by one or more satellite receivers. The audio signal from each satellite receiver is sent via phone lines to a comparator which "votes" the strongest signal and routes it to the appropriate destination.

The Motorola *Quantar* Satellite Receiver provides satellite receiving capabilities in a compact, software–controlled design. The satellite receiver architecture and microprocessor–controlled Station Control Module allow for fast and reliable expansion and upgrading.

Compact Mechanical Design

The entire *Quantar* Satellite Receiver is housed in a 5 rack-unit-high card cage weighing only 40 lbs. A single cage may be mounted in a 12" cabinet (shown in Figure 1) or multiple cages may be mounted in standard telephone-style equipment racks or various sizes of Motorola cabinets.

State-of-the-Art Electrical Design

Receiver Circuitry

The satellite receiver receive circuitry features multiple bandwidth (12.5, 25, & 30 kHz) capability, as well as *ASTRO* digital operation. Injection signals for the 1st and 2nd mixers are generated by frequency synthesizer circuitry electronically controlled by the Station Control Module. All receive signals (analog, *SECURENET*, and *ASTRO*) are detected and digitized before being sent to the Station Control Module, providing improved audio quality consistency throughout the coverage area.

Station Control Module

The *Quantar* 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 wireline circuitry provides a wide variety of telephone interfaces, including analog, *ASTRO*, *SECURENET*, and Tone Remote Control. Telephone line connections are easily made to the wireline circuitry via connectors on the rear of the station.

Switching Power Supply

Available as options are a battery revert ac supply and two dc input supplies (12/24 V dc and 48/60 V dc).

The *Quantar* Satellite Receiver features a switching-type power supply which accepts a wide range of ac inputs (90–280 V ac, 47–63 Hz) and generates the necessary dc operating voltages for the satellite receiver modules. The power supply continually monitors and adjusts the output voltages, and requires no external adjustments or calibration.

Summary of Operating Features

Standard Features

The following are a few of the standard *Quantar* Satellite Receiver features:

- Compact, single cage design
- Extensive Self-Test Diagnostics and Alarm Reporting
- FRU maintenance philosophy (reduces down time)
- Easily programmed via Radio Service Software
- Expansion and upgrades performed by module replacement and/or software upgrade
- Compatible with analog, *SECURENET*, and *ASTRO* digital signaling
- Versatile and reliable switching-type power supply
- Wide operating temperature range: -30° C to +60° C (-22° F to +140° F)

Optional Features

The following are a few of the optional features for the *Quantar* Satellite Receiver:

- Battery Revert – charges co-located storage batteries and automatically reverts to battery backup operation in the event of ac power failure
- *ASTRO* Modem – allows connection (for *ASTRO* digital signaling) to *ASTRO* fixed equipment

2 SATELLITE RECEIVER COMPONENTS

Figure 2 shows the *Quantar* Satellite Receiver modules and components.

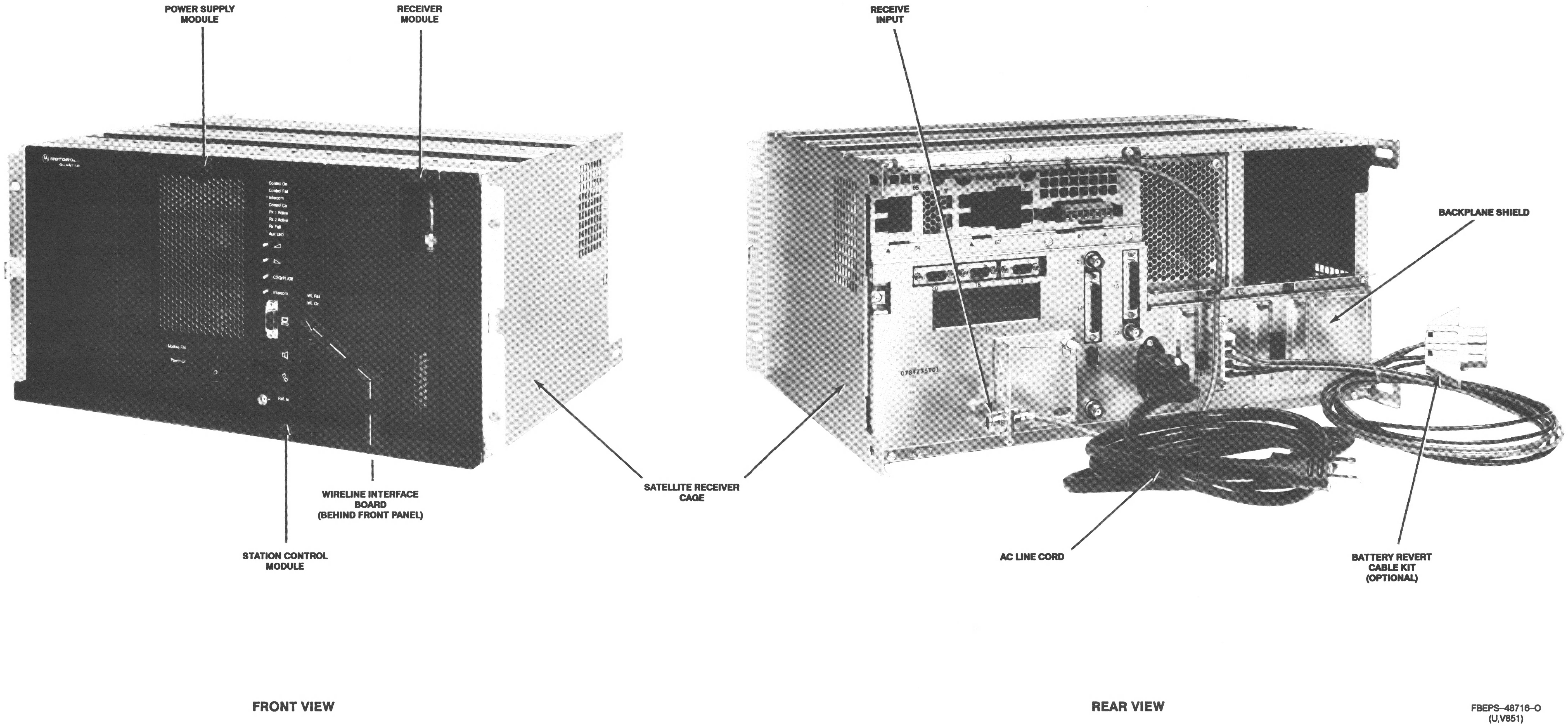

Figure 2. *Quantar* Satellite Receiver Components (Front and Rear Views; 800 MHz Model Shown)

3 FUNCTIONAL THEORY OF OPERATION

The following functional theory of operation provides an overview of the satellite receiver circuitry. For a more thorough functional description of a particular module, refer to the functional sections located behind the tab **SATELLITE RECEIVER MODULES**. Refer to the block diagram in Figure 3 for the following functional theory of operation.

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.

Receiver Module Operation

The receive signal is input from the site receive antenna to a preselector filter which provides highly selective bandpass filtering. The filtered signal is then fed to the rf input of the 1st mixer, which mixes the signal with an injection signal generated by the synthesizer/VCO, resulting in a 21.45 MHz (VHF) or 73.35 MHz (UHF and 800 MHz) 1st i–f (intermediate frequency) signal. (The injection signal frequency is determined by frequency programming data from the Station Control Module via the SPI bus.)

For VHF and UHF Satellite Receivers, the preselector is a separate assembly attached to the front of the Receiver Module behind the front panel. 800 MHz Satellite Receivers use a ceramic preselector filter which is mounted on the Receiver Module circuit board.

The 21.45/73.35 MHz 1st i–f signal is filtered and input to a custom receiver IC. This component contains circuitry for 2nd injection and mixing, amplification, and A/D (analog to digital) conversion, 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 satellite receiver. Major components include an MC68302 microprocessor, a 56002 Digital Signal Processor (DSP), and two ASIC devices (host and DSP). The SCM operates as follows.

Station Control Module Operation

The Host Microprocessor (µP) serves as the controller for the SCM, operating from the satellite receiver software stored in EPROM memory. This software determines the system capabilities of the satellite receiver (analog, *ASTRO*, *SECURENET*, etc.) The Host µP communicates with the satellite receiver modules and the SCM circuitry via address and data buses, an HDLC bus, and a SPI bus.

The DSP and DSP ASIC perform the necessary digital processing for the satellite receiver audio and data signals. The DSP circuitry interfaces with the Receiver Module (receive audio), the Wireline Interface Board (wireline audio), and external audio devices (microphone, handset, external speaker, and local speaker).

The 2.1 MHz Reference Oscillator generates the reference signal used by the Receiver Module.

Wireline Interface Board Operation

Introduction

The Wireline Interface Board (WIB) serves as the interface between the customer telephone lines and the satellite receiver. In general, the WIB processes and routes all wireline audio signals between the satellite receiver and the landline equipment (typically a comparator). Landline-to-satellite receiver and satellite receiver-to-landline audio signals are connected to the WIB via copper pairs at the rear of the satellite receiver.

Wireline Interface Board Operation

The WIB contains a microprocessor and an ASIC device to process and route the various audio signals. Analog, *ASTRO*, and *SECURENET* signals are processed as follows.

Analog signals are converted to digital signals and routed to the SCM via the TDM (time division multiplex) bus.

ASTRO data signals are processed by an *ASTRO* modem card (daughter board plugged into the WIB) and sent to/from the SCM via the HDLC bus. (The satellite receiver operates in *transparent* mode only, and **does not** perform encyption or decryption of the *ASTRO* signal.)

SECURENET encoded signals are processed by the ASIC, sent to/from the microprocessor via the data bus, and sent to/from the Station Control Module microprocessor via the HDLC bus. (The satellite receiver operates in *transparent* mode only, and **does not** perform encyption or decryption of the *SECURENET* signal.)

Power Supply Module Operation

The standard Power Supply Module is a switching-type power supply which accepts an ac input (90-280 V ac, 47-63 Hz) and generates the necessary dc operating voltages for the satellite receiver modules. The power supply module generates +5 and +14.2 V dc operating voltages.

Optional dc input power supply modules accept either 12/24 V dc or 48/60 V dc and generate +5V and +14.2 V dc operating voltages.

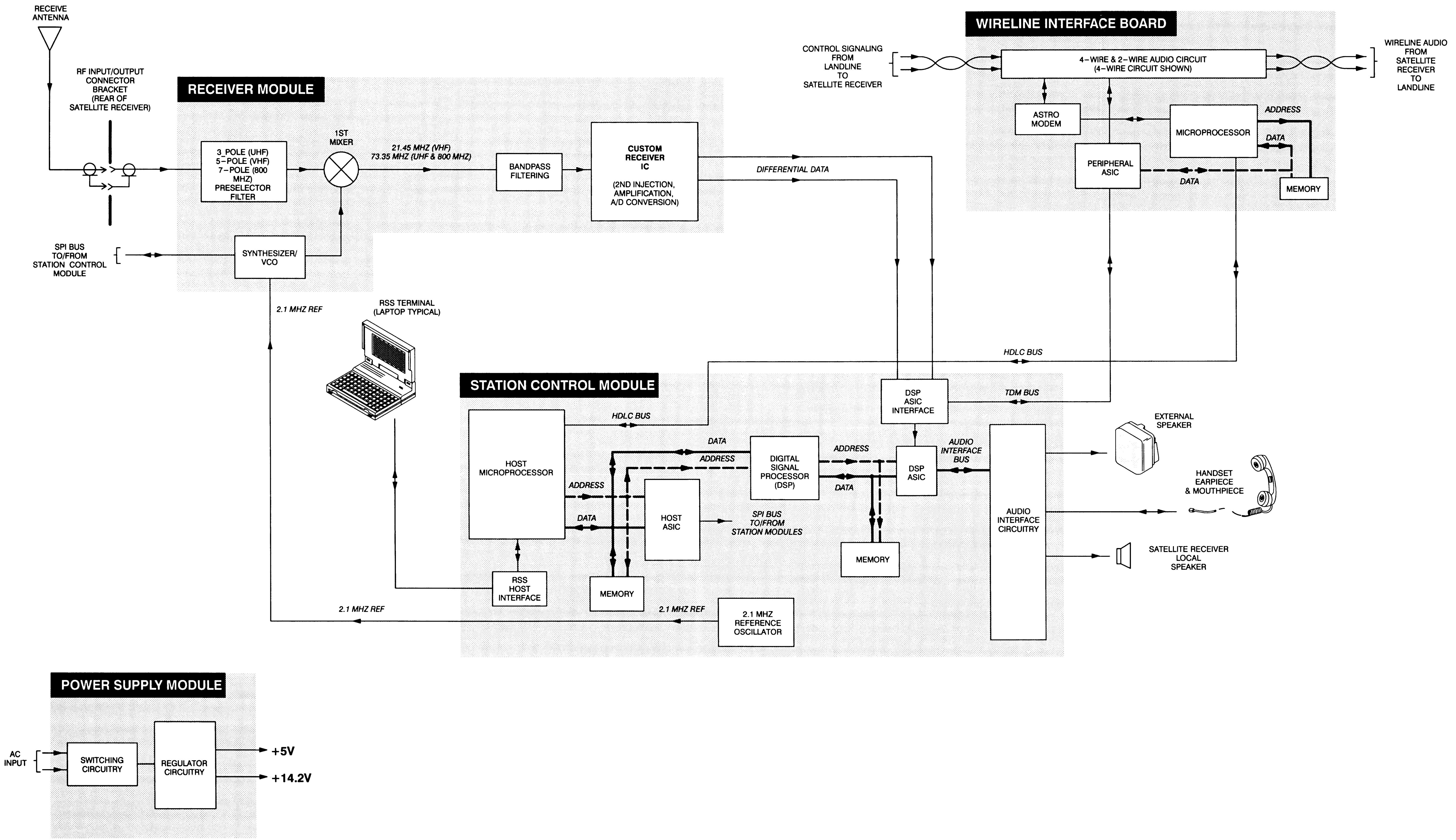

Figure 3. *Quantar* Satellite Receiver Functional Block Diagram

MOTOROLA

INSTALLATION

For *Quantar* Satellite Receivers (VHF, UHF, and 800 MHz)

Contents

Land Mobile Products Sector
1301 E. Algonquin Road, Schaumburg, IL 60196

68P81087E52-O
5/15/93-UP

1 PRE–INSTALLATION CONSIDERATIONS

A good installation is important to ensure the best possible performance and reliability of the satellite receiver equipment. Vital to a good installation is pre–installation planning. Planning the installation includes considering the mounting location of the equipment in relation to input power, antenna, and telephone interfaces. Also to be considered are site environmental conditions, the particular mounting method (several available), and required tools and equipment. The following paragraphs provide additional details on these and other pre–installation considerations.

Important– If this is your first time installing this type of equipment, it is highly recommended that you completely read the entire Installation section before beginning the actual installation.

Installation Overview

The following information is intended to serve as an overview for installing the *Quantar* Satellite Receiver. Step–by–step procedures for each of the major tasks are then provided beginning in paragraph 2.

- 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
- Make necessary electrical and cabling connections, including the following:
  - AC or DC input cabling
  - Coaxial cable to receive antenna
  - Phone line connections
- Perform a post–installation functional checkout test of the equipment to verify proper installation
- Proceed to the Optimization procedures (located behind the OPTIMIZATION tab) to customize the station parameters per customer specifications (e.g., operating frequency, PL codes, etc.)

Environmental Conditions at Intended Installation Site

***Important** — If the satellite receiver is to be installed in an environment which is unusually dusty or dirty (and thus does not meet the air quality requirements), the air used to cool the satellite receiver 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 *Quantar* satellite receiver 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 — -30°C to +60°C

Humidity — not to exceed 95% relative humidity @ 50°C

Air Quality — For equipment operating in an environmentally controlled environment with the station cage(s) rack mounted, the airborne particulates level must not exceed 25 μg/m³.

For equipment operating in an area which is not environmentally controlled (station cage(s) cabinet mounted), the airborne particulates level must not exceed 90 μg/m³.

Equipment Ventilation

The power supply module is equipped with cooling fans (thermostatically controlled) that are used to provide forced convection cooling. The air flow is front to back, allowing several satellite receiver cages to be stacked within a rack or cabinet. When planning the installation, observe the following ventilation guidelines:

- 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 satellite receiver cages are installed in a single cabinet, be sure ventilation openings surround **each** cage to allow for adequate cooling.
- All cabinets must have at least 6 inches of open space between the air vents and any walls or other cabinets. This allows adequate air flow.
- When multiple cabinets (each equipped with several satellite receiver cages) are installed in an enclosed area, make sure the ambient temperature of the room does not exceed the recommended maximum operating temperature (+60°C). It may be necessary to have air conditioning or other climate control equipment installed to satisfy the environmental requirements.

Input Power Requirements

AC Input Power Supplies

The standard *Quantar* satellite receiver power supply is a multiple-output dc power supply module that operates from 90Vrms to 280Vrms, 50 or 60 Hz ac input power (automatic range and line frequency selection). A standard 3-prong line cord is supplied to connect the power supply (rear of satellite receiver) to the ac source.

It is recommended that a standard 3-wire grounded electrical outlet be used as the ac source. The outlet must be connected to an ac source capable of supplying a maximum of 766 Watts. For a nominal 110V ac input, the ac source must supply 8.5 amperes and should be protected by a circuit breaker rated at 15 amperes. For a nominal 220V ac input, the ac source must supply approximately 4.25 amperes.

DC Input Power Supplies

Two dc input power supply modules are available as options for the *Quantar* satellite receiver. One model accepts a dc input of 12 V or 24 V dc, while the other model accepts a dc ijput of 48 or 60 V dc. Each of these supplies receives the dc input via a cable connected to the satellite receiver backplane.

Equipment Mounting Methods

The *Quantar* satellite receiver may be mounted in a variety of racks and cabinets (available as options), as follows:

- Satellite receiver shipped without rack or cabinet (Option X87AA) – customer may install satellite receiver in rack or cabinet of choice; satellite receiver is designed to fit standard EIA 19" rack configuration
- 7' (Model TRN7342), 7½' (Model TRN7343), or 8' (Model TRN7344) racks – open frame racks accept multiple *Quantar* satellite receivers; EIA 19" rack configuration. Note that rack mounting hardware (Option X153AA) is required for each *Quantar* cage to be rack mounted.
- Shipped in 12" x 20" cabinet (Option X430AA) – roll-formed cabinet with front and rear vented doors holds a single *Quantar* satellite receiver
- Shipped in 30" x 20" cabinet (Option X52AA) – roll-formed cabinet with front and rear vented doors holds up to three (3) *Quantar* satellite receivers
- Shipped in 46" x 20" cabinet (Option X308AA) – roll-formed cabinet with front and rear vented doors holds up to four (4) *Quantar* satellite receivers
- Shipped in 60" x 20" cabinet (Option X180AA) – roll-formed cabinet with front and rear vented doors holds up to five (5) *Quantar* satellite receivers

Site Grounding and Lightning Protection

CAUTION

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.

Site Grounding and Lightning Protection Recommendations

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 lightning protection is not within the scope of this instruction manual, there are several excellent industry sources for rules and guidelines on grounding and lightning protection at communications sites. Motorola recommends the following reference source:

Motorola Quality Standards FNE Installation Manual R56 ...... **68P81076E45**

Quantar *Equipment Grounding Guidelines*

The *Quantar* satellite receiver cage is equipped with a single ground lug located on the rear panel of the cage. Use this lug to connect the cage 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 previously mentioned reference source.

Recommended Tools and Equipment

In addition to the typical complement of hand tools, the following tools and equipment are recommended for proper installation of the satellite receiver equipment.

- A six to eight foot wooden step ladder (used to access the top of the 7', 7½', and 8' racks, if applicable)
- A block-and-tackle or suitable hoist is recommended to lift cabinets equipped with multiple stations. (Each fully equipped satellite receiver cage weighs approximately 40 lbs.)
- Tarpaulin or plastic drop cloth to cover surrounding equipment while drilling concrete anchor holes (for installations where cabinet or rack is being anchored to concrete flooring)
- Vacuum cleaner for removing concrete dust (for installations where cabinet or rack is being anchored to concrete flooring)

Equipment Unpacking and Inspection

The *Quantar* satellite receiver may be shipped either by air freight or electronic van (as specified by customer). The packing methods are as follows:

- If no cabinet or rack is selected, the satellite receiver cage is shipped in a cardboard container with styrofoam interior corner braces.
- If the 12" x 20" cabinet is selected, the satellite receiver cage is shipped installed in the cabinet, all contained within a cardboard container with corrugated interior corner braces.
- All other available cabinets are shipped with the *Quantar* satellite receiver cage(s) installed in the cabinet, with the cabinet bolted to a wooden skid and covered with a cardboard box with corrugated interior corner braces
- satellite receivers ordered for use in open frame racks (7', 7½', or 8' available) are shipped with the cage(s) in a cardboard container with corrugated interior corner braces. The rack is shipped separately wrapped in insulating foam.

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.

Physical Dimensions and Clearances

Quantar *Cage without Cabinet*

Figure 1 shows the dimensions and recommended clearances for a single *Quantar* satellite receivercage.

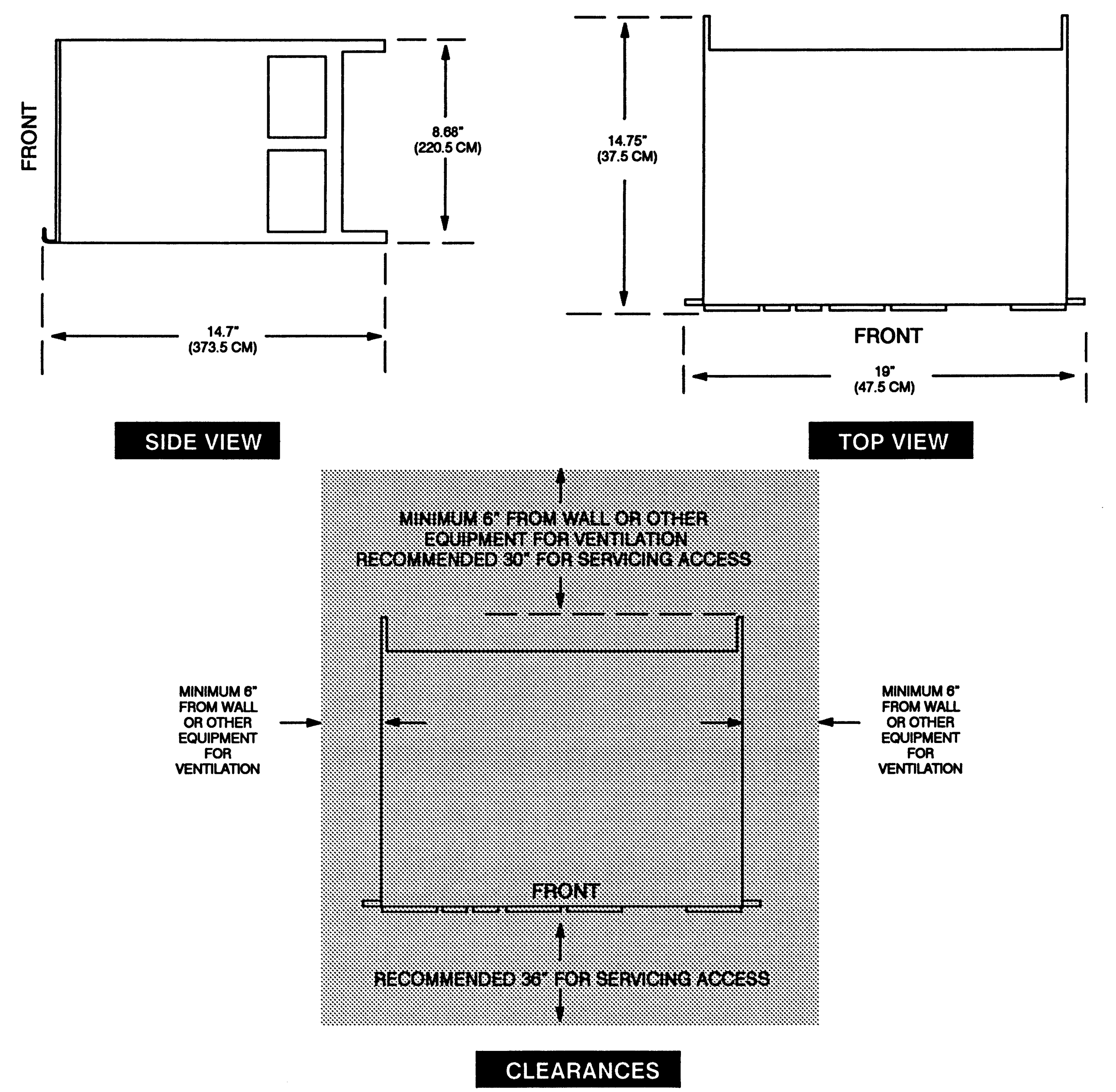

Figure 1. *Quantar* Satellite Receiver Cage Dimensions and Clearances

Physical Dimensions and Clearances (Continued)

Model numbers for the three rack sizes are:

7'	*TRN7342*
7½'	*TRN7343*
8'	*TRN7344*

Quantar *Cages Installed in 7', 7½', and 8' Racks*

Three sizes of racks are available for mounting *Quantar* satellite receiver cages and ancillary equipment. Figure 2 shows the physical dimensions for all three rack sizes (shown is 8' rack with ten (maximum) *Quantar* cages installed; 7' and 7½' racks each hold nine maximum). Recommended clearance front and rear is 36" minimum for servicing access. Refer to Equipment Ventilation on Page 3 for recommended ventilation clearances.

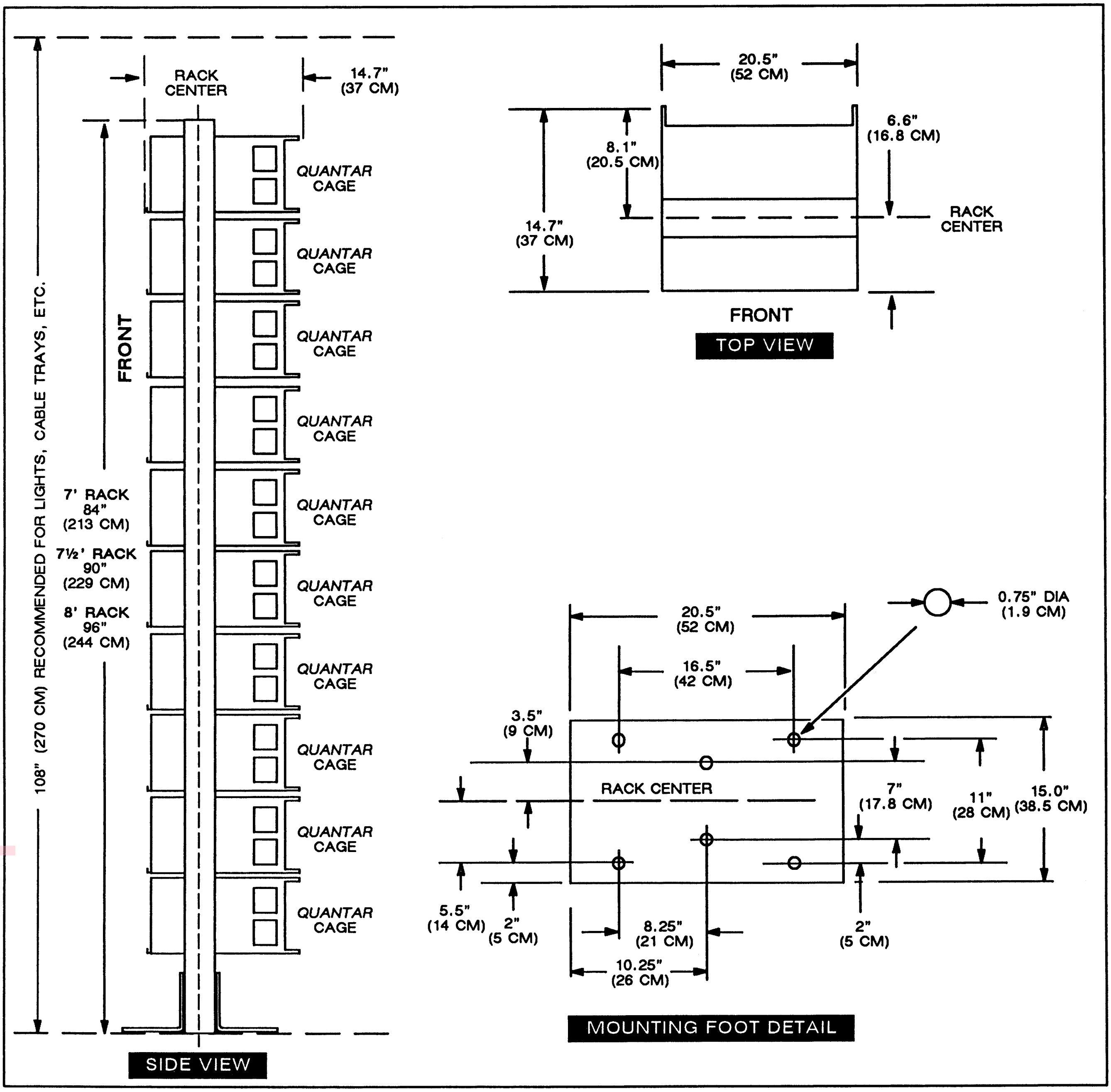

Figure 2. Dimensions and Clearances for 7', 7½', and 8' Racks

Physical Dimensions and Clearances (Continued)

12" x 20" Cabinet

Figure 3 shows the physical dimensions for a 12" x 20" cabinet (Option X430AA). Minimum recommended clearances are 30" (front) and 36" (rear) for installation access. Refer to Equipment Ventilation on Page 3 for recommended ventilation clearances.

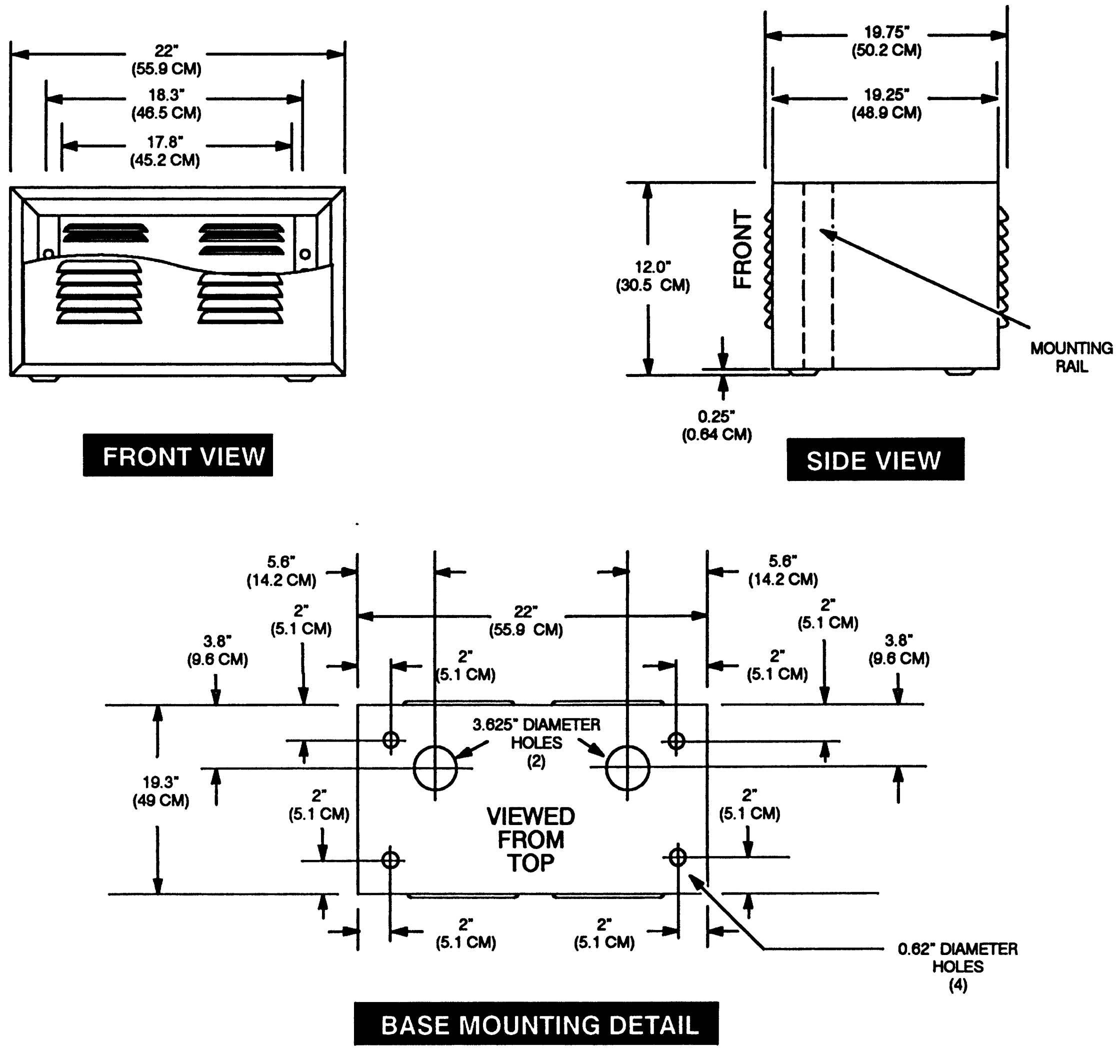

Figure 3. 12" x 20" Cabinet Dimensions

Physical Dimensions and Clearances (Continued)

30" x 20" Cabinet

Figure 4 shows the physical dimensions for a 30" x 20" cabinet (Option X52AA). Minimum recommended clearances are 30"(front) and 36" (rear) for installation access. Refer to Equipment Ventilation on Page 3 for recommended ventilation clearances.

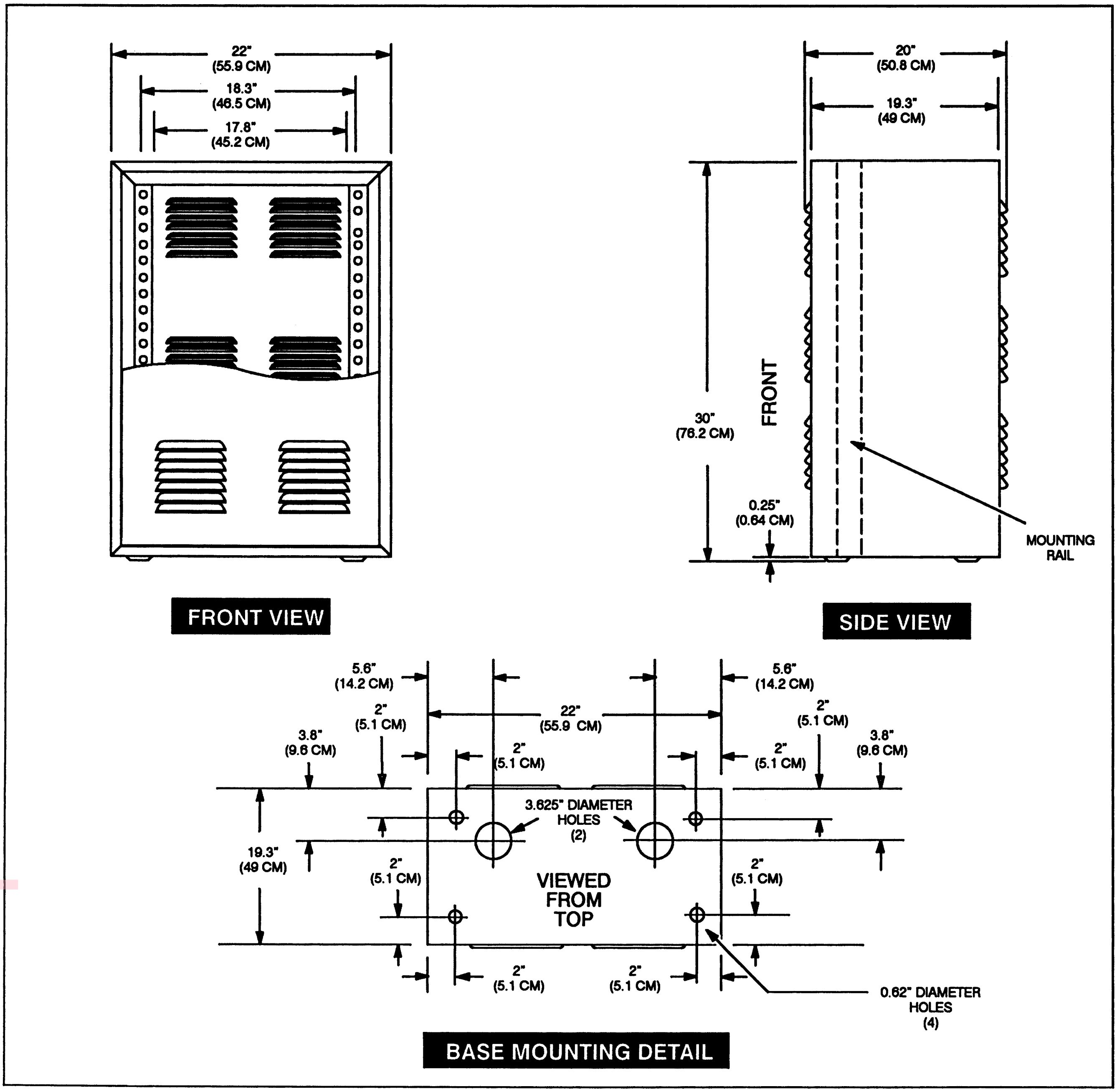

Figure 4. 30" x 20" Cabinet Dimensions

Physical Dimensions and Clearances (Continued)

46" x 20" Cabinet

Figure 5 shows the physical dimensions for a 46" x 20" cabinet (Option X308AA). Minimum recommended clearances are 30" (front) and 36" (rear) for installation access. Refer to Equipment Ventilation on Page 3 for recommended ventilation clearances.

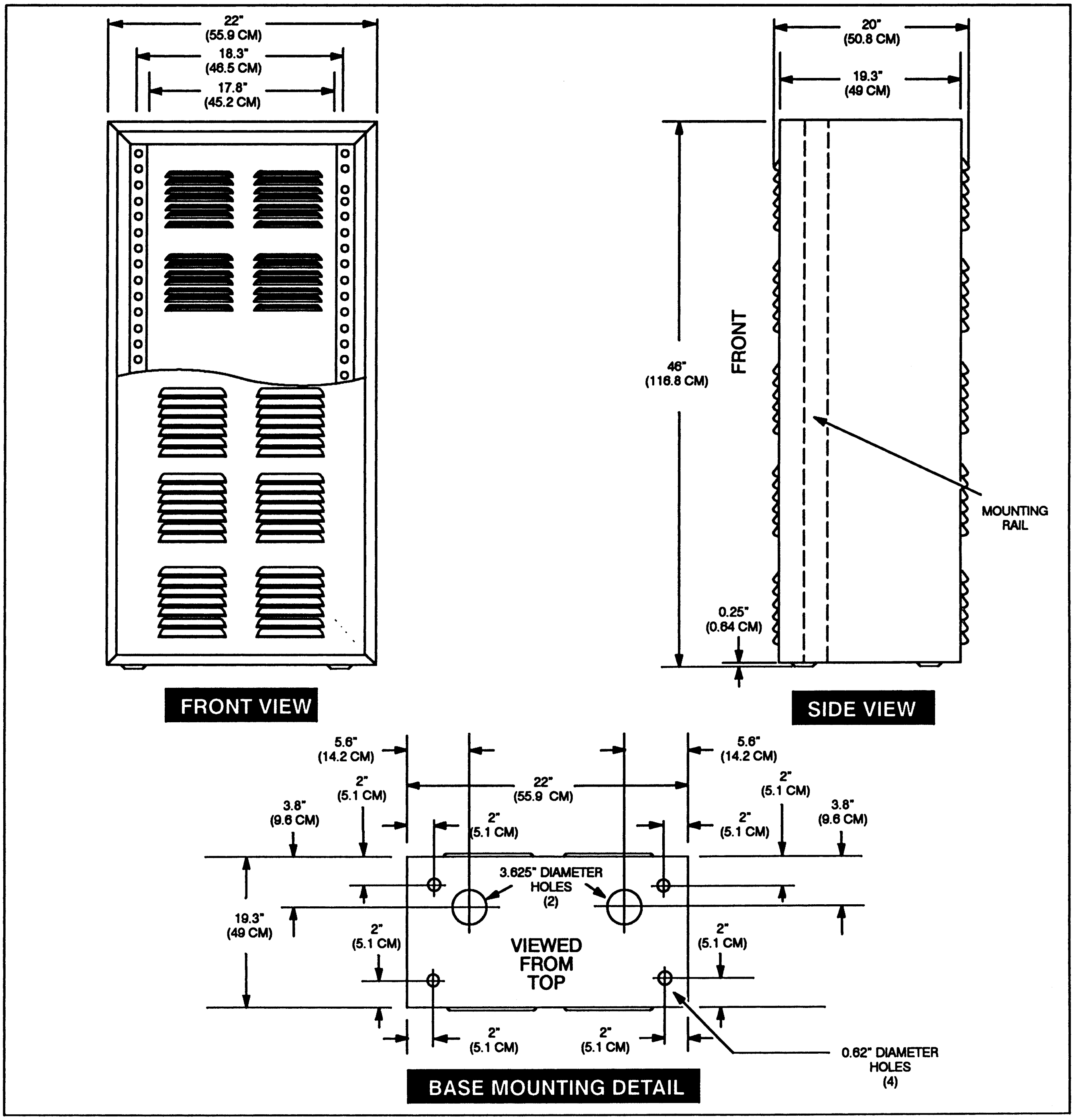

Figure 5. 46" x 20" Cabinet Dimensions

Physical Dimensions and Clearances (Continued)

60" Indoor Cabinet

Figure 6 shows the dimensions for a 60" indoor cabinet (Option X180AA). Minimum recommended clearances are 30"(front) and 36" (rear) for installation access. Refer to Equipment Ventilation on Page 3 for recommended ventilation clearances.

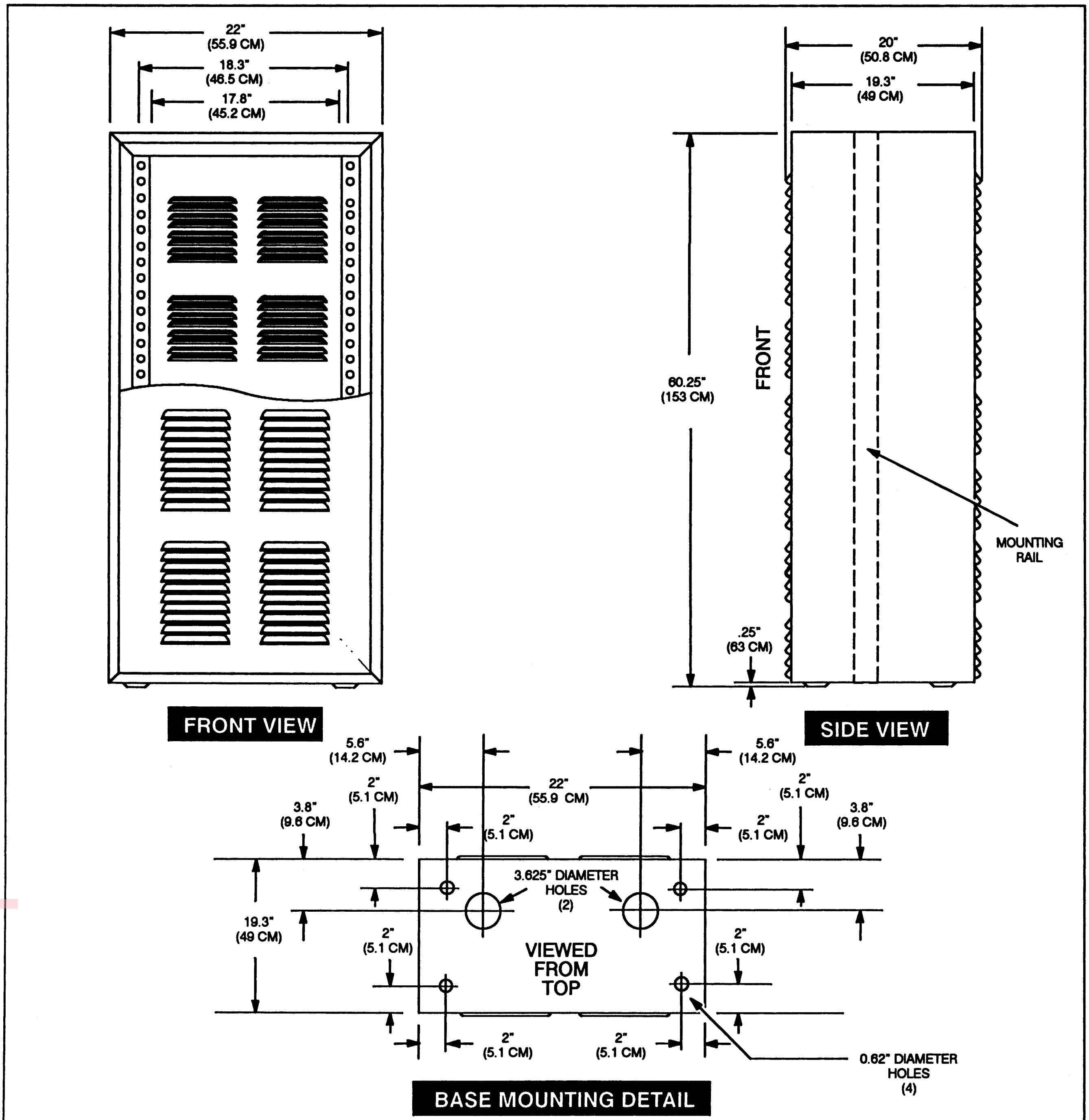

Figure 6. 60" Indoor Cabinet Dimensions

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2 MECHANICAL INSTALLATION

This section describes the procedures necessary to unpack and mechanically install the *Quantar* satellite receiver. A variety of mounting methods are possible, depending on such factors as which type of cabinet or rack (if any) has been selected to house the satellite receiver cage(s), whether stacking of cabinets is desired, etc. Procedures are provided for each of the cabinet/rack types.

Note that the satellite receiver modules are secured in the cage by a mechanical interlock. If it becomes necessary to remove any of the modules, refer to the *Module Replacement Procedures* located in the **Troubleshooting** section of this manual for removal instructions. Be sure to observe proper electro-static discharge precautions if modules must be removed from the cage.

Unpacking the Equipment

Important: *Regardless of the packing method, immediately inspect the equipment for damage after unpacking and report the extent of any damage to the transportation company.*

Introduction

Quantar satellite receiver equipment packing methods vary depending upon the type of optional rack or cabinet selected by the customer. *Quantar* satellite receiver cages may also be packed and shipped as standalone units with no cabinet or cage. Unpacking procedures for these various methods are provided in the following paragraphs.

Unpacking Standalone Quantar *Satellite Receiver Cage*

Standalone cages (ordered with Option X87AA, omit cabinet) are packed in a cardboard box with styrofoam interior spacers and cardboard stiffeners. Unpack as described in Figure 7.

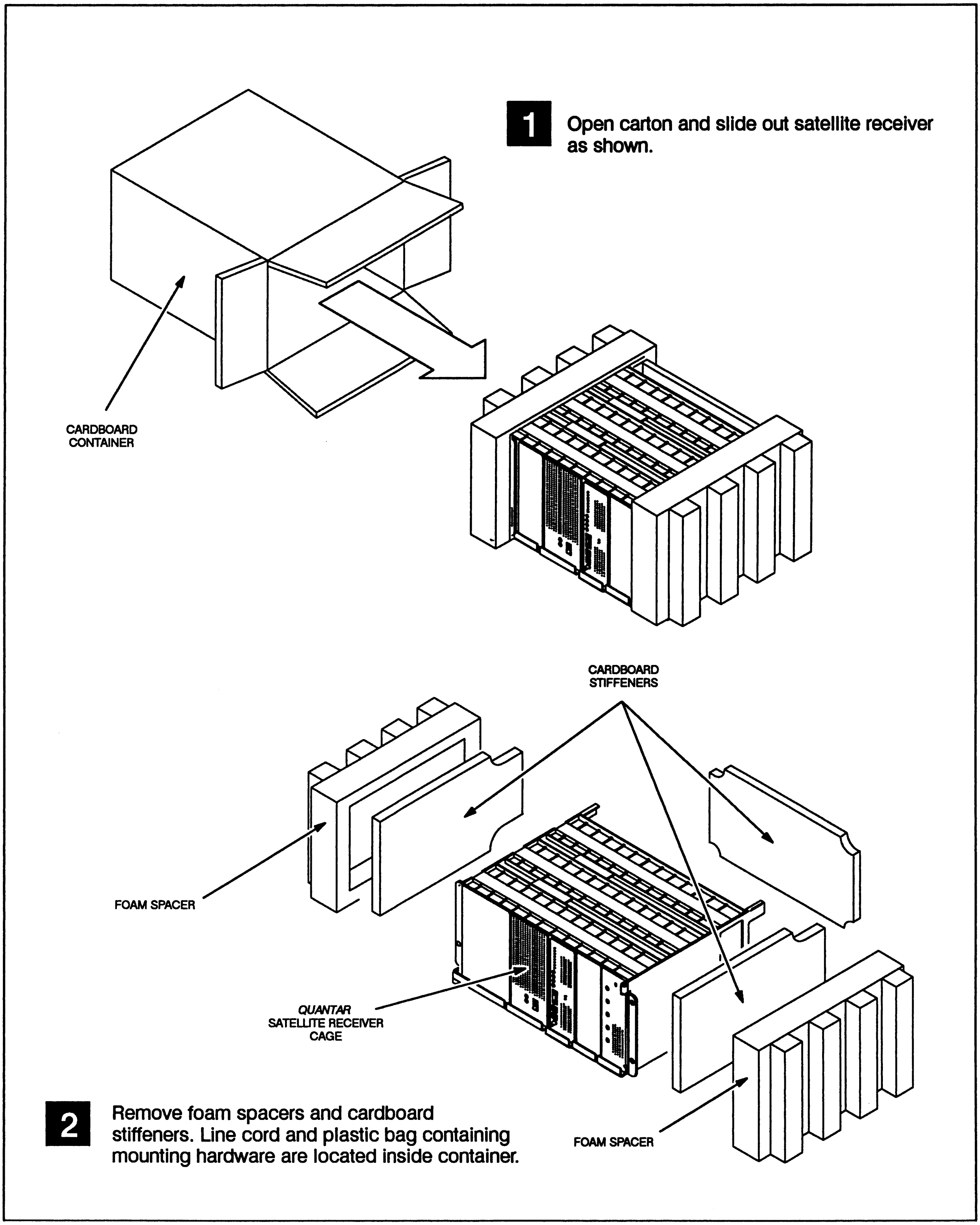


Figure 7. Unpacking Procedures for *Quantar* Satellite Receiver Cages

Unpacking the Equipment (Continued)

Unpacking 12" x 20" Cabinet

Quantar satellite receivers ordered with the 12" x 20" cabinet option are shipped installed in the cabinet and packed in a cardboard container with corrugated corner braces and a cardboard pallet. Unpack as described in Figure 8.

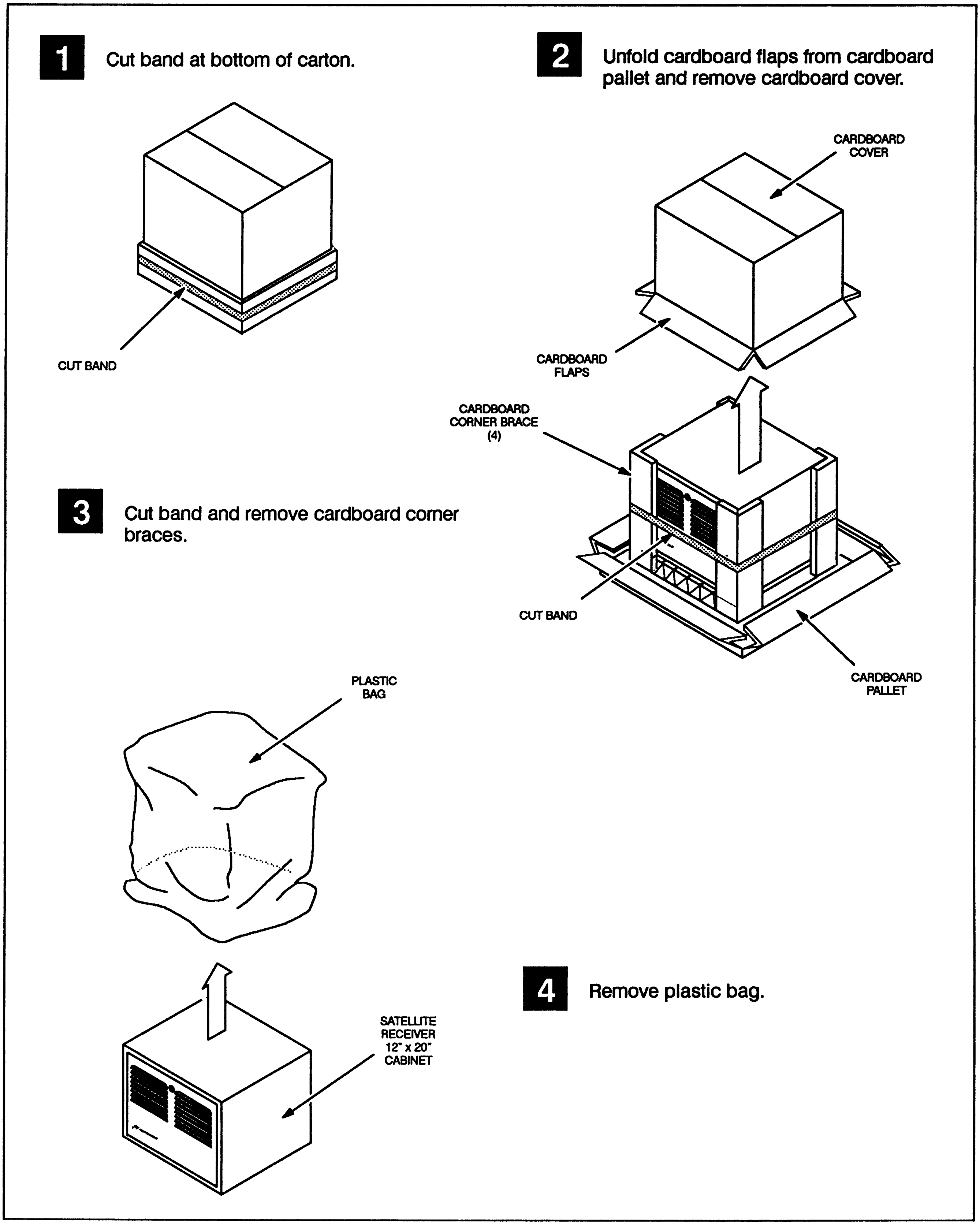


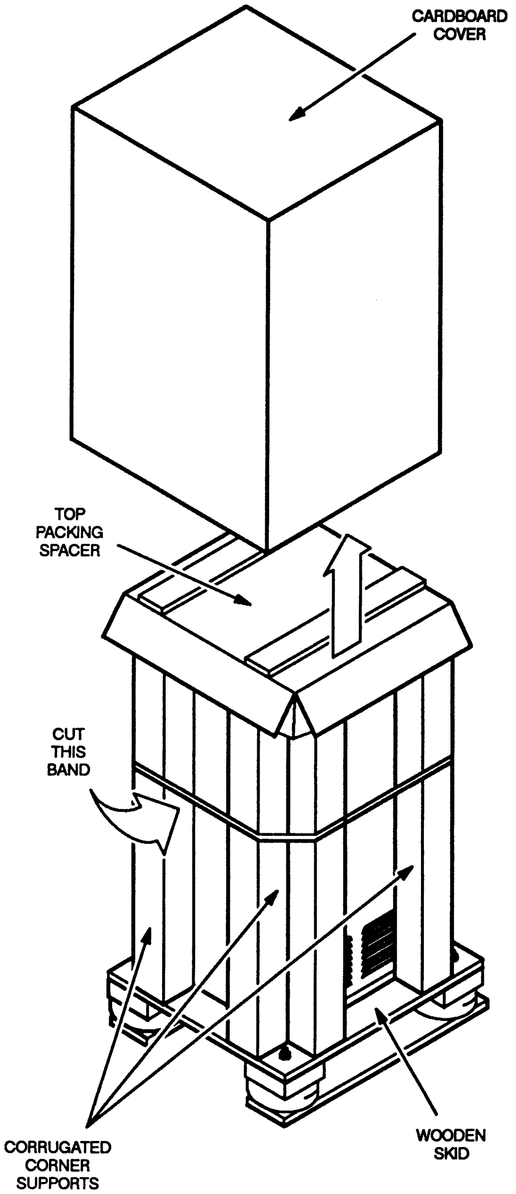
Figure 8. Unpacking Procedures for *Quantar* Satellite Receiver Cages Shipped in 12" x 20" Cabinets

Unpacking the Equipment (Continued)

Unpacking 30" x 20" Cabinet, 46" x 20" Cabinet, and 60" Indoor Cabinet

These cabinet styles 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 9.

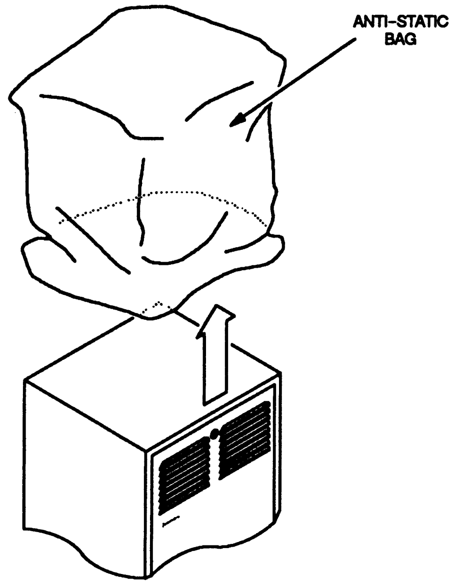
1 Remove cardboard cover from satellite receiver.



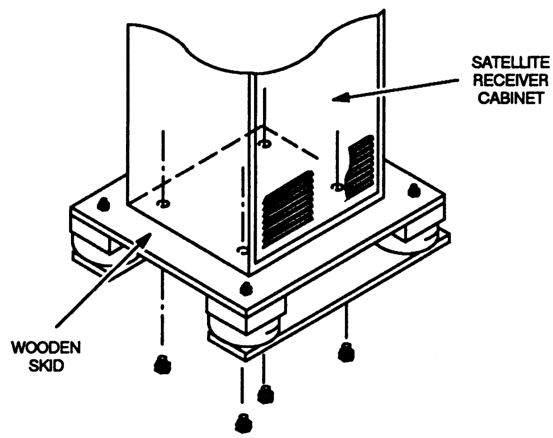
2 Cut band as shown.

3 Remove top packing spacer and corrugated corner supports.

4 Remove anti–static bag. **Do not** discard bag. It will be re–installed 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 satellite receiver to the wooden skid. Remove the bolts and nuts as shown.



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

7 Replace anti–static bag over satellite receiver to provide protection during installation.

Figure 9. Unpacking Procedures for 30", 46" (shown), and 60" Indoor *Quantar* Cabinets

Mounting Procedures

Introduction

Perform the following procedures to mechanically install the *Quantar* satellite receiver cages, racks, or cabinets. Note that racks and cabinets may house multiple *Quantar* satellite receiver cages, and some cabinets may be stacked one atop the other to maximize use of space.

Mounting Quantar Satellite Receiver Cage(s) in Customer-Supplied Cabinet

The *Quantar* satellite receiver cage is designed to fit in a standard EIA 19" enclosure. Mounting screws (M6 x 1.0 tapping) are provided to secure the cage flanges to the customer-supplied cabinet. Mount the cage(s) as follows:

Note: *Installing multiple cages one above the other is permitted as long as proper ventilation is maintained. Refer to Equipment Ventilation on page 3 for details.*

Step 1. Determine the location in the cabinet into which to mount the cage. Note that when installing multiple cages, it is recommended that you mount the first cage in the lowest possible position in the cabinet, making sure the modules clear the bottom frame of the cabinet, then continue towards the top with additional cages.

Step 2. Thread two of the supplied mounting screws into the lowest mounting holes of the cabinet mounting rails. Now insert the cage into the cabinet, resting the cage on the two screws.

Step 3. Insert the remaining two mounting screws through the bottom two mounting holes in the cage mounting flanges (left and right sides) and secure the cage to the cabinet mounting rails.

Step 4. Remove the two lower mounting screws and insert them through the upper two mounting holes in the cage mounting flanges.

Step 5. Tighten all four mounting screws securely.

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Mounting Procedures (Continued)

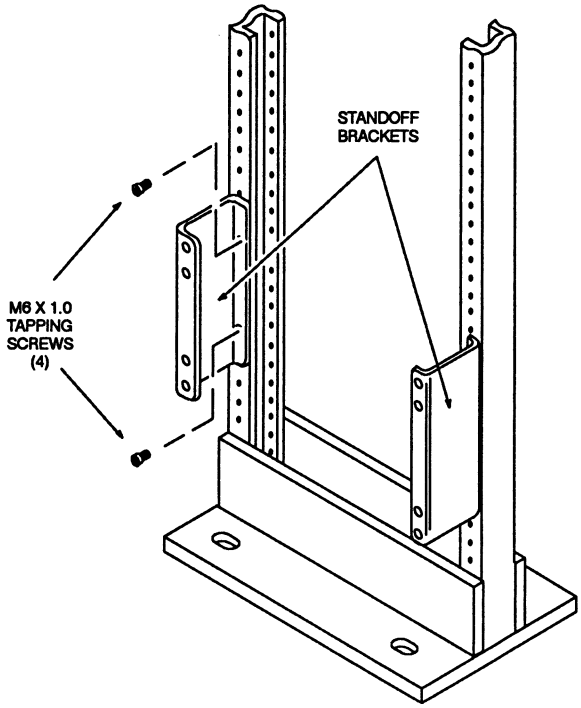
Mounting* Quantar *Satellite Receiver Cage(s) In Customer–Supplied Rack

Quantar satellite receiver cages intended for field mounting in a customer–supplied rack require standoff brackets to center the cage within the rack mounting rails. Mount the cage(s) as described in Figure 10.

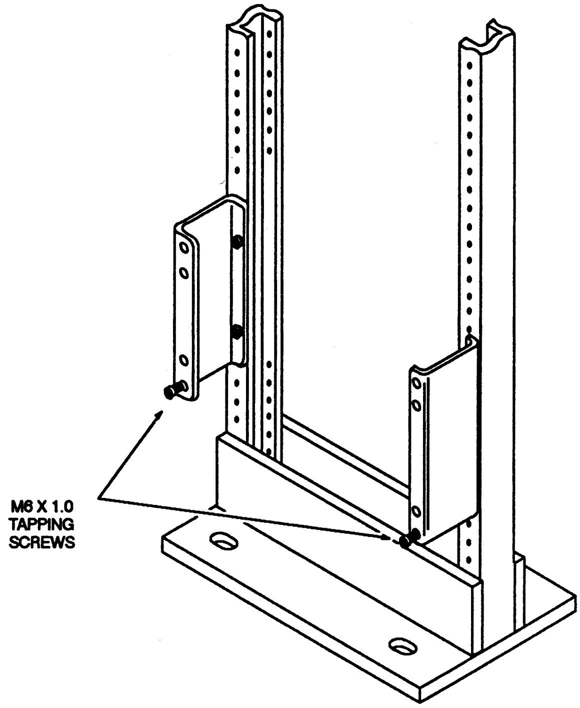
Note: *Option X153AA provides two (2) standoff brackets and four (4) self-tapping screws.*

Note that when installing multiple cages, it is recommended that you mount the first cage in the lowest possible position in the rack, then continue building towards the top with additional cages. Mounting screws (M6 x 1.0 tapping) are provided with each cage to secure the cage flanges to the standoff brackets.

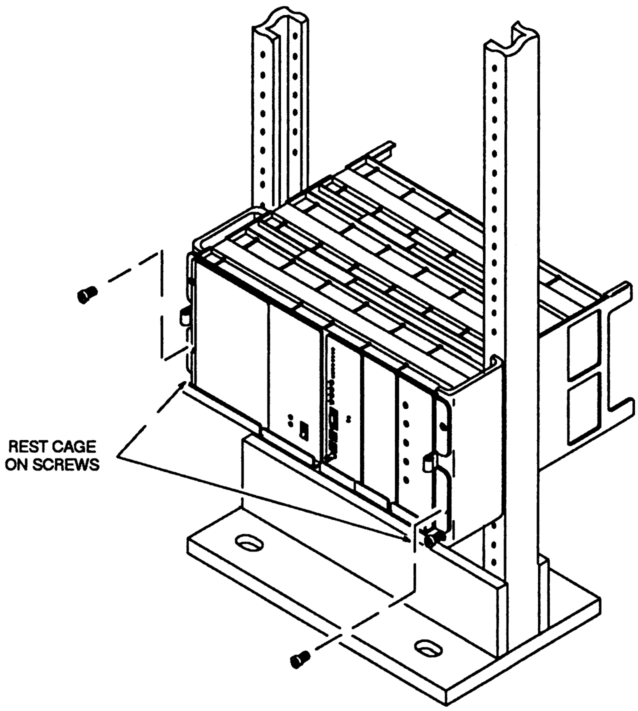
Note: *Installing multiple cages one above the other is permitted as long as proper ventilation is maintained. Refer to Equipment Ventilation on page 3 for details.*



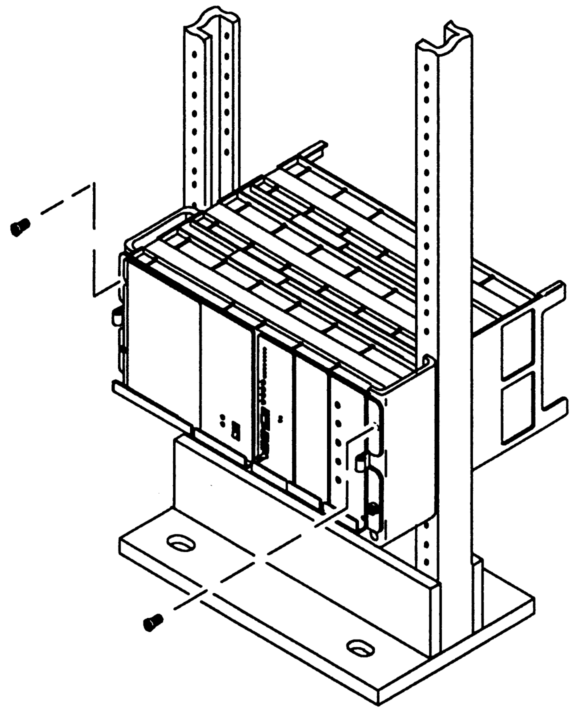
1 Position standoff brackets at desired position on rack (as shown). Secure to rack using M6 x 1.0 tapping screws.



2 Partially install M6 x 1.0 tapping screws in bottom holes in brackets, as shown.



3 Rest cage on lower two screws and install two M6 x 1.0 tapping screws in holes as shown. Tighten securely.



4 Remove two screws used to support cage and install in the upper two holes of the brackets. Tighten securely.

Figure 10. Installation Procedure for Rack Standoff Brackets

Mounting Procedures (Continued)

WARNING

A fully equipped 8' rack (ten *Quantar* cages) weighs approximately 400 lbs (182 kg). Handle with extreme caution to avoid tipping.

CAUTION

Cement dust from concrete flooring is harmful to electronic equipment and wiring. Make sure that the rack and any co-located 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 anti-static 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.

Installing 7', 7½', and 8' 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***.

Step 1. Carefully align the rack at the desired anchoring location.

Step 2. Use the rack mounting foot as a template and mark the location of the six ¾" (1.9 cm) diameter mounting holes. All six anchoring positions must be used.

Step 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.

Step 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.**

Step 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.

Step 6. Tightly secure the rack to the floor anchors making sure that it remains vertically plumb and horizontally level.

Step 7. After all debris is removed and cement dust is cleared away, remove whatever protective covering has been placed on the equipment, including the anti-static bag.

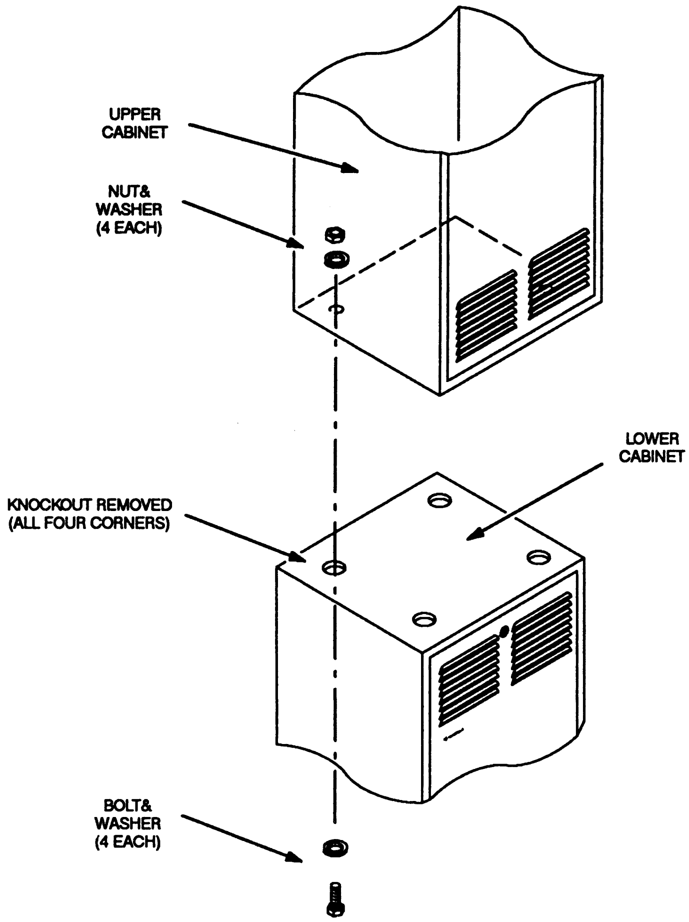
Mounting 30" x 20", 46" x 20", and 60" Indoor Cabinets

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 given for anchoring equipment racks (page 24). If installing on a wooden floor, use lag bolts and washers (customer supplied) to secure the cabinet to the floor.

Stacking Cabinets

The 12", 30", 46", and 60" cabinets may be stacked on atop another to maximize use of site space. Stacking kit TRN7750A contains the necessary bolts, nuts, and washers to stack one cabinet on another. Remove the knockouts on the top of the lower cabinet and use the hardware as shown below to attach the upper cabinet.

Note: *It is recommended that if different sizes of cabinets are being stacked (e.g., if a 30" cabinet is being stacked on top of a 46" cabinet), the larger size cabinet should be placed on the bottom.*



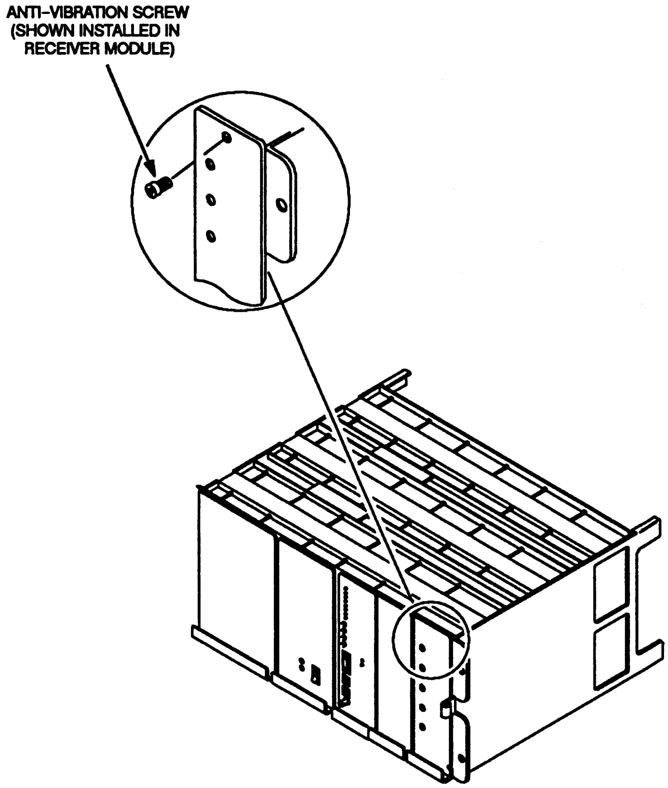
The table below lists the stacking limits for the available cabinet sizes.

Cabinet Stacking Limits

Cabinet Size	Maximum Stacking Number
12" x 20"	6 (72" max height)
30" x 20"	3 (90" max height)
46" x 20"	2 (92" max height)
60" Indoor	Not Stackable

Anti–Vibration Screws

Satellite receivers are shipped with Torx–head tapping screws installed at the top of each of the module front panels. These screws provide additional mechanical stability for installations where a high amount of vibration (such as from nearby heavy machinery) is encountered. For normal installations, these screws may be removed.



3 ELECTRICAL CONNECTIONS

After the satellite receiver equipment has been mechanically installed, electrical connections must be made. These include making power supply connections, connecting antenna coax cables, and telephone lines.

Power Supply Connections

CAUTION

Do not apply ac power to the station at this time. Make sure that the ac power switch (located on the front panel of the Power Supply Module) is turned to OFF and that the circuit breaker associated with the ac outlet is also turned to OFF.

AC Input Power Connection

Each satellite receiver cage is shipped with an eight foot 3-conductor line cord. Attach the receptacle end of the cord to the ac input plug located on the rear of the power supply module (as shown in Figure 11). Plug the 3-prong plug into a 110 V ac grounded outlet. (If you wish to connect to a 220 V ac outlet, you must obtain a suitable line cord from an electrical parts supplier.)

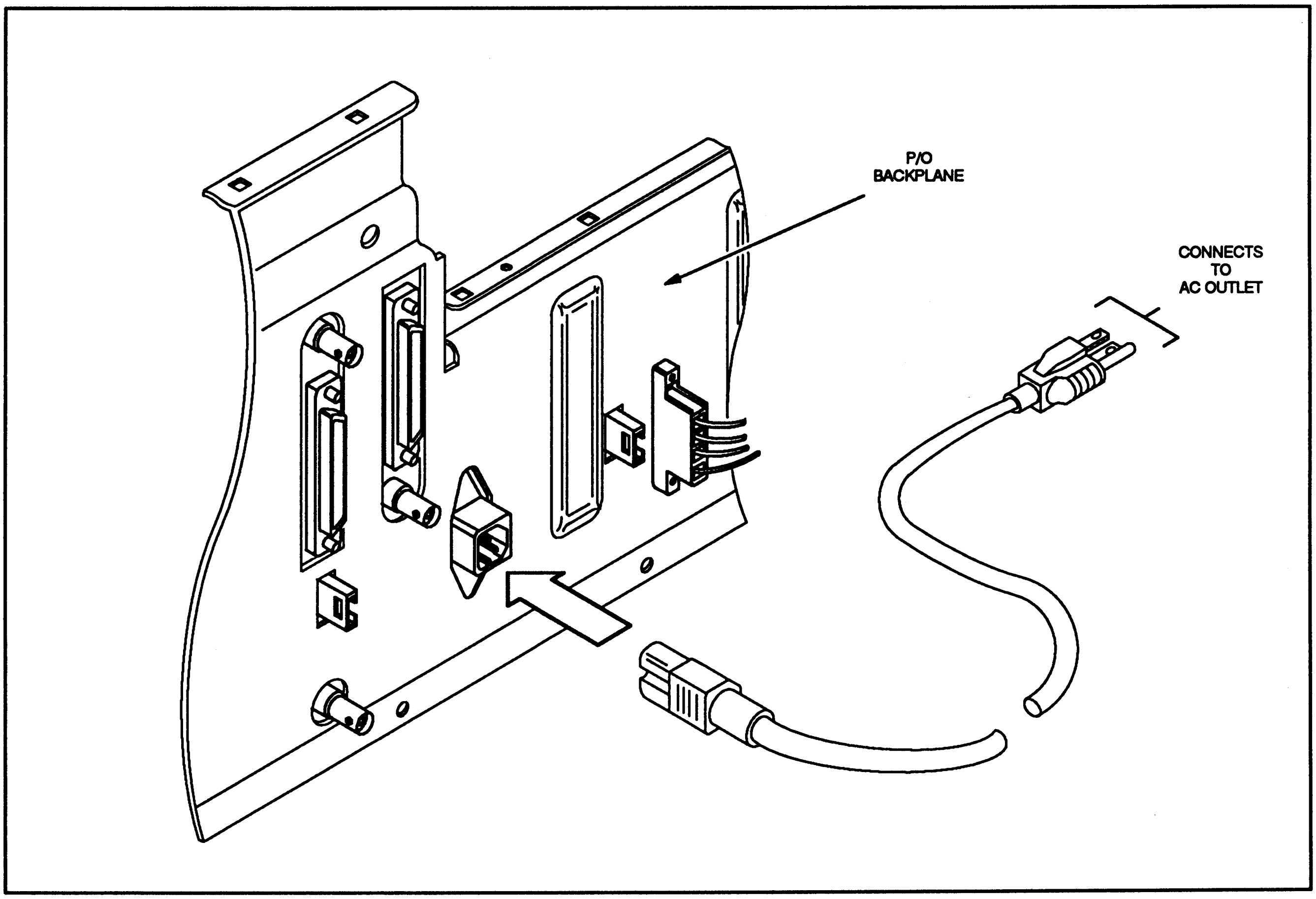


Figure 11. Connecting AC Line Cord

Power Supply Connections (Continued)

DC Input Power Connections

Satellite receivers shipped with the optional dc input power supply module accept a dc input from either a 12/24 V dc or 48/60 V dc source (e.g., a bank of storage batteries). Connections to the dc source are made via a 10' battery charger cable kit shipped with the satellite receiver, as shown in Figure 12.

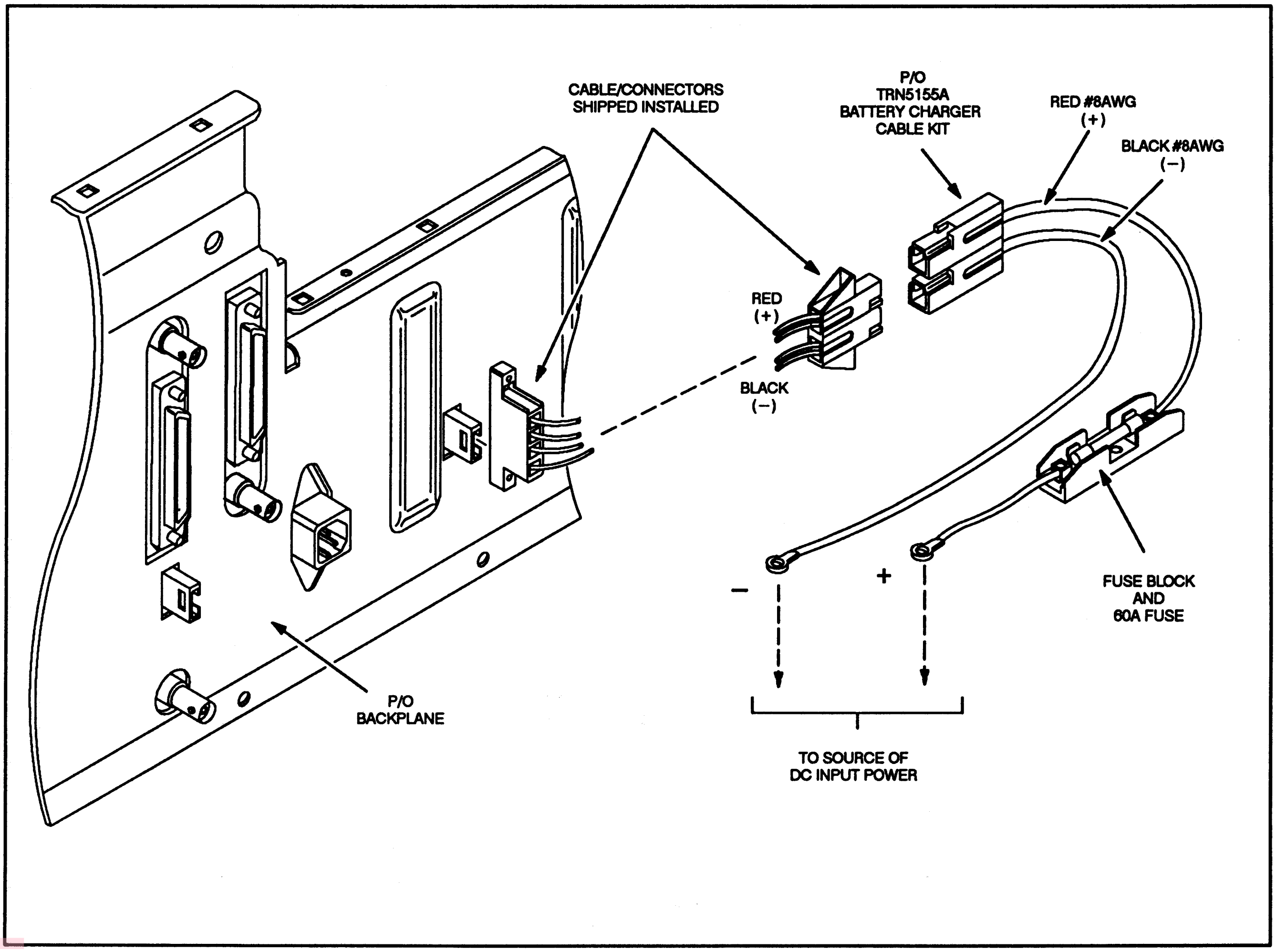


Figure 12. Making Connections to DC Power Source

Power Supply Connections (Continued)

Ground Connection

The *Quantar* satellite receiver cage is equipped with a single ground lug located on the rear panel of the cage. Connect this lug to the site ground point as shown in Figure 13.

Refer to *Motorola Quality Standards – FNE Installation Manual R56* (68P81076E45) for complete information regarding lightning protection.

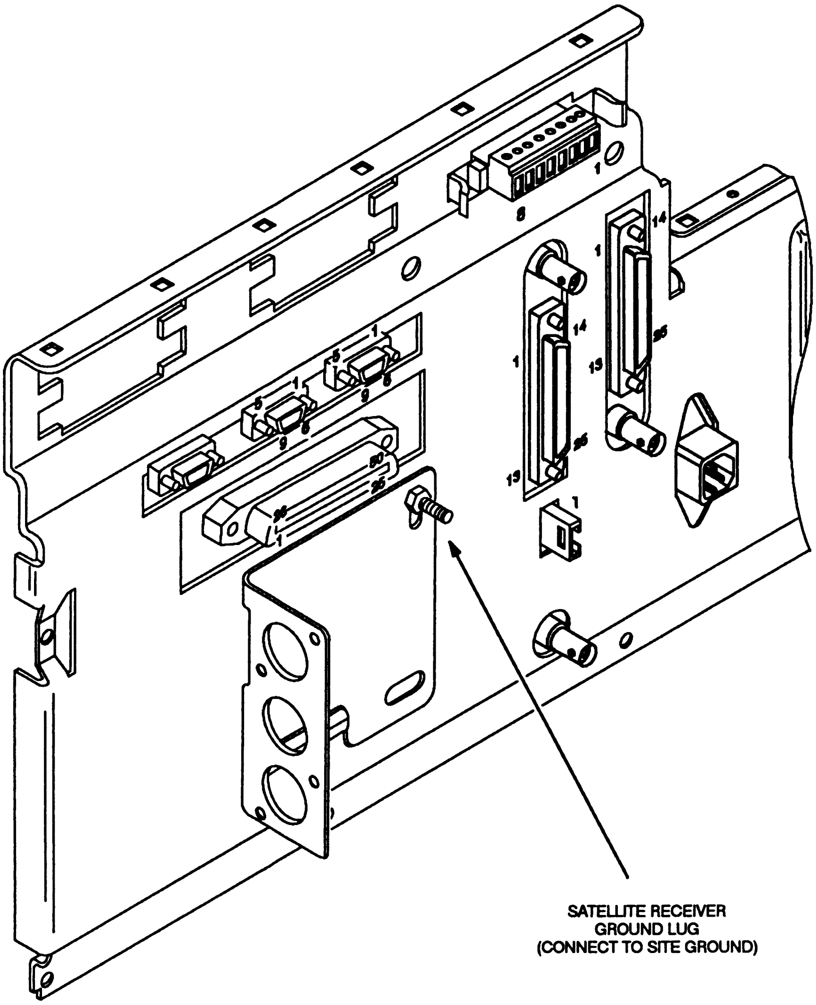


Figure 13. Connecting Satellite Receiver Ground Lug to Site Ground

Power Supply Connections (Continued)

Storage Battery Connections

Satellite Receivers with a power supply module equipped with the battery charger/revert option offer the capability of reverting to battery back-up power in the event of an ac power failure. Connections associated with the battery charger/revert feature are:

- Charger/Revert Cable – the satellite receiver is shipped with a 4-wire cable terminated in a heavy duty 2-position connector; cable kit TRN5155A (shipped with station) contains mating connector, two 10' lengths of red and black #8 AWG gauge wires, a fuse block and 60A fuse, and crimp-on ring lugs. Make connections to the storage battery as shown in Figure 14.
- Battery Temperature Cable – thermistor and cable (TKN8786A) is shipped with charger-style power supply); cable with three wires carries a variable resistance signal from the thermistor which is mounted in close proximity to storage battery; resistance is proportional to battery temperature and is used by diagnostic circuitry in power supply module. Make thermistor connections as shown in Figure 14.

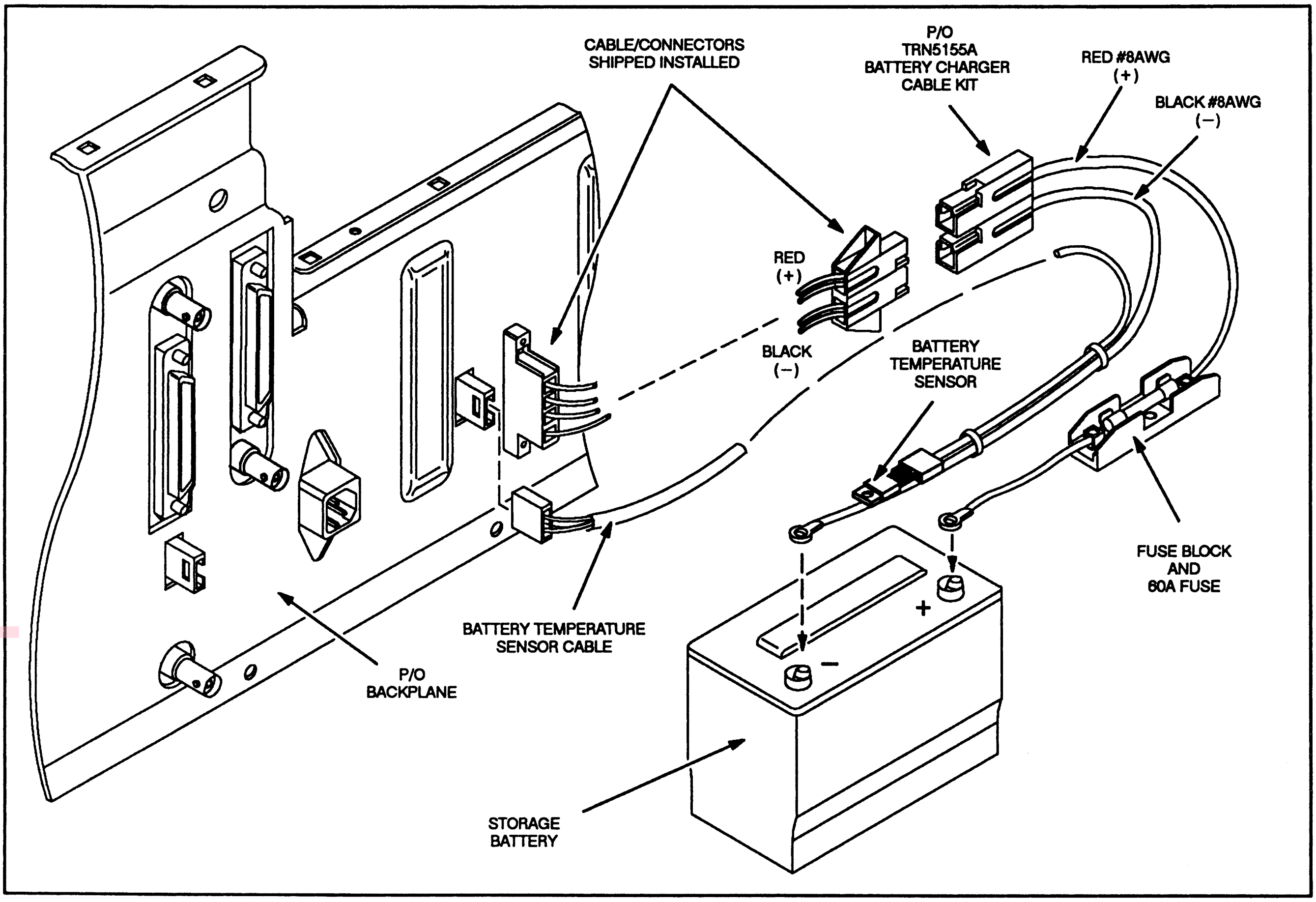


Figure 14. Making Connections to Storage Battery

RF Cabling Connections

The receive antenna rf connection is made at a bracket located on the rear of the satellite receiver. This bracket holds an N-type connector which accepts the coax cable from the receive antenna, as shown in Figure 15.

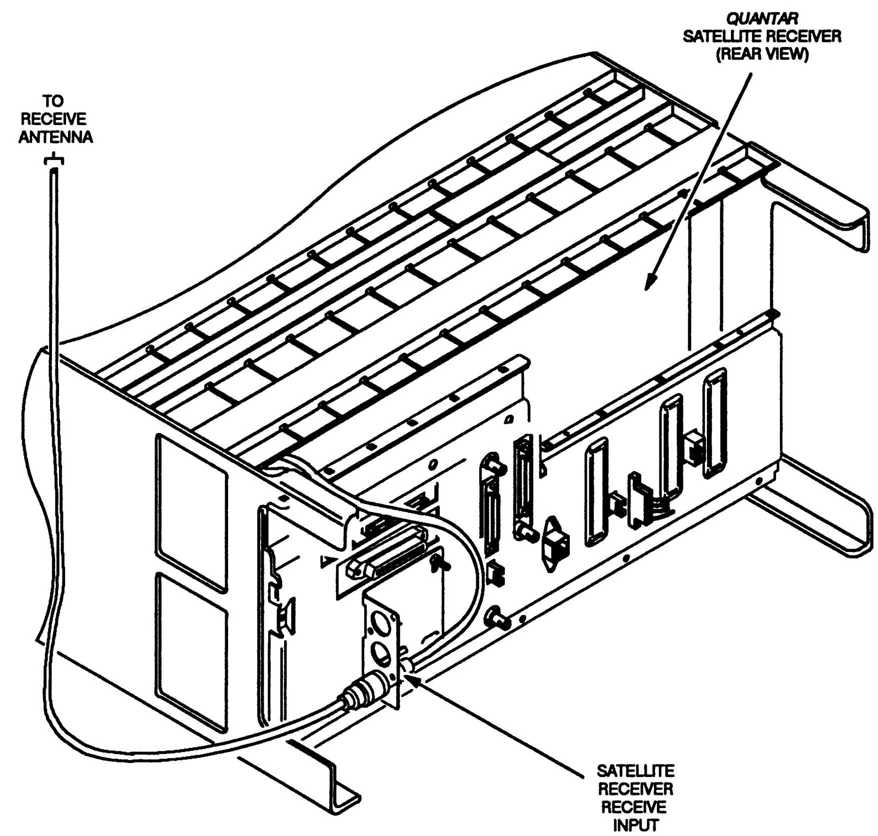


Figure 15. Connecting the Receiver Antenna Coax Cable

Connecting Telephone Lines

Introduction

In receiver voting systems, phone lines must be connected between the satellite receiver and (typically) a voting comparator. The phone lines may carry analog voice, *SECURENET*-encoded voice, and/or *ASTRO*-encoded voice. The following information defines the specifications for the phone lines, the location on the satellite receiver 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 *Quantar* satellite receiver. The following table shows the specifications for "3002" and "Type 5" phone line types.

Type 5 and "3002" Phone Line Specifications

Parameter	Type 5 Specification	3002 Specification
Loss Deviation	±4.0 dB	±4.0 dB
C-Notched Noise	51 dBrnCO	51 dBrnCO
Attenuation Distortion: 504 to 2504 Hz 404 to 2804 Hz 304 to 3004 Hz	 -2.0 to +8.0 dB -2.0 to +10.0 dB -3.0 to +12.0 dB	 -2.0 to +8.0 dB spec not available -3.0 to +12.0 dB
Signal to C-Notched Noise Ratio	≥ 24 dB	≥ 24 dB
Envelope Delay Distortion: 804 to 2604 Hz	1750 μsec	1750 μsec
Impulse Noise Threshold	71 dBrnCO	
Intermodulation Distortion: R2 R3	 ≥ 27 dB ≥ 32 dB	≥ 25 dB ≥ 30
Phase Jitter: 20-300 Hz 4-300 Hz	 ≥ 10 Degrees ≥ 15 Degrees	≥ 25 Degrees ≥ 30 Degrees
Frequency Shift	± 3 Hz	± 5 Hz

Connecting Telephone Lines (Continued)

Location of Telephone Line Connections

For added convenience, telephone line connections may be made in one of two locations on the satellite receiver rear panel.

- 50-pin Telco Systems Connector
- Orange 8-Position Screw Terminal Connector

The location of the telephone line connections is shown in Figure 16. Note that these connections are **not** surge or transient protected. Refer to *Motorola Quality Standards – FNE Installation Manual R56* (68P81076E45) for details.

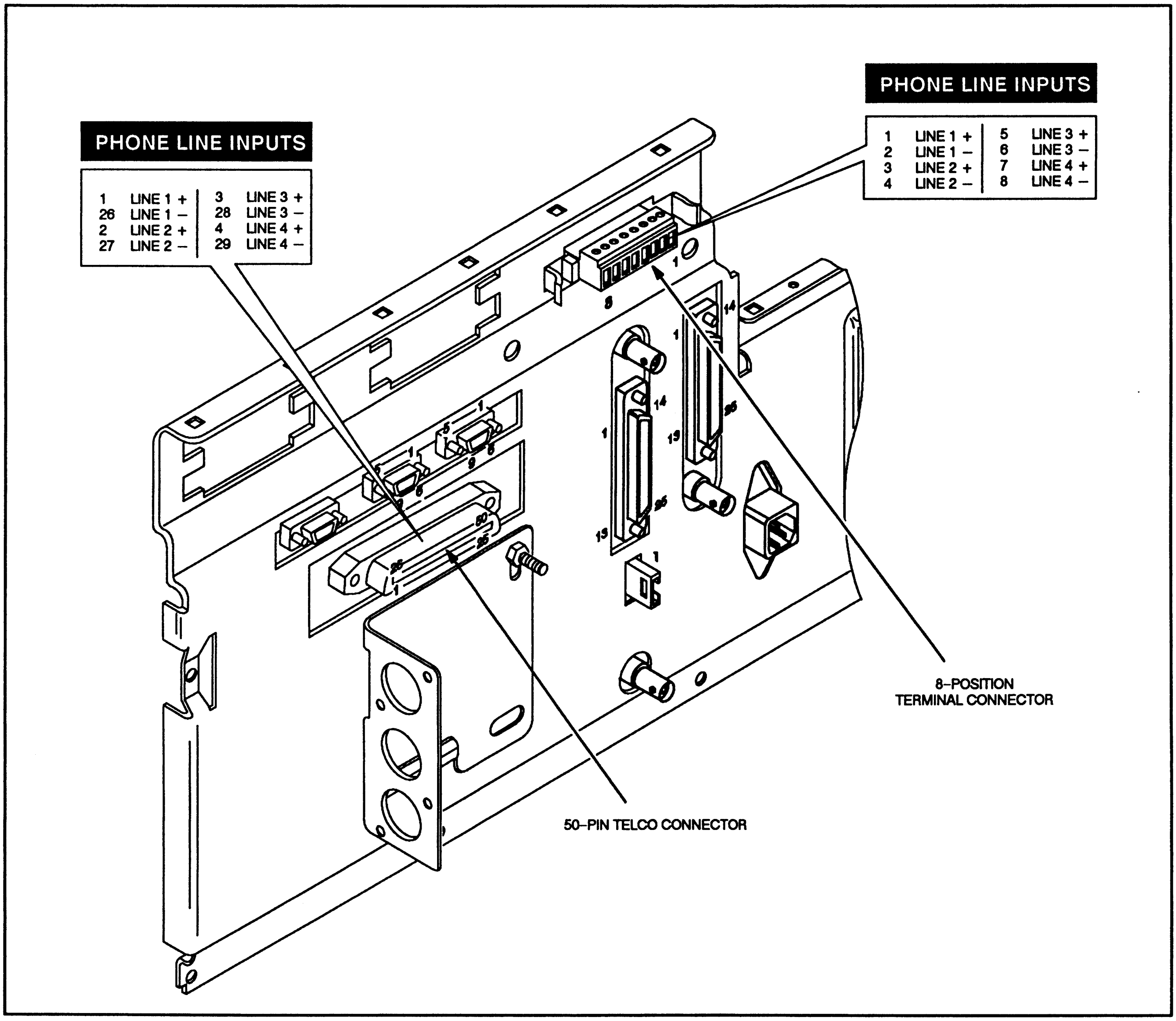


Figure 16. Two Locations for Telephone Line Connections

Connecting Telephone Lines (Continued)

Note: *Satellite receivers equipped with a 4-wire Wireline Interface Board (Model TRN7477) support a single 4-wire telephone line connection. Refer to the Wireline Interface Board section in this manual for details.*

System Type vs Wireline Circuit Matrix

The following table shows which of the four (4) wireline circuits to use for various system types.

System Type vs Wireline Circuit Matrix Table

System Type	Line 1 (Note 1)	Line 2 (Note 1)
Conventional Wide Area Analog	Comparator (Note 2)	Comparator
Conventional Wide Area *SECURENET*	DVM or DIGI-TAC (Note 2)	DVM or *DIGI-TAC*
Conventional Wide Area *ASTRO*	*ASTRO-TAC*	*ASTRO-TAC*

Notes:
1) Line 1 is transmit audio (landline to satellite receiver), and Line 2 is receive audio (satellite receiver to landline).
2) Line 1 connections for Conventional Wide Area Analog and Wide Area SECURENET are required only if customer requests Tone Remote Control capability to control specific satellite receiver functions.

4 POST–INSTALLATION CHECKOUT

After the satellite receiver has been mechanically installed and all electrical connections have been made, you may now apply power and check for proper operation prior to optimizing the satellite receiver.

Applying Power

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

Step 1. Turn ON the circuit breaker controlling the ac outlet that is supplying power to the satellite receiver Power Supply Module.

Step 2. Turn the satellite receiver power ON using the rocker switch located on the Power Supply Module front panel.

Verifying Proper Operation

Introduction

Upon turning the satellite receiver power ON, a start–up sequence begins which performs certain tests and initialization before entering normal satellite receiver operation. The satellite receiver LEDs provide a visual indication of the progress of the start–up sequence, and may be decoded to determine which test (if any) has failed.

The following describes the behavior of the LEDs upon powering up the satellite receiver, as well as how to decode the LEDs to isolate potential hardware and software malfunctions.

Station Control Module LEDs Power Up Sequence

Step 1. The **Control Fail** LED momentarily lights, followed by all eight LEDs turning on.

Step 2. The start–up sequence tests now run, and the LEDs go out (top to bottom) as each test is completed.

Step 3. Once **AUX LED** is turned off, the **Control Fail** LED is turned on while the station software and hardware are initilalized.

Step 4. Once intialized, the **Control Fail** LED is turned off and the **Control On** LED (green) is turned on. This indicates that the module has passed all the start–up tests and is now operational.

continued on next page

Verifying Proper Operation (Continued)

Station Control Module Failures

- If the **Control Fail** lights and stays on (Step 1), check to see if the Station Control Module and Power Supply Module are seated properly in the backplane. Also check to make sure that the EPROMs (two 40-pin socket-mounted ICs located on Station Control Board) are seated properly and installed with pin 1 of each IC closest to the center of the board. Otherwise, replace Station Control Module.
- If LEDs #6 and #7 (**RX 2 Active** and **RX Fail**, respectively) alternately blink, one of the start-up tests has failed, as indicated by one of the first three LEDs being turned on.

  – If LED #1 is turned on, replace the two socket-mounted EPROMs located on the Station Control Board

  – If LED #2 or #3 is turned on, check to make sure SIMMs are properly seated. If not, reseat the SIMMs in sockets. Otherwise, replace SIMMs.
- If start-up tests are run successfully (all LEDs light and go off one by one) and the **Control Fail** lights and stays on (Step 3), replace Station Control Module.

Wireline Module LEDs Power Up Sequence

Step 1. After Station Control Module passes all start-up tests and becomes operational, the Wireline start-up tests now run.

Step 2. If all tests are passed, the **WL On** LED is turned on (green).

Wireline Module Failures

- If the two LEDs alternately flash (in any one of several possible flashing patterns), replace the Wireline Interface Board.

Proceeding to Optimization

If all LEDs sequence properly, the satellite receiver may be considered electrically functional and is ready for optimizing and alignment. Proceed to the *Optimization* section in this manual.

MOTOROLA

OPTIMIZATION

For *Quantar* Satellite Receiver

1 DESCRIPTION

After the satellite receiver has been mechanically installed, properly cabled, and power applied (as described in the *Installation* section of this manual), the equipment must then be optimized before placing into operation.

An overview of the optimization tasks is as follows:

- Customize the station codeplug and saving the data to the satellite receiver
- Perform the following alignment tasks:
  - Rx Wireline
  - Tx Wireline (only if satellite receiver must respond to TRC commands)
  - Receiver RSSI calibration
  - Receiver Squelch Adjust
  - Reference Oscillator (via 5 MHz BNC connector on Station Control Module front panel)
- Perform post-optimization checkout procedures, such as running diagnostics, etc.

For detailed instructions to perform these optimization tasks, follow the procedures provided in *Optimizing a New Installation*, located in the RSS User's Guide (68P81085E35).

1 DESCRIPTION

This section describes the switches, pushbuttons, connectors and LED indicators provided on the *Quantar* satellite receiver used during local operation of the satellite receiver and servicing.

Summary of Switches, Pushbuttons, and Connectors

The following switches, pushbuttons, and connectors are provided to allow the satellite receiver to be operated and/or serviced locally. The location and function of these controls and connectors is shown in Figure 1.

Switches, Pushbuttons, and Connectors

Station Control Module	Power Supply Module
Volume Up Pushbutton Volume Down Pushbutton PL/CSQ/OFF Pushbutton (squelch mode) Intercom Pushbutton Handset/Microphone Connector External Speaker Connector RSS Port Connector External 5 MHz Input BNC Connector	Main Power On/Off Switch

Summary of LED Indicators

Note: *Refer to the Troubleshooting section of this manual for detailed descriptions and interpretation of the LED indicators.*

The following LED indicators are provided to indicate operating status of the satellite receiver. The location of these controls and connectors is shown in Figure 1.

Summary of LED Indicators

Station Control Module	Power Supply Module	Wireline Interface Module
Control On Control Fail Intercom Control Ch RX 1 Active RX 2 Active RX Fail Aux LED	Module Fail On	WL On* WL Fail* **LEDs visible on Station Control Module front panel*

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CONTROL ON LED

CONTROL FAIL LED

INTERCOM

CONTROL CH

RX1 ACTIVE LED

RX2 ACTIVE LED

RX FAIL LED

AUX LED

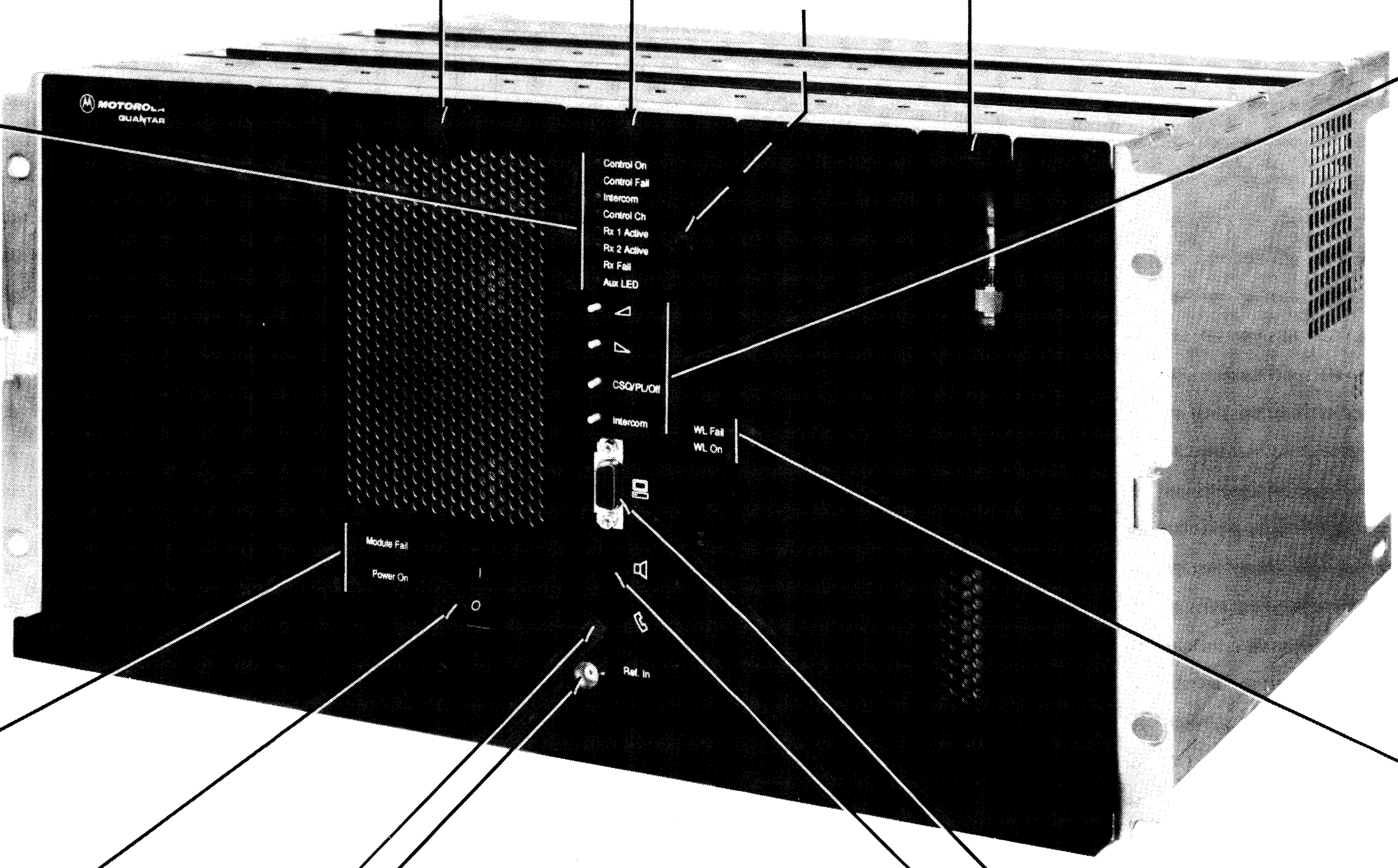
NOTE: FUNCTION OF LED INDICATORS IS DESCRIBED IN THE TROUBLESHOOTING SECTION IN THIS MANUAL.

POWER SUPPLY MODULE

STATION CONTROL MODULE

WIRELINE INTERFACE BOARD (BEHIND FRONT PANEL)

RECEIVER MODULE #1



VOLUME UP PUSHBUTTON

- USED TO INCREASE THE VOLUME OF THE LOCAL SPEAKER, EXTERNAL SPEAKER, AND HANDSET EARPIECE
- IF LOCAL SPEAKER ON, EACH DEPRESSION RAISES VOLUME LEVEL ONE OF 16 STEPS; STOPS AT STEP 16
- IF LOCAL SPEAKER OFF, DEPRESS ONCE TO RAISE VOLUME LEVEL ONE STEP AND TURN ON LOCAL SPEAKER

VOLUME DOWN PUSHBUTTON

- USED TO DECREASE THE VOLUME OF THE LOCAL SPEAKER, EXTERNAL SPEAKER, AND HANDSET EARPIECE
- EACH DEPRESSION LOWERS VOLUME LEVEL ONE OF 16 STEPS; STOPS AT STEP 0
- IF LOCAL SPEAKER ON, HOLD BUTTON IN FOR 2 SECONDS AND RELEASE TO LOWER VOLUME LEVEL ONE STEP AND TURN OFF LOCAL SPEAKER

SQUELCH SELECT PUSHBUTTON

- USED TO SELECT BETWEEN PL, CARRIER, OR SQUELCH OFF
- WITH SQUELCH OFF, EACH DEPRESSION OF PUSHBUTTON SELECTS SQUELCH IN FOLLOWING SEQUENCE:

OFF > CARRIER > PL

INTERCOM PUSHBUTTON

- USED TO TOGGLE INTERCOM MODE
- WHEN INTERCOM MODE ENABLED, TECHNICIAN AT SITE AND REMOTE CONSOLE OPERATOR MAY COMMUNICATE IN AN INTERCOM FASHION (USING MICROPHONE/HANDSET WITH PTT BUTTON)

DESCRIPTION OF SPECIAL FUNCTIONS

PUSHBUTTON COMBINATION	FUNCTION
VOLUME UP, VOLUME DOWN, & INTERCOM	RESET – PERFORMS A "WARM" RESET; TAKES APPROXIMATELY 5–10 SECONDS

WIRELINE FAIL LED

WIRELINE ON LED

NOTE: FUNCTION OF LED INDICATORS IS DESCRIBED IN THE TROUBLESHOOTING SECTION IN THIS MANUAL.

POWER SUPPLY MODULE FAIL LED

POWER ON LED

NOTE: FUNCTION OF LED INDICATORS IS DESCRIBED IN THE TROUBLESHOOTING SECTION IN THIS MANUAL.

ON/OFF SWITCH

EXTERNAL 5 MHZ INPUT

- USED TO CONNECT AN EXTERNAL SOURCE OF 5 MHZ FOR CALIBRATION OF STATION REFERENCE OSCILLATOR

HANDSET/MICROPHONE CONNECTOR (RJ-11)

- USED TO CONNECT TELEPHONE-STYLE HANDSET WITH PTT BUTTON (TMN6164 OR EQUIVALENT)
OR
MICROPHONE WITH PTT BUTTON (HMN1001A OR EQUIVALENT)

EIA-232 RSS PORT CONNECTOR

- USED TO CONNECT AN *IBM* PC (OR COMPATIBLE) PC RUNNING RSS SOFTWARE TO PERFORM ALIGNMENT, OPTIMIZATION, AND DIAGNOSTICS
- REQUIRES NULL MODEM CABLE (MOTOROLA PART NO. 30-80369E31)

EXTERNAL SPEAKER CONNECTOR (RJ-11)

- USED TO CONNECT 6W EXTERNAL SPEAKER (HSN1000)

FBEPS-48720-O
(S851)

Figure 1. Switches, Pushbuttons, Connectors, and LED Indicators for *Quantar* Satellite Receiver (800 MHz Model Shown)

MOTOROLA

ROUTINE MAINTENANCE

For *Quantar* Satellite Receiver

1 INTRODUCTION

This section provides routine maintenance recommendations and procedures for the *Quantar* Satellite Receiver.

Routine Maintenance Overview

The *Quantar* Satellite Receiver has been designed with state-of-the-art technology and operates under software control, thus requiring minimal routine maintenance. Virtually all 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 Pre-Installation planning for environmental specifications), the only routine maintenance task required is the calibration of the reference oscillator circuit. Details are provided beginning on page 2.

Note: If the satellite receiver is installed in a particularly dusty environment, precautions must be taken to filter the air used for forced cooling of the satellite receiver. Excessive dust drawn across and into the circuit modules by the cooling fans can adversely affect heat dissipation and circuit operation. In such installations, be sure to clean or replace external filtering devices periodically. Refer to Pre-Installation Planning in the Installation section of this manual for recommended filtering techniques.

2 RECOMMENDED TEST EQUIPMENT

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

List of Test Equipment

- R2001 Communications Analyzer with optional external frequency standard
- *IBM* PC (or compatible) equipped with RSS program

Land Mobile Products Sector
1301 E. Algonquin Road, Schaumburg, IL 60196

68P81087E83-O
5/15/93-UP

3 CALIBRATING REFERENCE OSCILLATOR

The circuit device(s) responsible for determining the satellite receiver 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 initial one year period, the device(s) remain stable for a substantially longer period of time. Therefore, it is recommended that the reference oscillator be calibrated after one year of operation, and thereafter less often as prescribed in a recommended schedule of periodic calibration.

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 FCC compliance or by the system requirements, whichever is more stringent.

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

Accuracy Desired/Required	***Recommended Interval***
±5 PPM	Every 4 years
±2.5 PPM	Every 2 years
±1.5 PPM	Once yearly

Reference Calibration Procedure

Perform the following procedure to calibrate the satellite receiver reference oscillator circuitry.

The accuracy of this procedure depends on the accuracy of the 5 MHz source. Be sure the 5 MHz source provides the necessary accuracy (as defined in Table 1).

Step 1. Connect the output of a stable 5 MHz reference source to the BNC connector located at the bottom of the Station Control Module front panel.

Step 2. Set the 5 MHz source for a 1.0 ± .5 V RMS output. The Station Control Module will sense the 5 MHz input and commence calibrating the reference oscillator using the 5 MHz signal as a reference.

Step 3. During calibration, the **CONTROL ON** LED will blink. When the LED returns to steady, the calibration process is complete. Remove the 5 MHz input.

Note that if the 5 MHz source is disconnected before calibration is complete (while LED is blinking), the calibration process is aborted, and the reference oscillator output returns to the original frequency (before 5 MHz was injected).

MOTOROLA

TROUBLESHOOTING

For *Quantar* Satellite Receivers (VHF, UHF, and 800 MHz)

1 INTRODUCTION

This section provides troubleshooting recommendations and procedures for the *Quantar* Satellite Receiver.

Troubleshooting Overview

The troubleshooting procedures and supporting diagrams provided in this section allow the service technician to isolate satellite receiver faults to the module/assembly level. Defective modules are then replaced with known good modules to restore the satellite receiver to proper operation.

Troubleshooting information includes:

- Table defining the function of the various alarm LED indicators
- Troubleshooting flow charts
- 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 *Quantar* satellite receiver.

List of Test Equipment

- Motorola R2001 Communications Analyzer
- PC with Radio Service Software (RSS) program
- Handset/Microphone with PTT switch (TMN6164 or equivalent)

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1301 E. Algonquin Road, Schaumburg, IL 60196

68P81087E82-O
5/15/93-UP

3 TROUBLESHOOTING PROCEDURES

The troubleshooting and repair philosophy for the *Quantar* satellite receiver is one of Field Replaceable Unit (FRU) substitution. The satellite receiver is comprised of self-contained modules (FRUs) which, when determined to be faulty, may be replaced with a known good module to quickly bring the satellite receiver back to normal operation. The faulty module must then be shipped to a Motorola repair depot for further troubleshooting and repair to the component level.

Because the *Quantar* satellite receiver is computer-controlled and employs state-of-the-art digital signal processing techniques, many of the troubleshooting procedures require the use of the Motorola-supplied Radio Service Software (RSS). The RSS may be run on a PC (or compatible) with RS-232 communication port capability. The RSS allows the technician to access alarm log files, run diagnostics, and set up the equipment for various audio and rf tests. Complete details on the operation of the RSS are provided in the RSS User's Guide (68P81085E35).

Troubleshooting Overview

Introduction

Two procedures are provided for troubleshooting the *Quantar* satellite receiver. Each procedure is designed to quickly identify faulty modules, which may then be replaced with known good modules to restore proper satellite receiver operation.

Procedure 1 – Routine Site Visit Functional Checkout

Procedure 1 consists of a series of non-intrusive tests that can be quickly run during a routine site visit. This procedure allows the technician to verify the proper satellite receiver operation without taking the satellite receiver out of service. An overview of the procedure is shown in the flow chart (Figure 1) on page 3.

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 is comprised of 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 (Figure 2) on page 4.

How to Use These Troubleshooting Procedures

Perform the following basic steps in order to efficiently troubleshoot the *Quantar* satellite receiver.

Step 1. Select the appropriate troubleshooting procedure flow chart (Procedure 1 or Procedure 2).

Step 2. Perform the tasks given in the selected flow chart. Tasks requiring additional explanation are marked with page references. Locate the additional information, perform the tasks (if any), and return to the flow chart.

Step 3. Once the faulty module has been identified, proceed to *Module Replacement Procedures*, beginning on page 11.

▶ PROCEDURE 1

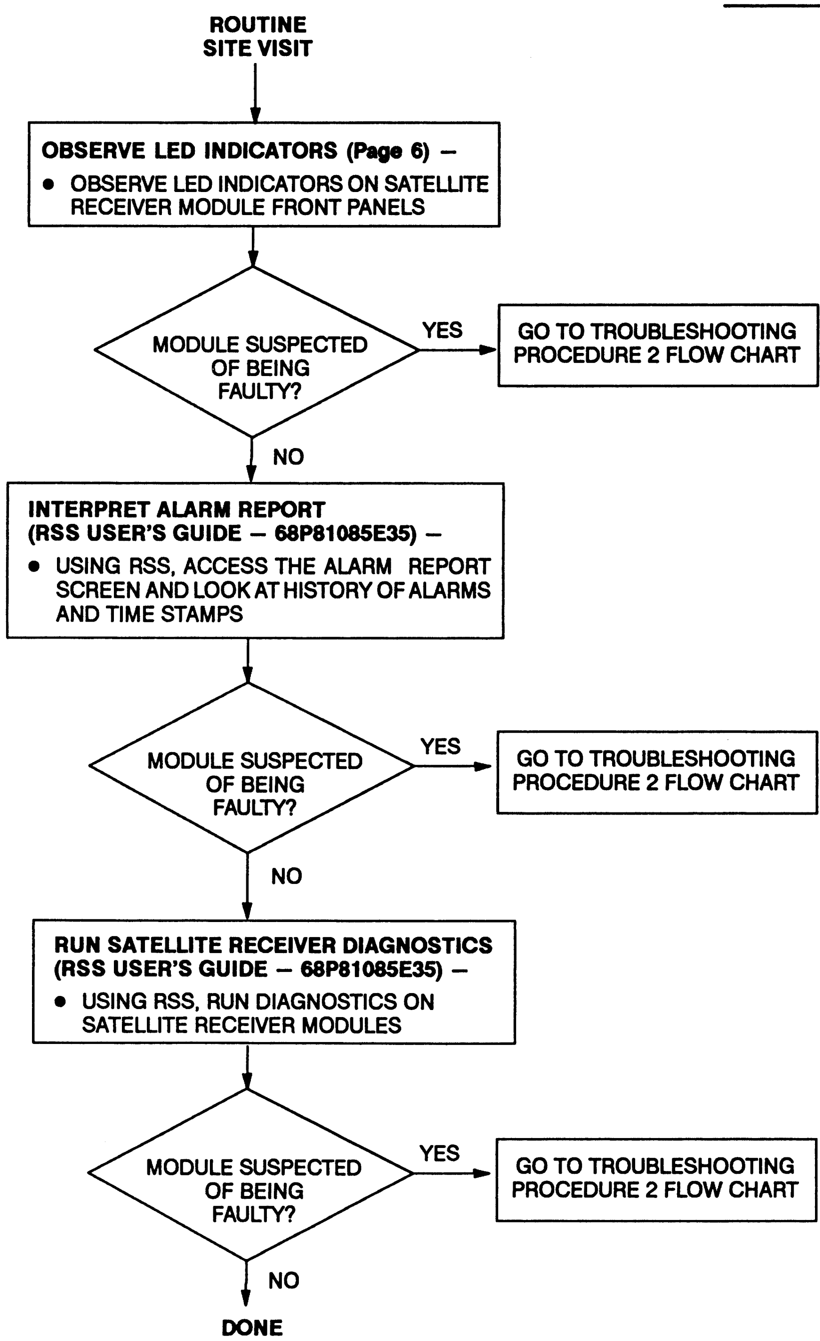


Figure 1. *Quantar* Satellite Receiver Troubleshooting Overview (Procedure 1 – Routine Site Visit)

▶ PROCEDURE 2

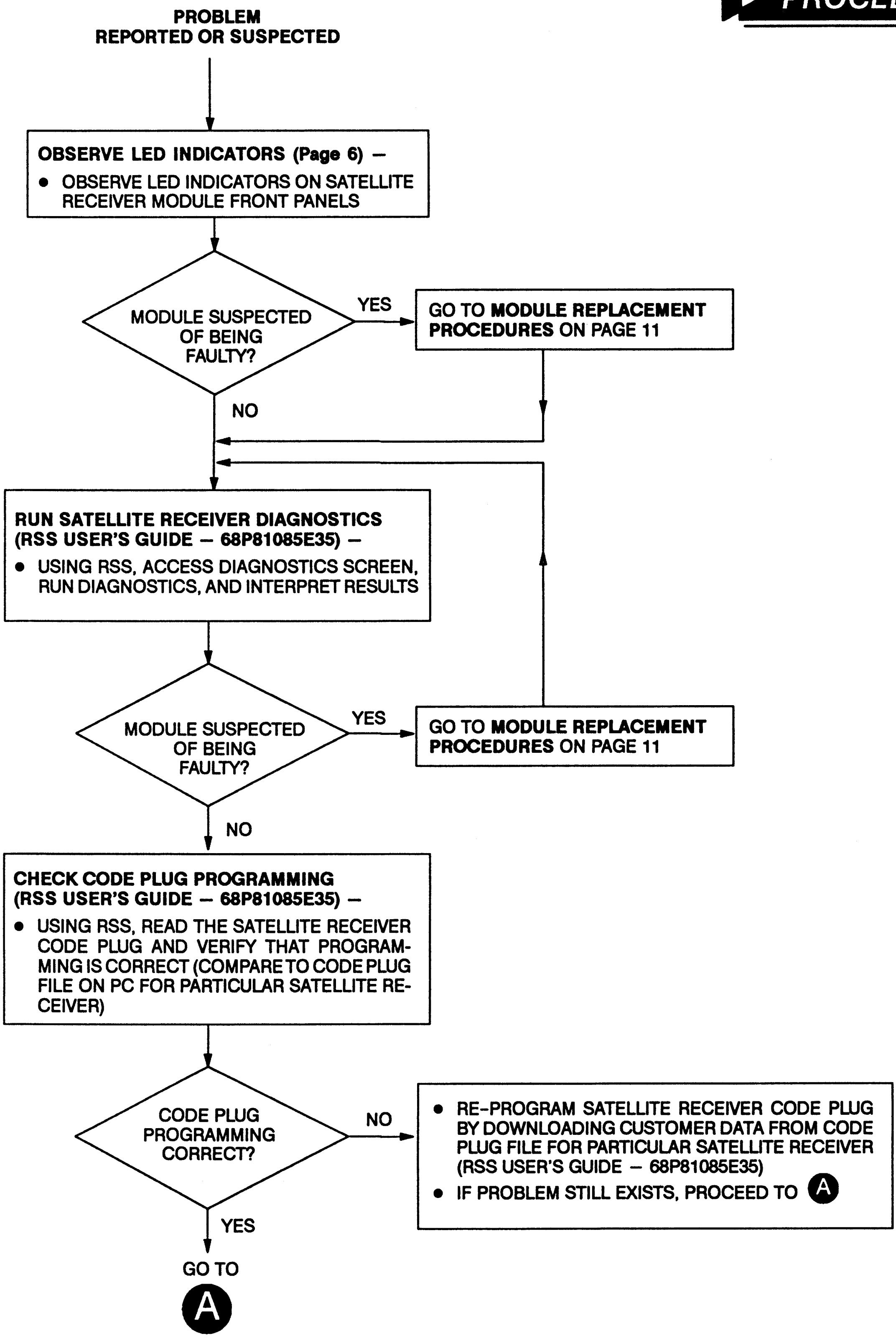


Figure 2. *Quantar* Satellite Receiver Troubleshooting Overview (Procedure 2 – Reported or Suspected Problem)

▶ PROCEDURE 2 (Cont'd)

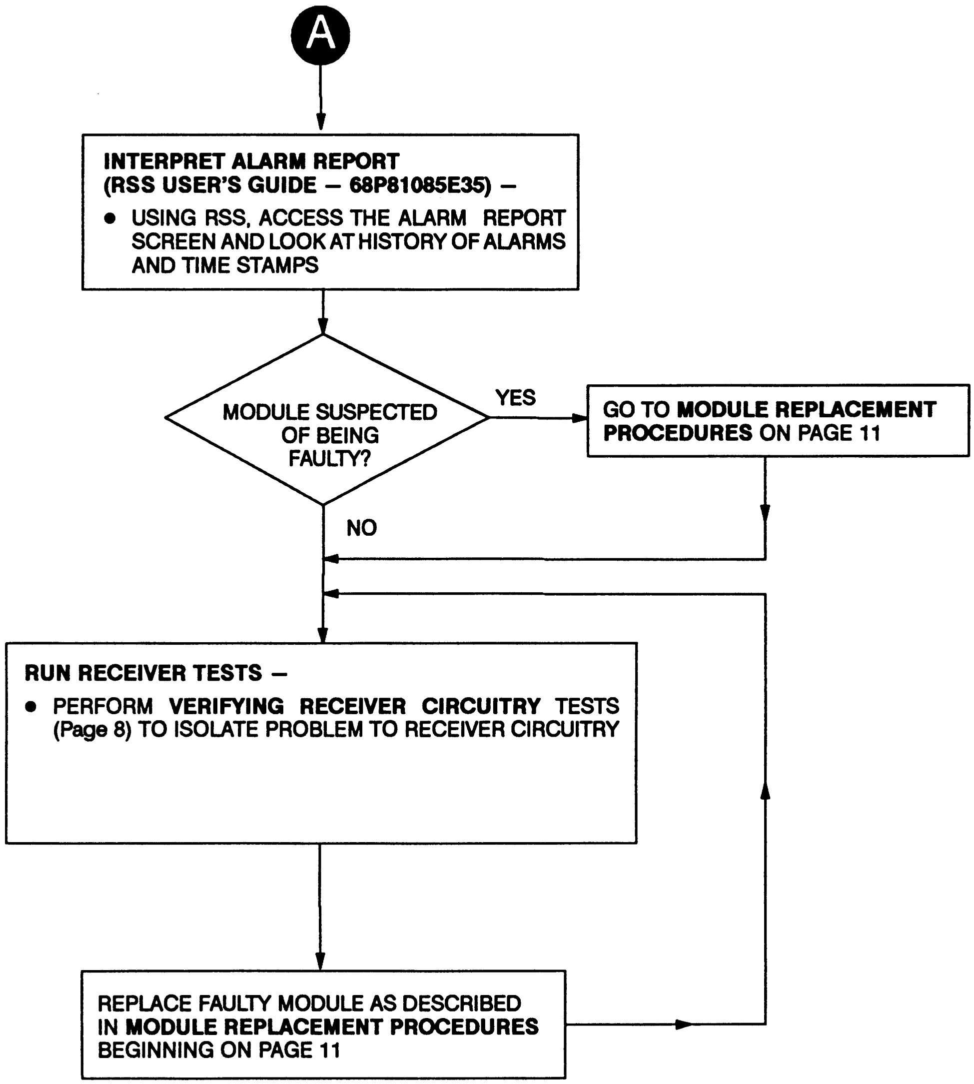


Figure 2. Troubleshooting Procedure 2 (Continued)

Interpreting LED Indicators

Several LED indicators are provided on the front panels of the modules that indicate specific operating conditions. The service technician may observe these LEDs to obtain a quick status indication of the satellite receiver.

Figure 3 shows the location of all LED indicators provided on the satellite receiver. Table 1 lists each LED indicator along with a description of the status indicated by each LED.

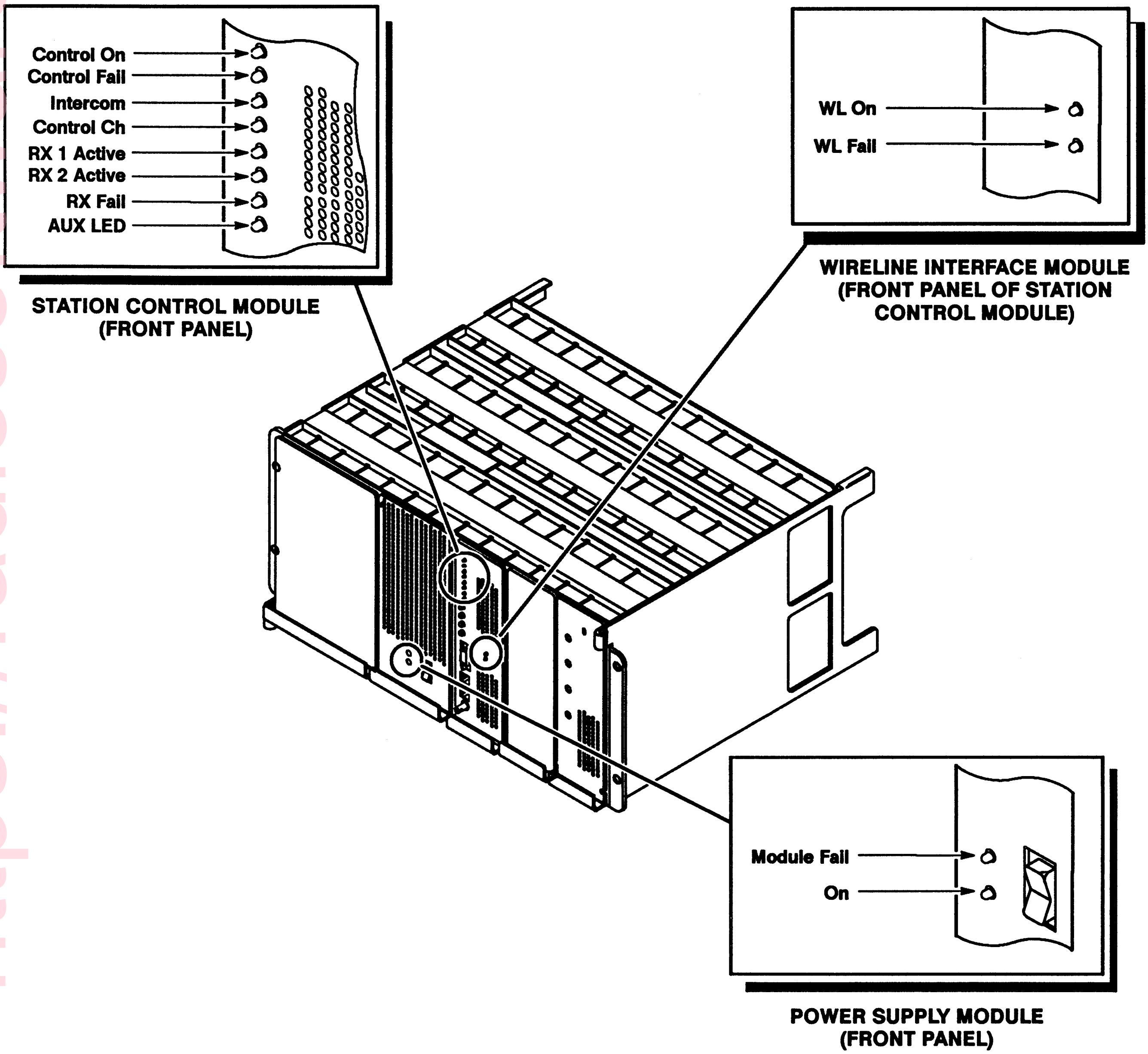


Figure 3. *Quantar* Satellite Receiver LED Indicators

Table 1. Quantar Satellite Receiver LED Indicator Functions

LED Location	LED Name	Status Definition
POWER SUPPLY MODULE	Module Fail	– OFF during normal operation. – Lights RED when module malfunction occurs, such as shorted output, current limit exceeded, loss of communication with Station Control Module, etc.
	On	– GREEN with ac input power present and switch turned ON – OFF when ac input power absent or switch turned OFF
STATION CONTROL MODULE (SCM)	Control On	– GREEN when SCM fully functional – FLASHING when front panel switch press detected or 5 MHz Net in process (5 MHz source signal injected thru either front panel or backplane BNC connector) – OFF for SCM failure
	Control Fail	– RED for SCM failure – FLASHES when station is in Failsoft mode (trunking systems only) – OFF when SCM fully functional (no failure)
	Intercom	– YELLOW when station is in Intercom mode – FLASHING when station is in Access Disable Mode – OFF when station is not in Intercom mode
	Control Ch	– GREEN when station is control channel (trunking systems only) – FLASHES each time station decodes ISW (trunking systems only) – OFF when station is not control channel (trunking systems only)
	RX 1 Active	– GREEN when Station Control Board is passing audio/data (receive path unmuted) from Receiver #1; The following conditions must be met: Carrier at proper frequency being received Carrier signal level is above threshold set in codeplug Squelch criteria met (carrier, PL, DPL, ASTRO, secure, etc.) (Note that squelch criteria can be manually altered via RSS for testing purposes) – OFF when above conditions are not met for Receiver #1
	RX 2 Active	– Indicates condition of Receiver #2; Same status definitions as RX 1 ACTIVE
	RX Fail	– RED when Receiver #1 and #2 are both non-functional * – BLINKING ONCE PER SECOND when Receiver #1 is non-functional * – BLINKING TWICE PER SECOND when Receiver #2 is non-functional * – OFF when both Receiver #1 and #2 are functional * (or no receiver modules installed) * A receiver module is considered non-functional if a failure is detected during diagnostics run at time of power-up or during normal operation.
	AUX LED	– GREEN LED available for customer-defined function
WIRELINE INTERFACE BOARD (WIB)	WL On	– GREEN when WIB fully functional – OFF for WIB failure
	WL Fail	– RED for WIB failure – OFF when WIB fully functional (no failure)

Notes:

1. All LEDs momentarily light following satellite receiver reset (Volume Up, Volume Down, and Intercom buttons on SCM front panel pressed simultaneously) or upon satellite receiver power up.
2. If no LED indicators are on, make sure that ac power to the satellite receiver power supply is present. Check the circuit breaker at the ac source. Check the ac line cord. If no problem found, suspect Power Supply Module.

Verifying Receiver Circuitry

IMPORTANT

Performing this procedure requires that the satellite receiver be taken out of service. It is recommended that, unless the satellite receiver 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 satellite receiver 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 receive circuitry, including:

- Receiver Module
- Power Supply Module
- 2.1 MHz reference oscillator circuitry
- Receiver-related circuitry in the Station Control Module (SCM)

In general, the receiver circuitry is exercised by injecting and measuring signals using a Motorola R2001 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 Communications Analyzer (or equivalent)
- Telephone-style handset with PTT switch (TMN6164 or similar)
- Female N-type to Female N-type coaxial cable
- RJ-11 to BNC cable

Verifying Receiver Circuitry Procedure

Step 1. Connect test equipment by performing Steps 1-3 shown in Figure 4.

Step 2. Disable PL and carrier squelch by repeatedly pressing the **PL/CSQ/Off** button until receiver noise is heard thru the handset (or external or internal speaker). If no audio is heard, suspect the following:

- Faulty Receiver Module
- Faulty Station Control Module
- R2001 is outputting a carrier signal

Step 3. Set R2001 to generate a .5 µV (-113 dBm) FM signal at the *Quantar* receiver frequency, modulated by a 1 kHz tone at 3 kHz deviation. The 1 kHz tone should be audible thru the handset (or internal or external speaker). If no audio is heard, suspect the following:

- Receiver Module out of tune (tune using RSS)
- Faulty Station Control Module (2.1 MHz reference)
- Faulty Receiver Module
- Faulty antenna-to-Receiver preselector rf cable
- Faulty R2001-to-station rf cable

(continued on page 10)

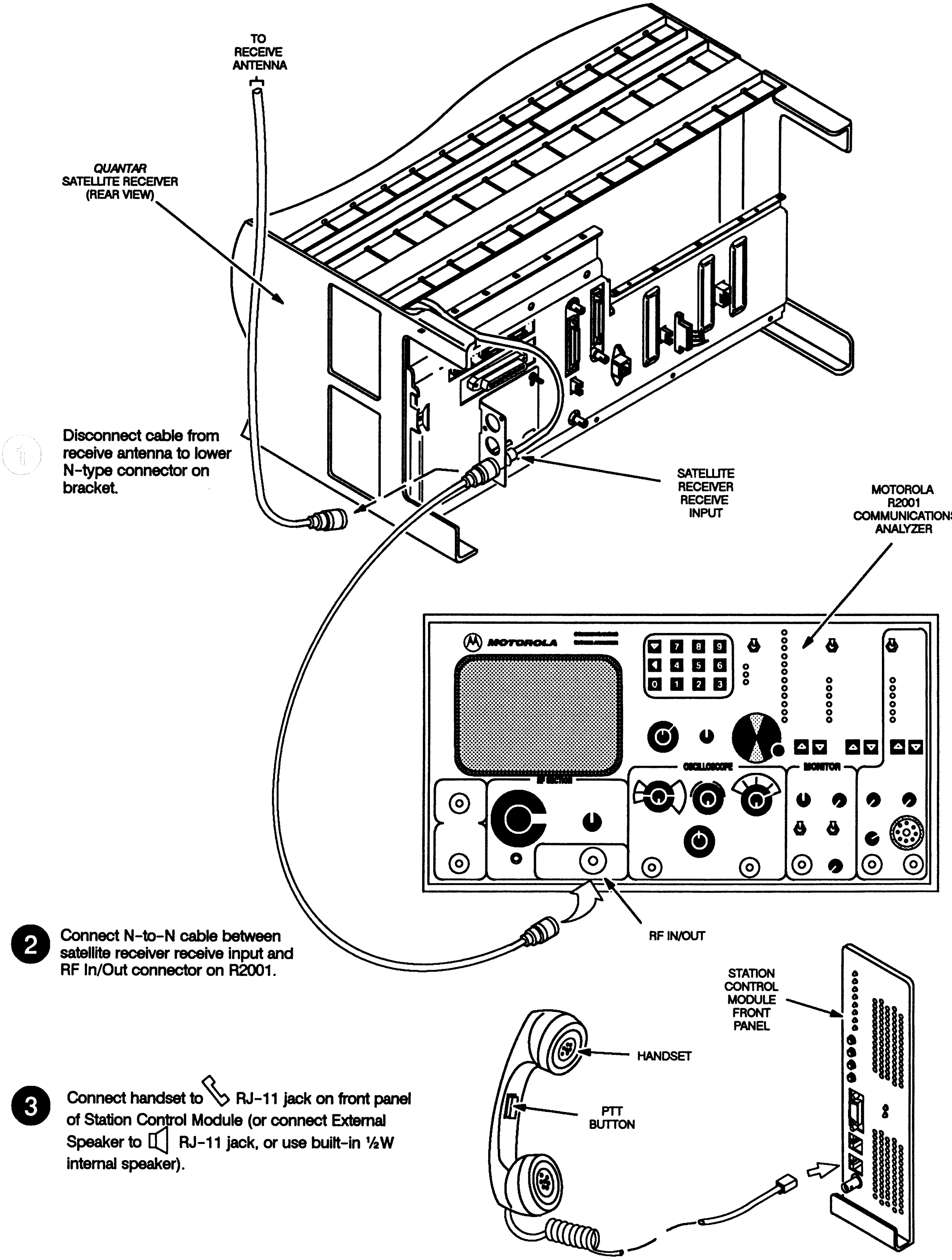
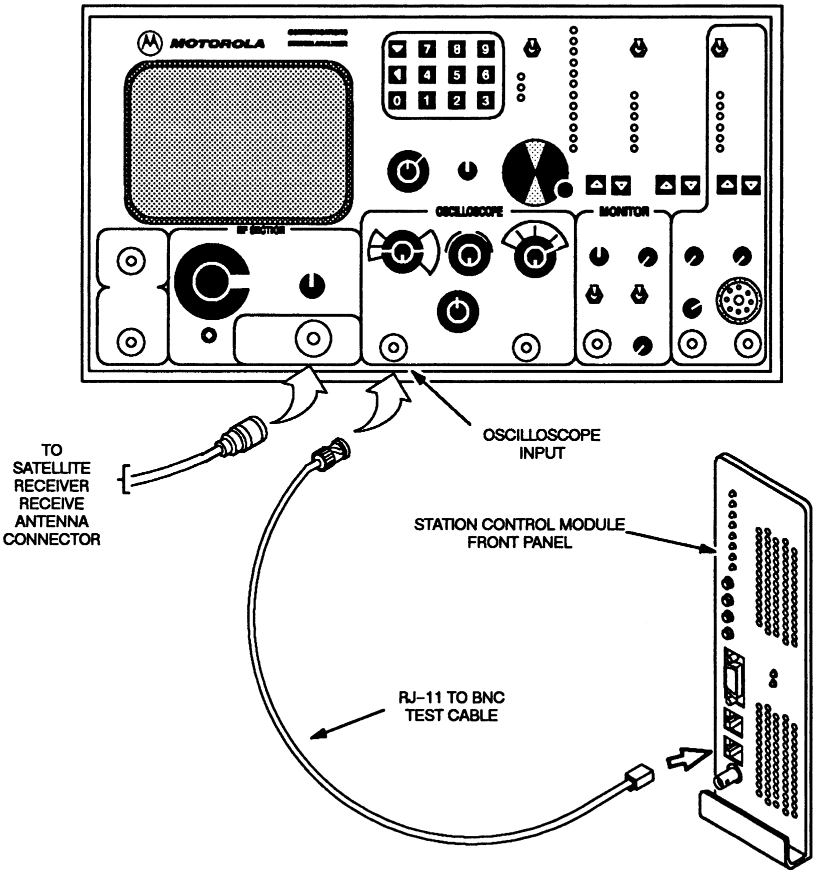


Figure 4. Test Equipment Setup for Verifying Receiver Circuitry

Verifying Receiver Circuitry (Continued)

Step 4. If audio is heard, connect the HANDSET RJ-11 jack to the Oscilloscope input BNC connector, as shown below:



Step 5. Use **Volume Up** button to increase volume to maximum. Measure the audio level using the R2001.

- Audio level should measure approximately .75 to 1.5 V p-p. If not, suspect faulty SCM.

Step 6. Change R2001 injection signal level to .25 µV (-119 dBm) for VHF, .30µV for 800 MHz, or .35 µV (-116 dBm) for UHF.

Step 7. Measure the receiver 12 dB SINAD sensitivity.

- If 12 dB SINAD is greater than -119 dBm for VHF, -116 dBm for UHF, or -117 dBm for 800 MHz, adjust preselector tuning (VHF and UHF only) to achieve best sensitivity. If sensitivity still not achieved, suspect faulty Receiver Module or SCM.

Note: Refer to ***5. Preselector Field Tuning Procedure*** *in this section for procedures to tune the receiver preselector (VHF and UHF satellite receivers only).*

Step 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 satellite receiver to normal service, and return to the troubleshooting flow chart to resume troubleshooting sequence.

4 MODULE REPLACEMENT PROCEDURES

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

General Replacement Information

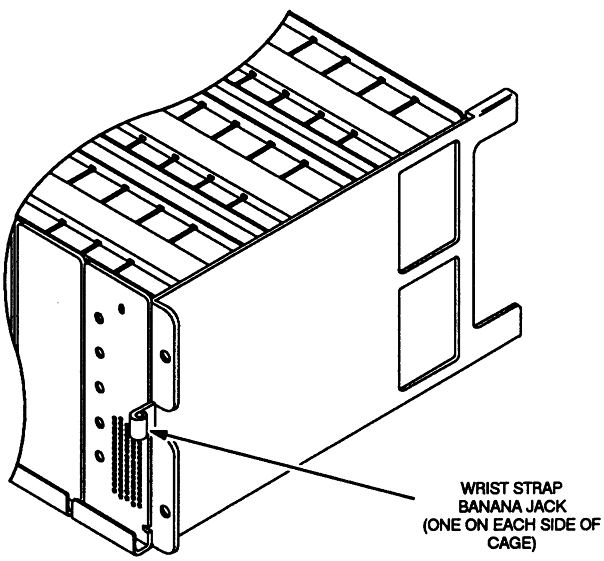
Anti-Static Precaution

The satellite receiver circuitry contains many C-MOS 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 Worldwide System and Aftermarket Products Division (WASPD, formerly National Parts). Some additional precautions are as follows:

WARNING

When wearing Conductive Wrist Strap, be careful near sources of high voltage. The good ground provided by the wrist strap will also increase the danger of lethal shock from accidentally touching high voltage sources.

- A wrist strap (Motorola Part No. RSX-4015A, or equivalent) should be worn while servicing to minimize static buildup. Banana jacks are built into the satellite receiver cage for connection of the wrist strap.



CAUTION

DO NOT insert or remove satellite receiver modules with power applied. This may result in damage to the modules.

- **Do not** insert or remove modules with power applied. Always turn off the satellite receiver using the On/Off switch located on the front of the Power Supply Module before inserting or removing modules.
- 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.

General Replacement Information (Continued)

Releasing Module Mechanical Interlock

Each module in the satellite receiver cage slides in on rails built into the cage and plugs into a connector(s) on the satellite receiver backplane. A mechanical interlock mechanism secures each module in the cage. To release the mechanical interlock, perform the removal procedure shown in Figure 5 below (Receiver Module removal being shown).

Note that other steps in addition to releasing the interlock may be required for removal of each of the satellite receiver modules. These additional steps are described in the replacement procedures for each module (provided in this section beginning on page 14).

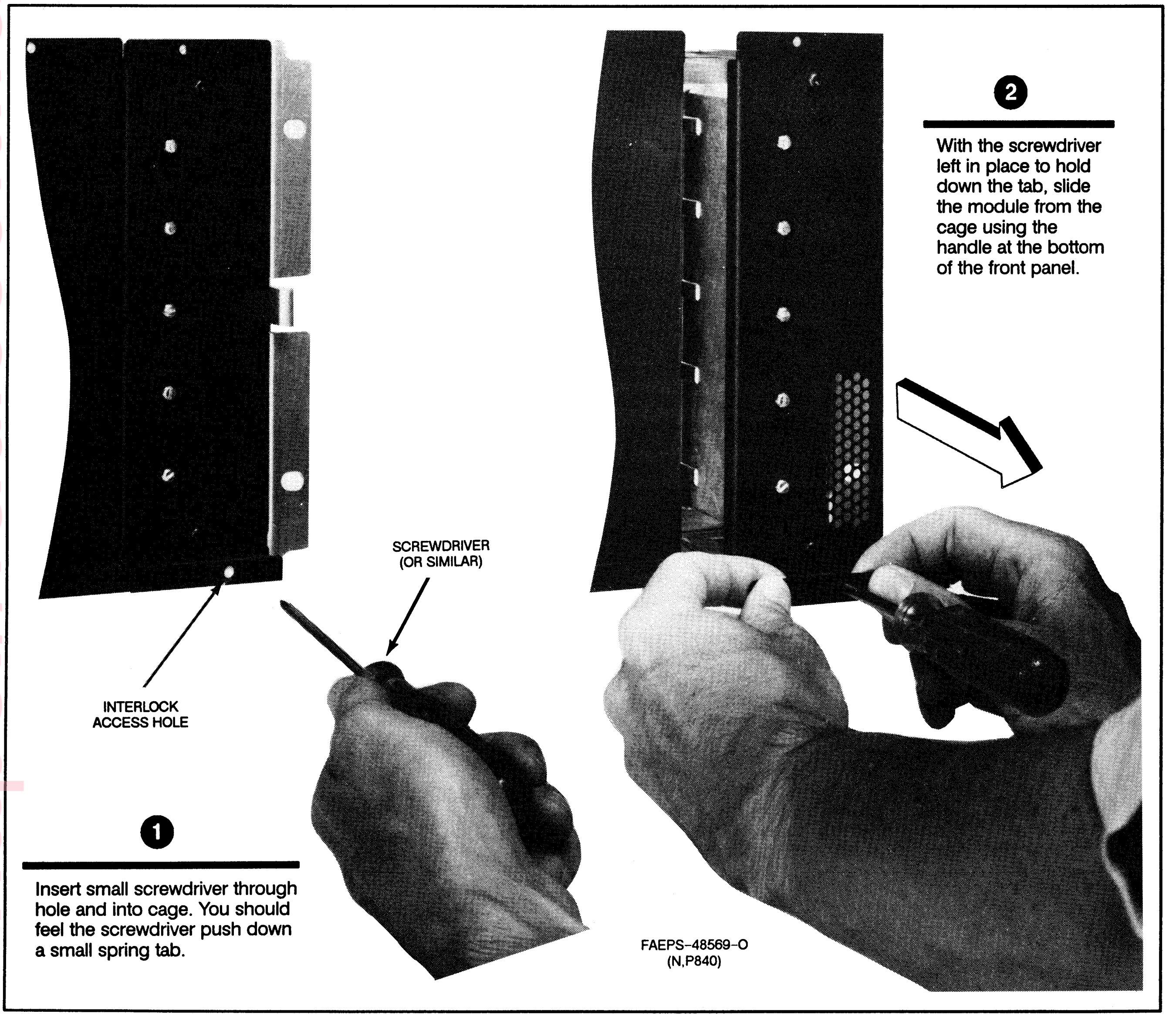


Figure 5. Releasing Mechanical Interlock for Module Removal

General Replacement Information (Continued)

Care of Gold-Plated Connector Contacts

The connections between the modules and the satellite receiver backplane board are made with gold-plated card edge 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 satellite receiver 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 card-edge connectors or the 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.

Cleaning Module Rails

After a few module extraction/insertion cycles, wipe the module rails with a soft cloth to remove any oxidation or foreign material. This ensures a good ground connection between the module and the cage.

Power Down Satellite Receiver Before Removing/Inserting Modules

Before removing or inserting a module into the satellite receiver cage and engaging the backplane connector, be sure to turn off the satellite receiver power using the Power Supply Module On/Off switch.

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 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 Power Supply Module

Replacement Procedure

Step 1. Turn off satellite receiver power using Power Supply Module On/Off switch.

Step 2. Remove anti-vibration screw (if installed) from top of module front panel.

Step 3. Release the interlock mechanism (page 12) and remove faulty module from cage.

Step 4. Install replacement Power Supply Module by sliding module into cage, pushing the module past the mechanical interlock and firmly seating the module connector into the backplane. (**Do not** slam the module against the backplane or push any harder than necessary to seat the connectors.)

Step 5. Restore power to the satellite receiver using Power Supply Module On/Off switch.

Post-Replacement Optimization Procedure

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

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Replacing Station Control Module

Replacement Procedure

Step 1. If the module is capable of communicating with the RSS, connect the PC to the RSS port, start the RSS program, and save the codeplug from the satellite receiver to a file on the PC hard disk. This will allow the codeplug information to be downloaded to the codeplug located on the replacement Station Control Board. 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 User's Guide (68P81085E35).

Step 2. Turn off satellite receiver power using Power Supply Module On/Off switch.

Step 3. Remove anti-vibration screw (if installed) from top of module front panel.

Step 4. Remove front panel and Station Control Board as described in Figure 6.

Step 5. Install replacement Station Control Board by sliding board into cage, pushing the board past the mechanical interlock and firmly seating the board card-edge connectors into the backplane. (**Do not** slam the board against the backplane or push any harder than necessary to seat the connectors.)

Step 6. Replace the front panel by pressing it into place. (The panel is secured by the board extraction tab at bottom of panel and tension clips along sides.) Be sure the 2-wire cable from the local speaker is connected to the 3-pin connector at the bottom front of the Station Control Board. You may connect the 3-pin connector in either polarity.

Step 7. Restore power to the satellite receiver using Power Supply Module On/Off switch.

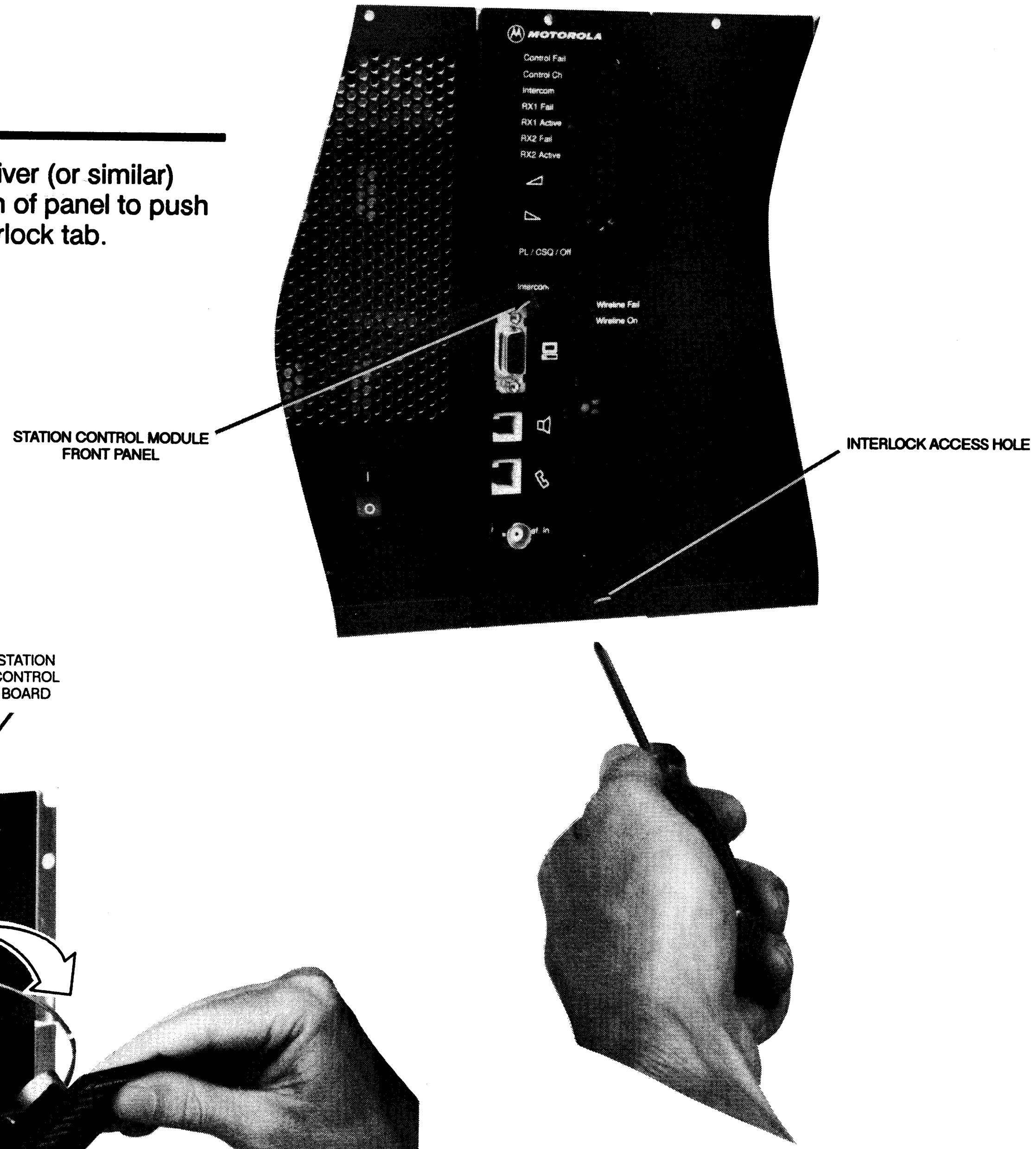
Post-Replacement Optimization Procedure

Step 1. Replacement Station Control Modules are shipped with default data programmed into the codeplug (EEPROM located on board). After replacing a Station Control Board, you must download codeplug data (unique to the particular satellite receiver) to the replacement board codeplug. Simply retrieve the file from your archive and follow the instructions in the RSS User's Guide (68P81085E35) for saving data to the codeplug.

Step 2. Calibrate the reference oscillator (satellite receiver reference) by performing the procedure in the Routine Maintenance section of this manual.

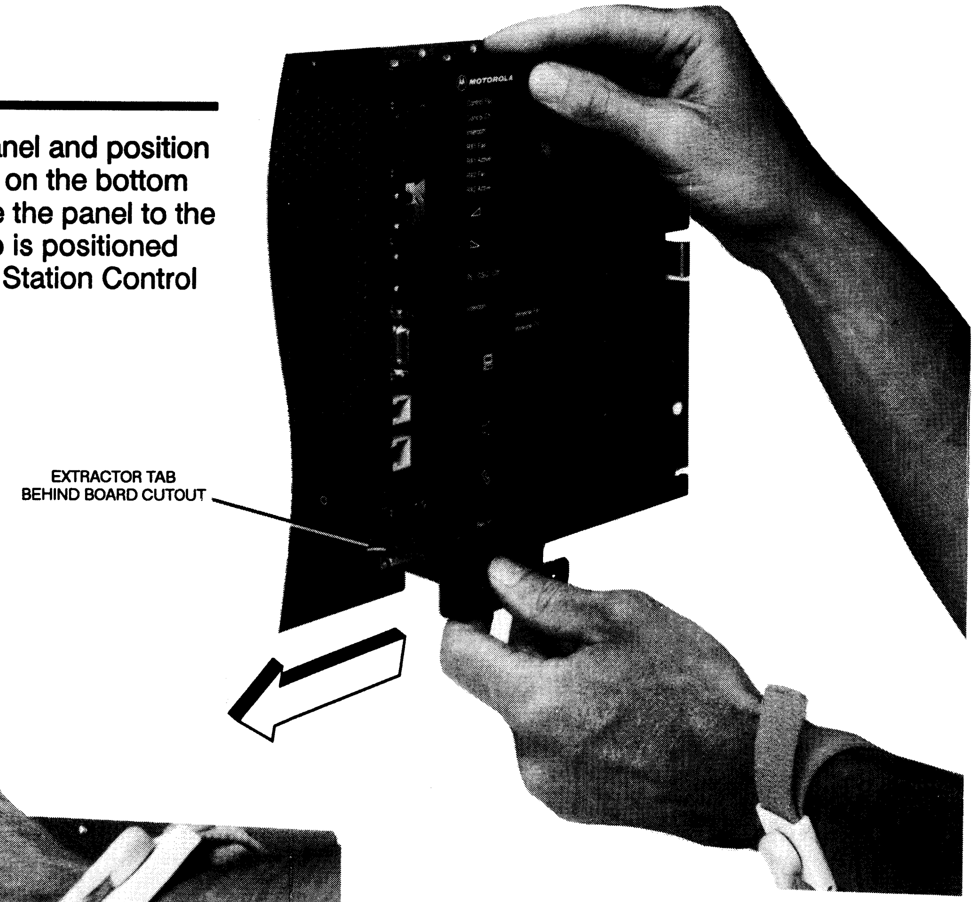
1

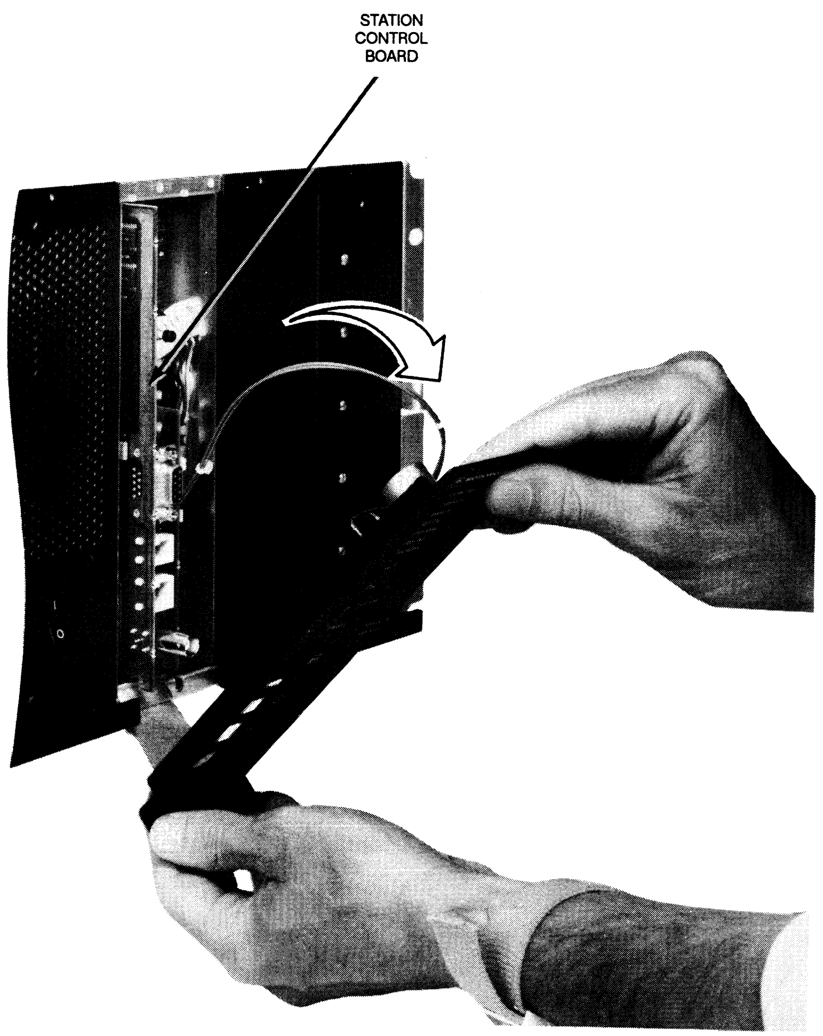
Insert a small screwdriver (or similar) into the hole at bottom of panel to push down mechanical interlock tab.



2

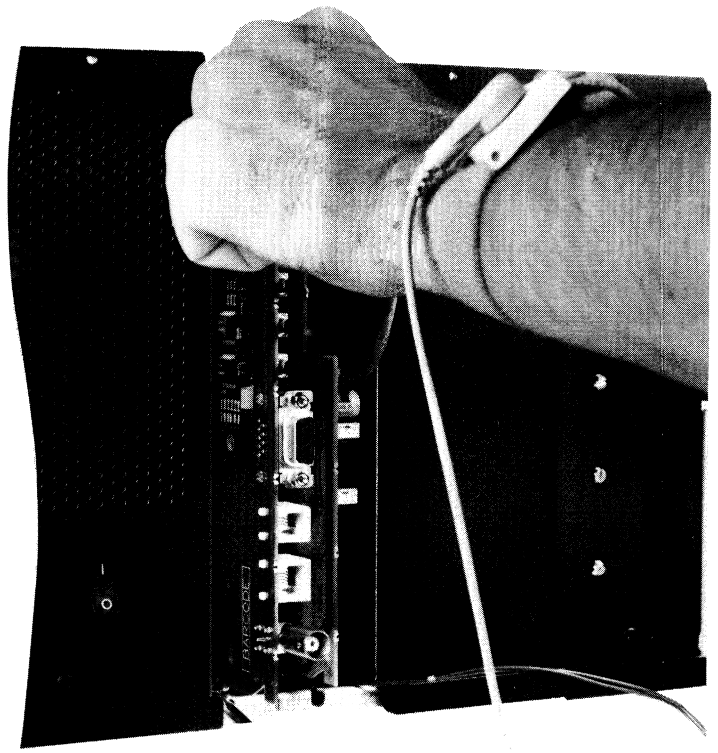
Partially remove front panel and position the board extraction tab on the bottom rail of the cage and slide the panel to the left until the lip of the tab is positioned behind the cutout in the Station Control Board.





3

Tip back on the panel to pry the Station Control Board out of the backplane connectors.



4

Remove Station Control Board from cage.

FBEPS-48570-O
(Q,R,S840, E841)

Figure 6. Removal Procedure for Station Control Board

Replacing Wireline Interface Board

Replacement Procedure

Step 1. Turn off satellite receiver power using Power Supply Module On/Off switch.

Step 2. Remove anti-vibration screw (if installed) from top of module front panel.

Step 3. Remove Station Control Module front panel and Wireline Interface Board as described in Figure 7.

Step 4. Set all jumpers on replacement board to match those on the faulty board. These include input/output impedance matching jumpers, 2-wire/4-wire select jumper, and dc remote control selection jumpers.

Step 5. Install replacement Wireline Interface Board by sliding board into cage, pushing the board past the mechanical interlock and firmly seating the board card-edge connectors into the backplane. (**Do not** slam the board against the backplane or push any harder than necessary to seat the connectors.)

Step 6. Replace the front panel by pressing it into place. (The panel is secured by the board extraction tab at bottom of panel and tension clips along sides.) Be sure the 2-wire cable from the local speaker is connected to the 3-pin connector at the bottom front of the Station Control Board. You may connect the 3-pin connector in either polarity.

Step 7. Restore power to the satellite receiver using Power Supply Module On/Off switch.

Post-Replacement Optimization Procedure

Perform the *Rx Wireline* and *Tx Wireline* adjustment procedures located in the RSS User's Guide (68P81085E35).

Replacing ASTRO Modem Card

Replacement Procedure

Step 1. Turn off satellite receiver power using Power Supply Module On/Off switch.

Step 2. Remove the Wireline Interface Board as described above.

Step 3. Unplug faulty ASTRO Modem Card from Wireline Interface Board. Install replacement modem card.

Step 4. Install Wireline Interface Board as described above.

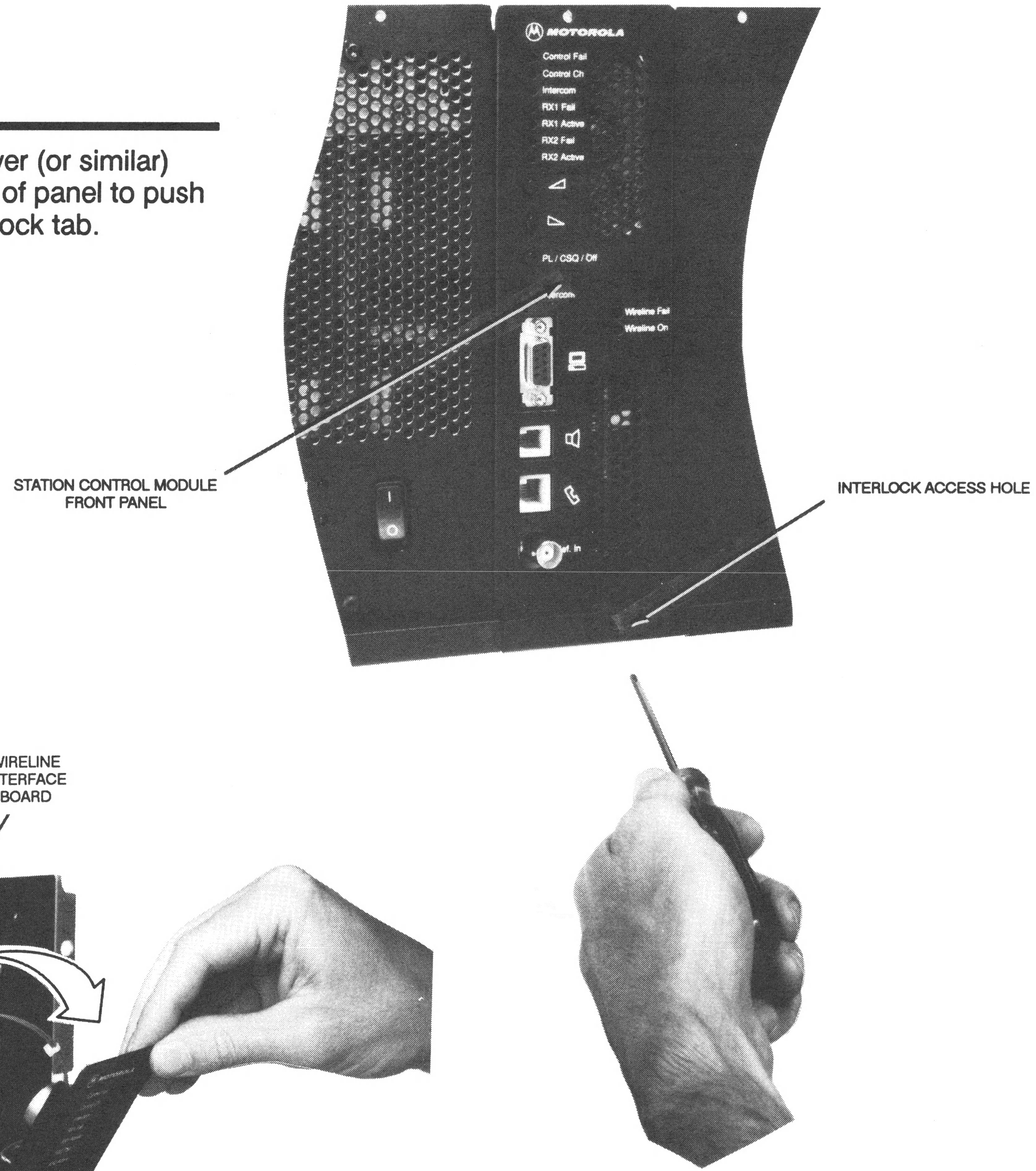
Step 5. Restore power to the satellite receiver using Power Supply Module On/Off switch.

Post-Replacement Optimization Procedure

The ASTRO Modem Card requires no settings or adjustments. The card is configured by the Station Control Module on satellite receiver power up.

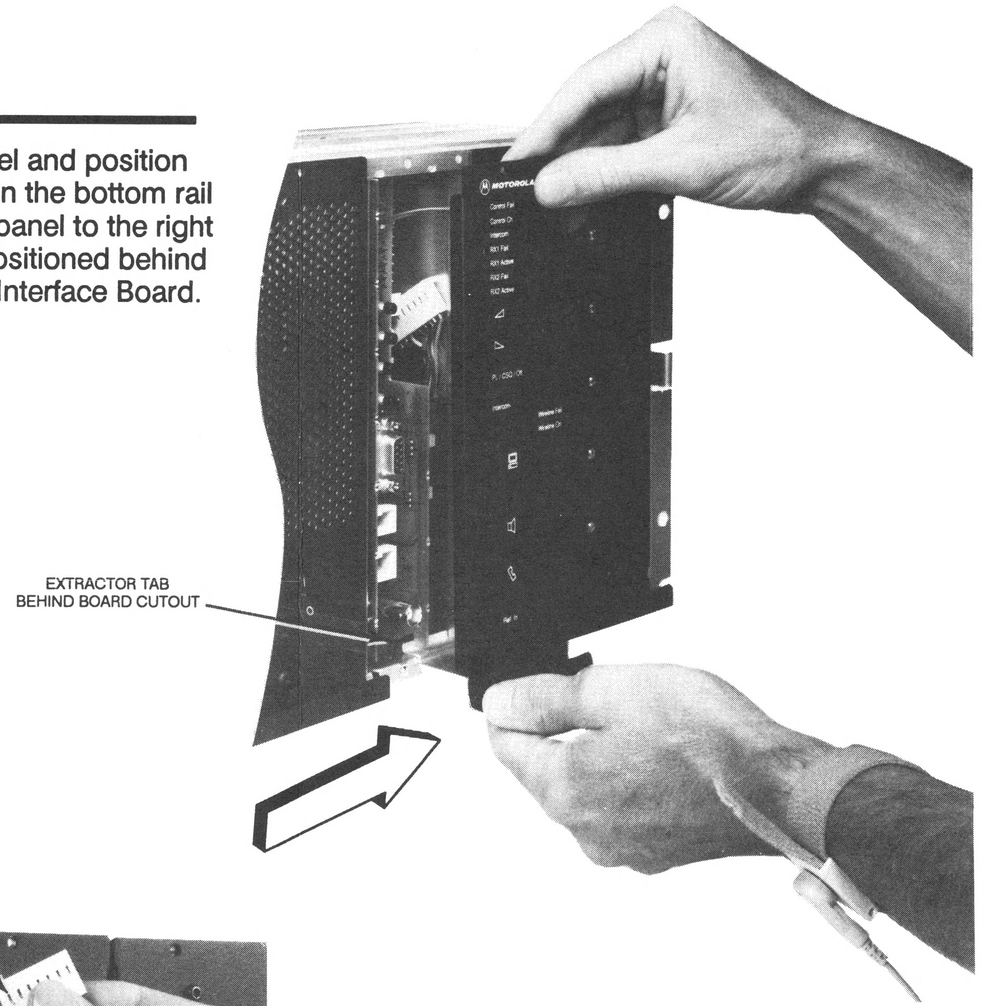
1

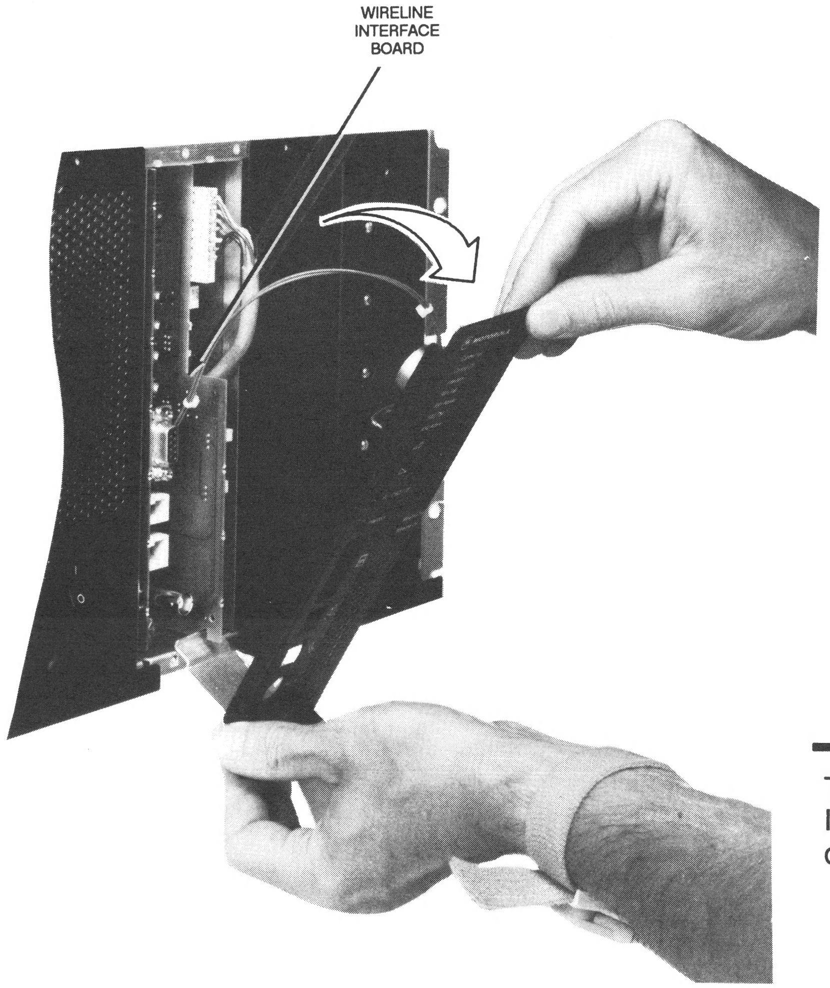
Insert a small screwdriver (or similar) into the hole at bottom of panel to push down mechanical interlock tab.



2

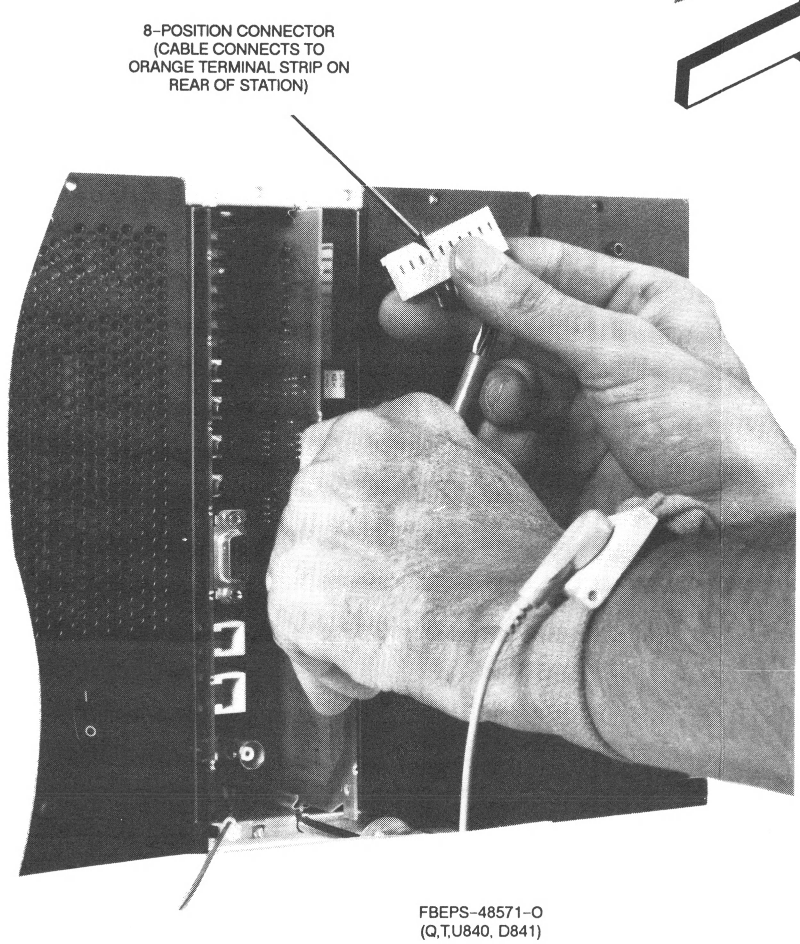
Partially remove front panel and position the board extraction tab on the bottom rail of the cage and slide the panel to the right until the lip of the tab is positioned behind the cutout in the Wireline Interface Board.





3

Tip back on the panel to pry the Wireline Interface Board out of the backplane connectors.



4

Disconnect the 8-position connector as shown and remove Wireline Interface Board from cage.

Figure 7. Removal Procedure for Wireline Interface Board

Replacing Receiver Module and/or Preselector Assembly

Note: *VHF and UHF Receiver Modules are comprised of a Preselector Assembly and a Receiver Board attached to a module housing. The Preselector Assembly and the Receiver Board are each considered to be a field replaceable unit (FRU). Replacement procedures are given for each FRU. If you choose to replace the entire module (including receiver board and preselector), you must perform the preselector tuning procedure.*

Replacement Procedure

Step 1. Turn off satellite receiver power using Power Supply Module On/Off switch.

Step 2. Remove anti-vibration screw (if installed) from top of module front panel.

Step 3. Slide the module out to the first stop. Disconnect mini-UHF connector on rf cable (rf input to the module) connected to the preselector assembly (VHF/UHF) or module input (800 MHz).

Step 4. Release the interlock mechanism (page 12) and remove faulty module from cage.

Step 5. If **Receiver Board** is being replaced:

- Disconnect cable (mini-UHF connector) connected to Receiver Board.
- Remove nine (9) Torx-head screws securing Receiver Board to module housing. Note location of foam insulating pad beneath VCO portion of Receiver Board.
- Remove faulty board and replace with known good board. Be sure to position the foam insulating pad (noted in previous step) behind the VCO.
- Secure board using Torx-head screws removed previously. Reconnect rf cable to mini-UHF connector on board.

Step 6. If **Preselector Assembly** is being replaced (VHF and UHF only):

- Disconnect cables (mini-UHF connectors) from assembly.
- Remove faulty Preselector Assembly by removing two(2) Torx-head screws securing assembly to module housing.
- Install known good assembly and secure using Torx-head screws removed previously. Reconnect rf cables to mini-UHF connectors.

(continued on next page)

Replacing Receiver Module and/or Preselector Assembly (Continued)

Replacement Procedure (Continued)

Step 7. Install repaired Receiver Module by sliding module into cage, pushing the module past the mechanical interlock to the first stop (module about 2 inches from full insertion). Connect the rf input cable to the mini-UHF connector on the Preselector Assembly (VHF/UHF) or module input (800 MHz).

Step 8. Slide the module in completely and firmly seat the module connector into the backplane. (**Do not** slam the module against the backplane or push any harder than necessary to seat the connectors.)

Step 9. Restore power to the satellite receiver using the Power Supply Module On/Off switch.

Post-Replacement Optimization Procedure

Step 1. If you replaced the **Receiver Board** – Perform the *Squelch Adjust* and the *RSSI* alignment procedures located in the RSS User's Guide (68P81085E35).

Step 2. If you replaced the **Preselector Assembly** – Perform the preselector field tuning procedure beginning on page 23.

Replacing Backplane Board

Replacement Procedure

Step 1. Turn off satellite receiver power using Power Supply Module On/Off switch.

Step 2. Remove all modules/boards from the cage as described on the previous pages. Make sure that all modules/boards are placed on properly grounded anti-static surface.

Step 3. Label all cables connected to the rear of the Backplane Board. Disconnect all cables from the backplane.

Step 4. Remove the eleven (11) Torx-head screws which secure the metal shield and backplane board to the cage.

Step 5. Remove the metal shield from the backplane, sliding the two guide pins located at each end at the bottom of the shield from the backplane board. Remove the backplane board.

Step 6. Install the replacement Backplane Board and metal shield using the 11 Torx-head screws removed previously, reconnect all cables, and reinstall all modules/boards.

Post-Replacement Optimization Procedure

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

5 PRESELECTOR FIELD TUNING PROCEDURE

VHF and UHF Receiver Modules are comprised of a circuit board and a preselector assembly, both secured in a slide–in module housing. The preselector assembly is a 5–pole (VHF) or 3–pole (UHF) bandpass filter equipped with tuning slugs to adjust the passband corresponding to the operating frequency(s) of the satellite receiver. The preselector assembly must be field tuned if replaced in the field or if the satellite receiver operating frequency(s) are modified. The tuning procedure follows.

Required Test Equipment

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.

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

- RF Signal Generator – Motorola R2600 Communications Analyzer, R2001 Communications Analyzer (see note), 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 12 in–lbs of torque and 10 mm deep well socket
- Tuning probe – Motorola Part No. 0180763D22, p/o TRN7799A tuning kit
- Flat–blade screwdriver

Note: *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, rf signal* ***must*** *be taken from the Antenna port.*

VHF Tuning Procedure

Calculating Proper Alignment Frequency

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

For satellite receivers with a **single receive frequency**, calculate the frequency of the alignment signal as follows:

Step 1. From the site documentation or the RSS, determine the satellite receiver receive frequency.

Step 2. If the frequency is $\leq$ 148 MHz (Range 1), or $\leq$ 156 MHz (Range 2), subtract 250 kHz. Otherwise, note actual frequency.

Example: If satellite receiver receive frequency is 134.575 MHz, subtract 250 kHz since frequency is less than 143 MHz.

134.575 MHz – 250 kHz = 134.325 MHz

Step 3. If Receiver Module is **Range 1**, determine the alignment frequency as follows:

If frequency (from Step 2) is < 134 MHz, then alignment frequency = 133.75 MHz.

If frequency (from Step 2) is > 152 MHz, then alignment frequency = 152 MHz.

Otherwise, use actual frequency from Step 2.

Step 4. If Receiver Module is **Range 2**, determine the alignment frequency as follows:

If frequency (from Step 2) is < 152 MHz, then alignment frequency = 151.75 MHz.

If frequency (from Step 2) is > 172 MHz, then alignment frequency = 172 MHz.

Otherwise, use actual frequency from Step 2.

For satellite receivers with **multiple receive frequencies**, calculate the frequency of the alignment signal as follows:

Step 1. From the site documentation or the RSS, note the receive frequency for each channel supported by the satellite receiver.

Step 2. Calculate a midpoint frequency as follows:

$$F_{mid} = (F_{highest} + F_{lowest}) \div 2$$

Step 3. Using F_{mid} in place of the satellite receiver receive frequency, perform Step 2 thru Step 4 from above.

VHF Tuning Procedure (Continued)

Preparing Equipment

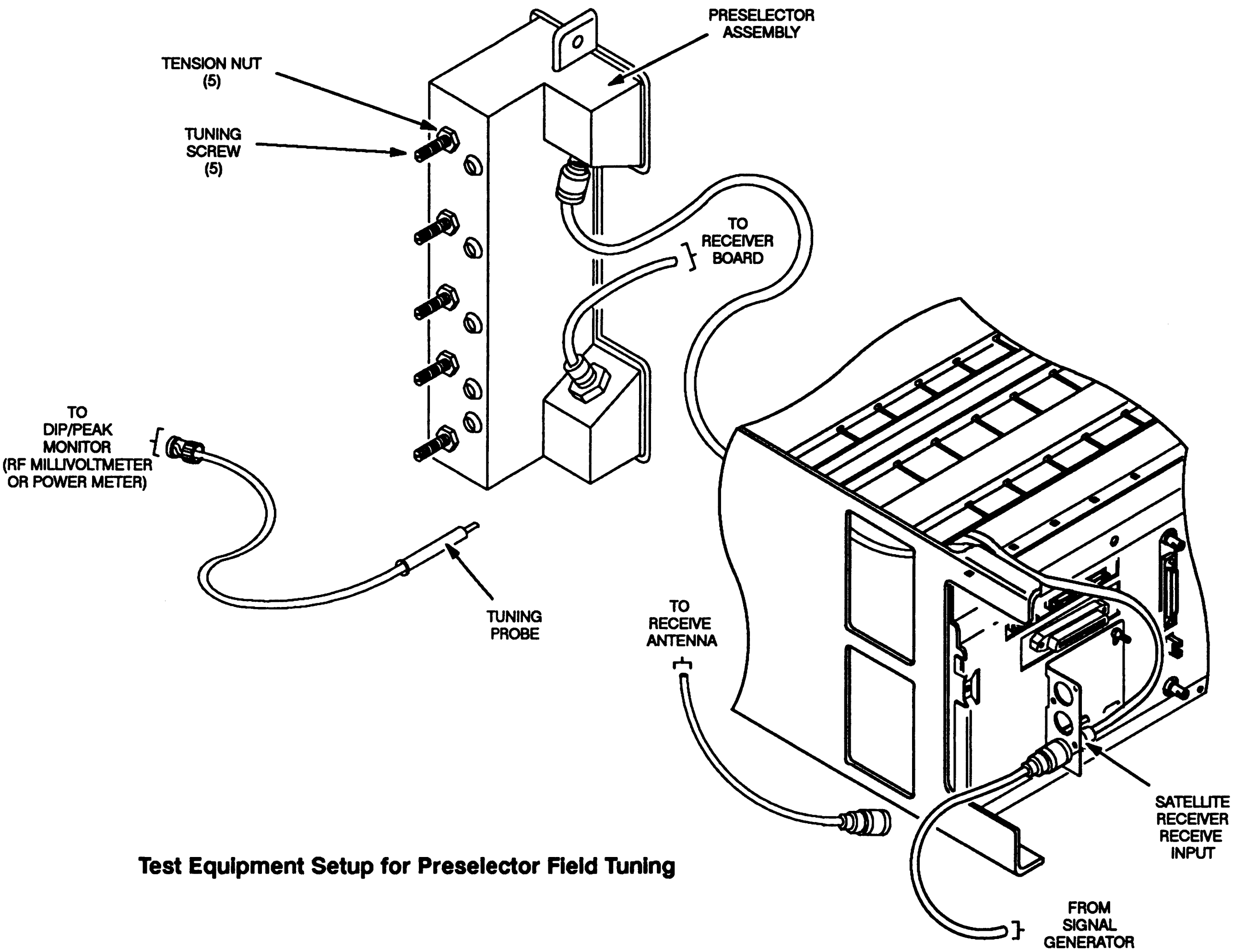
Step 1. Make sure Receiver Module (with Preselector Assembly) is installed in a functional satellite receiver cage equipped with a Power Supply Module.

Step 2. Remove the two Torx-head screws from the Receiver Module front panel and remove the panel.

Step 3. Detune the preselector as follows.
If the alignment frequency (calculated on the previous page) is greater than 148 MHz (Range 1) or 156 MHz (Range 2), turn the five tuning screws in (CW) until 1/8" protrudes past each of the tension nuts. If the alignment frequency is less than or equal to 148 MHz (Range 1) or 156 MHz (Range 2), back out (CCW) the five tuning screws until ¾" protrudes past each of the tension nuts.

Step 4. Using the torque driver and deep well socket, tighten the five tension nuts on the adjustment screws to 6 in-lbs.

Step 5. Connect the test equipment as shown below:



Test Equipment Setup for Preselector Field Tuning

VHF Tuning Procedure (Continued)

IMPORTANT

When tuning for peak or dip, turn the tuning screw ½ turn past the peak or dip to verify that you have obtained a true peak or dip. After ensuring you have found true peak or dip, turn the screw back to the location of the original peak or dip.

Tuning Procedure

Step 1. Turn the satellite receiver power supply ON (to provide the active 50Ω termination).

Step 2. Adjust the signal generator to the frequency calculated on page 24. Set the level to +5 dBm.

Step 3. Insert tuning probe into cavity H1 and adjust tuning screw 1 for a **PEAK.**

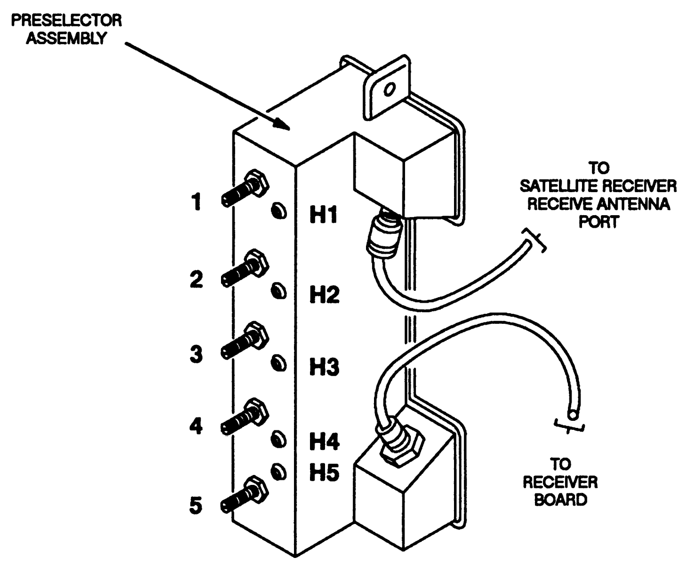
Step 4. Leave tuning probe in cavity H1 and adjust tuning screw 2 for a **DIP**.

Step 5. Insert tuning probe into cavity H2 and adjust tuning screw 3 for a **DIP.**

Step 6. Insert tuning probe into cavity H3 and adjust tuning screw 4 for a **DIP.**

Step 7. Insert tuning probe into cavity H4. Decrease output from signal generator to -5 dBm.

Step 8. Adjust tuning screw 5 for a **DIP**. Then turn tuning screw 5 ¼ turn CCW. (Note that dip will not be as sharp for screw 5 as it was for screws 2 thru 4.)



Location of Tuning Screws and Cavity Probe Holes

UHF Tuning Procedure

Calculating Proper Alignment Frequency

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

For satellite receivers with a **single receive frequency**, calculate the frequency of the alignment signal as follows:

Step 1. From the site documentation or the RSS, determine the satellite receiver receive frequency. **Add 200 kHz.**

Step 2. If Receiver Module is **Range 1**, determine the alignment frequency as follows:

If frequency (from Step 1) is > 431 MHz, then alignment frequency = 431 MHz.

If frequency (from Step 1) is < 405 MHz, then alignment frequency = 405 MHz.

Otherwise, use actual frequency from Step 1.

Step 3. If Receiver Module is **Range 2**, determine the alignment frequency as follows:

If frequency (from Step 1) is > 468 MHz, then alignment frequency = 468 MHz.

If frequency (from Step 1) is < 440 MHz, then alignment frequency = 440 MHz.

Otherwise, use actual frequency from Step 1.

Step 4. If Receiver Module is **Range 3 or 4**, determine the alignment frequency as follows:

If frequency (from Step 1) is > 518 MHz, then alignment frequency = 518 MHz.

If frequency (from Step 1) is < 472 MHz, then alignment frequency = 472 MHz.

Otherwise, use actual frequency from Step 1.

Otherwise, use actual frequency from Step 1.

For satellite receivers with **multiple receive frequencies**, calculate the frequency of the alignment signal as follows:

Step 1. From the site documentation or the RSS, note the receive frequency for each channel supported by the satellite receiver.

Step 2. Calculate a midpoint frequency as follows:

$$F_{mid} = (F_{highest} + F_{lowest}) \div 2$$

Step 3. Using F_{mid} in place of the satellite receiver receive frequency, perform Step 1 thru from above Step 4.

UHF Tuning Procedure (Continued)

Preparing Equipment

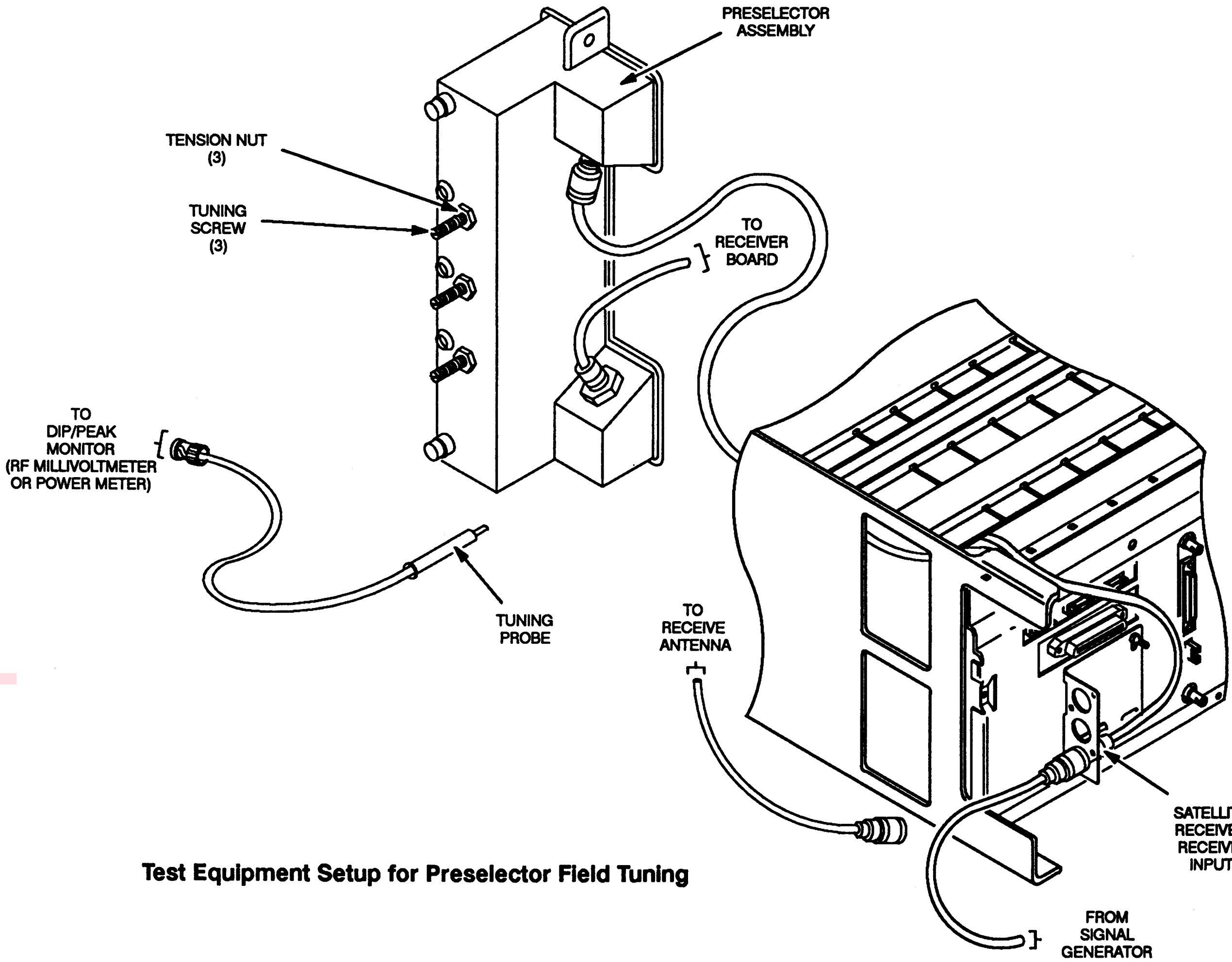
Step 1. Make sure Receiver Module (with Preselector Assembly) is installed in a functional cage equipped with a Power Supply Module.

Step 2. Remove the two Torx-head screws from the Receiver Module front panel and remove the panel.

Step 3. Using the torque driver and deep well socket, loosen the three tension nuts on the adjustment screws.

Step 4. Detune the preselector as follows.
Turn tuning screws **3** and **4** clockwise until they bottom out. Be careful not to apply more than 3 in-lbs of torque to prevent warping preselector cover and housing.

Step 5. Connect the test equipment as shown below:



Test Equipment Setup for Preselector Field Tuning

UHF Tuning Procedure (Continued)

IMPORTANT

When tuning for peak or dip, turn the tuning screw ½ turn past the peak or dip to verify that you have obtained a true peak or dip. After ensuring you have found true peak or dip, turn the screw back to the location of the original peak or dip.

Tuning Procedure

Step 1. Turn the satellite receiver power supply ON (to provide the active 50Ω termination).

Step 2. Adjust the signal generator to the frequency calculated on page 24. Set the level to +5 dBm.

Step 3. Insert tuning probe into cavity U2 and adjust tuning screw 2 for a **PEAK**.

Step 4. Tighten tension nut on tuning screw 2 to at least 12 in-lb and fine tune tuning screw 2 for a **PEAK**.

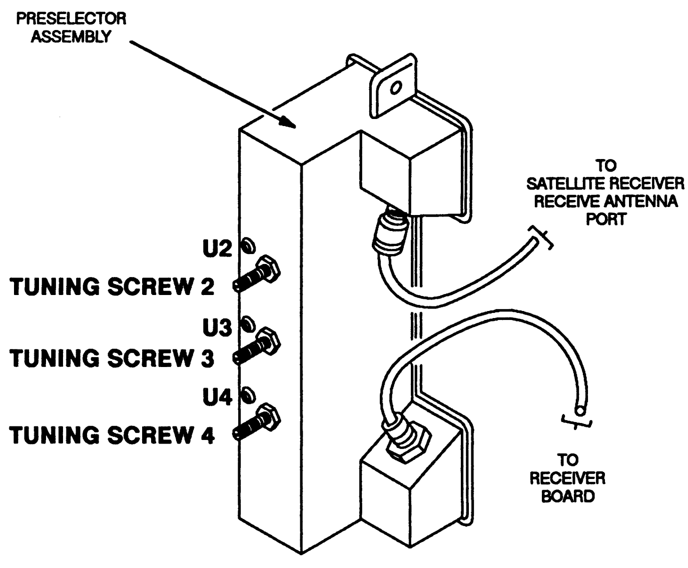
Step 5. Keep tuning probe in cavity U2 and adjust tuning screw 3 for a **DIP**.

Step 6. Tighten tension nut on tuning screw 3 to at least 12 in-lb and fine tune tuning screw 2 for a **DIP**.

Step 7. Insert tuning probe into cavity U3. Decrease output from signal generator to -5 dBm.

Step 8. Adjust tuning screw 4 for a **DIP**.

Step 9. Tighten tension nut on tuning screw 4 to at least 12 in-lb and fine tune tuning screw 4 for a **DIP**.



Location of Tuning Screws and Cavity Probe Holes

RECEIVER CIRCUITRY

MOTOROLA

RECEIVER MODULE

INCLUDES MODELS:
TRD6361A Receiver Board(132–154 MHZ)
TFD6511A Preselector Filter (132–154 MHZ)
TRD6362A Receiver Board (150–174 MHZ)
TFD6512A Preselector Filter (150–174 MHZ)

1 DESCRIPTION

The *Quantar* VHF High Band Receiver Modules are 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 Receiver Module provides the receiver functions for the *Quantar* VHF station. Each receiver module is comprised of a Preselector Filter Assembly and a Receiver Board, all contained within a slide–in module housing. The receiver module performs highly selective bandpass filtering and dual down conversion of the station receive 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.

The Models TFD6511/TFD6512 Preselector Filter Assemblies and the TRD6361/TRD6362 Receiver Boards differ only in the range of operation. Models TFD6511/TRD6361 operate in VHF Range 1 (132–154MHz); Models TFD6512/TRD6362 operate in VHF Range 2 (150–174MHz). Unless otherwise noted, the information provided in this section applies to all models.

Overview of Circuitry

The receiver module contains the following circuitry:

- Frequency Synthesizer Circuitry – consisting of a phase–locked loop and VCO, generates the 1st LO injection signal
- Preselector Filter Assembly – provides 5–pole bandpass filtering of the station receive rf input
- Receiver Front End Circuitry – performs filtering, amplification, and the 1st down conversion of the receive rf signal
- Custom Receiver IC Circuitry – consists of a custom IC which performs the 2nd down conversion, filtering, amplification, and analog to digital conversion of the receive signal
- Address Decode & A/D Converter Circuitry – performs address decoding to provide board and chip select signals; also converts analog status signals to digital format for transfer to Station Control Module
- Local Power Supply Regulation – accepts +14.2V dc input and outputs +10V and +5V dc operating voltages

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the receiver module controls, indicators, and all input and output external connections.

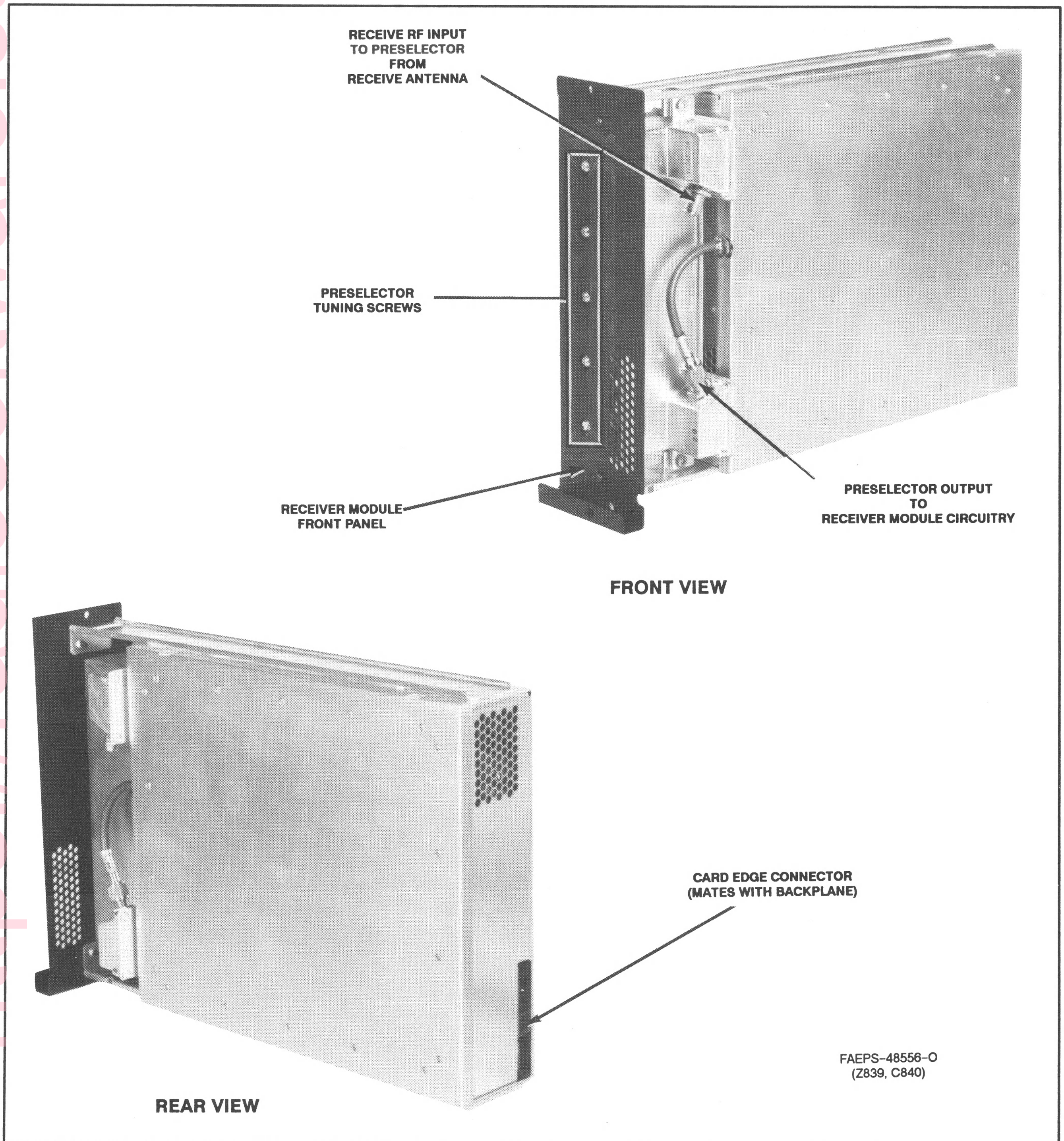

Figure 1. *Quantar* VHF Receiver Module Controls, Indicators, and Inputs/Outputs

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 generate the 1st LO injection signal for the 1st 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 the Station Control Module) with a 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*. (Note that 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 1st LO injection signal. Within each band (Range 1 and Range 2), 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 ampifier and impedance matching and output to the 1st 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.

Preselector Filter Assembly

The preselector filter assembly provides 5 poles of bandpass filtering for the station receive rf input signal. The filter assembly is mounted to the front of the receiver module housing and provides mini-UHF connectors for input from the receive antenna and output to the receiver board. Tuning screws are provided for filter tuning. (Refer to the *Troubleshooting* section in this manual for instructions on tuning the preselector assembly.)

Receiver Front End Circuitry

The receive rf input is fed from the antenna through the 5-pole preselector assembly to the receiver board. The signal is low-pass filtered, amplified, image filtered, and fed to one input of the 1st mixer. The signal is mixed with the 1st LO injection signal (generated by the synthesizer/VCO circuitry) to produce a 21.45 MHz 1st i-f signal.

The 1st i-f signal is 2-pole bandpass filtered and fed to an amplifier. The amplifier gain (high or low) is determined by an AGC switch circuit that is controlled by an AGC select signal from the Station Control Board. The amplified 1st 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 2nd i-f signal. The digital receive signal is then output via differential driver circuitry to the Station Control Board. This data signal contains the necessary I and Q quadrature information, AGC information, and other data transfer information required by the Station Control Board to process the receive signal. (Note that 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 Board and on the Wireline Interface Board at the phone line connections to and from the station.)

The remainder of the custom receiver IC circuitry consists of timing and tank circuits to support the internal oscillator, 2nd LO synthesizer circuitry, and 2nd i-f circuitry.

A serial bus allows data communications between the custom receiver IC and the DSP ASIC located on the Station Control Board. This bus allows the DSP ASIC to control various current and gain settings, establish the data bus clock rate, program the 2nd LO, and perform other control functions.

Address Decode and A/D Converter Circuitry

Address Decode Circuitry

The address decode circuitry allows the Station Control Board to use the address bus to select a specific device on a specific station board for control or data communications purposes (via the SPI bus). If the board select circuitry decodes address lines A2 thru A5 as the receiver module address, it enables the chip select circuitry. The chip select circuitry then decodes address lines A0 and A1 and generates chip select signals for the PLL and A/D converter and the *SYNTH ADAPT* signal to control the loop filter bypass switch in the synthesizer circuitry.

A/D Converter Circuitry

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

Voltage Regulator Circuitry

The voltage regulator circuitry consists of +10V and two +5V regulators. The +10V regulator accepts a +14.2V dc input and generates a +10V dc operating voltage for the receiver board circuitry.

The +10V regulator output also feeds two +5V regulators which output Custom Analog +5V and Custom Digital +5V dc operating voltages to supply the custom receiver IC. In addition, a +5V dc operating voltage is input at the backplane (from the station power supply) to supply Digital +5V to the remainder of the receiver board circuitry.

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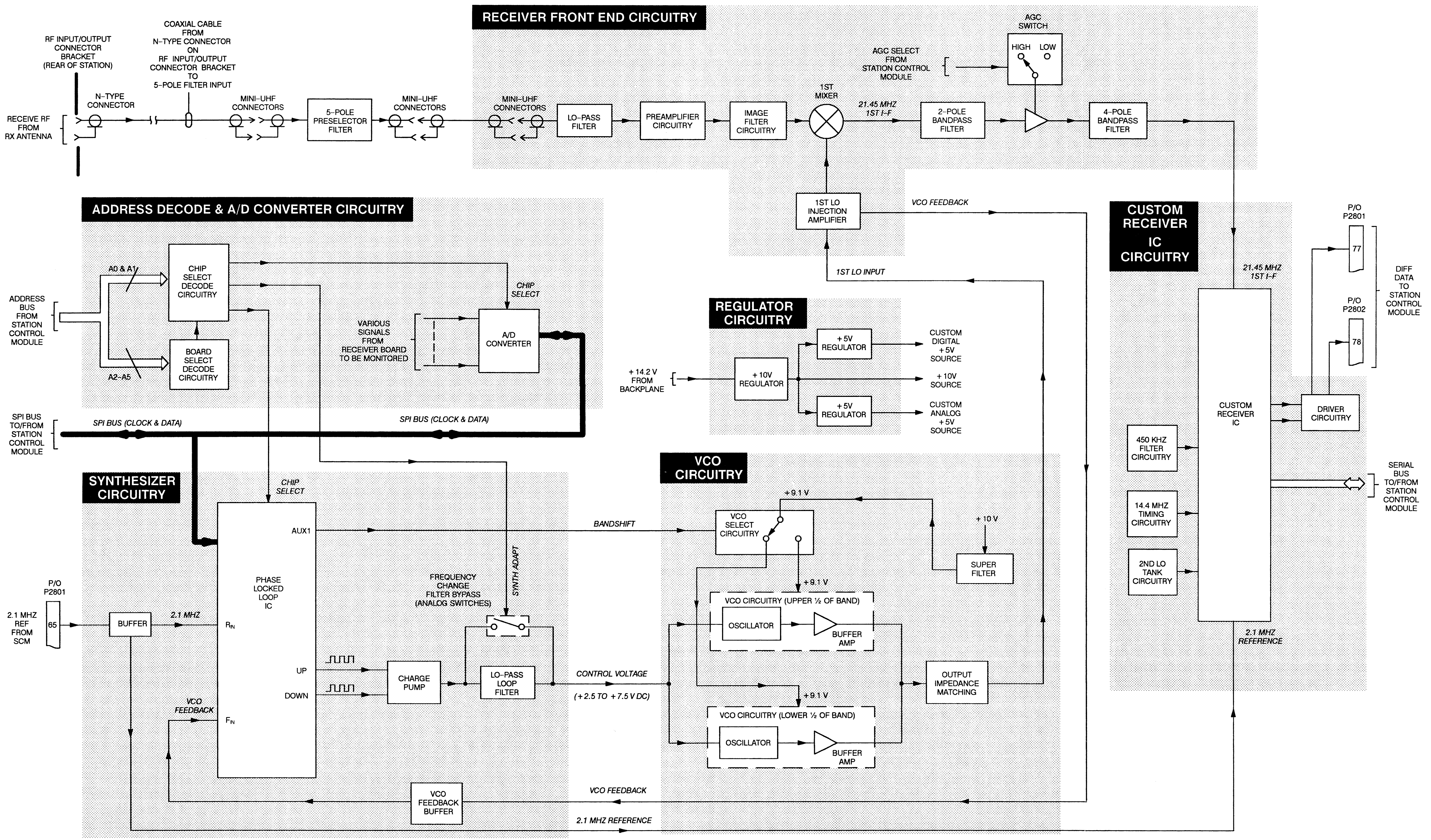

Figure 2. VHF Ranges 1 and 2 Receiver Module Functional Block Diagram

MOTOROLA

RECEIVER MODULE

INCLUDES MODELS:

TRE6281A-C Receiver Board/TLE5991A Preselector (403-433 MHZ)
TRE6282A-C Receiver Board/TLE5992A Preselector (438-470 MHZ)
TRE6283A-C Receiver Board/TLE5993A Preselector (470-494 MHZ)
TRE6284A-C Receiver Board/TLE5993A Preselector (494-520 MHZ)

1 DESCRIPTION

The *Quantar/Quantro* UHF Receiver Modules (ranges 1 thru 4) are 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 equipment modules.)

General Description

The Receiver Module provides the receiver functions for the *Quantar/Quantro* communications equipment. Each receiver module is comprised of a Preselector Filter Assembly and a Receiver Board, all contained within a slide-in module housing. The receiver module performs highly selective bandpass filtering and dual down conversion of the receive 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.

The preselector and receiver board models differ only in the range of operation. Unless otherwise noted, the information provided in this section applies to all models.

Overview of Circuitry

The receiver module contains the following circuitry:

- Frequency Synthesizer Circuitry – consisting of a phase-locked loop and VCO, generates the 1st LO injection signal
- Preselector Filter Assembly – provides 3-pole bandpass filtering of the receive rf input
- Receiver Front End Circuitry – performs filtering, amplification, and the 1st down conversion of the receive rf signal
- Custom Receiver IC Circuitry – consists of a custom IC which performs the 2nd down conversion, filtering, amplification, and analog to digital conversion of the receive signal
- Address Decode & A/D Converter Circuitry – performs address decoding to provide board and chip select signals; also converts analog status signals to digital format for transfer to Station Control Module
- Local Power Supply Regulation – accepts +14.2 V dc input and outputs +10V and +5V dc operating voltages

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the receiver module controls, indicators, and all input and output external connections.

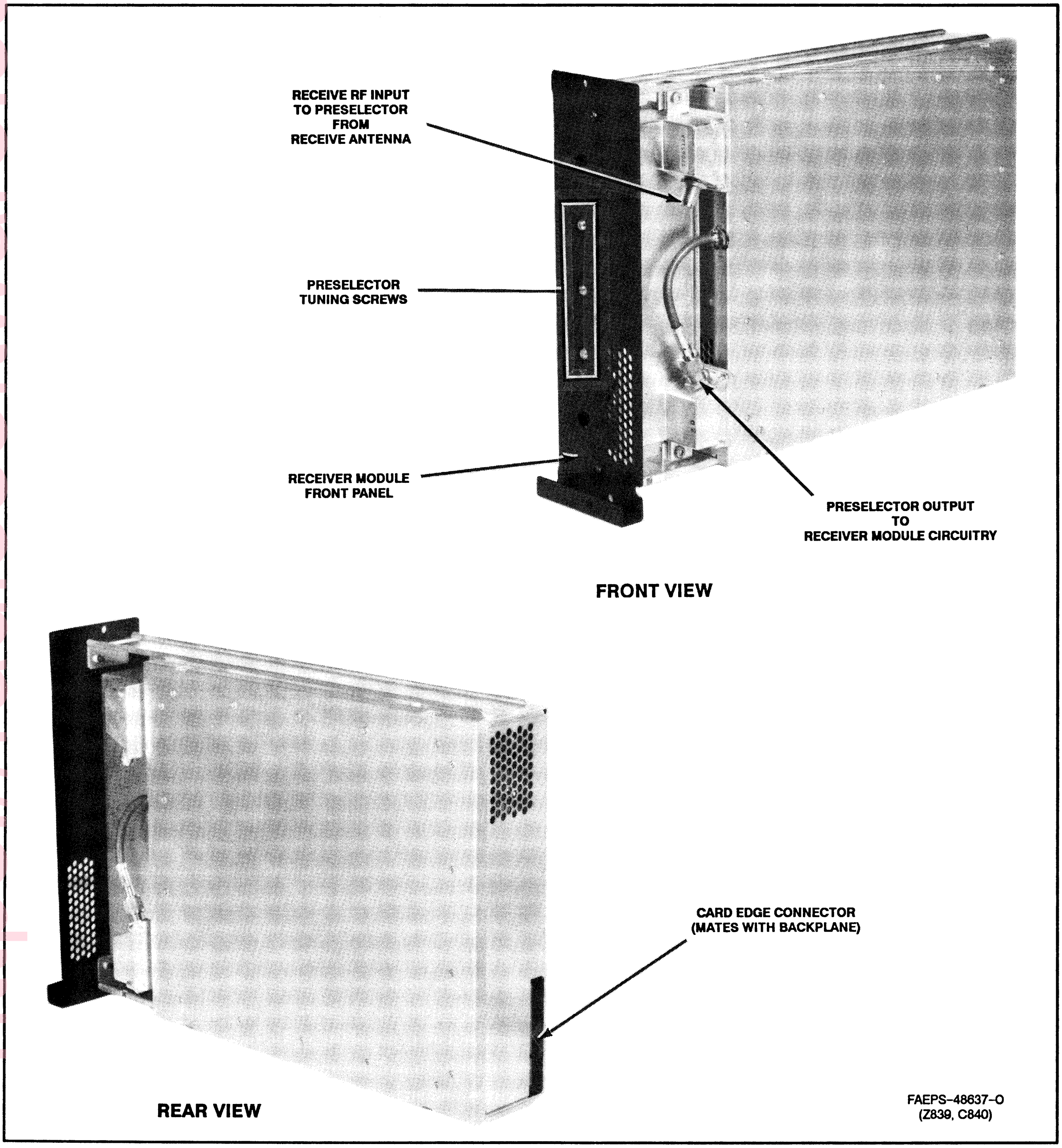

Figure 1. UHF Receiver Module Controls, Indicators, and Inputs/Outputs

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 generate the 1st LO injection signal for the 1st 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 the Station Control Module) with a 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*. (Note that 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 1st LO injection signal. Within each band (Ranges 1 thru 4), 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 1st 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.

Preselector Filter Assembly

The preselector filter assembly provides 3 poles of bandpass filtering for the receive rf input signal. The filter assembly is mounted to the front of the receiver module housing and provides mini-UHF connectors for input from the receive antenna and output to the receiver board. Tuning screws are provided for filter tuning. (Refer to the *Troubleshooting* section in this manual for instructions on tuning the preselector assembly.)

Receiver Front End Circuitry

The receive rf input is fed from the antenna through the 3-pole preselector assembly to the receiver board. The signal is low-pass filtered, amplified, image filtered, and fed to one input of the 1st mixer. The signal is mixed with the 1st LO injection signal (generated by the synthesizer/VCO circuitry) to produce a 73.35 MHz 1st i-f signal.

The 1st i-f signal is 2-pole bandpass filtered and fed to an amplifier. The amplifier gain (high or low) is determined by an AGC switch circuit that is controlled by an AGC select signal from the Station Control Module. The amplified 1st 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 2nd i-f signal. The digital receive signal is then output via differential driver circuitry to the Station Control Board. This 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. (Note that the recovered audio signal is in digital format throughout the equipment circuitry, resulting in a more noise-free, linear receiver. Analog audio is present only in the external speaker driver circuitry on the Station Control Board and on the Wireline Interface Board at the phone line connections to and from the equipment.)

The remainder of the custom receiver IC circuitry consists of 2nd LO VCO circuitry and timing and tank circuits to support internal circuitry.

A serial bus allows data communications between the custom receiver IC and the DSP ASIC located on the Station Control Board. This bus allows the DSP ASIC to control various current and gain settings, establish the data bus clock rate, program the 2nd LO, and perform other control functions.

Address Decode and A/D Converter Circuitry

Address Decode Circuitry

The address decode circuitry allows the Station Control Board to use the address bus to select a specific device on a specific station board for control or data communications purposes (via the SPI bus). If the board select circuitry decodes address lines A2 thru A5 as the receiver module address, it enables the chip select circuitry. The chip select circuitry then decodes address lines A0 and A1 and generates chip select signals for the PLL and A/D converter and the *SYNTH ADAPT* signal to control the loop filter bypass switch in the synthesizer circuitry.

A/D Converter Circuitry

Analog signals from various strategic operating points throughout the receiver board are fed to the 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 +10V and three +5V regulators. The +10V regulator accepts a +14.2V dc input and generates a +10V dc operating voltage for the receiver board circuitry.

The +10V regulator output also feeds three +5V regulators. Two of the regulators provide Custom Analog +5V and Custom Digital +5V dc operating voltages to supply the custom receiver IC. The third regulator provides Synth +5V to supply the synthesizer circuitry.

In addition, a +5V dc operating voltage is input at the backplane (from the station power supply) to supply Digital +5V to the remainder of the receiver board circuitry.

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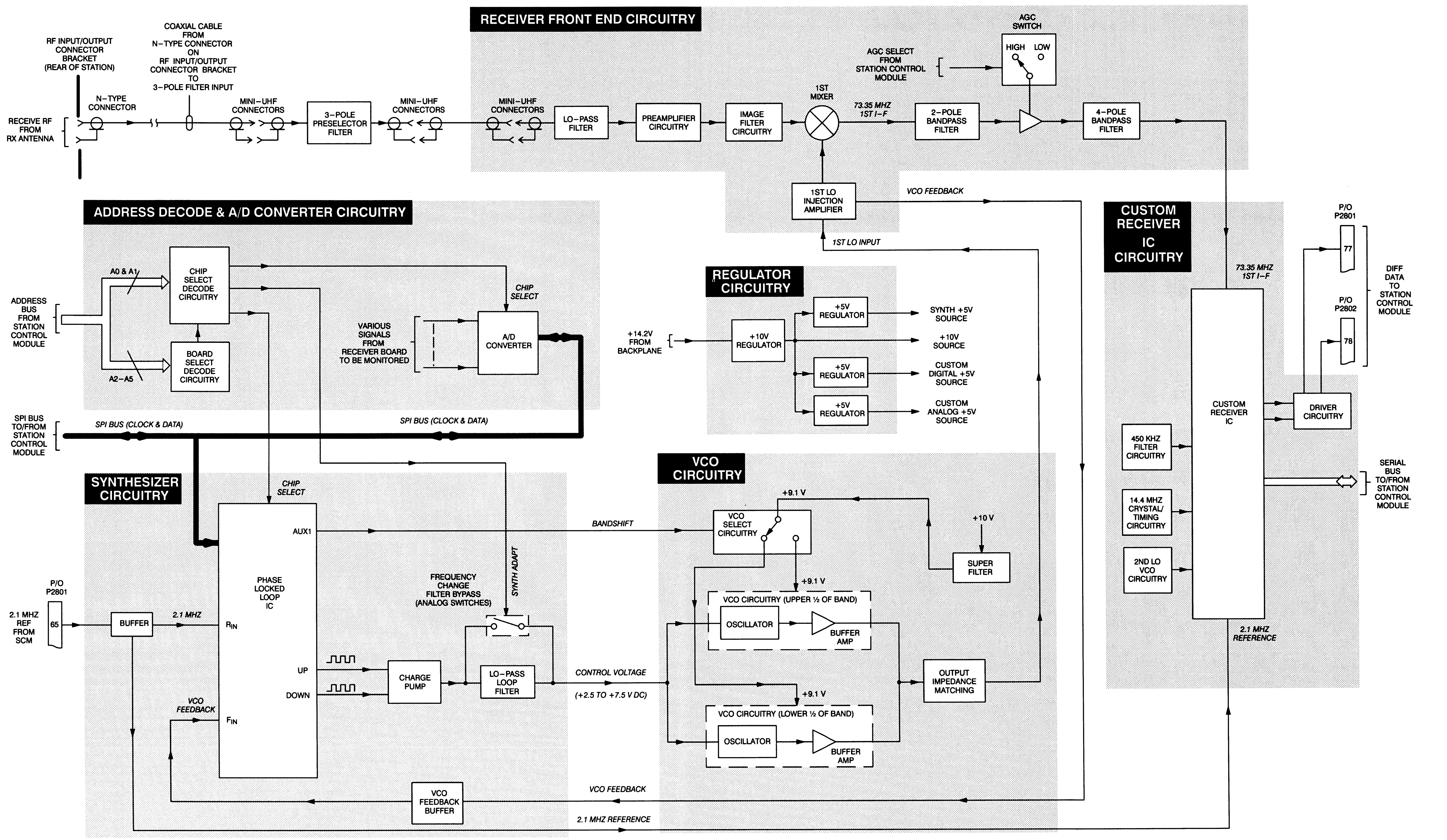

Figure 2. *Quantar/Quantro* UHF (Ranges 1 thru 4) Receiver Module Functional Block Diagram

MOTOROLA

RECEIVER MODULE

Includes TRF6551A Receiver Board

1 DESCRIPTION

The *Quantro* 800 MHz Receiver Module 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 Receiver Module provides the receiver functions for the *Quantro* 800 MHz station. The receiver module is comprised of a Receiver Board and a ceramic preselector (mounted on board), all contained within a slide-in module housing. The receiver module performs highly selective bandpass filtering and dual down conversion of the station receive 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 1st LO injection signal
- Ceramic Preselector Filter – provides 7-pole bandpass filtering of the station receive rf input
- Receiver Front End Circuitry – performs filtering, amplification, and the 1st down conversion of the receive rf signal
- Custom Receiver IC Circuitry – consists of a custom IC which performs the 2nd down conversion, filtering, amplification, and analog to digital conversion of the receive signal
- Address Decode & A/D Converter Circuitry – performs address decoding to provide board and chip select signals; also converts analog status signals to digital format for transfer to Station Control Module
- Local Power Supply Regulation – accepts +14.2V dc input and outputs +10V and +5V dc operating voltages

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the receiver module controls, indicators, and all input and output external connections.

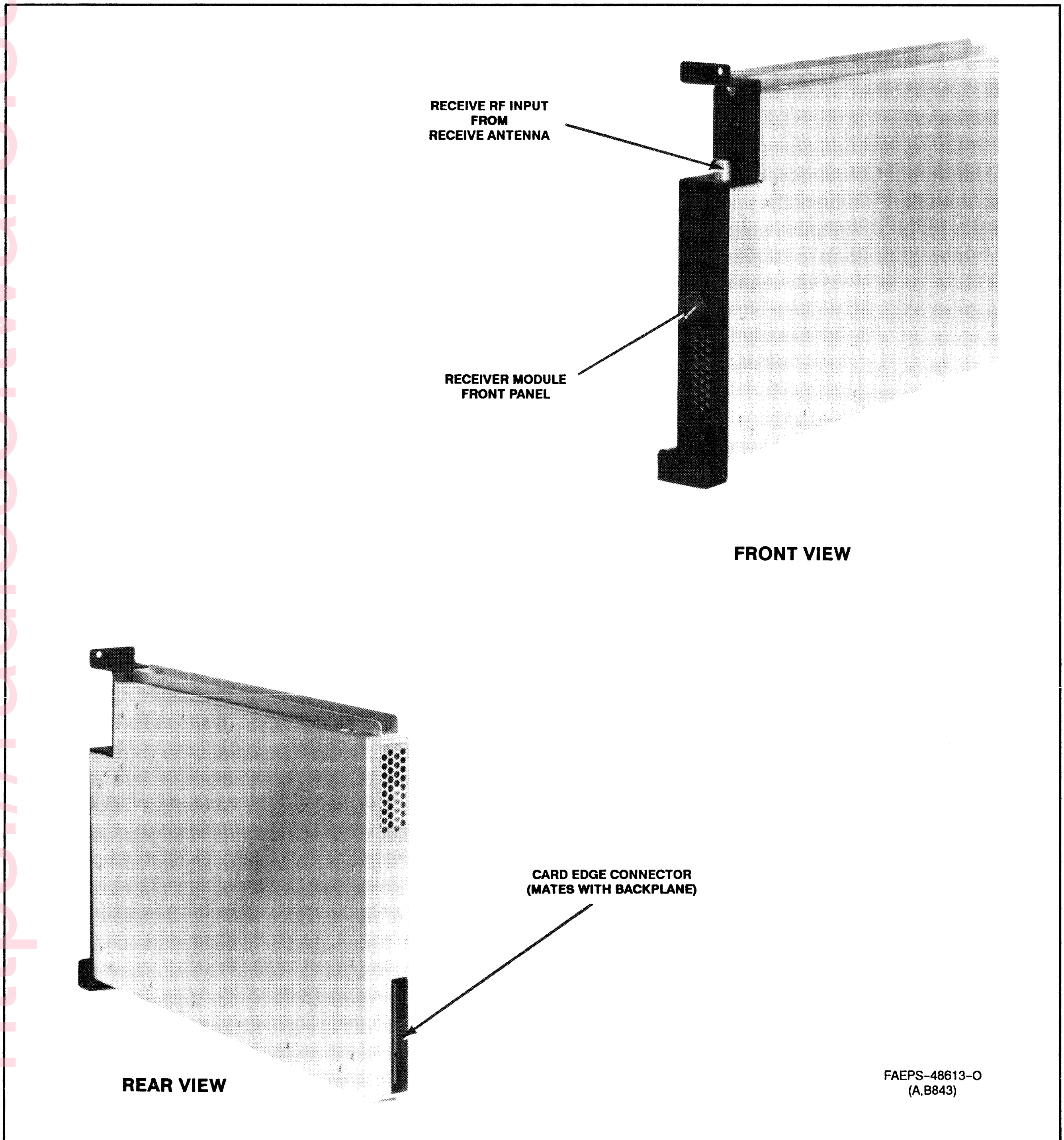

Figure 1. *Quantro* 800 MHz Receiver Module Controls, Indicators, and Inputs/Outputs

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 generate the 1st LO injection signal for the 1st 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 the Station Control Module) with a 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*. (Note that 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 1st 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 1st 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 receive rf input is fed from the antenna to a 7–pole ceramic preselector filter which provides highly selective bandpass filtering. The output of the preselector filter is then low–pass filtered, amplified, image filtered, and fed to one input of the 1st mixer. The signal is mixed with the 1st LO injection signal (generated by the synthesizer/VCO circuitry) to produce a 73.35 MHz 1st i–f signal.

The 1st i–f signal is 2–pole bandpass filtered and fed to an amplifier. The amplifier gain (high or low) is determined by an AGC switch circuit that is controlled by an AGC select signal from the Station Control Module. The amplified 1st 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 2nd i–f signal. The digital receive signal is then sent via differential driver circuitry to the Station Control Board. This 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. (Note that 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 Board and on the Wireline Interface Board at the phone line connections to and from the station.)

The remainder of the custom receiver IC circuitry consists of timing and tank circuits to support the internal oscillator, 2nd LO synthesizer circuitry, and 2nd i–f circuitry.

A serial bus allows data communications between the custom receiver IC and the DSP ASIC located on the Station Control Board. This bus allows the DSP ASIC to control various current and gain settings, establish the data bus clock rate, program the 2nd LO, and perform other control functions.

Address Decode and A/D Converter Circuitry

Address Decode Circuitry

The address decode circuitry allows the Station Control Board to use the address bus to select a specific device on a specific station board for control or data communications purposes (via the SPI bus). If the board select circuitry decodes address lines A2 thru A5 as the receiver module address, it enables the chip select circuitry. The chip select circuitry then decodes address lines A0 and A1 and generates chip select signals for the PLL and A/D converter and the *SYNTH ADAPT* signal to control the loop filter bypass switch in the synthesizer circuitry.

A/D Converter Circuitry

Analog signals from various strategic operating points throughout the receiver board are fed to the 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 +10V and two +5V regulators. The +10V regulator accepts a +14.2V dc input and generates a +10V dc operating voltage for the receiver board circuitry.

The +10V regulator output also feeds two +5V regulators which output Custom Analog +5V and Custom Digital +5V dc operating voltages to supply the custom receiver IC and Synthesizer IC. In addition, a +5V dc operating voltage is input at the backplane (from the station power supply) to supply Digital +5V to the remainder of the receiver board circuitry.

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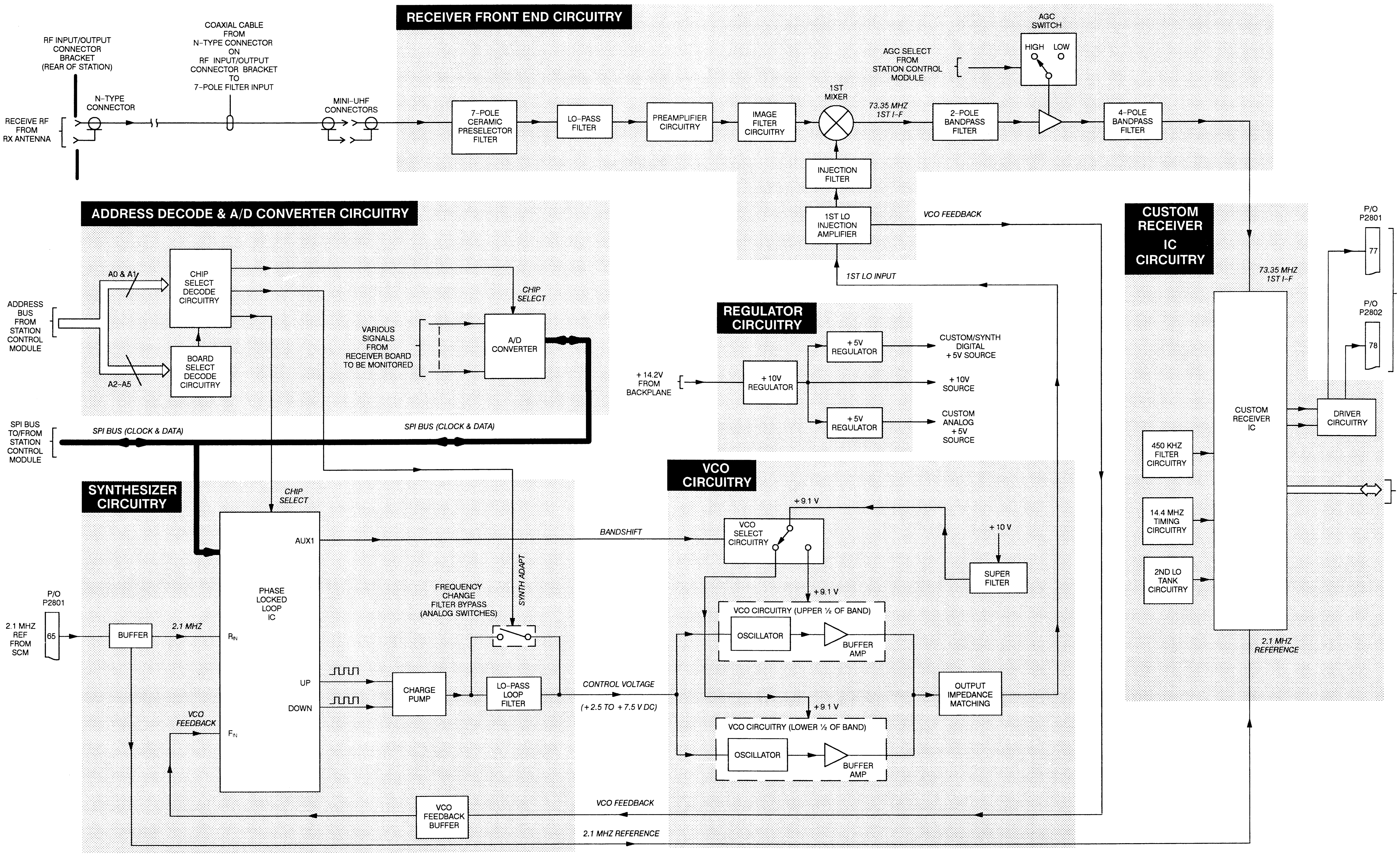

Figure 2. *Quantro* 800 MHz Receiver Module Functional Block Diagram

MOTOROLA

STATION CONTROL MODULE

MODELS TRN7474A
TRN7475A
TRN7760A

1 DESCRIPTION

The Models TRN7474A, TRN7475A, and TRN7660A Station Control Modules (SCM) are 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 for the station. The SCM board contains a 68302 microprocessor, a 56002 Digital Signal Processor, and support circuitry which combine to provide signal processing and operational control over the other station modules. The SCM also contains the station operating software and codeplug which define the personality of the station, including system capabilities (*ASTRO*, *SECURENET*, *IntelliRepeater*, etc.) and operating parameters such as output power and operating frequency.

The Models TRN7474A, TRN7475A, and TRN7760A SCMs provide three levels of capabilities and standard features. The TRN7474A is considered the basic model, suitable for most conventional systems not requiring MRTI, Data (GCC), 6809 trunking, or *IntelliRepeater* capabilities. The TRN7475A provides for MRTI, Data (GCC), and 6809 trunking capabilities, and is easily upgraded to support *IntelliRepeater* applications. The TRN7760A is a full-featured model and is required for use in *IntelliRepeater* applications. Specific differences among the three models are shown throughout the functional block diagram (Figure 2).

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Overview of Circuitry

The SCM contains the following circuitry:

- Host Microprocessor and Host ASIC – two ICs which comprise the central controller of the SCM and station.
- Non-Volatile Memory – consists of EPROMs that contain the station operating software and an EEPROM that contains the station codeplug data
- DRAM Memory – Dynamic RAM into which station software is downloaded and executed
- External Line Interface Circuitry – provides interface between the SCM and external devices such as *IntelliRepeater* DLAN ports, RSS port, and miscellaneous backplane connectors
- Digital Signal Processor (DSP) and DSP ASIC Circuitry– performs high-speed processing of audio and signaling data signals
- Station Reference Circuitry – generates the 2.1 MHz reference signal used throughout the station
- HDLC Bus Control Circuitry – provides bus control to allow Host Microprocessor communications port SCC1 to communicate with the Wireline Interface Board and other optional modules via the HDLC interprocessor communications bus
- Audio Interface Circuitry – routes the various audio input signals (such as microphone, wireline, and receiver audio) to output devices (such as external speaker, built-in local speaker, and exciter modulation inputs)
- Input / Output Ports Circuitry – three 16-line output buses allow miscellaneous control signals to be sent to various circuits throughout the station; two 16-line input buses allow miscellaneous inputs to be received from throughout the station
- Front Panel LEDs and Switches – general purpose input/output ports control eight status LEDs and accept inputs from four momentary switches, all located on the SCM front panel
- Supply Voltages Circuitry – contains filtering and regulator circuitry which accepts +14.2 V and +5 V from backplane and generates the operating voltages required by the SCM circuitry

2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

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

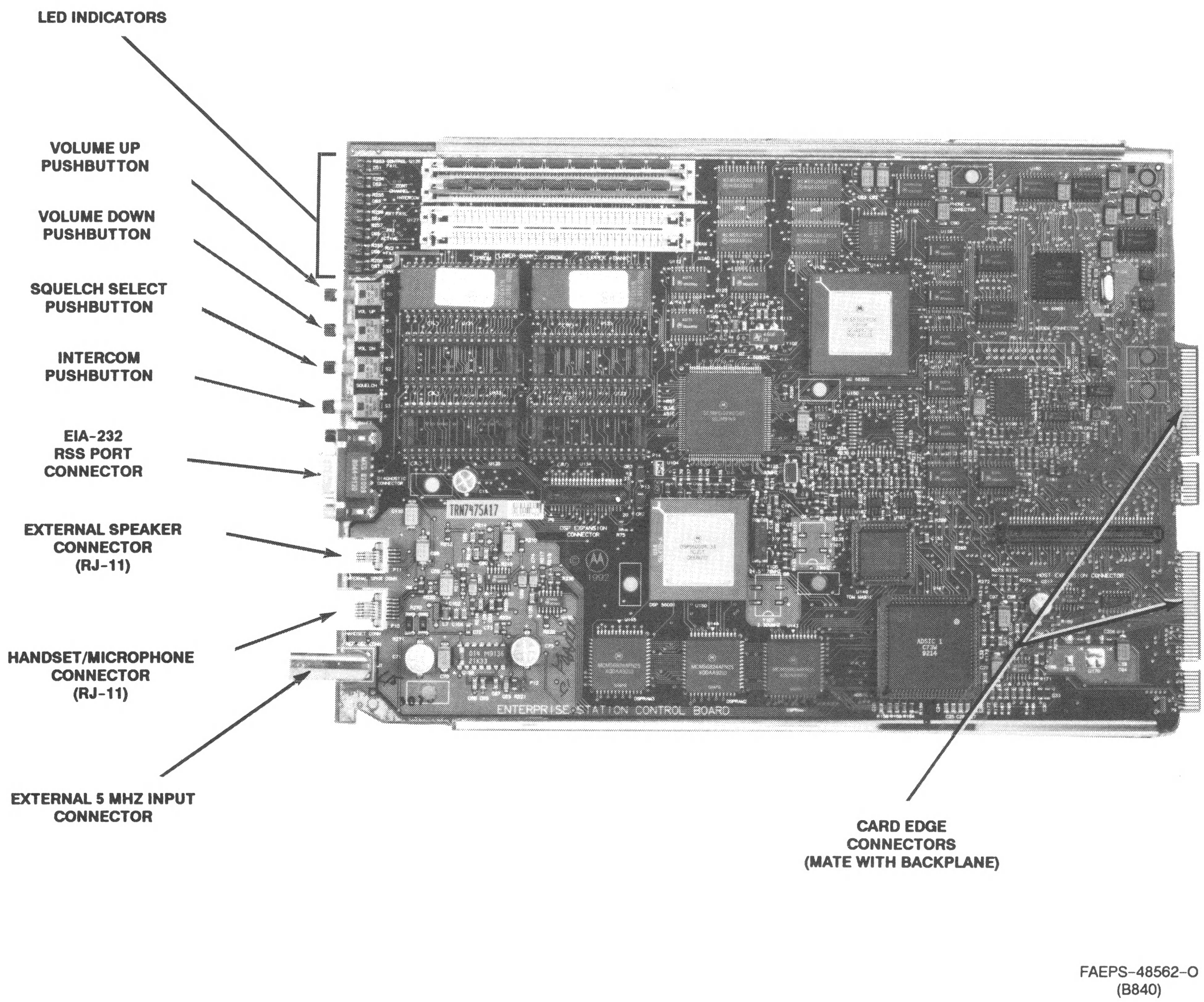

Figure 1. Station Control Module Controls, Indicators, and Inputs/Outputs (TRN7475A shown)

3 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the SCM 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 SCM.

Host Microprocessor/ Host ASIC Circuitry

Host Microprocessor

The Host Microprocessor (µP) serves as the main controller for the SCM (and station). The µP, an MC68302 running at a clock speed of 16.5 MHz (from the Host ASIC), controls the operation of the station as determined by the station software (contained in two EPROMs) and the station codeplug (EEPROM).

The µP provides three general-purpose serial communications buses, as follows:

- SCC1 – Used as the Interprocessor Communications Bus (HDLC protocol) to allow the Host µP to communicate with the Wireline Interface Board and other optional modules
- SCC2 – Used as primary port to allow the station to connect into the local network of an *IntelliRepeater* trunking site; bus is connected to 9-pin D-type connector located on backplane (DLAN1) via a dual LocalTalk Interface IC and bus transceiver (p/o External Line Interface Circuitry on SCM board)
- SCC3 – Used as redundant port to allow the station to connect into the local network of an *IntelliRepeater* trunking site; bus is multiplexed between **1)** a 9-pin D-type connector located on backplane (DLAN2) via a dual LocalTalk Interface IC and bus transceiver (p/o External Line Interface Circuitry on SCM board), and **2)** a 25-pin D-type connector located on backplane (future use) via EIA-232 bus receivers/drivers.

The µP is equipped with a 23-line address bus used to access the non-volatile memory, DRAM memory, and provide control (via memory mapping) for other circuitry in the SCM. A 16-line data bus (buffered for the non-volatile and DRAM memory) is used to transfer data to/from the SCM memory, as well as other SCM circuitry.

Host ASIC

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

- SPI Bus – The SPI bus is used as a general-purpose communications bus to allow the Host µP to communicate with other modules in the station.
- DRAM Controller – provides signals necessary to access and refresh the DRAM memory.

(continued)

Host Microprocessor/ Host ASIC Circuitry (Continued)

- Battery Backup Select (Reset) – The Host ASIC generates a RESET signal which is used to select (via a multiplexer) the source of the DRAM backup signals [either from the Host ASIC (under normal conditions), or the Battery Backup DRAM Refresh Circuitry (under battery backup conditions)].
- Host µP Clock – The Host ASIC buffers the 33 MHz crystal outputs, performs a divide–by–2, and outputs a clock signal for the Host µP at 16.5 MHz.
- Address Decoding – provides decoding of addressing from Host µP and generates corresponding chip select signals for various SCM devices, such as DRAM, EPROM, DUART, I/O Ports, DSP, and internal Host ASIC registers.
- Interrupt Controller – accepts interrupt signals from various SCM circuits (such as the DSP and DUART), prioritizes the interrupts (based on hardware–defined priority ranking), and sends interrupt and priority level information to Host µP (via IPL lines 1–3).

Non–Volatile Memory

Station Software EPROMs

The station software resides in two 256K x 8 EPROMs. These EPROMs are accessed by the Host µP via the 23–line Host Address Bus and the 16–line Host Data Bus.

Codeplug EEPROM

The data which determines the station personality resides in an 8K x 8 codeplug EEPROM. Stations are shipped from the factory with generic default data programmed into the codeplug EEPROM. 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.

DRAM Memory

Note:
*Models TRN7474A and TRN7475A contain two 256K x 8 DRAM SIMMs (additional memory required for use in **IntelliRepeater** applications.*

Note:
Battery backup circuitry is provided as part of Model TRN7760A only.

DRAM Memory and Addressing

Each SCM contains a minimum of .5 Mbyte of DRAM into which the station software code is downloaded and run. The DRAM also provides short-term storage for data generated/required during normal operation. Read and write operations are performed using the Host Address and Data buses in conjunction with column and row select lines from the Host ASIC.

DRAM Battery Backup and Refresh Circuitry

During normal operation (not in battery backup mode), the DRAM memory locations are sequentially refreshed by the address bus and column and row signals from the Host ASIC. If dc power to the SCM should be interrupted, a multiplexer (p/o the DRAM Memory Circuitry) selects row and column signals generated by the Battery Backup DRAM Refresh Circuitry, which is powered by VBB from the Battery Backup Circuitry (refer to Supply Voltages Circuitry, page 11).The DRAM will be refreshed for up to approximately 60 minutes until main power has been restored.

External Line Interface Circuitry

HDLC Bus Transceiver

A high-impedance bus transceiver interfaces the HDLC-protocol communications bus used by the Host µP to communicate with the Wireline Interface Board and other optional modules via an interprocessor communications bus. This bus is provided by one (SCC1) of three general-purpose serial ports provided by the Host µP.

IntelliRepeater *DLAN Network Ports*

Primary (DLAN1) and redundant (DLAN2) ports are provided on the station backplane to allow the station to connect into the local network of an *IntelliRepeater* trunking site. These DLAN ports are provided by Host µP serial communication buses SCC2 and SCC3.

SCC2 serves as one of two inputs to a Dual *LocalTalk* Interface IC which provides the TXD and RXD signals required by the primary DLAN port. These signals are connected to a 9-pin D-type connector located on the station backplane, which typically mates with a *PhoneNET* adapter module connected into the *IntelliRepeater* local network.

SCC3 serves as the other of two inputs to the Dual *LocalTalk* Interface IC and provides a redundant DLAN port at the station backplane.

RSS Port

A 9-pin D-type connector is provided on the SCM front panel to allow service personnel to connect a PC loaded with the Radio Service Software (RSS) and perform programming and maintenance tasks. The RSS port is provided by a DUART which interfaces with the Host Data Bus. The DUART communicates with the RSS port via EIA-232 Bus Receivers/Drivers.

Digital Signal Processor (DSP) and DSP ASIC Circuitry

General

All station transmit and receive audio/data is processed by the DSP and related circuitry. This circuitry includes the DSP IC, the DSP ASIC, and the DSP ASIC Interface Circuitry. All audio signals input to or output from the DSP are in digitized format.

Inputs to the DSP circuitry are:

- Digitized receive signals from the Receiver Module
- Audio from handset or microphone connected to appropriate SCM front panel connector; signal is digitized by CODEC IC (p/o Audio Interface Circuitry) before being sent to DSP via Audio Interface Bus
- Digitized voice audio/data from Wireline Interface Board and other optional modules via TDM bus
- ASTRO modem data from Wireline Interface Board via HDLC bus
- SECURENET modem data from Wireline Interface Board via HDLC bus

Outputs from the DSP circuitry are:

- Digitized voice audio/data from DSP to Wireline Interface Board and other optional modules via TDM bus
- Digitized voice audio from DSP to external speaker, built-in speaker, or handset earpiece via Audio Interface Bus and Audio Interface Circuitry
- Digitized voice audio/data from DSP to Exciter Module (modulation signals) via Audio Interface Bus and Audio Interface Circuitry

Digital Signal Processor (DSP)

The DSP, a 56002 operating at a clock speed of 40 MHz, 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.

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
- Accepts 16.8 MHz signal from Station Reference Circuitry and outputs a 2.1 MHz reference signal used throughout the station
- Provides interfaces for the HDLC bus, TDM bus, and serial bus used to communicate with the Receiver Module,
- Accepts digitized data from Receiver Module via DSP ASIC Interface Circuitry
- Provides interfaces for several A/D and D/A converters

Station Reference Circuitry

The Station Reference Circuitry consists of a phase–locked loop comprised of a high–stability VCO and a PLL IC. The output of the VCO is a 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 separated and buffered by a splitter and output to the Exciter Module and Receiver Module as 2.1 MHz REF.

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 1 PPM per year.
- **Manual Netting Mode** – Periodically, an external 5 MHz source is required to fine tune, or "net", the 16.8 MHz reference signal. In this mode, the PLL compares the 5 MHz reference and a sample of the 16.8 MHz VCO output and generates up/down pulses. The Host µP 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 ±0.3 ppm.
- **High–Stability Mode** – For some systems (e.g., Simulcast systems), the free–running stability of the VCO is unacceptable for optimum system performance. Therefore, an external 5 MHz source is connected permanently to one of the BNC connectors. In this mode, the PLL compares the 5 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 ±0.3 ppm. The VCO operates in this closed loop mode and is continually being frequency controlled by the control voltage from the PLL.

Note:
Two BNC connectors (one located on SCM front panel, the other located on the station backplane) are provided to allow an external 5 MHz source to be input to the OSC_{in} input to the PLL to perform frequency netting. Refer to the Maintenance section in this manual for recommended intervals and procedures for netting the station reference.

HDLC Bus Control Circuitry

The HDLC Bus Control Circuitry provides high–impedance buffering and data routing for the Interprocessor Communications Bus (a serial data bus implementing HDLC protocol). This bus allows the Host µP to communicate with the microprocessor located on the Wireline Interface Board and other optional modules via an interprocessor communications bus.

Audio Interface Circuitry

General

The Audio Interface Circuitry interfaces external analog audio inputs and outputs with the DSP circuitry.

External Audio Sources

A multiplexer, under control of the Host µP, is used to select one of eight possible external audio input sources (four for diagnostic loopback signals, three for future use, and one for handset or microphone audio). The selected audio source signal is converted to a digital signal by the A/D portion of the CODEC IC and sent to the DSP ASIC via the Audio Interface Bus. The DSP circuitry processes the signal and routes it to the desired destination.

External Audio Destinations

Digitized audio from the DSP circuitry is input to the D/A portion of the CODEC IC and is output to one of three external devices:

- External Speaker – connects to RJ-11 jack ( ) located on SCM front panel
- Handset Earpiece/Microphone – connects to RJ-11 jack ( ) located on SCM front panel
- Local Built-In Speaker – internal speaker and ½ W audio amplifier; may be switched on/off and volume controlled by using volume up ( ) and down ( ) buttons on SCM front panel

Exciter Modulation Signals

Digitized audio/data intended to be transmitted from the station is output from the DSP circuitry to a D/A converter via the TX/Voice Audio signal (p/o the Serial Synchronous Interface bus, connected between the DSP and the DSP ASIC). The digitized signal is converted to analog, level shifted and amplified, and fed to a 0–6 kHz filter. The output of the filter is then fed to one of the inputs of a multiplexer. The output of the multiplexer is fed to two individual digitally controlled potentiometers (each of which is adjusted by the Host µP via the SPI Bus) and output to the Exciter Module as modulation signals VCO MOD AUDIO and REF MOD AUDIO.

Input/Output Ports

Input Ports

Two general–purpose 16–line input ports are provided to allow various input signals from the SCM and station circuitry to be accepted and sent to the Host µP. The two ports (I/O Port P0 In and I/O Port P1 In) are each comprised of 16 lines which come from circuitry in the SCM as well as other modules in the station via the backplane. The buses are input to buffers which make the data available to the Host µP via the Host Data Bus. Typical inputs include the pushbutton switches located on the SCM front panel and the MIC PTT signal from the handset/microphone.

Output Ports

Four general–purpose 16–line output ports are provided to allow various control signals from the Host µP to be output to the SCM and station circuitry via the backplane. The four ports (I/O Port P0 Out thru I/O Port P3 Out) are each comprised of 16 lines which come from the Host Data Bus via latches. Typical output control signals include the control lines for the eight LEDs located on the SCM front panel and the local speaker enable signal.

Front Panel LEDs and Switches

Note:
Refer to the Troubleshooting section of this manual for complete details on the interpretation of the LEDs.

LEDs

Eight status LEDs are provided on the SCM front panel to provide visual indications of various station operating conditions.The LEDs are controlled by eight lines from I/O Port P0 Out.

Note:
Refer to the Operation section of this manual for complete details on the use of the pushbutton switches.

Switches

Four momentary contact pushbutton switches are provided on the SCM front panel to allow various station functions to be selected. Depressing a pushbutton causes a high to be sent to the Host µP via I/O Port P0 In.

Supply Voltages Circuitry

WARNING

***Do not** dispose of the NiCad battery in an incinerator as this may cause battery to explode.*

***Do not** short the contacts of the battery together as this may cause battery to explode.*

Supply Voltages Circuitry

The SCM contains on-board regulator and filtering circuitry to generate the various operating voltages required by the SCM circuitry. +14.2 V and +5V from the backplane are used as sources for the following supply voltage circuits:

- +10V Regulator Circuitry – provides +10 V dc and a +5 V reference voltage (½ of +10V) for the Audio Interface Circuitry in the SCM.
- VCCA Supply Circuitry – provides VCCA (+5V) and a +2.5 V reference voltage (½ of VCCA) for the Audio Interface Circuitry in the SCM.
- Filtering Circuitry – filters the +14.2 V and +5V from the backplane to provide A+ and VCC, respectively, for the SCM digital circuitry.

DRAM Supply Power and Battery Backup Circuitry

The DRAM memory and support circuitry operate from supply voltage VBB (+5V). VBB is generated by one of two circuits, depending on whether the battery backup option is installed. Each circuit is described below.

If the Battery Backup Option is ***Installed,*** the DRAM supply circuitry consists of a switching power supply IC, a +3.6V NiCad battery, and battery revert and charging circuitry. With VCC (+5V from the station backplane) present, the switching power supply IC accepts VCC and generates VBB to power the DRAM memory and associated support circuitry located in the SCM. The battery charging circuitry maintains a charge on the NiCad battery. If VCC should fail (station power turned off, module malfunction, etc.), the NiCad battery provides input power to the switching power supply IC, which continues to generate VBB to keep the DRAM memory powered up and refreshed. This continues until VCC is restored. The battery backup option provides approximately 60 minutes of DRAM data protection.

If the Battery Backup Option is ***not Installed,*** VCC (+5V) from the backplane is jumpered to supply VBB to power the DRAM memory and associated support circuitry located in the SCM. Without battery backup, any interruption of VCC results in the loss of all data contained in the DRAM memory located in the SCM.

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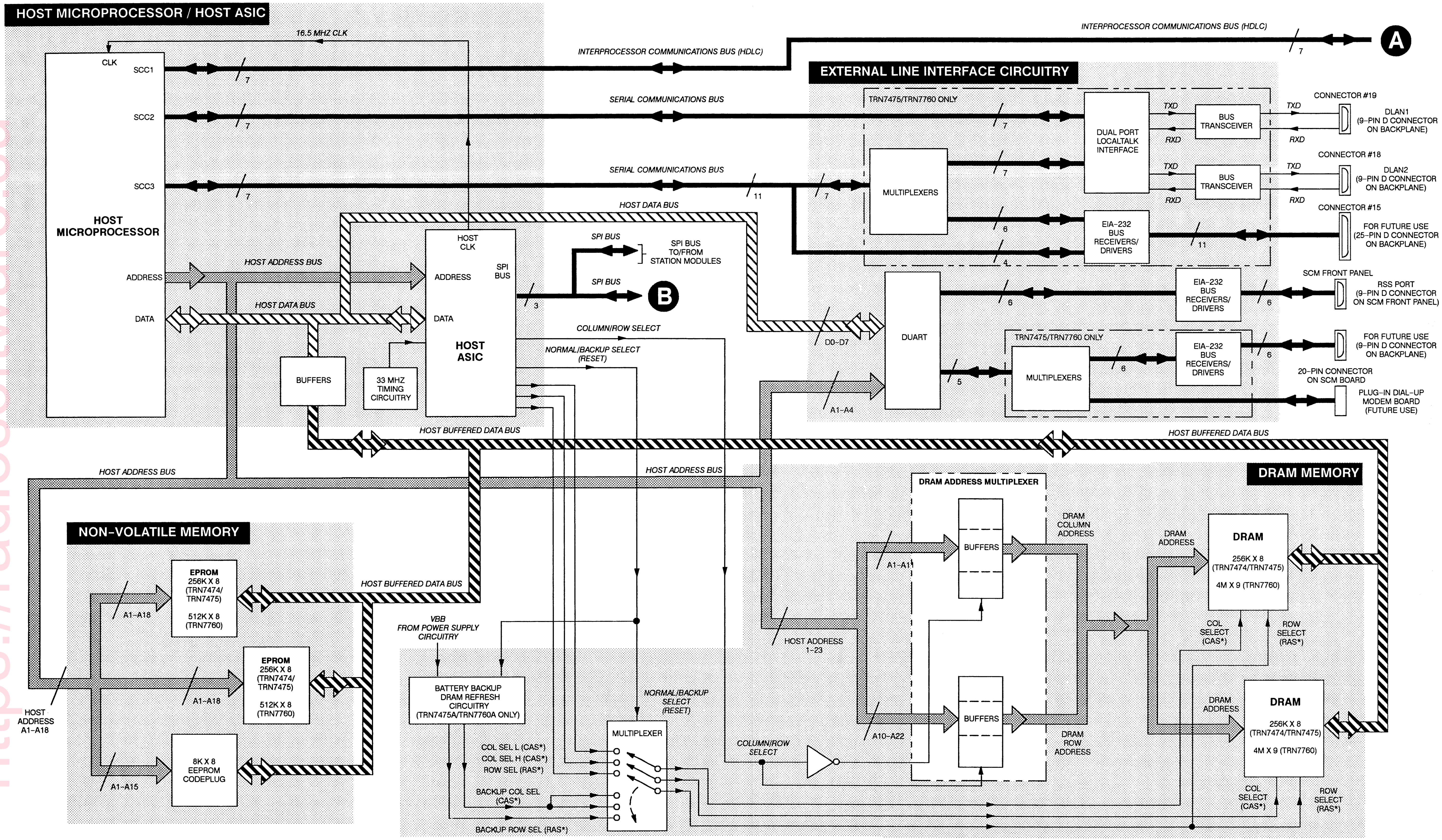

Figure 2. TRN7474A/TRN7475A/TRN7660A Station Control Module Functional Block Diagram (1 of 3)

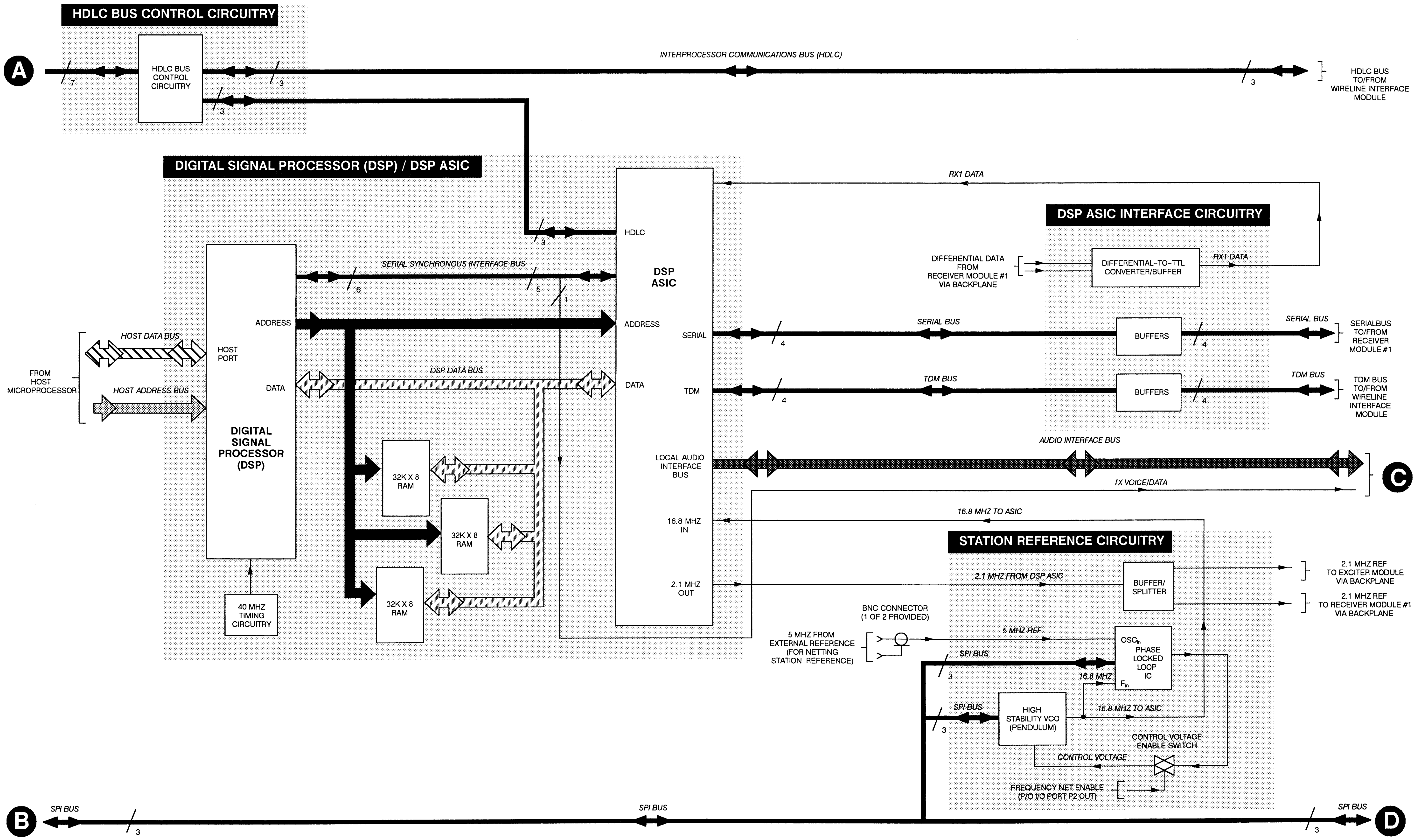

Figure 2. TRN7474A/TRN7475A/TRN7660A Station Control Module Functional Block Diagram (2 of 3)

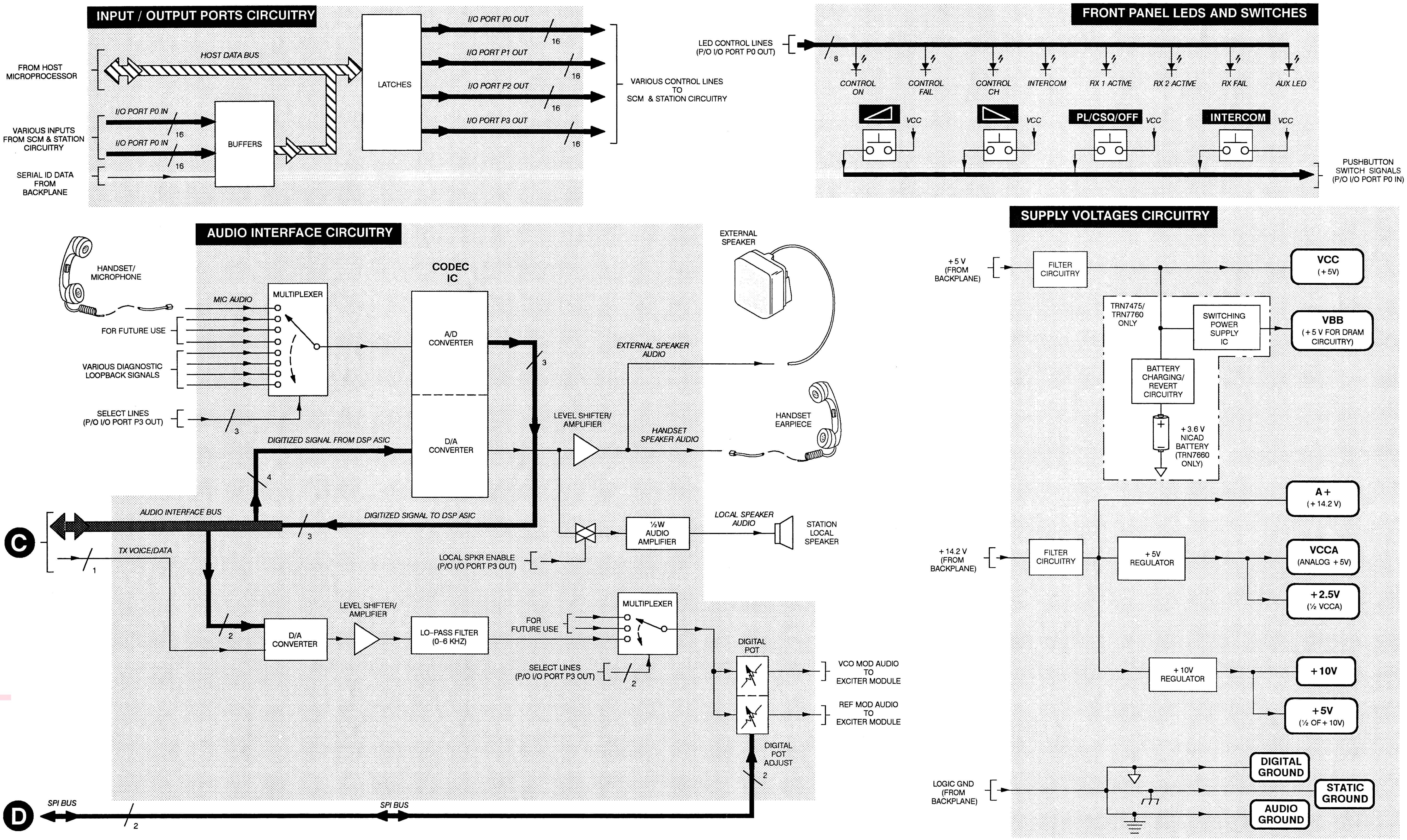

Figure 2. TRN7474A/TRN7475A/TRN7660A Station Control Board Functional Block Diagram (3 of 3)

MOTOROLA

WIRELINE INTERFACE BOARD

MODEL TRN7477A

1 DESCRIPTION

The Model TRN7477 Wireline Interface Board is described in this section. A general description, identification of jumpers, indicators, 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. In addition, the board contains a connector to accept one modem card. This card is required to interface with a 9.6kbps (ASTRO) input.

The WIB is installed behind the Station Control Module front panel, and is connected via the backplane to a 50–pin Telco connector located on the rear panel of the station. Additionally, a separate cable connects to a connector mounted on the WIB and routes the phone line connections to a screw terminal connector mounted on the backplane. For domestic (USA) applications, phone line connections may be made to either the 50–pin Telco connector or the screw terminal 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
- Microprocessor – serves as the main controller for the WIB; communicates with the Station Control Module microprocessor, interfaces with the ASTRO and *SECURENET* data signals, and provides monitoring and control for a variety of on–board I/O circuits
- Peripheral Application Specific IC (PASIC) – primarily responsible for injecting and retrieving PCM voice signals into/from the TDM (time division multiplex) bus that connects from the WIB to the Station Control Module
- DC Remote Detection – circuitry provides current sensing and detection for dc remote control of station
- Simulcast Processing Circuitry – circuitry is provided for summing and control of Simulcast PL and reverse burst tones

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2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

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

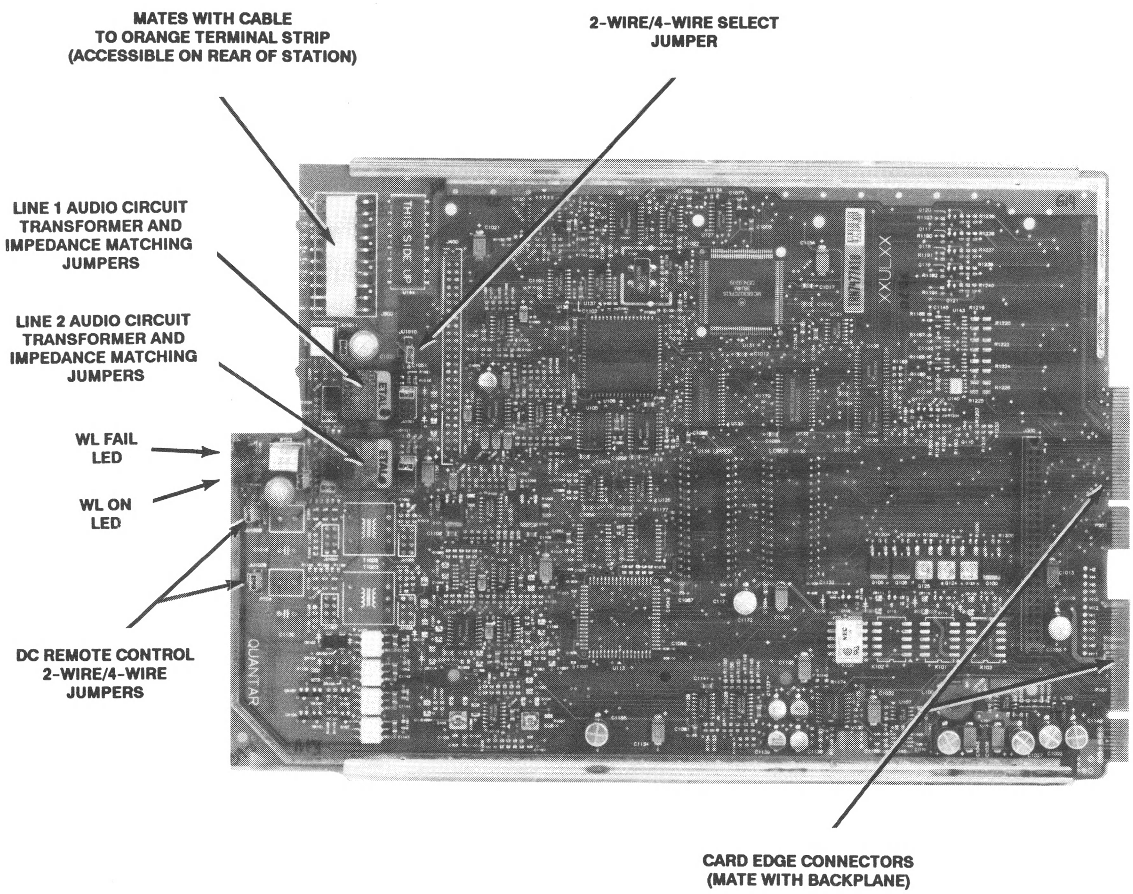

Figure 1. TRN7477 Wireline Interface Board Jumpers, Indicators, and Inputs/Outputs

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 2 for an overall block diagram of the WIB, and Figure 3 thru Figure 6 for block diagrams for 2-wire voice, 4-wire voice, 9.6kbps (ASTRO), and 12kbps *SECURENET* signal paths.

Functional Overview
(Refer to Figure 2)

Introduction

As mentioned previously, the WIB serves as the interface between the customer telephone lines and the station equipment. In general, the WIB processes and 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 diagram in Figure 2, the WIB contains a microprocessor with RAM and EPROM, a Peripheral Application Specific IC (PASIC), one 4-wire audio circuit, and one 2-wire audio circuit. Also provided are a dc remote decoding circuit, Simulcast processing circuitry, and miscellaneous I/O circuits. All of these circuits are described in the following paragraphs.

Microprocessor Circuitry

The WIB microprocessor (μP) provides overall control of the WIB operation, provides two serial bus links, and communicates with the microprocessor in the Station Control Module.

The WIB operating code and other parameters are stored in two 128k x 8 EPROMs. Short term storage is provided by two 32k x 8 RAM ICs.

The μP data bus is connected to each of the PASICs to provide control and to input and output 12kbps *SECURENET* data.

Two serial bus links are provided and managed by the μP. One of these is dedicated to interfacing with a plug-in modem card for 9.6kbps (ASTRO) applications. The other serial link is used to interface with the microprocessor in the Station Control Module using HDLC protocol.

Peripheral Application Specific IC (PASIC)

One PASIC is provided on the WIB to interface with the various audio/data circuits. In general, the PASIC is responsible for accepting either PCM voice information (for 4-wire or 2-wire operation) or 12kbps secure data (12kbps *SECURENET* operation) and routing the information to the proper destination (i.e., from landline to station, and from station to landline). Details of the signal paths are provided in **Description of Audio/Data Signal Paths** later in this section.

Functional Overview (Cont'd) (Refer to Figure 2)

Audio/Data Circuits

Each WIB contains circuitry for one 4-wire audio/data circuit, one 2-wire audio/data circuit, one 9.6kbps (ASTRO) data circuit, and one 12kbps *SECURENET* data circuit. As shown in the block diagram, the PASIC and its associated circuitry function to provide the following signal paths:

- 4-wire voice audio from landline to station, and from station to landline
- 2-wire voice audio from landline to station, and from station to landline
- 9.6kbps (ASTRO) modem data from landline to station, and from station to landline
- 12kbps *SECURENET* modem data from landline to station, and from station to landline

Description of Audio/Data Signal Paths provided later in this section contains block diagrams of each of the major signal paths along with an explanation of the signal flows.

DC Remote Detection

The WIB contains circuitry to monitor the Line 1 Audio and Line 2 Audio input lines and detect dc control currents. The detection outputs (±12.5mA, ±5.5 mA, +2.5 mA, and -2.5 mA) are dc voltages (nominally either +.7V or +5V) which are fed to an A/D converter. The converter serves as a comparator and interprets the inputs as highs and lows. The data is then sent serially to the microprocessor.

Miscellaneous Inputs/Outputs

The following inputs and outputs are provided on the WIB. These lines may be assigned various functions according to customer specifications.

- One (1) optically-coupled inputs
- Seven (7) transistor-coupled inputs
- One (1) relay closure outputs (normally open contacts)
- Three (3) transistor-coupled outputs

Simulcast Processing Circuitry

Summing and gating circuitry is provided on the WIB to allow PL tones, reverse burst, and TX audio (GEN TX DATA) to be combined and output to the VCO in the Exciter Module (after signal processing by the SCM) to directly modulate the rf carrier. The simulcast circuitry is controlled by the Station Control Board microprocessor via theWIB microprocessor and the PASIC on the WIB.

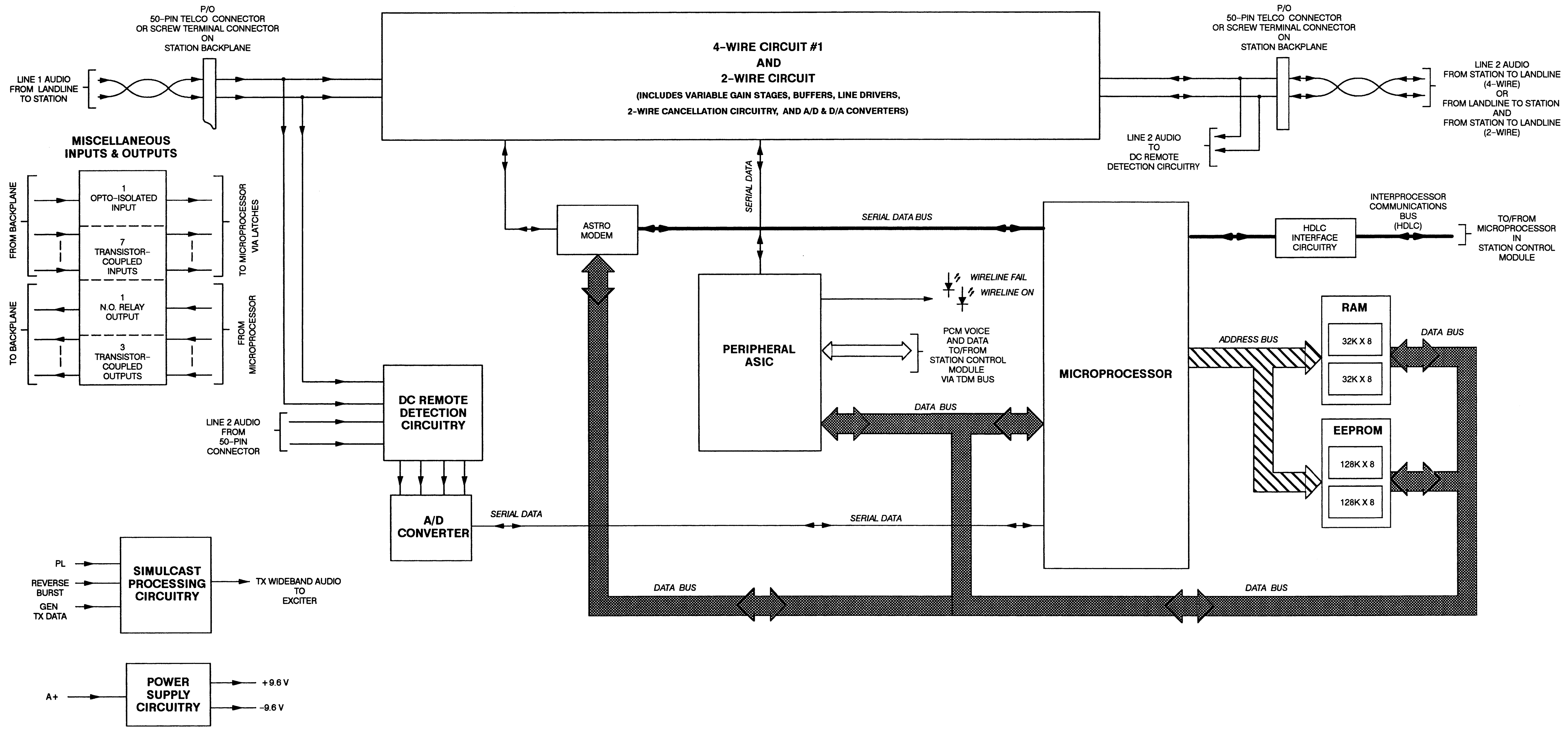

Figure 2. TRN7477 Wireline Interface Board Functional Block Diagram

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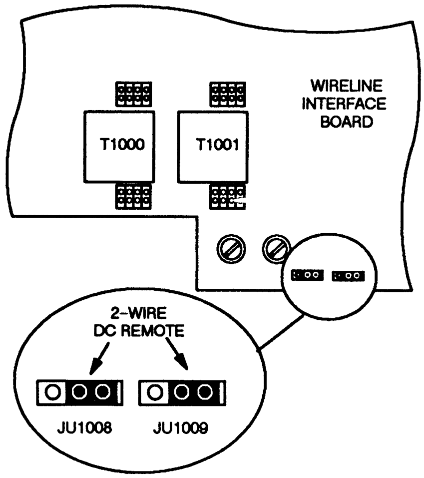
Description of Audio/Data Signal Paths

Note:
For domestic (USA) version WIB, phone line connections may be made at either the 50-pin Telco connector or the screw terminal connector on the station backplane. 2-wire audio connections are made at Line 2 Audio.

For systems using dc remote control, set jumpers JU1008 and JU1009 as shown below for 2-wire applications:



Four levels of gain adjustment 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.

(Note that a sample of the outbound signal is fed from one of the output transistors to the cancellation amplifier in the landline to station circuitry. This signal is used to cancel the outbound signal and allow the inbound signal to pass through the landline to station circuitry.)

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, and therefore employs circuitry to pass audio in each direction while cancelling the alternate signal. 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 an amplifier. [Note that jumper fields in parallel with both the primary and secondary coils provide for selectable impedance matching. For domestic (USA) versions, the jumpers should be set at 600 Ω as shown below.]

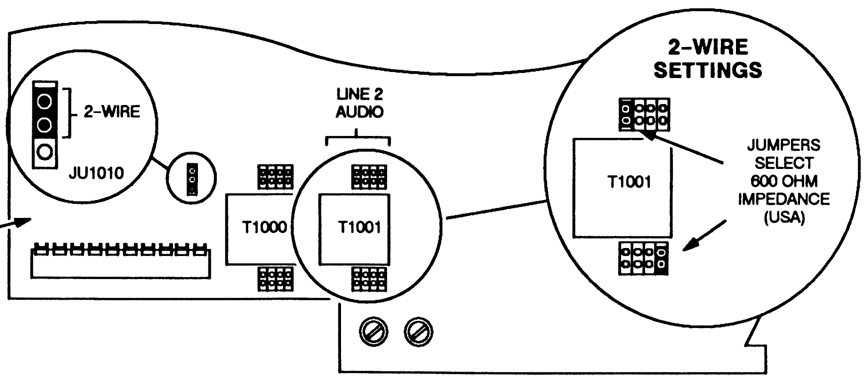
The amplifier sums the inbound and outbound signals and feeds one input to the cancellation amplifier. The other input to this amplifier is the output signal only. A cancellation of the outbound signal results, and the output from this amplifier is the inbound signal only. The signal is fed to a buffer (through jumper JU1010 placed in the 2-wire position, as shown below) which feeds the gain adjust circuitry. Under control of the PASIC, the gain control circuitry provides eight levels of gain adjust (3, 8, 13, 18, 23, 28, 33, and 38 dB).

The output of the gain adjust circuitry is fed to an A/D converter, which digitizes the audio signal into a PCM output. This output is fed serially to the PASIC, which places the data in the proper TDM timeslot (as instructed by the microprocessor in the SCM) and output to the SCM on the TDM Bus.

Station to Landline audio is input to the PASIC in the form of PCM data on the TDM bus. The PASIC extracts the data and feeds it to a D/A converter, 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 PASIC, the gain control circuitry provides four levels of gain adjust (0dB, -6dB, -12dB, and -18dB).

The output of the gain adjust circuitry is fed thru 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 an audio transformer. The audio signal is induced into the secondary and output to the landline system (via either the 50-pin Telco connector or screw terminal connector) as balanced audio.

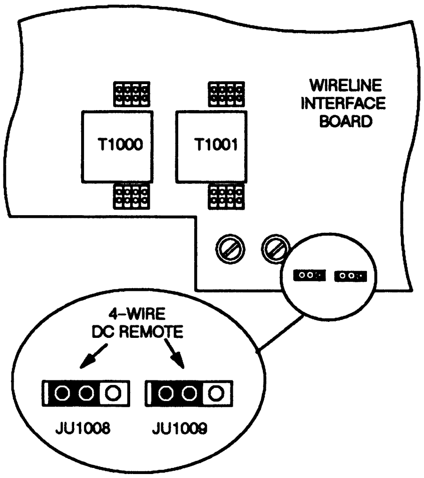
WIRELINE
INTERFACE
BOARD



Description of Audio/Data Signal Paths (Continued)

Note:
For domestic (USA) version WIB, phone line connections may be made at either the 50-pin Telco connector or the screw 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 dc remote control, set jumpers JU1008 and JU1009 as shown below for 4-wire applications:



Four levels of gain adjustment 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.

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

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

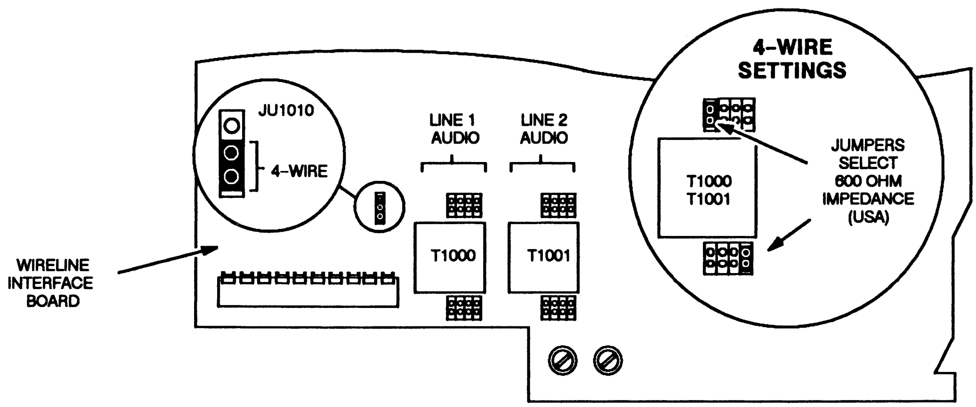
Landline to Station balanced audio is input to the primary of an audio transformer. The signal is induced into the transformer secondary and fed to a buffer (through jumper JU1010 placed in the 4-wire position, as shown below). [Note that jumper fields in parallel with both the primary and secondary coils provide for selectable impedance matching. For domestic (USA) versions, the jumpers should be set at 600 Ω as shown below.]

The buffer output is fed to the gain adjust circuitry. Under control of the PASIC, the gain control circuitry provides eight levels of gain adjust (3, 8, 13, 18, 23, 28, 33, and 38 dB).

The output of the gain adjust circuitry is fed to an A/D converter, which digitizes the audio signal into a PCM output. This output is fed serially to the PASIC, which places the data in the proper TDM timeslot (as instructed by the microprocessor in the Station Control Module) and output to the SCM on the TDM Bus.

Station to Landline audio is input to the PASIC in the form of PCM data on the TDM bus. The PASIC extracts the data and feeds it to a D/A converter, 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 PASIC, the gain control circuitry provides four levels of gain adjust (0dB, -6dB, -12dB, and -18dB).

The output of the gain adjust circuitry is fed thru 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 an audio transformer. The audio signal is induced into the secondary and output to the landline system (via either the 50-pin Telco connector or screw terminal connector) as balanced audio.



Description of Audio/Data Signal Paths (Continued)

9.6KBPS (ASTRO) Modem Data Path (Refer to Figure 5)

9.6kbps (ASTRO) modem data signals are sent to/from the station via 4-wire copper pairs and are processed by the 4-wire audio circuit on the WIB (Line 1 Audio & Line 2 Audio). The 4-wire circuit operates as follows:

Note:
For domestic (USA) version WIB, phone line connections may be made at either the 50-pin Telco connector or the screw 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.

Landline to Station modem data is input to the primary of an audio transformer as balanced audio. The signal is induced into the transformer secondary and fed to a buffer (through jumper JU1010 placed in the 4-wire position, as shown at the bottom of page 8). [Note that jumper fields in parallel with both the primary and secondary coils provide for selectable impedance matching. For domestic (USA) versions, the jumpers should be set at 600 Ω as shown in the 4-wire diagram at the bottom of page 8.]

The buffer output is fed to a modem (a separate card which plugs into the WIB) which converts the modem signal to detected data. The data signal is then fed to the microprocessor over a serial bus. The microprocessor sends the data to the microprocessor in the Station Control Module over an interprocessor communications bus (HDLC protocol).

The WIB is equipped with a connector to accept a plug-in ASTRO modem card.

Station to Landline modem data is input to the microprocessor from the Station Control Module microprocessor via the interprocessor communications bus (HDLC protocol). The microprocessor feeds the data to the modem which converts the data to a modem signal.

The output of the modem is fed to the gain adjust circuitry. Under control of the PASIC, the gain control circuitry provides four levels of gain adjust (0dB, -6dB, -12dB, and -18dB).

The output of the gain adjust circuitry is fed thru 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 an audio transformer. The modem data signal is induced into the secondary and output to the landline system (via either the 50-pin Telco connector or screw terminal connector) as balanced audio.

Description of Audio/Data Signal Paths (Continued)

The Quantar station supports SECURENET transparent mode only.

Note:
For domestic (USA) version WIB, phone line connections may be made at either the 50-pin Telco connector or the screw 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.

12KBPS SECURENET *Modem Data Path (Refer to Figure 6)*

12kbps *SECURENET* modem data signals are sent to/from the station via 4-wire copper pairs and are processed by the 4-wire audio circuit on the WIB (Line 1 Audio & Line 2 Audio). The 4-wire circuit operates as follows:

Landline to Station modem data is input to the primary of an audio transformer as balanced audio. The signal is induced into the transformer secondary and fed to a buffer (through jumper JU1010 placed in the 4-wire position, as shown at the bottom of page 8). [Note that jumper fields in parallel with both the primary and secondary coils provide for selectable impedance matching. For domestic (USA) versions, the jumpers should be set at 600 Ω as shown in the 4-wire diagram at the bottom of page 8.]

The buffer output is fed through a 3-pole low-pass filter to a limiter, which converts the modem signal to a data signal. The output of the limiter is fed to the PASIC as serial data.

The PASIC sends the data to the microprocessor as 8-bit parallel data over the data bus.The microprocessor sends the data to the microprocessor in the Station Control Module over an interprocessor communications bus (HDLC protocol).

Station to Landline modem data is input to the microprocessor from the Station Control Module microprocessor via the interprocessor communications bus (HDLC protocol). The microprocessor feeds the data to the PASIC as 8-bit parallel data over the data bus.

The PASIC outputs the data serially through a 3-pole low-pass filter to the gain adjust circuitry. Under control of the PASIC, the gain control circuitry provides four levels of gain adjust (0dB, -6dB, -12dB, and -18dB).

The output of the gain adjust circuitry is fed to 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 an audio transformer. The modem data signal is induced into the secondary and output to the landline system (via either the 50-pin Telco connector or screw terminal connector) as balanced audio.

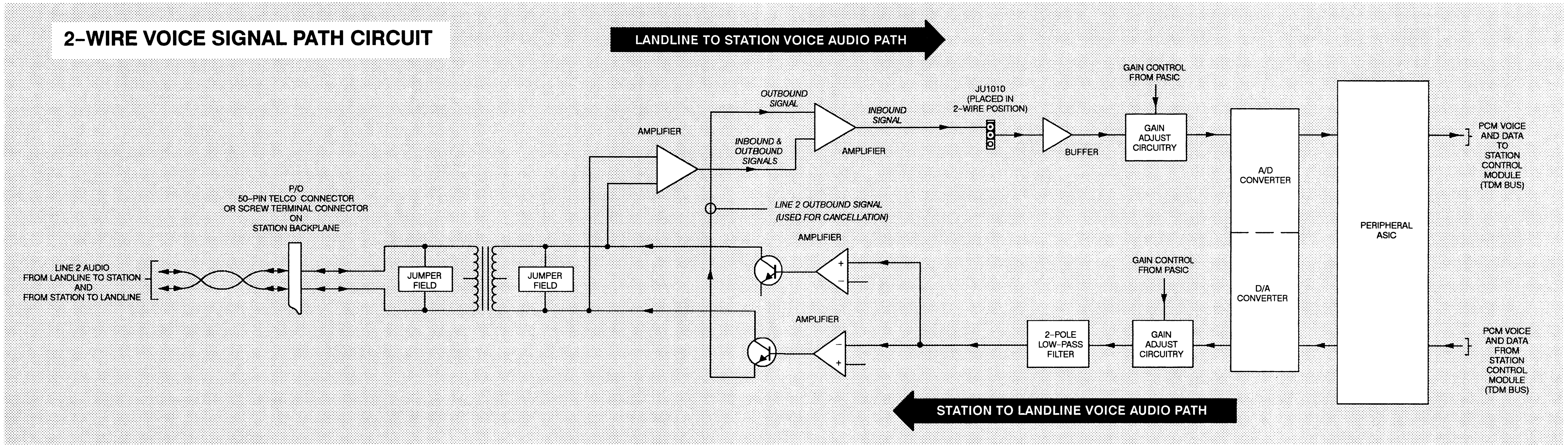


Figure 3. 2-Wire Voice Audio Path Functional Block Diagram

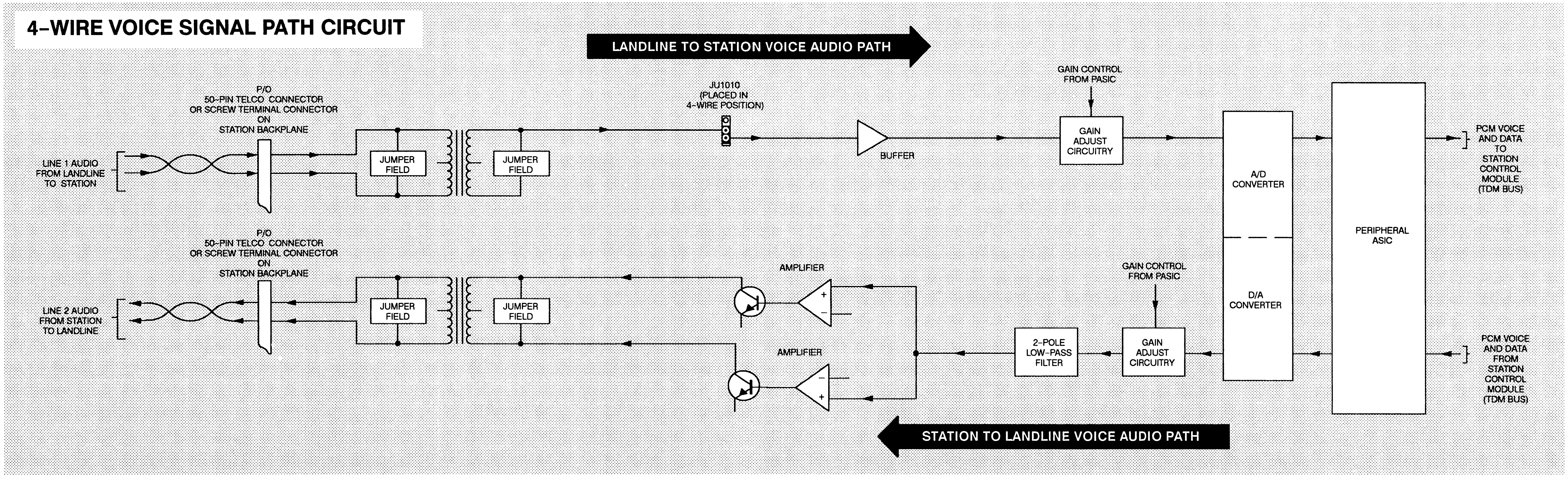


Figure 4. 4-Wire Voice Audio Path Functional Block Diagram

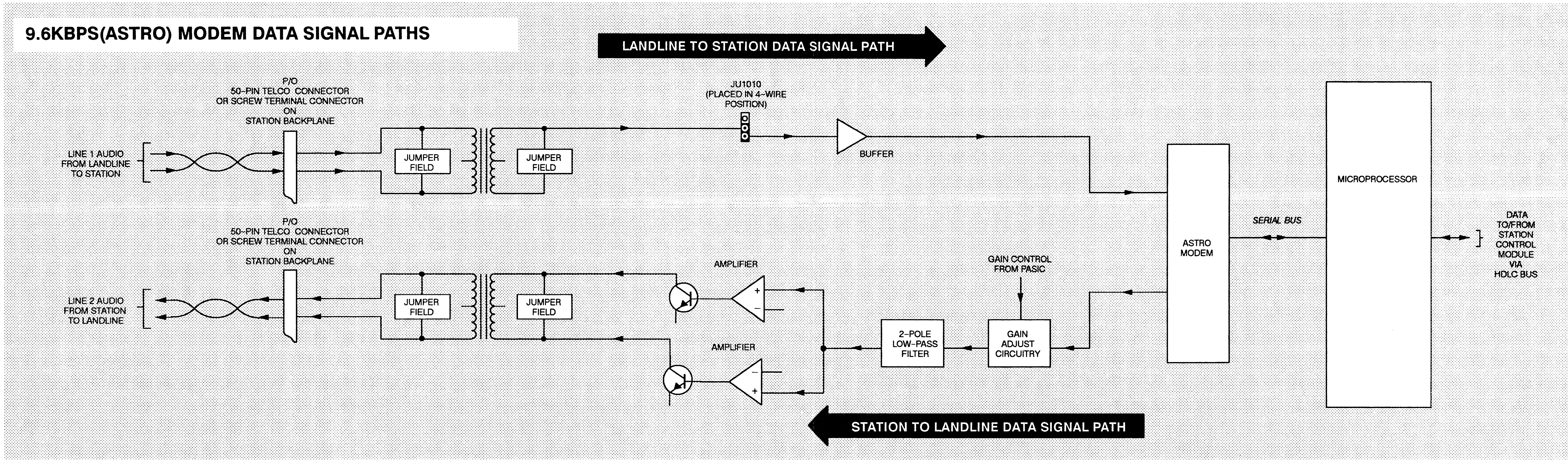


Figure 5. 9.6kbps (ASTRO) Modem Data Signal Path Functional Block Diagram

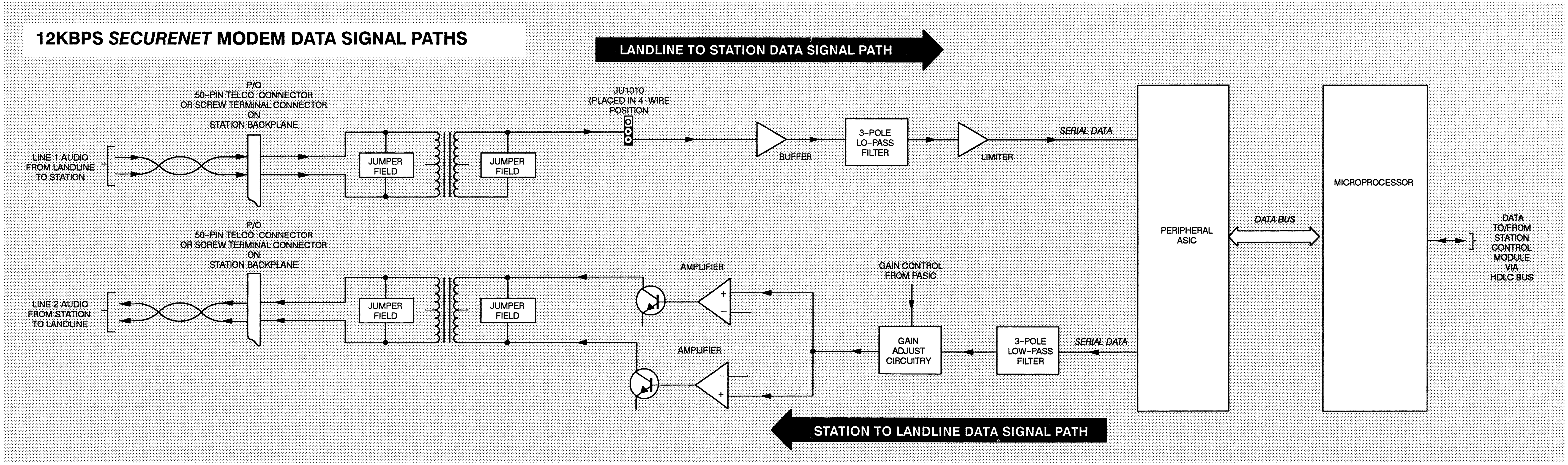


Figure 6. 12kbps *SECURENET* Modem Data Signal Path Functional Block Diagram

MOTOROLA

SATELLITE RECEIVER BACKPLANE BOARD

MODEL TRN7480A

1 DESCRIPTION

The TRN7480A Backplane Board provides the electrical interconnections for the plug-in modules of a *Quantar* Satellite Receiver. The board also provides the connectors necessary to interface the satellite receiver to phone lines,and other communications and maintenance equipment. This section provides a general description, identification of inputs/outputs, and a pin-out listing for all interface connectors, including information on signal names, functions, and levels.

General Description

The backplane board (mounted across the rear of the *Quantar* satellite receiver card cage) is constructed with connectors on both sides. The connectors on one side mate with the various plug-in modules; the connectors on the other side allow interface connections between the satellite receiver and the phone lines and other communications and maintenance equipment.

As shown in Figure 1, 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 RFI shielding. This shield also provides a mounting location for the antenna connector bracket and the satellite receiver grounding lug.

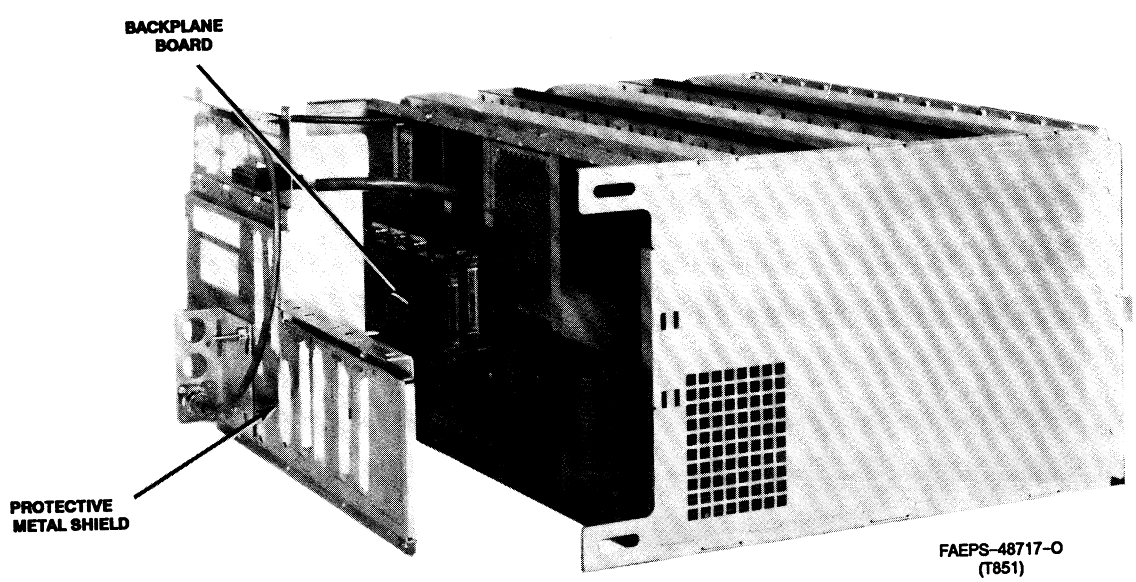


Figure 1. Backplane (Shown with Protective Metal Shield Removed)

Land Mobile Products Sector
1301 E. Algonquin Road, Schaumburg, IL 60196

68P81085E11-O
5/15/93-UP

2 LOCATION OF BACKPLANE CONNECTORS

Figure 2 shows the location of the connectors on each side of the satellite receiver backplane board.

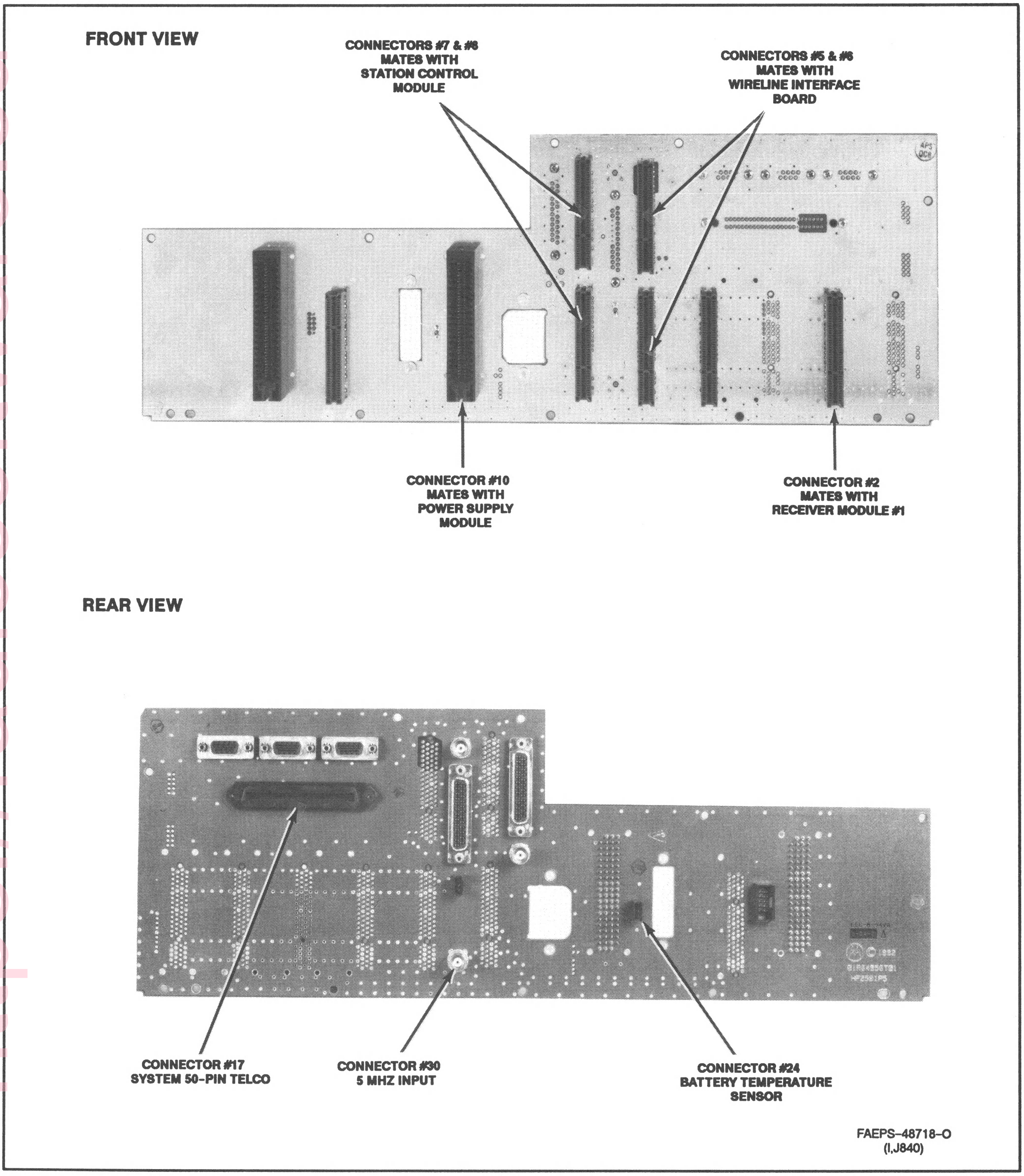


Figure 2. *Quantar* Satellite Receiver Backplane (TRN7480A) Connector Locations (Front and Rear Views)

3 BACKPLANE CONNECTORS INFORMATION

Each connector on the backplane has been assigned a connector number. In some cases, the connector number is stamped into the metal shield covering the rear of the backplane board. The connectors which accept the plug-in modules are not marked. Table 1 lists each connector and its assigned number.

Figure 3 provides pin-out information for all connectors located on the rear of the backplane board. As shown, each connector pin is defined by signal name, input or output (with reference to connector), to/from location, and a brief description of the signal function. Note that pin-out information for any connectors intended for future applications is not shown. Also, note that in the "To/From" column the source or destination of the signal is given as a connector number followed by a pin number. The first number (preceded by a "#") represents the assigned connector number, followed by the specific connector pin number.

Table 1. Assigned Connector Number vs Function/Location Information

Connector #	Function/Location
1	Not used
2	Accepts plug-in Receiver Module #1
3	Not used
4	Accepts plug-in Receiver Module #2
5	Accepts bottom card-edge connector of plug-in Wireline Interface Board
6	Accepts top card-edge connector of plug-in Wireline Interface Board
7	Accepts bottom card-edge connector of plug-in Station Control Module
8	Accepts top card-edge connector of plug-in Station Control Module
9	Not used
10	Accepts plug-in Power Supply Module
11	Not used
12	Not used
13	Not used
14	Future Use
15	Future Use
16	Not used
17	50-pin Telco System Connector (accepts customer phone line connections, access to customer-defined inputs/outputs, etc.; connector located on backplane at rear of satellite receiver)
18	Not used
19	Not used
20	Future Use
21	Future Use
22	Future Use
23	Not used
24	Battery Temperature 3-pin AMP-type connector (used to accept variable resistance proportional to temperature of co-located storage batteries; connector located on backplane at rear of satellite receiver)
25	Not used
26	Not used
27	Not used
28	Not used
29	Not used
30	BNC input connector (used to accept 5 MHz reference signal from external frequency standard for calibrating reference oscillator in Station Control Module; connector located on backplane at rear of satellite receiver; electrically connected to BNC connector on front panel of Station Control Module, allowing signal to be injected at either front or rear of satellite receiver)

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CONNECTOR #17 — SYSTEM 50-PIN TELCO

Pin #	Signal	Input	Output	To/From	Function
1	Line 1+	✓		#6–pin 1	Customer 4–wire Phone Line Input (Line 1+)
2	Line 2+	✓	✓	#6–pin 7	Customer 2–wire Phone Line Input/Output (Line 2+)
3	Line 3+	✓		#6–pin 13	Customer 4–wire Phone Line Input (Line 3+)
4	Line 4+		✓	#6–pin 19	Customer 4–wire Phone Line Output (Line 4+)
5	n/a			#8–pin 2	Not used
6	Open			n/c	Open
7	GND			Station GND	Station Ground
8	5 VDC Out		✓	5V Bus	+5V dc from Power Supply (1 Amp Max.)
9	n/a			#6–pin 64	Not used
10	n/a	✓		#6–pin 62	Not used
11	Aux In 1	✓		#6–pin 60	Customer–defined transistor buffered Input
12	Aux In 2	✓		#6–pin 58	Customer–defined transistor buffered Input
13	Aux In 3	✓		#6–pin 65	Customer–defined transistor buffered Input
14	Aux In 4 (RX Inh)	✓		#6–pin 56	Customer–defined transistor buffered Input (Note 1)
15	Aux In 5	✓		#6–pin 63	Customer–defined transistor buffered Input
16	Aux In 6	✓		#6–pin 54	Customer–defined transistor buffered Inpu
17	Aux In 7 (Channel 4)	✓		#6–pin 59	Customer–defined transistor buffered Input (Note 1)
18	Aux Out 7		✓	#6–pin 52	N.O. contact of Relay A
19	Aux Out 8		✓	#6–pin 57	N.O. contact of Relay B
20	Aux Out 9		✓	#6–pin 50	N.O. contact of Relay C
21	Aux Out 10		✓	#6–pin 51	N.O. contact of Relay D
22	Aux In 9	✓		#6–pin 48	Opto–isolated customer–defined input (Opto A+)
23	Aux In 10 (channel 1)	✓		#6–pin 49	Opto–isolated customer–defined input (Opto B+)
24	Aux In 11 (Chanel 2)	✓		#6–pin 46	Opto–isolated customer–defined input (Opto C+)
25	Aux In 12 (Channel 3)	✓		#6–pin 43	Opto–isolated customer–defined input (Opto D+)
26	Line 1 —	✓		#6–pin 2	Customer 4–wire Phone Line Input (Line 1—)
27	Line 2 —	✓	✓	#6–pin 8	Customer 2–wire Phone Line Input/Output (Line 2—)
28	Line 3 —	✓		#6–pin 14	Customer 4–wire Phone Line Input (Line 3 —)
29	Line 4 —		✓	#6–pin 20	Customer 4–wire Phone Line Output (Line 4—)
30	n/a			#8–pin 1	Not used
31	Open			n/c	Open
32	GND			Station GND	Station Ground
33	14.2 VDC Out		✓	14.2V Bus	+14.2 V dc from Power Supply (1 Amp Max.)
34	n/a			#6–pin 26	Not used
35	n/a			#6–pin 27	Not used
36	Aux Out 1 (Failsoft Ind)		✓	#6–pin 28	Customer–defined transistor buffered output (Note 1)
37	Aux Out 2 (RX Code Det)		✓	#6–pin 29	Customer–defined transistor buffered output (Note 1)
38	Aux Out 3		✓	#6–pin 30	Customer–defined transistor buffered output
39	Aux Out 4		✓	#6–pin 31	Customer–defined transistor buffered output
40	Aux Out 5		✓	#6–pin 32	Customer–defined transistor buffered output
41	Aux Out 6		✓	#6–pin 33	Customer–defined transistor buffered output
42	Aux In 8	✓		#6–pin 34	Customer–defined transistor buffered input
43	Aux Out 7 (RD Stat)		✓	#6–pin 35	N.O. contact of Relay A (Note 1)
44	Aux Out 8		✓	#6–pin 36	N.O. contact of Relay B
45	Aux Out 9		✓	#6–pin 37	N.O. contact of Relay C
46	Aux Out 10		✓	#6–pin 40	N.O. contact of Relay D
47	Aux In 9	✓		#6–pin 39	Opto–isolated customer–defined input (Opto A—)
48	Aux In 10	✓		#6–pin 42	Opto–isolated customer–defined input (Opto B—)
49	Aux In 11	✓		#6–pin 41	Opto–isolated customer–defined input (Opto C—)
50	Aux In 12	✓		#6–pin 44	Opto–isolated customer–defined input Opto D—)

Notes:

1. Some of the customer–defined inputs and outputs have been preassigned wtih signal names and functions usually required in typical receiver voting systems. These default preassignments have been made for customer convenience only, and may be re–assigned as necessary. The preassigned signal names are shown in parentheses in the SIGNAL column.

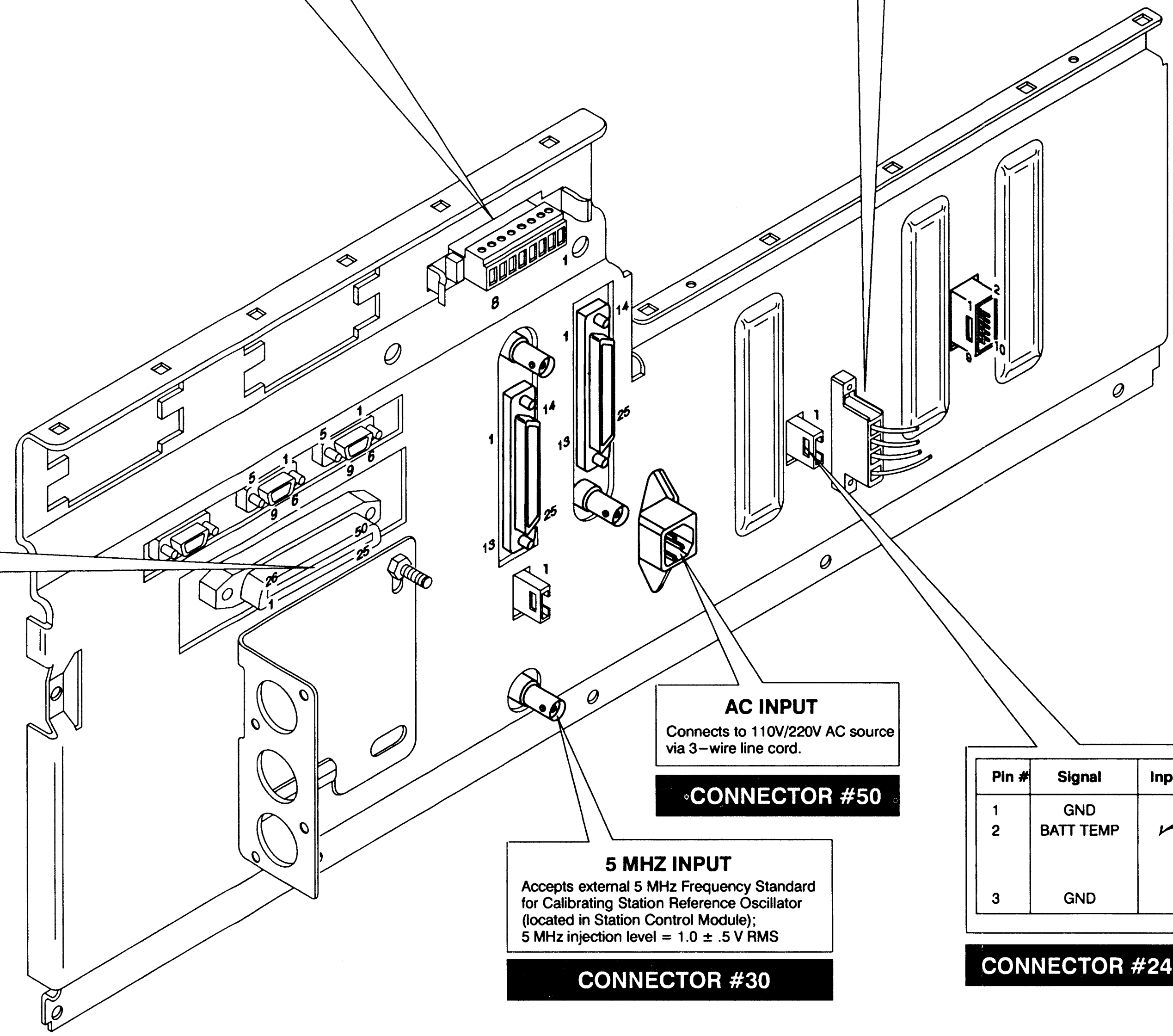
PHONE LINE INPUTS

1	LINE 1 +	5	LINE 3 +
2	LINE 1 —	6	LINE 3 —
3	LINE 2 +	7	LINE 4 +
4	LINE 2 —	8	LINE 4 —

CONNECTOR #25

BATTERY CHARGER OUTPUT

Two RED (top) and two BLACK (bottom) wires to battery revert connector mounted on station cage.



AC INPUT

Connects to 110V/220V AC source via 3–wire line cord.

CONNECTOR #50

5 MHZ INPUT

Accepts external 5 MHz Frequency Standard for Calibrating Station Reference Oscillator (located in Station Control Module); 5 MHz injection level = 1.0 ± .5 V RMS

CONNECTOR #30

Pin #	Signal	Input	Output	To/From	Function
1	GND			Station GND	Station Ground
2	BATT TEMP	✓		#10–pin 59	Variable resistance proportional to battery temperature from sensor near storage batteries
3	GND			Station GND	Station Ground

CONNECTOR #24 — BATTERY TEMPERATURE

Figure 3. TRN7480A Backplane Rear Connectors Pin–Out Information

MOTOROLA

POWER SUPPLY MODULE

INCLUDES MODELS:
TPN6186A (265W w/o Battery Charger; AC Input)
TPN6187A (265W with Battery Charger; AC Input)

1 DESCRIPTION

The Models TPN6186A/TPN6187A Power Supply Modules are described in this section. A general description, performance specifications, 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 Models TPN6186A/TPN6187A Power Supply Modules each accept an ac input (90–280 V ac, 47–63 Hz) and generate +5V dc and +14.2V dc operating voltages to power the station modules. Each power supply module is comprised of several switching-type power supply circuits, power factor correction circuitry, battery charger/revert circuitry (TPN6187A only), and diagnostics and monitoring circuitry, all contained within a slide-in module housing.

The power supply module provides the following features:

- Auto-ranging for input voltage and frequency — circuitry automatically adjusts for input ranges of 90–280 V ac and 47–63 Hz; no jumpers, switches, or other settings are required
- Input transient and EMI protection — MOV, gas discharge, and filter devices protect the power supply circuitry from ac line voltage transients and electro-magnetic interference
- Internal voltage and current limiting — circuitry continually monitors critical voltages and currents and shuts supply down if preset thresholds are exceeded
- Temperature protection — module contains built-in cooling fan which is thermostatically controlled; supply shuts down if temperature exceeds preset threshold
- Diagnostic monitoring — critical internal parameters are continually monitored and reported to the Station Control Module, which can automatically provide correction for certain operating conditions

The Models TPN6186A and TPN6187A differ only in the inclusion of battery charger/revert circuitry (TPN6187A only). Unless otherwise noted, the information provided in this section applies to both models.

1 DESCRIPTION (Continued)

Overview of Circuitry

The power supply module contains the following circuitry:

- Input Conditioning Circuitry— consisting of ac line transient protection, EMI filtering, rectifier, and power factor correction circuitry, and filtering.
- Startup Inverter Circuitry — provides VCC for power supply circuitry during initial power-up
- Main Inverter Circuitry — consists of switching-type power supply that generates the +14.2V dc supply voltage
- +5 V Inverter Circuitry — consists of switching-type power supply that generates the +5 dc supply voltage
- Clock Generator Circuitry — generates 267 kHz and 133 kHz clock signals used by pulse width modulators in the three inverter circuits
- Diagnostics Circuitry — converts analog status signals to digital format for transfer to Station Control Module
- Address Decode Circuitry — performs address decoding to provide chip select signals for the A/D and D/A converters
- Battery Charging/Revert Circuitry (TPN6187A only) — charges external storage battery and automatically reverts to battery power in case of ac power failure

2 PERFORMANCE SPECIFICATIONS

Table 1 shows the electrical performance specifications for the Models TPN6186A and TPN6187A Power Supply Modules.

Performance Specifications

Table 1. TPN6186A/TPN6187A Power Supply Modules Performance Specifications

Parameter	Specification
Weight	6.5 kg (14.3 lbs)
Operating Temperature Range	-30 to +45° C (no derating) -30 to +60° C (derated)
Input Voltage Range	90 to 280 V ac
Input Frequency Range	47 to 63 Hz
Maximum Input Current	8.5 A
Steady State Output Voltages	+14.2 V dc ±5% +5.0 V dc ±5%
Output Current Ratings	+14.2 12.5 A +5.0 9 A
Total Output Power Rating	no derating 265 W* * *including 50W for battery charger*
Output Ripple	All outputs 50 mV p-p (measured with 20 MHz BW oscilloscope at 25°C). High Frequency individual harmonic voltage limits in 10 kHz-100 MHz frequency band: 14.2 V 1.5 mV p-p 5V 5 mV p-p
Short Circuit Current	0.5 A avg. max

3 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the power supply module controls, indicators, and all input and output external connections.

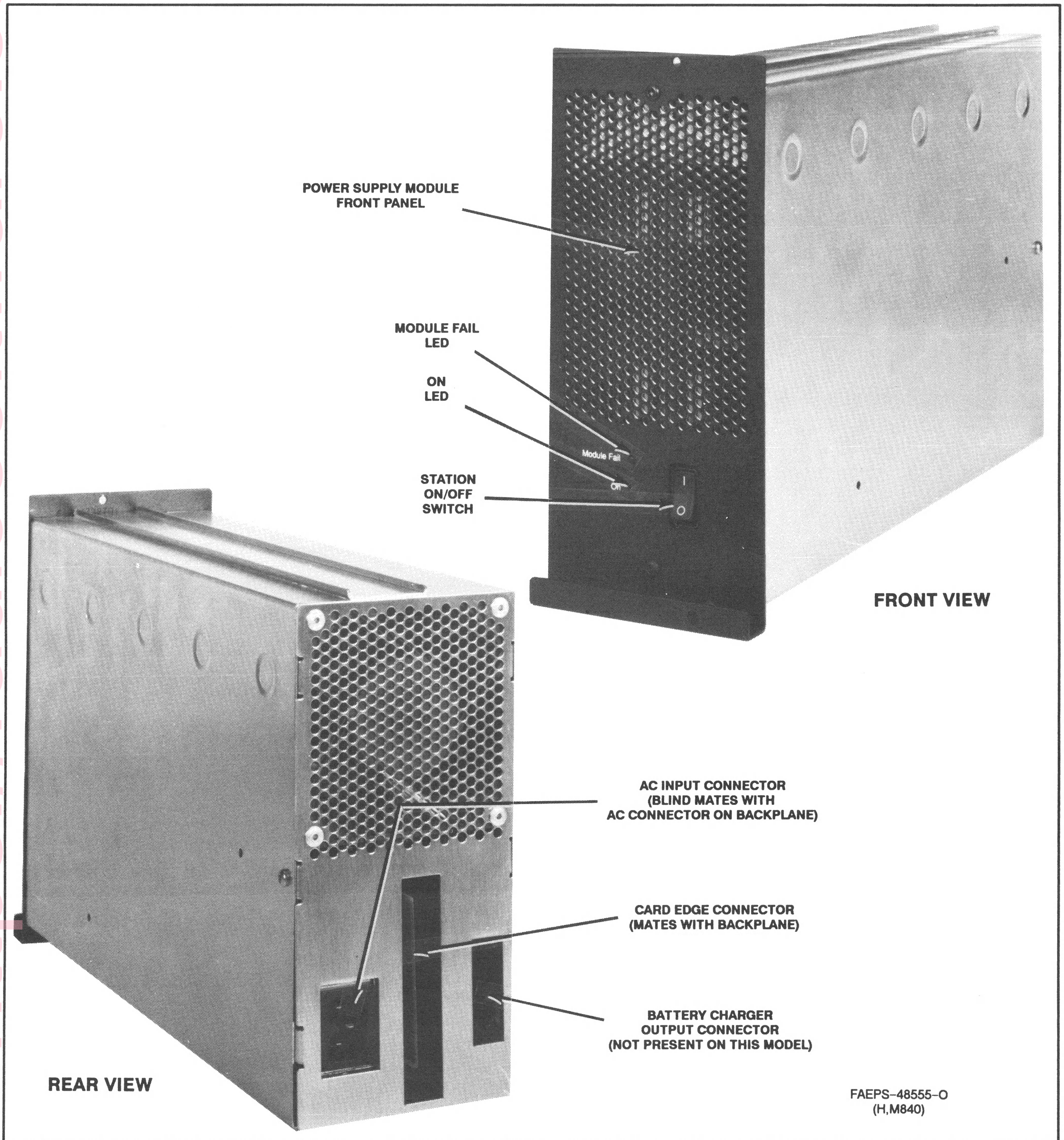


Figure 1. Power Supply Module Controls, Indicators, and Inputs/Outputs (TPN6186A shown)

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.

Input Conditioning Circuitry

Introduction

The power supply module accepts ac power from an external source, typically a 110V ac wall receptacle. AC power is connected to the module via a 3-wire line cord plugged into an ac receptacle mounted on the station backplane, into which the power supply module slides (blind mate connection).

Transient and EMI Protection

The ac line input is fed to the power supply module circuitry via transient protection and EMI filter circuits. The transient protection devices provide protection against voltage spikes by providing an effective short to ground under high voltage transient conditions. The EMI filter prevents electrical noise generated by the power supply module from interfering with other equipment connected to the same ac line circuit.

Front Panel On-Off Switch

A rocker-type switch located on the power supply module front panel allows the power supply (and station) to be turned off by removing the ac line input voltage.

Rectifier and Filtering Circuitry

The ac line voltage is rectified by a full-wave bridge rectifier and fed to the Power Factor Correction/Boost Converter Circuitry.

Power Factor Correction/Boost Converter Circuitry

This circuitry consists of a switching-type power supply which generates approximately 400 V dc at the output of the filter circuitry. Additionally, this circuitry monitors the ac line input frequency and current and maintains an in-phase relationship between the average current and input voltage. This effectively makes the impedance of the power supply module appear resistive in order to satisfy regulatory agency requirements.

Startup Inverter Circuitry

This circuitry consists of a switching-type power supply which generates a +12 V dc supply voltage used by the power supply module circuitry as VCC at the time of initial power up. When all supply voltages have stabilized, this circuit is overridden by +14.2 V BULK which continues to supply VCC to the module circuitry.

The circuitry consists of a pulse width modulator (PWM) running at 133 kHz (internal circuitry provides clock signal during initial power up). The PWM output pulses control a transistor switch which repetitively gates voltage (divided down 400 V dc from the Input Conditioning Circuitry) to the primary of the startup isolation transformer. The result is an induced voltage in the secondary winding which feeds two half-wave rectifier circuits. One circuit provides the +12 V dc Startup Bias voltage (used by the module circuitry as initial VCC), and the other provides a BULK DETECT signal used by the Diagnostics Circuitry to generate the AC FAIL signal.

Main Inverter Circuitry

Overview

The main inverter circuitry is comprised of a switching-type power supply which generates a +14.2 V dc supply voltage. This voltage is used as the source for the +5 V inverter circuit in the power supply module, as well as the +14.2 V supply voltage for the station modules (via the backplane).

Switching Power Supply Operation

The main inverter switching power supply consists of a pulse width modulator (PWM) running at 267 kHz. The PWM output pulses control a pair of power FETs which alternately gate the 400 V dc (from the Input Conditioning Circuitry) to the primary of the main isolation transformer. The result is an induced voltage in the three secondary windings of the transformer at 133 kHz rate.

Transformer Secondary Voltages

The main isolation transformer has three secondary windings, as follows:

- **Battery Charger Winding** – used to provide an ac source to the switching-type power supply portion of the battery charger circuitry (TPN6187A only).
- **Module Fail Winding** – operates in conjunction with a half-wave rectifier circuit to provide a dc signal (Mod Fail) to the A/D converter (p/o Diagnostics Circuitry); indicates that the main inverter circuitry is functioning properly.
- **+14.2 V Winding** – operates in conjunction with a full-wave rectifier circuit to generate a +14.2 V dc supply voltage. Overcurrent and overvoltage detect circuits monitor the circuit operation and, if preset thresholds are exceeded, generate a shutdown signal which is fed to the softstart circuitry to shutdown the main inverter.

+5 V Inverter Circuitry

Overview

The +5 V inverter circuitry is comprised of a switching-type power supply which generates a +5 V dc supply voltage. This voltage is used as the +5 V supply voltage for the station modules (via the backplane).

Switching Power Supply Operation

The +5 V inverter switching power supply consists of a pulse width modulator (PWM) running at 133 kHz. The PWM output pulses control a power FET which repetitively gates the +14.2 V dc (from the Main Inverter Circuitry) to the filtering circuitry. The result is a +5 V dc supply voltage.

Protection Circuitry

An overvoltage detect circuit monitors the output voltage and, if preset thresholds are exceeded, generates a shutdown signal which is fed to the softstart circuitry to shutdown the main inverter. Upon an overvoltage detection, a FET crowbar circuit immediately discharges the output to protect other modules in the station.

An overcurrent detect circuit monitors the current draw from the +5 V inverter circuit and, if a preset threshold is exceeded, shuts down the +5 V inverter. If the overcurrent condition lasts for a preset length (approx. 50 msec), the surge current delay circuit generates a shutdown signal which is fed to the softstart circuitry to shutdown the main inverter.

Diagnostics Circuitry

Overview

The diagnostics circuitry consists of a 12-channel A/D converter which converts analog status signals from critical points in the module to digital format for transfer to the Station Control Module via the SPI bus. Most of the status signals are generated by detect circuits to indicate the status of dc supply voltages and references.

Temperature Monitor and Control Circuitry

A thermistor mounted on the power supply module heatsink provides a varying resistance input to several detect and control circuits, as follows:

- **Heatsink Status Detect** – compares signal from thermistor to reference voltage to generate an output proportional to heatsink temperature; signal is sent to Station Control Board via A/D converter and SPI bus.
- **Hi-Temp Detect** – compares signal from thermistor to reference voltage to generate a high temperature signal if preset threshold is exceeded; signal is sent to softstart circuitry to shut down main inverter if overtemperature condition is detected.
- **Fan Control Circuitry** – compares signal from thermistor to reference voltage to generate a fan control signal to turn on cooling fan mounted in power supply module; also generated is a FAN ON status signal which is sent to Station Control Board via A/D converter and SPI bus.

  Note that a Fan Fault Detect circuit accepts a pulsed feedback signal from the cooling fan to indicate whether the fan is functioning (when turned on by Fan Control Circuitry); a FAN FAIL status signal is sent to Station Control Board via A/D converter and SPI bus

***Note:** The cooling fan in the Power Supply Module is thermostatically controlled and may come on at any time during station operation. Failure of the fan to rotate continuously does not indicate a failure of the module.*

Status LED Indicators

Two LEDs located on the power supply module front panel indicate module status as follows:

- **AC On** – lights GREEN when power supply module is turned on and functioning properly; LED turns off when module is turned off, ac power is removed, or module startup circuitry is in fail mode
- **Module Fail** – lights RED when power supply module is in fail mode; LED turns off when module is functioning properly

Address Decode Circuitry

The address decode circuitry allows the Station Control Board to use the address bus to select either the D/A converter (Battery Charging/Revert Circuitry) or the A/D converter (Diagnostics Circuitry) for communications via the SPI bus. Typical communications include reading status signals from the Diagnostics Circuitry and providing charger output control signals to the Battery Charging Circuitry.

Battery Charging/Revert Circuitry (TPN6187A Only)

Overview

The Battery Charging/Revert Circuitry charges an external storage battery and automatically reverts to battery power in case of an ac power failure. The circuitry offers features such as output short circuit protection, battery temperature monitoring, and immediate revert to battery backup with no interruption of station operation.

Switching Power Supply Operation

The battery charging circuitry consists of a switching power supply comprised of a pulse width modulator (PWM) running at 133 kHz. The PWM output pulses control a power FET which repetitively gates the +33 V dc (from a circuit comprised of a secondary winding on the main isolation transformer and a full-wave rectifier and filter) to the filtering circuitry. The result is a dc voltage used to charge an externally mounted storage battery. The output of the charging circuit is controlled by charger output select lines from the Station Control Board via the SPI bus and D/A converter. (In determining the appropriate charger output voltage, the Station Control Board uses parameters such as battery type, equalize voltage, battery temperature, and float voltage which are entered via the RSS at the time of installation.)

Battery Revert Circuitry

In case of ac power failure, a battery revert relay is energized which places the storage battery on the +14.2 V bus, thus maintaining station operation under battery backup power. An SCR in parallel with the relay contacts provides instantaneous battery revert and protection for the relay contacts against arcing.

Note: *The duration of battery-supplied station operation depends on the capacity of the installed battery.*

A 3-pin connector located on the station backplane allows the connection of an externally mounted thermistor to provide an indication of battery temperature. The thermistor resistance is converted to a voltage signal (BAT TEMP) proportional to battery temperature. The BAT TEMP signal is sent to the Station Control Module via the A/D converter and SPI bus.

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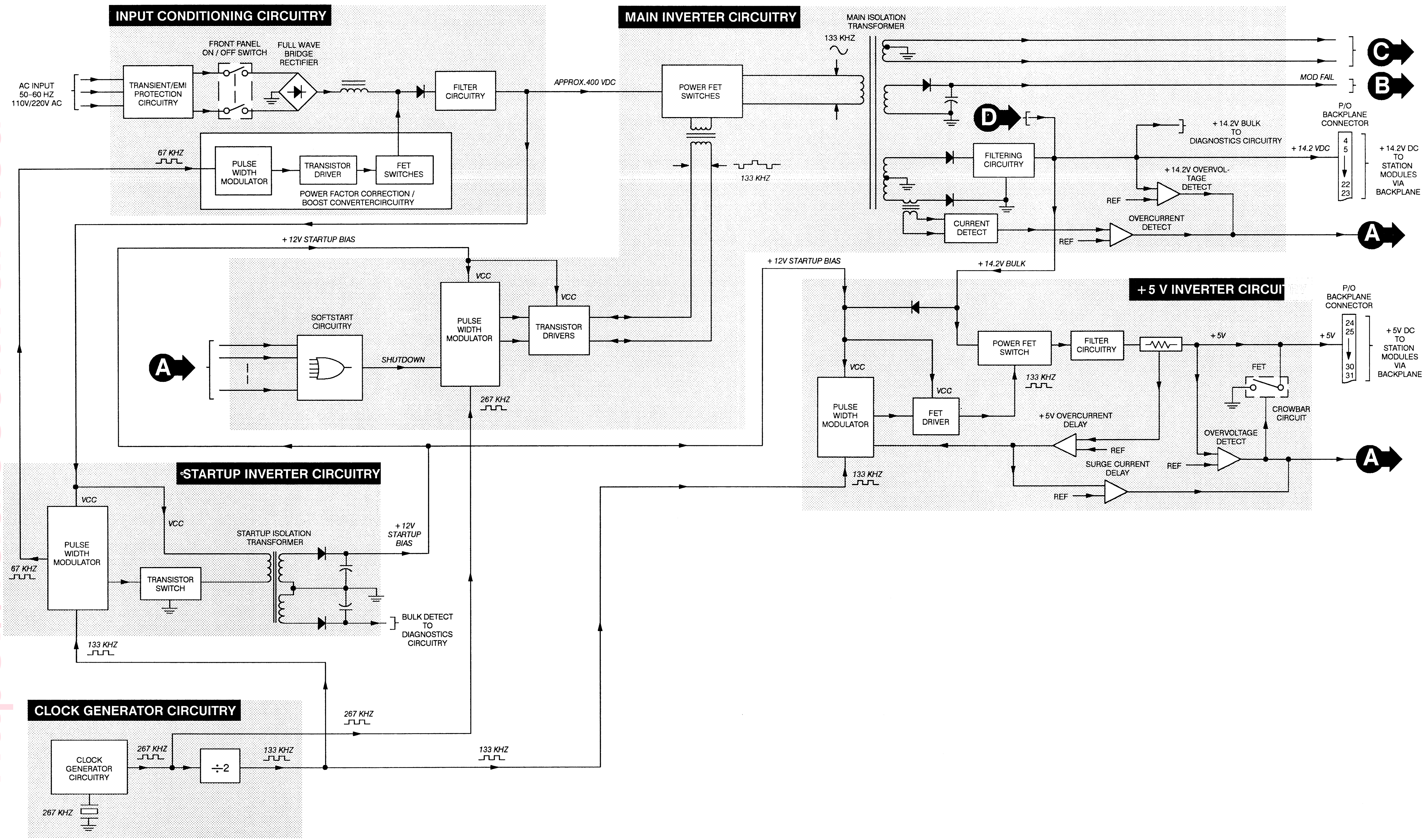

Figure 2. 265W AC Power Supply Module Functional Block Diagram (Sheet 1 of 2)

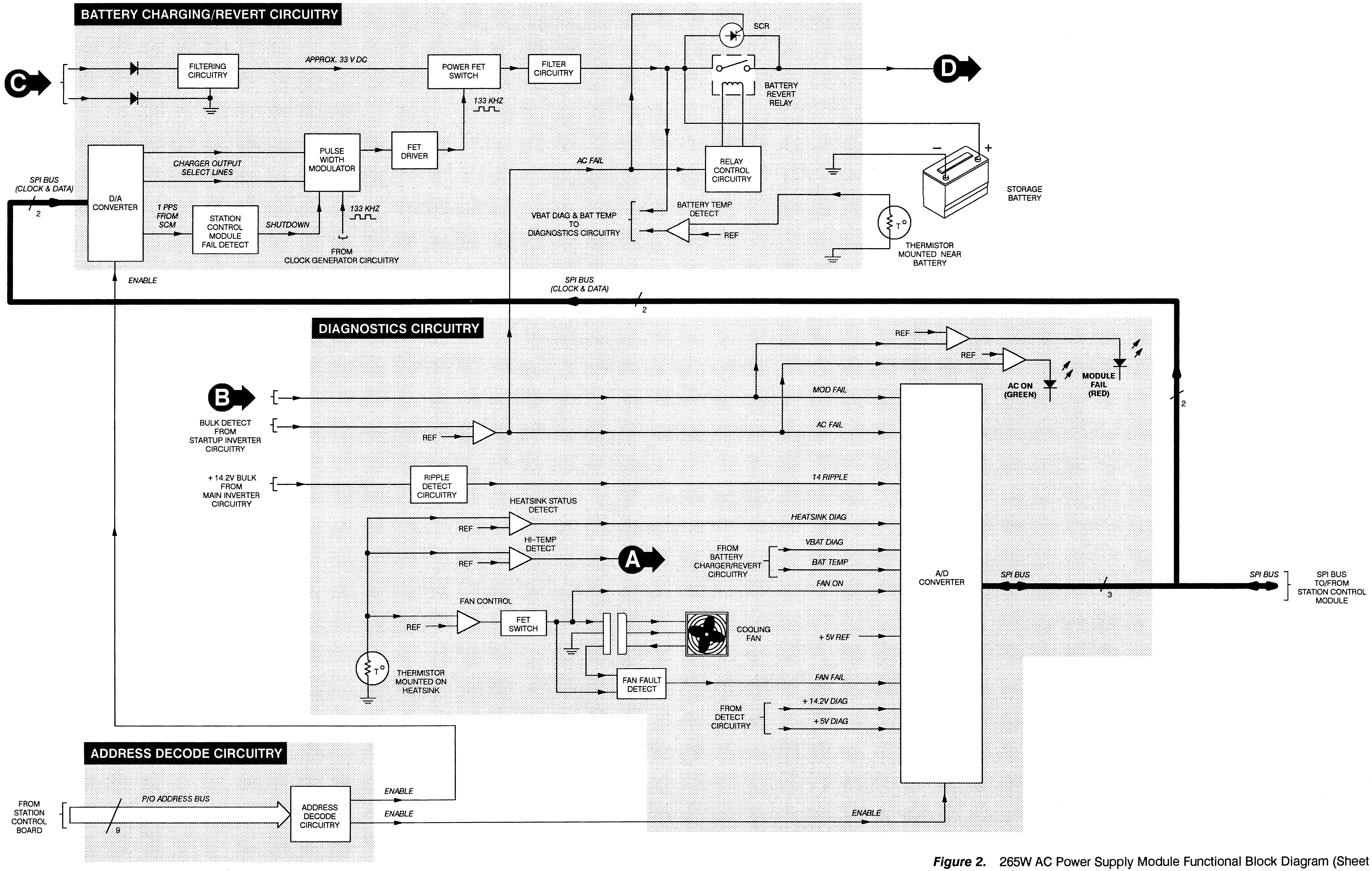

Figure 2. 265W AC Power Supply Module Functional Block Diagram (Sheet 2 of 2)

MOTOROLA

POWER SUPPLY MODULE

INCLUDES MODELS:
TRN7802A (210W; 12/24V DC Input)
TRN7803A (210W; 48/60V DC Input)

1 DESCRIPTION

The Models TRN7802A/TRN7803A Power Supply Modules are described in this section. A general description, performance specifications, 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 satellite receiver.)

General Description

The Model TRN7802A Power Supply Module accepts an input of either 12 V dc or 24 V dc, while the Model TRN7803A Power Supply Module accepts an input of either 48 V dc or 60 V dc. Each module generates +5V dc and +14.2V dc operating voltages to power the satellite receiver modules. Each power supply module is comprised of several switching–type power supply circuits and diagnostics and monitoring circuitry, all contained within a slide–in module housing.

The power supply module provides the following features:

- Internal voltage and current limiting – circuitry continually monitors critical voltages and currents and shuts supply down if preset thresholds are exceeded
- Temperature protection – module contains built–in cooling fan which is thermostatically controlled; supply shuts down if temperature exceeds preset threshold
- Diagnostic monitoring – critical internal parameters are continually monitored and reported to the Station Control Module, which can automatically provide correction for certain operating conditions
- Front panel On/Off switch with built–in circuit breaker (30A for TRN7802A, 10A for TRN7803A)

The Models TRN7802A and TRN7803A differ only in the required dc input voltage. Unless otherwise noted, the information provided in this section applies to both models.

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1 DESCRIPTION (Continued)

Overview of Circuitry

The power supply module contains the following circuitry:

- Startup Inverter Circuitry – provides VCC for power supply circuitry during initial power-up
- Main Inverter Circuitry – consists of switching-type power supply that generates the +14.2V dc supply voltage
- +5 V Inverter Circuitry – consists of switching-type power supply that generates the +5 dc supply voltage
- Clock Generator Circuitry – generates 267 kHz and 133 kHz clock signals used by pulse width modulators in the three inverter circuits
- Diagnostics Circuitry – converts analog status signals to digital format for transfer to Station Control Module
- Address Decode Circuitry – performs address decoding to provide chip select signals for the A/D and D/A converters

2 PERFORMANCE SPECIFICATIONS

Table 1 shows the electrical performance specifications for the Models TRN7802A and TRN7803A Power Supply Modules.

Performance Specifications

Table 1. TRN7802A/TRN7803A Power Supply Modules Performance Specifications

Parameter	Specification
Weight	6.5 kg (14.3 lbs)
Operating Temperature Range	-30 to +45° C (no derating) -30 to +60° C (derated)
Input Voltage Range	TRN7802A 10.5 - 34.5 V dc TRN7803A 41 - 72 V dc
Maximum Input Current	8.5 A
Steady State Output Voltages	+14.2 V dc ±5% +5.0 V dc ±5%
Output Current Ratings	+14.2 12.5 A +5.0 9 A
Total Output Power Rating	no derating 210 W
Output Ripple	All outputs 50 mV p-p (measured with 20 MHz BW oscilloscope at 25°C). High Frequency individual harmonic voltage limits in 10 kHz-100 MHz frequency band: 14.2 V 1.5 mV p-p 5V 5 mV p-p
Short Circuit Current	0.5 A avg. max

3 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the power supply module controls, indicators, and all input and output external connections.

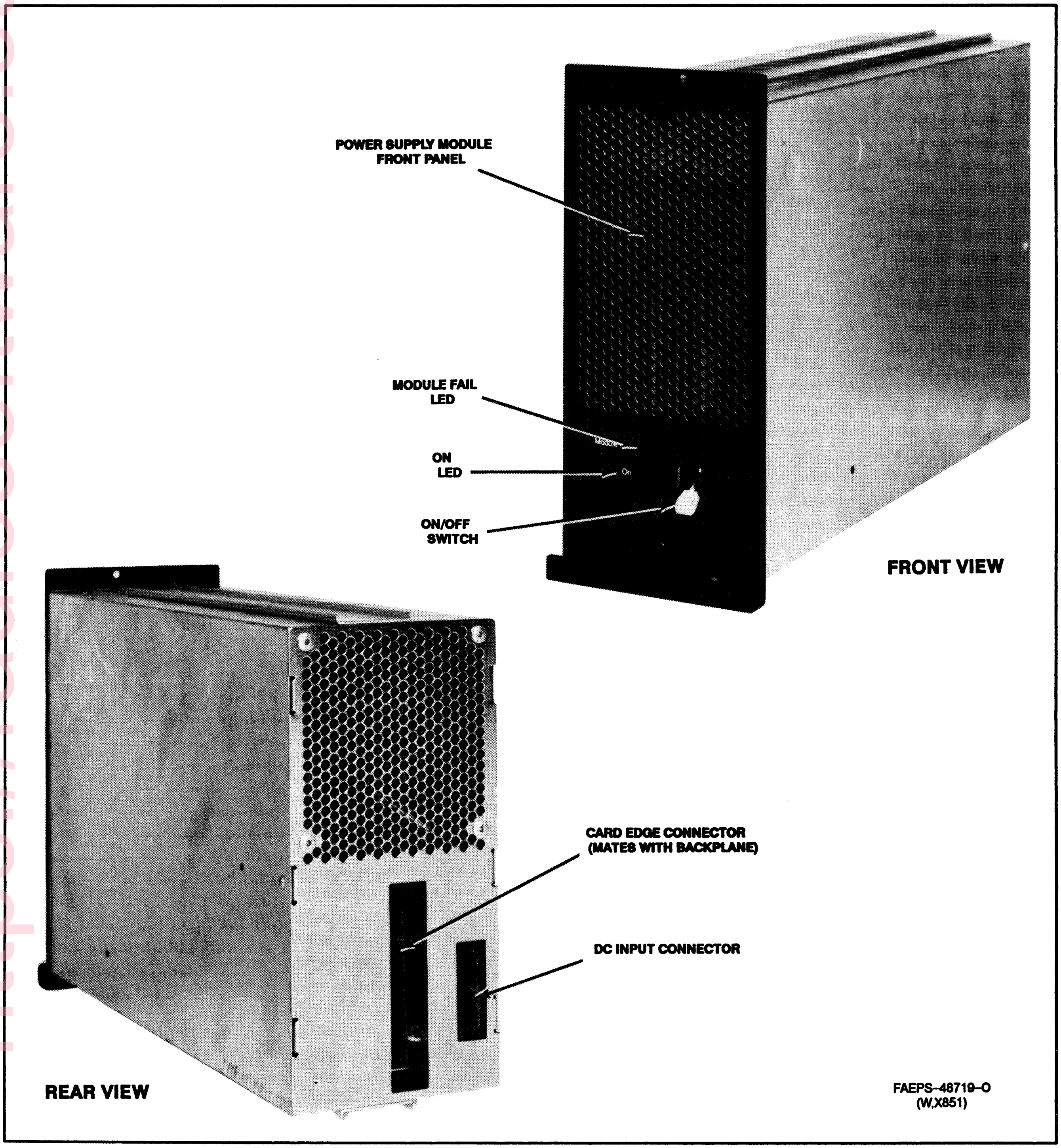

Figure 1. Power Supply Module Controls, Indicators, and Inputs/Outputs

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.

Input Conditioning Circuitry

Introduction

The power supply module accepts dc power from an external source, typically a bank of storage batteries. DC power is connected to the module via a 4-wire dc input cable mounted on the satellite receiver backplane.

Transient and EMI Protection

The dc input is fed to the power supply module circuitry via transient protection and EMI filter circuits. The transient protection devices provide protection against voltage spikes by providing an effective short to ground under high voltage transient conditions. The EMI filter prevents electrical noise generated by the power supply module from interfering with other equipment connected to the same dc source.

Front Panel On-Off Switch and Breaker

A toggle-type switch located on the power supply module front panel allows the power supply (and satellite receiver) to be turned off by removing the dc input voltage. The switch controls a built-in circuit breaker (rated at 30A for TRN7802A, 10A for TRN7803A) to provide overload protection for the power supply and satellite receiver circuitry.

Startup Inverter Circuitry

This circuitry consists of a switching-type power supply which generates a +12 V dc supply voltage used by the power supply module circuitry as VCC at the time of initial power up. When all supply voltages have stabilized, this circuit is overridden by +14.2 V BULK which continues to supply VCC to the module circuitry.

The circuitry consists of a pulse width modulator (PWM) running at 133 kHz (internal circuitry provides clock signal during initial power up). The PWM output pulses control a transistor switch which repetitively gates voltage (divided down 400 V dc from the Input Conditioning Circuitry) to the primary of the startup isolation transformer. The result is an induced voltage in the secondary winding which feeds two half-wave rectifier circuits. One circuit provides the +12 V dc Startup Bias voltage (used by the module circuitry as initial VCC), and the other provides a BULK DETECT signal used by the Diagnostics Circuitry to generate the DC FAIL signal.

Main Inverter Circuitry

Overview

The main inverter circuitry is comprised of a switching-type power supply which generates a +14.2 V dc supply voltage. This voltage is used as the source for the +5 V inverter circuit in the power supply module, as well as the +14.2 V supply voltage for the satellite receiver modules (via the backplane).

Switching Power Supply Operation

The main inverter switching power supply consists of a pulse width modulator (PWM) running at 67 kHz. The PWM output pulses control a power FET bridge which alternately gate the input dc voltage (from the Input Conditioning Circuitry) to the primary of the main isolation transformer. The result is an induced voltage in the secondary windings of the transformer at 133 kHz rate.

Transformer Secondary Voltages

The main isolation transformer has two secondary windings, as follows:

- **Module Fail Winding** – operates in conjunction with a half-wave rectifier circuit to provide a dc signal (Mod Fail) to the A/D converter (p/o Diagnostics Circuitry); indicates that the main inverter circuitry is functioning properly.
- **+14.2 V Winding** – operates in conjunction with a full-wave rectifier circuit to generate a +14.2 V dc supply voltage. Overcurrent and overvoltage detect circuits monitor the circuit operation and, if preset thresholds are exceeded, generate a shutdown signal which is fed to the softstart circuitry to shutdown the main inverter.

+5 V Inverter Circuitry

Overview

The +5 V inverter circuitry is comprised of a switching-type power supply which generates a +5 V dc supply voltage. This voltage is used as the +5 V supply voltage for the satellite receiver modules (via the backplane).

Switching Power Supply Operation

The +5 V inverter switching power supply consists of a pulse width modulator (PWM) running at 133 kHz. The PWM output pulses control a power FET which repetitively gates the +14.2 V dc (from the Main Inverter Circuitry) to the filtering circuitry. The result is a +5 V dc supply voltage.

Protection Circuitry

An overvoltage detect circuit monitors the output voltage and, if preset thresholds are exceeded, generates a shutdown signal which is fed to the softstart circuitry to shutdown the main inverter. Upon an overvoltage detection, a FET crowbar circuit immediately discharges the output to protect other modules in the satellite receiver.

An overcurrent detect circuit monitors the current draw from the +5 V inverter circuit and, if a preset threshold is exceeded, shuts down the +5 V inverter. If the overcurrent condition lasts for a preset length (approx. 50 msec), the surge current delay circuit generates a shutdown signal which is fed to the softstart circuitry to shutdown the main inverter.

Diagnostics Circuitry

Overview

The diagnostics circuitry consists of a 11-channel A/D converter which converts analog status signals from critical points in the module to digital format for transfer to the Station Control Module via the SPI bus. Most of the status signals are generated by detect circuits to indicate the status of dc supply voltages and references.

Temperature Monitor and Control Circuitry

A thermistor mounted on the power supply module heatsink provides a varying resistance input to several detect and control circuits, as follows:

- **Heatsink Status Detect** – compares signal from thermistor to reference voltage to generate an output proportional to heatsink temperature; signal is sent to Station Control Board via A/D converter and SPI bus.
- **Hi-Temp Detect** – compares signal from thermistor to reference voltage to generate a high temperature signal if preset threshold is exceeded; signal is sent to softstart circuitry to shut down main inverter if overtemperature condition is detected.
- **Fan Control Circuitry** – compares signal from thermistor to reference voltage to generate a fan control signal to turn on cooling fan mounted in power supply module; also generated is a FAN ON status signal which is sent to Station Control Board via A/D converter and SPI bus.

  Note that a Fan Fault Detect circuit accepts a pulsed feedback signal from the cooling fan to indicate whether the fan is functioning (when turned on by Fan Control Circuitry); a FAN FAIL status signal is sent to Station Control Board via A/D converter and SPI bus

Note: *The cooling fan in the Power Supply Module is thermostatically controlled and may come on at any time during satellite receiver operation. Failure of the fan to rotate continuously does not indicate a failure of the module.*

Status LED Indicators

Two LEDs located on the power supply module front panel indicate module status as follows:

- **On** – lights GREEN when power supply module is turned on and functioning properly; LED turns off when module is turned off, input power is removed, or module startup circuitry is in fail mode
- **Module Fail** – lights RED when power supply module is in fail mode; LED turns off when module is functioning properly

Address Decode Circuitry

The address decode circuitry allows the Station Control Board to use the address bus to select the A/D converter (Diagnostics Circuitry) for communications via the SPI bus. Typical communications include reading status signals from the Diagnostics Circuitry.

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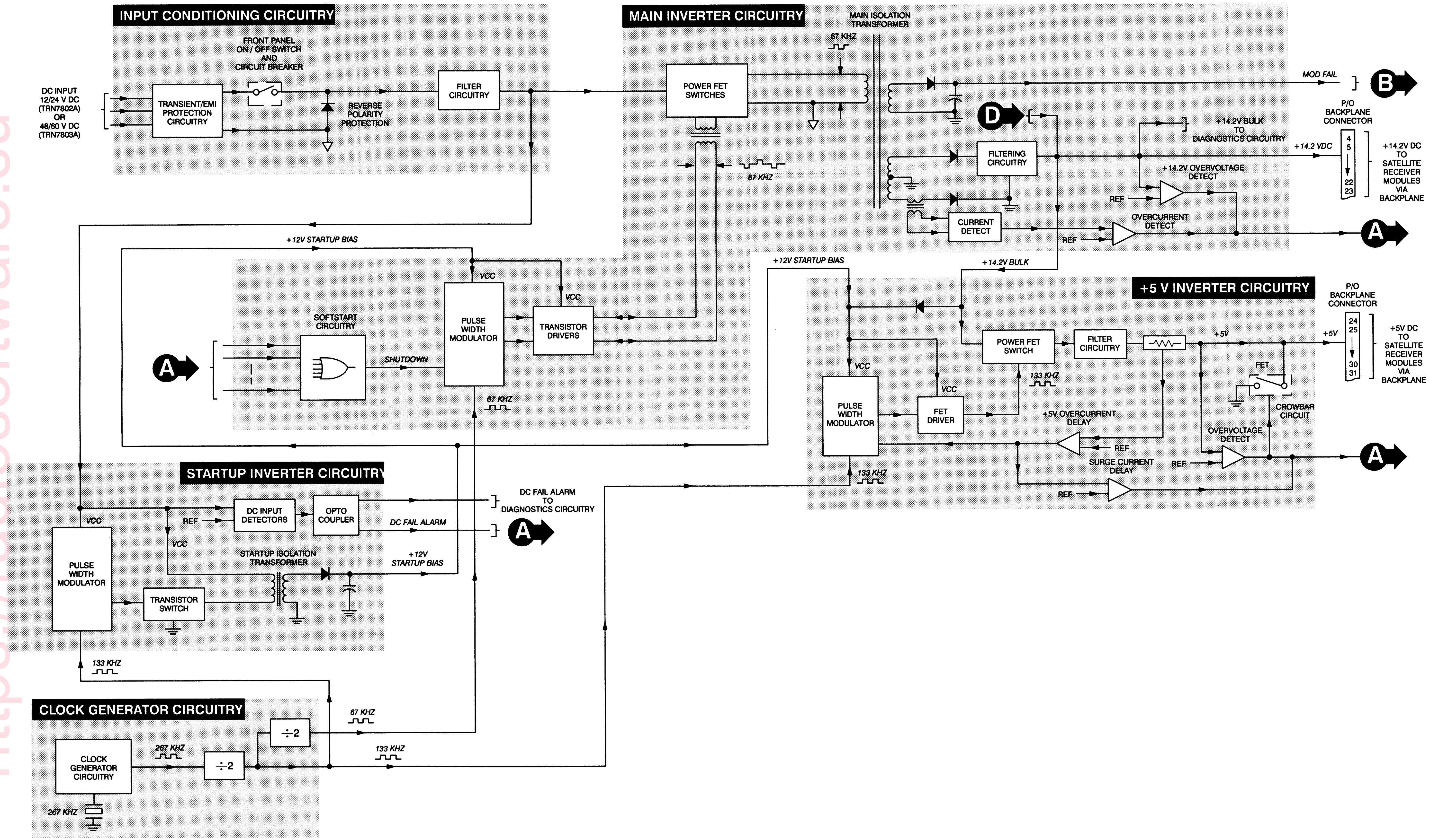

Figure 2. 210W DC/DC Power Supply Module Functional Block Diagram (Sheet 1 of 2)

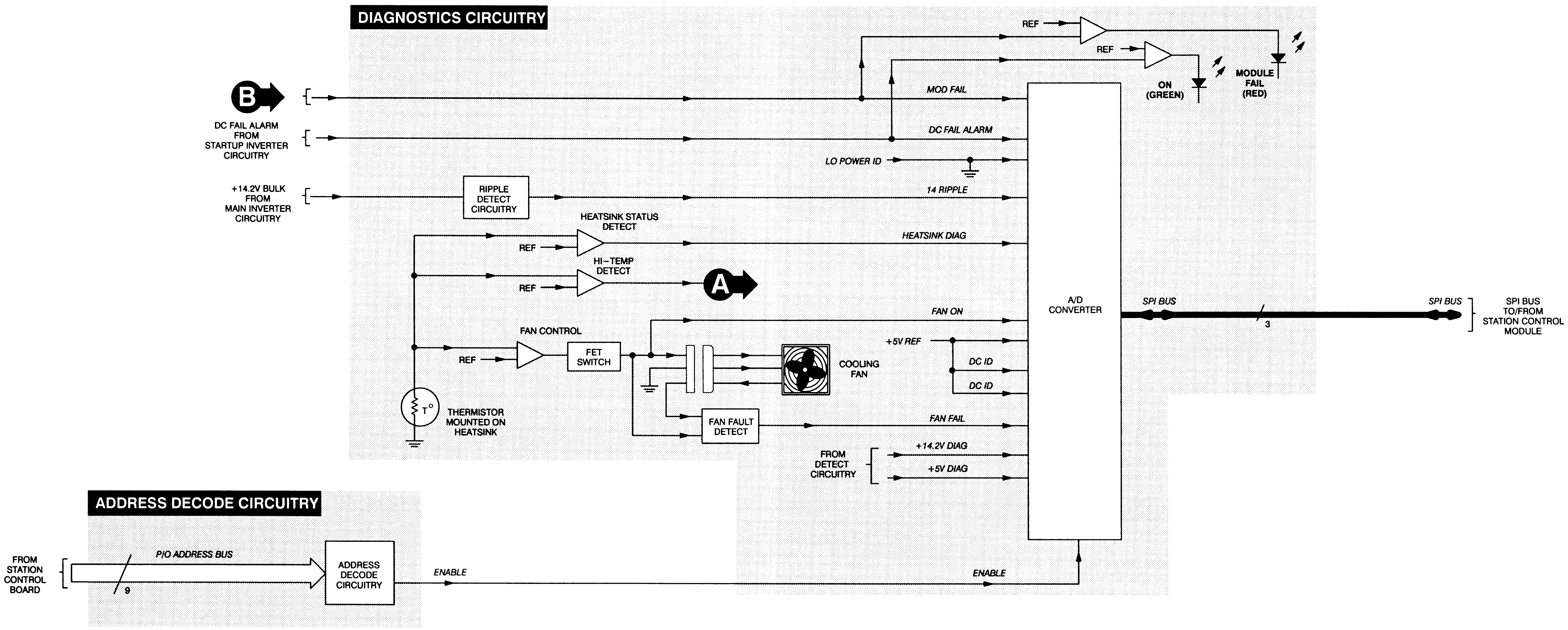

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Figure 2. 210W DC/DC Power Supply Module Functional Block Diagram (Sheet 2 of 2)

MOTOROLA

ASTRO MODEM CARD

(Option X437AA)

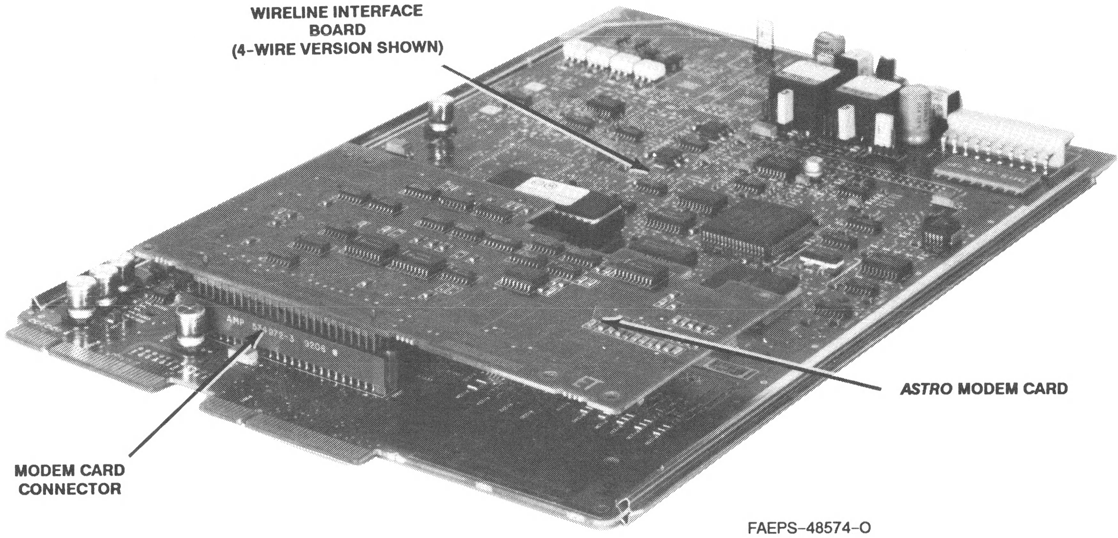

Figure 1. *ASTRO* Modem Card Installed on Wireline Interface Board (4-wire Model Shown)

1 DESCRIPTION

Option X437AA provides a single *ASTRO* Modem Card for use with *Quantar* station products. The *ASTRO* Modem Card provides the interface between the station and the wireline in systems using *ASTRO* 9.6 kbps signaling. The card connects to the Wireline Interface Board, as shown in Figure 1. Note that 8-wire Wireline Interface Boards are equipped with connectors for two *ASTRO* modem cards.

General Description

Note: *The* ASTRO *modem card contains no jumpers or switches and requires no adjustments. The card is auto-configured upon station power-up.*

The modem card accepts *ASTRO* modem signaling from the wireline and converts the signal to detected data, which is then fed to the Station Control Module for further processing. Data from the StationControl Module is fed to the modem card, which converts the signal to an *ASTRO* modem signal and outputs the signal to the wireline. (Refer to the Wireline Interface Board sections in this manual for block diagrams showing the interface between the *ASTRO* modem card and the wireline/station.)

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