MOTOROLA

MSF 5000

DIGITAL CAPABLE AND ANALOG PLUS STATIONS

Instruction Manual

68P81092E05-O

Manual Scan

I hope this service manual is of use to you. Motorola does not make this available as a PDF and all other available copies are of poor quality.

Each page is captured at 600 DPI, and as 24-bit color, 8-bit grayscale or black and white and at the proper page size, up to 11x34 inches in many cases. OCR has been preformed on the document, even on the large pages. The document is condensed into one single PDF with text overlay. You should be able to print the larger sheets on 11x17 or tile them onto 8.5x11 if needed.

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This was captured on a Canon DR-G2140 scanner which is ~ 7500 USD unit circa 2021. You may note some artifacts and lines in on the scans, these are due to scratches on the sensor glass, and are minor. The replacement glass is about 250 USD if you're feeling generous :-)

If you have a hard to find/out of print manual and would like to make it available please reach out, I may be able to scan and return it to you.

Thank you,

Bryan Fields, W9CR
bryan@bryanfields.net

FCC INTERFERENCE WARNING

The FCC requires that manuals pertaining to Class A 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 A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

COMMERCIAL WARRANTY (STANDARD)

Motorola radio communications products (the "Product") is 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, 1301 E. Algonquin Road, Schaumburg, Illinois 60196 to the original end use 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 EXPRESS 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 by Motorola, or if appropriate to specifications accepted by Motorola in writing, during the period shown, Motorola, at its option, will either repair or replace the product or refund the purchase price thereof. Repair at Motorola's option, may include the replacement of parts or boards with functionally equivalent reconditioned or new parts or boards. Replaced parts or boards are warranted for the balance of the original applicable warranty period. All replaced parts or product shall become the property of Motorola.

This express commercial warranty is extended by Motorola to the original end user purchaser or lessee only and is not assignable or transferable to any other party. This is the complete warranty for the Product manufactured by Motorola. Motorola assume no obligations or liability for additions or modifications to this warranty unless made in writing and signed by an officer of Motorola. Unless made in a separate agreement between Motorola and the original end user purchaser, Motorola does not warrant the installation, maintenance or service of the Products.

Motorola cannot be responsible in any way for any ancillary equipment not furnished by Motorola which is attached to or used in connection with the Product, or for operation of the Product with any ancillary equipment, and all such equipment is expressly excluded from this warranty. Because each system which may use Product is unique, Motorola disclaims liability for range, coverage, or operation of the system as a whole under this warranty.

This warranty does not cover:

a) Defects or damage resulting from use of theProduct in other than its normal and customary manner.

b) Defects or damage from misuse, accident, water or neglect

c) Defects or damage from improper testing, operation, maintenance installation, alteration, modification, or adjusting.

d) Breakage or damage to antennas unless caused directly by defects in material workmanship.

e) A Product subjected to unauthorized Product modifications, disassembies or repairs (including without limitation, the addition to the Product of non-Motorola supplied equipment) which adversely affect performance of the Product or interfere with Motorola's normal warranty inspection and testing of the Product to verify any warranty claim.

f) Product which has had the serial number removed or made illegible.

g) A Product which, due to illegal to unauthorized alteration of the software/firmware in the Product, does not function in accordance with Motorola's published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from Motorola.

This warranty sets forth the full extent of Motorola's responsibilities regarding the Product. Repair, replacement or refund of the purchase date, at Motorola's option is the exclusive remedy. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OR TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGE ARISING OUT OF THE USE OR INBILITY TO USE SUCH PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

SOFTWARE NOTICE/WARRANTY

Laws in the United States and other countries preserve for Motorola certain exclusive rights for copyrighted Motorola software such as the exclusive rights to reproduce in copies and distribute copies of such Motorola software. Motorola software may be used in only the Product in which the software was originally embodied and such software in such Product may not be replaced, copied, distributed, modified in any way, or used to produce any derivative thereof. No other use including without limitation alteration, modification, reproduction, distribution, or reverse engineering of such Motorola software or exercise of rights in such Motorola software is permitted. No license is granted by implication, estoppel or otherwise under Motorola patent rights or copyrights.

This warranty extends only to individual products: batteries are excluded, but carry their own separate limited warranty.

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 fifty (50) United States and the District of Columbia.

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Foreword

Maintenance Philosophy

The *MSF 5000* is comprised of many boards and assemblies. These boards and assemblies should be replaced with known good boards and assemblies whenever they are determined to be faulty. This Instruction Manual, in conjunction with the *MSF 5000* Service Manual (Service Manual), is used to return the station to normal operation as quickly as possible.

Due to the high percentage of surface mount components and multi-layer circuit boards, field repair of station boards and assemblies is discouraged.

Scope of Manual

This manual is provides the experienced service technician with an overview of basic *MSF 5000* operations and functions. It contains the information necessary for an operational understanding of each board or assembly.

Refer to the Service Manual for detailed information on each board and assembly. The Service Manual contains schematics, parts lists, and other detailed information.

The information in the *MSF 5000* Manual is current as of the printing date. Changes occurring after the printing date are temporarily incorporated into the manual through Schaumburg Manual Revisions (SMRs). This manual will be revised on a periodic basis as SMRs and other engineering changes are made to the *MSF 5000* equipment.

General Safety Information

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

The following precautions are always recommended:

- DO NOT operate the transmitter of a fixed radio (base station, microwave and rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.
- DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.
- DO NOT operate this equipment near electrical caps or in an explosive atmosphere.
- All equipment must be properly grounded according to Motorola installation instructions for safe operation. Refer to the R56 Quality Standards FNE Installation manual.
- All equipment should be serviced only by a qualified technician.

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

WARNING

Possible electrical shock hazard. Before attempting removal or installation, make sure the primary power and batteries are disconnected.

CAUTION

This station contains CMOS devices. Proper troubleshooting and installation techniques require grounding precautions by personnel prior to handling equipment.

Service and Repairs

Motorola Service

Motorola's National Service Organization offers one of the finest nationwide installation and maintenance programs available. This organization includes approximately 900 authorized Motorola Service Stations (MSS) located throughout the United States. Each service station is manned by one or more trained FCC licensed technicians.

Each MSS is independently owned and operated. An MSS is selected by Motorola to service its customers. Motorola maintenance is available on a time and material basis or a periodic fixed fee arrangement.

The administrative staff of this organization consists of national, area and district service managers and district representatives, all of whom are Motorola employees. Their objective is to improve the service to our customers.

For additional information about purchasing a service contract for Motorola equipment, contact your Motorola Service Representative, or write to:

National Service Manager

Motorola Communications and Electronics, Inc.

1301 E. Algonquin Road SH4

Schaumburg, Illinois 60196

Replacement Parts

When ordering replacement parts or equipment information, include the station model number, option numbers (if applicable), and the replacement part number. This applies to all components, kits, and chassis. If the component part number is not known, include its chassis or kit number and a description of the component on the order.

Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the model number using the part.

Orders for active filters should specify type number and frequency, identify the owner/operator of the communications system to use these items, and any serial number stamped on the components being replaced.

Refer to the addresses and phone numbers listed on the following pages when ordering replacement parts.

Mail Orders

Send all written orders to the following addresses listed below:

Replacement Parts/Test Equipment/Crystal Service Items:

Motorola
Worldwide System and Aftermarket Products Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, Illinois 60196

International Orders:

Motorola
Worldwide System and Aftermarket Products Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, Illinois 60196

Federal Government Orders:

Motorola
Worldwide System and Aftermarket Products Division
Attention: Order Processing
7230 Parkway Drive
Hanover, Maryland 21076

Fax Orders

Fax orders to the following numbers listed below:

Replacement Parts/Test Equipment/Crystal Service Items:

Domestic Fax - (708) 538-8198

International Fax - (708) 576-3023

Federal Government Orders:

Fax - (301) 925-2690

Trunked & 900 MHz Customer Response Center:

Fax - (800) 526-8644

Telephone Orders/Customer Service

Telephone customer service or place phone orders to the following numbers listed below:

Replacement Parts/Test Equipment/Crystal Service Items:

National Parts - (800) 422-4210

Federal Government Orders - (800) 826-1913

International Orders - (708) 538-8023

Product Services:

Telephone - (708) 576-0180

Trunked & 900 MHz Customer Response Center:

Telephone - (800) 247-2346

National Service Training Video Tapes:

Telephone - (708) 576-8012

System Support Center:

Telephone - (800) 448-3245

Upload Center:

Telephone - (800) 874-5574

Parts Identification:

Telephone - (708) 538-0021

Indirect Distribution Dealer Support Group:

Telephone - (800) 356-9058

Direct Product Services:

Telephone - (800) 523-4007

Radio Service Software (RSS) Support:

See Direct Product Services

Training

Contact training at the number listed below:

National Service Training (NST):

Telephone - (708) 576-8012

How to Interpret Motorola Model Numbers

Refer to the information provided below for breakdown of Motorola model numbers for the MSF 5000 station.

C 7 3 CX B 7 1 0 6 B T

HOUSING TYPE
C = COMPA

POWER OUTPUT
0 = no TX pwr
1 = less than .75w
2 = .75 to 6w
3 = 6w to 15w
4 = 15w to 40w
5 = 40w to 70w
6 = 70w to 100w
7 = 100w to 135w
8 = 135w to 260w
9 = over 260w

FREQUENCY BAND
0 = less than 25 MHz
1 = 25 to 54 MHz (low band)
2 = 66 to 88 MHz (mid band)
3 = 132 to 174 MHz (VHF)
4 = 406 to 512 MHz (UHF)
5 = 806 to 960 MHz
7 = 1.5 GHz
8 = 280 MHz

RADIO SERIES
GF = MSF Analog Plus (900 MHz)
CX = MSF Capable
RL = MSF Limited
RU = MSF Canada

PRIMARY VOLTAGE
(also be determined by options)
A = 12v DC (ext supply)
B = 120v AC
C = DC source (battery)
D = 120v AC / 12 vDC
G = 120/240v AC & 12v DC
K = 120v AC / 240v AC

SQUELCH
1 = CSQ
2 = Data
3 = PL
5 = Connect Tone
6 = DPL
7 = Programmable

CHANNEL SPACING
0 = wide
1 = 25 kHz
2 = 12.5 kHz
4 = 25 kHz w/extender

CHANNELS
obsolete field
for MSF Stations
MSF always 0

CONTROL TYPE
0 = None
1 = Data
2 = No Control
3 = Local
4 = EXT Local
5 = DC Remote
6 = Tone
7 = DC & Tone
8 = TAC RX

VERSION
ALPHA CODE

UNIQUE MODEL
VARIATIONS
EXAMPLES
T = Repeater
R = Rack mount

MSFX016
022494KOM

MODEL COMPLEMENT CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS

VHF: 132-174 MHz

LEGEND:

= Items Supplied

* = Refer to 1st Item Breakdown Chart

@ = Frequency Dependent

132-158 MHz = Range 1

146-174 MHz = Range 2

DESCRIPTION	MODEL	TBN6583A 26" Universal Rack	TBN6584A 37" Universal Rack	TFD1000A* VHF Low Pass High Power Filter	THN6663A 26" Universal Cabinet	THN6664A 37" Universal Cabinet	TKN8487A Watt Meter Cable	TKN8492A Line Interface Cable	TKN8498B 25' Trunking Central Controller Cable	TKN8500C Secure Smartnet System Cable	TKN8543A Trunked Toned Remote Control/J-Box Trunking Cable	TKN8551A Repeater Station Cable	TKN8572A DC Power Supply Cable	TKN8573A Power Supply to Fan Cable	TKN8574A DC Power Supply Cable	TKN8579A Low Power PA Power Supply Interconnect Cable	TKN8580A High Power PA Power Supply Interconnect Cable	TKN8610A VHF Base Station Cable	TKN8613A High Power Base Station Cable	TKN8670A Directional Coupler Cable	TKN8671A Low Power VHF Trunking Cable	TKN8672A High Power VHF Trunking Cable	TKN8710A RX Loopback Cable	TKN8713A 26 Pin Ribbon Cables for SAM to Base Station Control	TKN8720A SAM to RLC Board Cable Kit	TKN8993A Expansion Cables	TLD2670A* Peripheral Box w/o Antenna Switch 132-174 MHz	TLD2680A* Peripheral Box w/ Antenna Switch 132-174 MHz	TLD2691A* 125W Power Amplifier 132-158 MHz
6W Data Base Station	C23CXB2106A						2					1				1				1	1		1	1	1	1	1		
6W Base Station	C23CXB7106B							1		1						1		1		1								1	
6W Repeater Station	C23CXB7106BT							1		1		1				1				1							1		
25W Data Base Station	C43CXB2106A						2					1				1							1	1	1	1	1		
25W Trunked Station	C43CXB5103BT						1	1	1	1	1	1				1											1		
25W Base Station	C43CXB7106B							1		1						1		1										1	
25W Repeater Station	C43CXB7106BT							1		1		1				1											1		
25W Canada Conv. Base Station	C43RUB7106A							1		1						1		1										1	
25W Canada Conv. Repeater Station	C43RUB7106AT							1		1		1				1											1		
75W Data Base Station	C63CXB2106A						2					1		1		1						1	1	1	1	1	1		
75W Trunked Station	C63CXB5103BT						1	1	1	1	1	1		1		1											1		
75W Base Station	C63CXB7106B							1		1				1		1		1				1						1	
75W Repeater Station	C63CXB7106BT							1		1		1		1		1											1		
100W Ltd. Conv. Base Station	C63RLB7106B	1			1			1		1				1		1		1				1						1	@
100W Ltd. Conv. Repeater Station	C63RLB7106BT		1			1		1		1		1		1		1											1		@
125W Data Base Station	C73CXB2106A						2					1		1		1						1	1	1	1	1	1		@
125W Trunked Station	C73CXB5103BT						1	1	1	1	1	1		1		1						1					1		@
125W Base Station	C73CXB7106B							1		1				1		1		1				1						1	@
125W Repeater Station	C73CXB7106BT							1		1		1		1		1						1					1		@
350W Trunked Station	C93CXB5103BT			1			1	1	1	1		1	1	1	1		1					1							
350W Base Station	C93CXB7106B			1				1		1			1	1	1		1		1			1							
350W Repeater Station	C93CXB7106BT			1				1		1		1	1	1	1		1					1							

DESCRIPTION	MODEL	TLD2692A* 125W Power Amplifier 146-174 MHz	TLD2741B* 350W Final Power Amplifier 132-158 MHz	TLD2742B* 350W Final Power Amplifier 146-174 MHz	TLD2770B* 25W Power Amplifier 132-174 MHz	TLD3061B* 75W Power Amplifier 132-158 MHz	TLD3062B* 75W Power Amplifier 146-174 MHz	TLD9610A 6W Directional Coupler	TLD9640B VHF Watt Meter	TLN2490A* 110V 15A 60Hz Low Power Junction Box	TLN3045C* MSF Encode/Decode Secure Module (Option)	TLN3086B* 110V 20A 60Hz High Power Junction Box	TLN3112E* Trunked Tone Remote Control Audio Board	TLN3182A* Narrow Band Secure Capable Station Control Board (Option)	TLN3189A* VHF/UHF Secure Capable Station Control Board	TLN3221B* Station Access Module (SAM)	TLN3267A* Transparent Only Secure Module (Option)	TLN3318A* Narrow Band VHF/UHF Data Station Control Board (Option)	TLN3319A* VHF/UHF Data Station Control Board	TPN1186B* 500W 60Hz Power Supply	TPN1260A* 675W 60 Hz Dual Output Power Supply	TRN5177A Expansion Tray Hardware	TRN5178B Expansion Tray Power Supply Board	TRN5200A Blank Bezel	TRN5352A RF Connector Plug	TRN5353A Auxiliary Connector Plug	TRN5355A Battery Connector Plug	TRN5427A 110V AC Power Cord	TRN5954A Blank Bezel
6W Data Base Station	C23CXB2106A							1	2	1						1			1	1		1	1	1	1	1	1	1	2
6W Base Station	C23CXB7106B							1		1			1		1					1					2	2	1	1	
6W Repeater Station	C23CXB7106BT							1		1			1		1					1					1	2	1	1	
25W Data Base Station	C43CXB2106A				1				2	1						1			1	1		1	1	1	1	1	1	1	2
25W Trunked Station	C43CXB5103BT				1				1	1			1		1					1					1	1	1	1	
25W Base Station	C43CXB7106B				1					1			1		1					1					2	2	1	1	
25W Repeater Station	C43CXB7106BT				1					1			1		1					1					1	2	1	1	
25W Canada Conv. Base Station	C43RUB7106A				1					1			1		1					1					2	2	1	1	
25W Canada Conv. Repeater Station	C43RUB7106AT				1					1			1		1					1					1	2	1	1	
75W Data Base Station	C63CXB2106A					@	@		2	1						1			1		1	1	1	1	1	1	1	1	2
75W Trunked Station	C63CXB5103BT					@	@		1	1			1		1						1				1	1	1	1	
75W Base Station	C63CXB7106B					@	@			1			1		1						1				2	2	1	1	
75W Repeater Station	C63CXB7106BT					@	@			1			1		1						1				1	2	1	1	
100W Ltd. Conv. Base Station	C63RLB7106B	@								1			1		1						1				2	2	1	1	
100W Ltd. Conv. Repeater Station	C63RLB7106BT	@								1			1		1						1				1	2	1	1	
125W Data Base Station	C73CXB2106A	@							2	1						1			1		1	1	1	1	1	1	1	1	2
125W Trunked Station	C73CXB5103BT	@							1	1			1		1						1				1	1	1	1	
125W Base Station	C73CXB7106B	@								1			1		1						1				2	2	1	1	
125W Repeater Station	C73CXB7106BT	@								1			1		1						1				1	2	1	1	
350W Trunked Station	C93CXB5103BT		@	@	1				1			1	1		1						2				1	2	2		
350W Base Station	C93CXB7106B		@	@	1							1	1		1						2				2	2	2		
350W Repeater Station	C93CXB7106BT		@	@	1							1	1		1						2				1	2	2		

DESCRIPTION	MODEL	TRN7039A Station Control Hardware	TRN7040A Trunked Tone Remote Control Bezel	TRN7188A Antenna Relay	TRN7200A Universal 9" Slides Tray Hardware	TRN7201A Universal PA/PS Hardware	TRN7221A VHF Universal RF Tray Power Supply Panel Hardware	TRN7247A Universal Blank 3.5" Panel Hardware	TRN7249A Universal Rails Label Kit	TRN7254A VHF Universal Peripheral Hardware	TRN7385A RF Interconnect Hardware	TRN7551A Station Access Module Bezel	TRN7717A FCC Label	TRN7754A* Trunked Tone Remote Control Logic Board	TRN7794A Tuning Tool Kit	TRN7882A 10.7 MHz IF 40dB RSSI/Loopback	TRN7986A VHF Ltd Tray Panel Hardware	TRN7988A Label Kit w/ D.O.C.	TRN9871B 2 Fan Kit	TRN9892B 3 Fan Kit	TUD2641A* 125W Universal Chassis RF Tray INT REF 132-158 MHz	TUD2642A* 125W Universal Chassis RF Tray INT REF 146-174 MHz	TUD2712A* 350W Universal Chassis RF Tray INT REF 146-174 MHz	TUD2721A* 350W Universal Chassis RF Tray EXT REF 132-158 MHz	TUD2722A* 350W Universal Chassis RF Tray EXT REF 146-174 MHz	TUD2741A* VHF WB INT REF 6/75W RF Tray 132-158 MHz	TUD2842A* VHF WB INT REF 6/75W RF Tray 146-174 MHz	TUD2861A* VHF WB INT REF 25W RF Tray 132-158 MHz	TUD2862A* VHF WB INT REF 25W RF Tray 146-174 MHz
6W Data Base Station	C23CXB2106A	1			1	1	1		1	1	1	1	1		1	1										@	@		
6W Base Station	C23CXB7106B	1	1		1	1	1		1	1			1	1	1						@	@							
6W Repeater Station	C23CXB7106BT	1	1		1	1	1		1	1			1	1	1						@	@							
25W Data Base Station	C43CXB2106A	1			1	1	1		1	1	1	1	1		1	1												@	@
25W Trunked Station	C43CXB5103BT	1	1		1	1	1		1	1			1	1	1								@	@	@				
25W Base Station	C43CXB7106B	1	1		1	1	1		1	1			1	1	1								@	@	@				
25W Repeater Station	C43CXB7106BT	1	1		1	1	1		1	1			1	1	1								@	@	@				
25W Canada Conv. Base Station	C43RUB7106A	1	1		1	1	1		1	1				1	1			1					@	@	@				
25W Canada Conv. Repeater Station	C43RUB7106AT	1	1		1	1	1		1	1				1	1			1					@	@	@				
75W Data Base Station	C63CXB2106A	1			1	1	1		1	1	1	1	1		1	1			1							@	@		
75W Trunked Station	C63CXB5103BT	1	1		1	1	1		1	1			1	1	1				1		@	@							
75W Base Station	C63CXB7106B	1	1		1	1	1		1	1			1	1	1				1		@	@							
75W Repeater Station	C63CXB7106BT	1	1		1	1	1		1	1			1	1	1				1		@	@							
100W Ltd. Conv. Base Station	C63RLB7106B	1	1		1	1			1	1			1	1	1		1		1		@	@							
100W Ltd. Conv. Repeater Station	C63RLB7106BT	1	1		1	1		1	1	1			1	1	1		1		1		@	@							
125W Data Base Station	C73CXB2106A	1			1	1	1		1	1	1	1	1		1	1			1							@	@		
125W Trunked Station	C73CXB5103BT	1	1		1	1	1		1	1			1	1	1				1		@	@							
125W Base Station	C73CXB7106B	1	1		1	1	1		1	1			1	1	1				1		@	@							
125W Repeater Station	C73CXB7106BT	1	1		1	1	1		1	1			1	1	1				1		@	@							
350W Trunked Station	C93CXB5103BT	1	1		1	2	1	2	1	1			1	1	1					1			@	@	@				
350W Base Station	C93CXB7106B	1	1	1	1	2	1		1	1			1	1	1					1			@	@	@				
350W Repeater Station	C93CXB7106BT	1	1		1	2	1		1	1	1		1	1	1					1			@	@	@				

MSFX001
021894JNM

1st ITEM BREAKDOWN CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS

VHF: 132-174 MHz

LEGEND:

= Items Supplied

* = Refer to 2nd Item Breakdown Chart

132-158 MHz = Range 1

146-174 MHz = Range 2

DESCRIPTION	MODEL	TFD1011A* Preselector Filter Hybrid 132-162 MHz	TFD1012A* Preselector Filter Hybrid 146 -174 MHz	TFD6471A Image Injection Filter 132-162 MHz	TFD6472A Image Injection Filter 146-174 MHz	TFN6480A Low Pass Filter Circuit	TFN6045A Hybrid PL Filter	TFN6056A 2175 Hz Hybrid Notch Filter	TFN6061A 2175 Hz Hybrid Band Pass Filter	TKN8486A PA Power Cable	TKN8549A PA DC Cable	TKN8559A PA Deck Cable	TKN8562A Intermediate Power Amplifier Cable	TKN8565A 20A Hi Power Junction Box Cable	TKN8599B Control Tray Cables	TKN8602A PA Deck Output Cable	TKN8612A Intermediate Power Amplifier Cable	TKN8842A Intermediate Power Amplifier Feedthru Cable	TLD2641A* Intermediate Power Amplifier 132-162 Mhz	TLD2642A* Intermediate Power Amplifier 146-174 MHz	TLD9450B RF Power Combiner 132-174 MHz	TLD9460B RF Power Splitter 132-174 MHz	TLD9480A 75W/125W Directional Coupler 132-174 MHz	TLD9491A PA Module 132-158 MHz	TLD9492A PA Module 146-174 MHz	TLD9500A Peripheral Hybrid Board w/o Antenna Switch	TLD9510A Peripheral Hybrid Board w/ Antenna Switch	TLD9540B Left 6-Way Combiner 132-174 MHz	TLD9550C Right 6-Way Combiner 132-174 MHz	TLD9560B Left 6-Way Splitter 132-174 MHz
VHF Low Pass High Power Filter	TFD1000A					1																									
Peripheral Box w/o Antenna Switch	TLD2670A																									1				
Peripheral Box w/ Antenna Switch	TLD2680A																										1			
125W Power Amplifier 132-158 MHz	TLD2691A										1										1	1	1	2						
125W Power Amplifier 146-174 MHz	TLD2692A										1										1	1	1		2					
350W Final Power Amplifier 132-158 MHz	TLD2741B										1													6				1	1	1
350W Final Power Amplifier 146-174 MHz	TLD2742B										1														6			1	1	1
25W Power Amplifier 132-174 MHz	TLD2770B									1		1																			
75W Power Amplifier 132-158 MHz	TLD3061B									1						1							1	1						
75W Power Amplifier 146-174 MHz	TLD3062B									1						1							1		1					
110V 15A 60Hz Low Power Junction Box	TLN2490A																													
MSF Encode/Decode Secure Module (Option)	TLN3045C																													
110V 20A 60Hz High Power Junction Box	TLN3086B													1																	
Trunked Tone Remote Control Audio Board	TLN3112E							1	1																					
Narrow Band Secure Capable Station Control Board (Option)	TLN3182A																													
VHF/UHF Secure Capable Station Control Board	TLN3189A																													
Station Access Module (SAM)	TLN3221B																													
Transparent Secure Module (Option)	TLN3267A																													
VHF/UHF VHF/UHF Data Station Control Board	TLN3318A																													
VHF/UHF Data Station Control Board	TLN3319A																													
500W 60 Hz Power Supply	TPN1186B																													
675W 60 Hz Dual Output Power Supply	TPN1260A																													
Trunked Toned Remote Control Logic Board	TRN7754A																													
125W Univ. Chas. RF Tray INT REF 132-158 MHz	TUD2641A	1		1											1		1	1	1											
125W Univ. Chas. RF Tray INT REF 146-174 MHz	TUD2642A		1		1										1		1	1		1										
350W Univ. Chas. RF Tray INT REF 146-174 MHz	TUD2712A		1		1								1		1			1		1										
350W Univ. Chas. RF Tray EXT REF 132-158 MHz	TUD2721A	1		1									1		1			1	1											
350W Univ. Chas. RF Tray EXT REF 146-174 MHz	TUD2722A		1		1										1		1	1		1										
VHF WB INT REF 6/75W RF Tray 132-158 MHz	TUD2841A		1		1								1		1			1		1										
VHF WB INT REF 6/75W RF Tray 146-174 MHz	TUD2842A		1		1										1		1	1		1										
VHF WB INT REF 25W RF Tray 132-158 MHz	TUD2861A	1		1									1		1			1	1											
VHF WB INT REF 25W RF Tray 146-174 MHz	TUD2862A		1		1								1		1			1		1										

DESCRIPTION	MODEL	TLD9570B Right 6-Way Splitter 132-174 MHz	TLD9600B 35W PA Module Hybrid	TLD9880A 25W Directional Coupler 132-174 Mhz	TRD1841A* Receiver VCO 132-158 MHz	TRD1842B* Receiver VCO 146-174 MHz	TRD6350A Injection Amplifier 132-175 MHz	TRN5159B Line Interface Board	TRN5205A Feedthru Plate	TRN5207A Balancing Resistor	TRN7006A VHF Uniboard	TRN7008A Display Board	TRN7028A EXT REF Uniboard	TRN7065A 2-Way Hybrid Isolation Load	TRN7077A PA Hardware	TRN7078A Hybrid Peripheral Box Hardware w/o Antenna Switch	TRN7079A Hybrid Peripheral Box Hardware w/ Antenna Switch	TRN7084A Final DC Distribution Board	TRN7087A PA Deck Hardware	TRN7088C 25W-75W RF Distribution Board	TRN7097A 675W 60 Hz Power Supply Miscellaneous Hardware	TRN7098A 675W 60 Hz Power Supply Hardware	TRN7110B 60Hz Hi Power Junction Box Hardware	TRN7113A 350W PA Hardware	TRN7117A 500W Power Supply Miscellaneous Hardware	TRN7141B VHF RF Interconnect Board	TRN7164B Interconnect Board	TRN7205A RF Tray Internal Reference VHF IPA Hardware	TRN7213B 500W Power Supply Hardware	TRN7242A 14V Distribution Board
VHF Low Pass High Power Filter	TFD1000A															1														
Peripheral Box w/o Antenna Switch	TLD2670A															1														
Peripheral Box w/ Antenna Switch	TLD2680A																1													
125W Power Amplifier 132-158 MHz	TLD2691A													2	1															
125W Power Amplifier 146-174 MHz	TLD2692A													2	1															
350W Final Power Amplifier 132-158 MHz	TLD2741B	1								4				2				1						1					
350W Final Power Amplifier 146-174 MHz	TLD2742B	1								4				2				1						1					
25W Power Amplifier 132-174 MHz	TLD2770B		1	1					1										1	1										
75W Power Amplifier 132-158 MHz	TLD3061B								1										1	1										
75W Power Amplifier 146-174 MHz	TLD3062B								1										1	1										
110V 15A 60Hz Low Power Junction Box	TLN2490A							1																							
MSF Encode/Decode Secure Module (Option)	TLN3045C																													
110V 20A 60Hz High Power Junction Box	TLN3086B							1															1						
Trunked Tone Remote Control Audio Board	TLN3112E																													
Narrow Band Secure Capable Station Control Board (Option)	TLN3182A											1																	
VHF/UHF Secure Capable Station Control Board	TLN3189A											1																	
Station Access Module (SAM)	TLN3221B																													
Transparent Secure Module (Option)	TLN3267A																													
VHF/UHF VHF/UHF Data Station Control Board	TLN3318A																													
VHF/UHF Data Station Control Board	TLN3319A																													
500W 60 Hz Power Supply	TPN1186B																								1				1	1
675W 60 Hz Dual Output Power Supply	TPN1260A																				1	1								
Trunked Toned Remote Control Logic Board	TRN7754A																													
125W Univ. Chas. RF Tray INT REF 132-158 MHz	TUD2641A				1		1				1														1		1		
125W Univ. Chas. RF Tray INT REF 146-174 MHz	TUD2642A					1	1				1														1		1		
350W Univ. Chas. RF Tray INT REF 146-174 MHz	TUD2712A					1	1				1															1	1		
350W Univ. Chas. RF Tray EXT REF 132-158 MHz	TUD2721A				1		1						1														1			
350W Univ. Chas. RF Tray EXT REF 146-174 MHz	TUD2722A					1	1																		1				
VHF WB INT REF 6/75W RF Tray 132-158 MHz	TUD2841A					1	1																			1			
VHF WB INT REF 6/75W RF Tray 146-174 MHz	TUD2842A					1	1																		1				
VHF WB INT REF 25W RF Tray 132-158 MHz	TUD2861A				1		1																			1			
VHF WB INT REF 25W RF Tray 146-174 MHz	TUD2862A					1	1																			1			

DESCRIPTION	MODEL	TRN7206A RF Tray External Reference VHF IPA Hardware	TRN7248A Distribution Board	TRN7273D Trunked Tone Remote Control Audio Board	TRN7352A VHF/UHF Narrow Band SecureCapable Station Control Board	TRN7358A VHF Secure Capable StationControl Board	TRN7497A 110V 15A 60 Hz Junction Box and Labels	TRN7509A 110V 20A 60Hz Junction Box and Labels	TRN7537A Station Access Board	TRN7564A 110V 60 Hz Junction Box Hardware	TRN7571A VHF WB INT REF Uniboard W/SSI/LPBK	TRN7580A Power Supply Hardware Plus Universal	TRN7584A RF Tray Hardware For Data Station	TRN7606A VHF Socketed Display Board	TRN7670A 20A Line Cord Hardware	TRN7690A Transparent Secure Board	TRN7784A VHF/UHF Narrow Band Data Station Control Board	TRN7785A VHF/UHF Data Station Control Board	TRN7827A Standoff HDW	TRN9256A EXT RF Connector	TRN9961A Interconnect Pockets Board	TRN9987A DC Distribution Board 132-174 MHz	TRN9999C MSF Secure Module	TTD1731A* Transmit VCO 132-158 MHz	TTD1732B* Transmit VCO 146-174 MHz	TVN6055A Station Control Board Firmware	TVN6056A Trunked Toned Remote Control Board Firmware	TVN6057A Secure Module Firmware	TVN6118A Station Access Module Firmware
VHF Low Pass High Power Filter	TFD1000A																												
Peripheral Box w/o Antenna Switch	TLD2670A																												
Peripheral Box w/ Antenna Switch	TLD2680A																												
125W Power Amplifier 132-158 MHz	TLD2691A																				1	1							
125W Power Amplifier 146-174 MHz	TLD2692A																				1	1							
350W Final Power Amplifier 132-158 MHz	TLD2741B																				1								
350W Final Power Amplifier 146-174 MHz	TLD2742B																				1								
25W Power Amplifier 132-174 MHz	TLD2770B																												
75W Power Amplifier 132-158 MHz	TLD3061B																												
75W Power Amplifier 146-174 MHz	TLD3062B																												
110V 15A 60Hz Low Power Junction Box	TLN2490A						1			1																		
MSF Encode/Decode Secure Module (Option)	TLN3045C																						1					1	
110V 20A 60Hz High Power Junction Box	TLN3086B							1				1			1													
Trunked Tone Remote Control Audio Board	TLN3112E			1																								
Narrow Band Secure Capable Station Control Board (Option)	TLN3182A				1																				1			
VHF/UHF Secure Capable Station Control Board	TLN3189A					1																			1			
Station Access Module (SAM)	TLN3221B								1										1										1
Transparent Secure Module (Option)	TLN3267A															1											1	
VHF/UHF VHF/UHF Data Station Control Board	TLN3318A													1			1								1			
VHF/UHF Data Station Control Board	TLN3319A													1				1							1			
500W 60 Hz Power Supply	TPN1186B																												
675W 60 Hz Dual Output Power Supply	TPN1260A		1																									
Trunked Toned Remote Control Logic Board	TRN7754A																										1		
125W Univ. Chas. RF Tray INT REF 132-158 MHz	TUD2641A																							1					
125W Univ. Chas. RF Tray INT REF 146-174 MHz	TUD2642A																								1				
350W Univ. Chas. RF Tray INT REF 146-174 MHz	TUD2712A																								1				
350W Univ. Chas. RF Tray EXT REF 132-158 MHz	TUD2721A	1																		1				1					
350W Univ. Chas. RF Tray EXT REF 146-174 MHz	TUD2722A										1		1												1				
VHF WB INT REF 6/75W RF Tray 132-158 MHz	TUD2841A										1		1												1				
VHF WB INT REF 6/75W RF Tray 146-174 MHz	TUD2842A										1		1												1				
VHF WB INT REF 25W RF Tray 132-158 MHz	TUD2861A										1		1											1					
VHF WB INT REF 25W RF Tray 146-174 MHz	TUD2862A										1		1												1				

MSFX002
022494JNM

2nd ITEM BREAKDOWN CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS

VHF: 132-174 MHz

LEGEND:

= Items Supplied

132-158 MHz = Range 1

146-174 MHz = Range 2

DESCRIPTION	MODEL	TFD6491A Hybrid Low Pass Filter 132-174 MHz	TLD9400A VCO Hardware 132-174 MHz	TLD9411A Intermediate Power Amplifier Module 132-158 MHz	TLD9412A Intermediate Power Amplifier Module 146-174 MHz	TLD9420A Hybird IPA Circuit 132-174 MHz	TRD6331A Receiver VCO Circuit Board 132-158 MHz	TRD6332B Receiver VCO Circuit Board 146-174 MHz	TRD6340A Hybrid RF Amp/Mixer 132-174 MHz	TRN7125A Preselector Hardware 132-158 MHz	TRN7126A Preselector Hardware 146-174 MHz	TRN9930A Intermediate Power Amplifier Hardware	TTD6231A Transmit VCO Circuit Board 132-158 MHz	TTD6232B Transmit VCO Circuit Board 146-174 MHz
Preselector Filter Hybrid 132-162 MHz	TFD1011A	1							1	1				
Preselector Filter Hybrid 146-174 MHz	TFD1012A	1							1		1			
Intermediate Power Amplifier 132-162 MHz	TLD2641A			1		1						1		
Intermediate Power Amplifier 146-174 MHz	TLD2642A				1	1						1		
Receive VCO 132-158 MHz	TRD1841A		1				1							
Receive VCO 146-174 MHz	TRD1842B		1					1						
Transmit VCO 132-158 MHz	TTD1731A		1										1	
Transmit VCO 146-174 MHz	TTD1732B		1											1

MSFX003
021894JNM

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MODEL COMPLEMENT CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS

UHF: 403-475 MHz

LEGEND:

= Items Supplied

* = Refer to 1st Item Breakdown Chart

@ = Frequency Dependent

403-435 MHz = Range 1

435-475 MHz = Range 2

DESCRIPTION	MODEL	TBN6583A 26" Universal Rack	TBN6584A 37" Universal Rack	TFE6591B Low Pass Filter	THN6663A 26" Universal Cabinet	THN6664A 37" Universal Cabinet	TKN8305A Line Interface Cable	TKN8315A Basic Base Cable	TKN8487A Watt Meter Cable	TKN8492A Line Interface Cable	TKN8498B 25' Trunking Central Controller Cable	TKN8499A Station Receiver Cable	TKN8500C Secure Smartnet System Cable	TKN8543A Trunked Tone Remote Control/J-Box Trunking Cable	TKN8573A Power Supply to Fan Cable	TKN8598A Interconnect Board Cable	TKN8605A Base Station Cable	TKN8606A Repeater Station Cable	TKN8607A RF Tray Cable	TKN8628A Station Cable	TKN8710A RX Loopback Cables	TKN8713A 26 Pin Ribbon Cables for SAM to Base Station Control	TKN8720A SAM to RLC Board Cable Kit	TKN8993A Expansion Cables
6W Data Base Station	C24CXB2106A			1					2			1				1					1	1	1	1
6W Base Station	C24CXB7106B			1			1	1					1			1								
6W Repeater Station	C24CXB7106BT			1			1					1	1			1								
15W Data Base Station	C34CXB2106A			1					2			1				1					1	1	1	1
15W Trunked Station	C34CXB5103BT			1			1		1		1	1	1	1		1								
15W Base Station	C34CXB7106B			1			1	1					1			1								
15W Repeater Station	C34CXB7106BT			1			1					1	1			1								
40W Data Base Station	C44CXB2106A			1					2			1				1					1	1	1	1
40W Trunked Station	C44CXB5103BT			1			1		1		1	1	1	1		1								
40W Base Station	C44CXB7106B			1			1	1					1			1								
40W Repeater Station	C44CXB7106BT			1			1					1	1			1								
25W Canada Conv. Base Station	C44RUB7106A			1			1	1					1			1								
25W Canada Repeater Station	C44RUB7106AT			1			1					1	1			1								
75W Data Base Station	C64CXB2106A			1					2			1				1					1	1	1	1
75W Trunked Station	C64CXB5103BT			1			1		1		1	1	1	1		1								
75W Base Station	C64CXB7106B			1			1	1					1			1								
75W Repeater Station	C64CXB7106BT			1			1					1	1			1								
100W Ltd. Conv. Repeater Station	C64RLB7106B	1		1	1		1	1					1			1								
100W Ltd. Base Station	C64RLB7106BT		1	1		1	1					1	1			1								
110W Data Base Station	C74CXB2106A			1					2			1				1					1	1	1	1
110W Trunked Station	C74CXB5103BT			1			1		1		1	1	1	1	1	1								
110W Base Station	C74CXB7106B			1			1	1					1		1	1								
110W Repeater Station	C74CXB7106BT			1			1					1	1		1	1								
225W Trunked Station	C84CXB5103BT			1					1	1	1		1	1	1				1	1				
225W Base Station	C84CXB7106B			1						1			1		1		1		1	1				
225W Repeater Station	C84CXB7106BT			1						1			1		1		1	1	1	1				

DESCRIPTION	MODEL	TLE2511A* 110W PA, 403-435 MHz	TLE2512A* 110W PA, 435-475 MHz	TLE2521A* 75W PA, 403-435 MHz	TLE2522A* 75W PA, 435-475 MHz	TLE2840A 3 Fan Kit	TLE5910B UHF Watt Meter	TLN2490A* 110V 15A 60Hz Lo Power Junction Box	TLN3022B* 110V 20A 60Hz Hi Power Junction Box	TLN3045C* MSF Encode/Decode Secure Module (Option)	TLN3112E* Trunked Tone Remote Control Audio Board	TLN3182A* Narrow Band Secure Capable Station Control Board (Option)	TLN3189A* VHF/UHF Secure Capable Station Control Board	TLN3221B* Station Access Module (SAM)	TLN3267A* Transparent Only Secure Module (Option)	TLN3319A* VHF/UHF Data Station Control Board	TPN1186B* 500W 60Hz Power Supply	TRN5177A Expansion Tray Hardware	TRN5178B Expansion Tray Power Supply Board	TRN5200A Blank Bezel	TRN5208B Antenna Relay
6W Data Base Station	C24CXB2106A						2	1						1		1	1	1	1	1	
6W Base Station	C24CXB7106B							1			1		1				1				1
6W Repeater Station	C24CXB7106BT							1			1		1				1				
15W Data Base Station	C34CXB2106A						2	1						1		1	1	1	1	1	
15W Trunked Station	C34CXB5103BT						1	1			1		1				1				
15W Base Station	C34CXB7106B							1			1		1				1				1
15W Repeater Station	C34CXB7106BT							1			1		1				1				
40W Data Base Station	C44CXB2106A						2	1						1		1	1	1	1	1	
40W Trunked Station	C44CXB5103BT						1	1			1		1				1				
40W Base Station	C44CXB7106B							1			1		1				1				1
40W Repeater Station	C44CXB7106BT							1			1		1				1				
25W Canada Conv. Base Station	C44RUB7106A							1			1		1				1				1
25W Canada Repeater Station	C44RUB7106AT							1			1		1				1				
75W Data Base Station	C64CXB2106A			@	@		2	1						1		1	1	1	1	1	
75W Trunked Station	C64CXB5103BT			@	@		1	1			1		1				1				
75W Base Station	C64CXB7106B			@	@			1			1		1				1				1
75W Repeater Station	C64CXB7106BT			@	@			1			1		1				1				
100W Ltd. Conv. Repeater Station	C64RLB7106B	@	@					1			1		1				1				1
100W Ltd. Base Station	C64RLB7106BT	@	@					1			1		1				1				
110W Data Base Station	C74CXB2106A	@	@			1	2	1						1		1	1	1	1	1	
110W Trunked Station	C74CXB5103BT	@	@			1	1	1			1		1				1				
110W Base Station	C74CXB7106B	@	@			1		1			1		1				1				1
110W Repeater Station	C74CXB7106BT	@	@			1		1			1		1				1				
225W Trunked Station	C84CXB5103BT					1	1		1		1		1				2				
225W Base Station	C84CXB7106B					1			1		1		1				2				
225W Repeater Station	C84CXB7106BT					1			1		1		1				2				

DESCRIPTION	MODEL	TRN5352A RF Connector Plug	TRN5353A Auxiliary Connector Plug	TRN5355A Battery Connector Plug	TRN5427A 110 Power Cord	TRN5954A Blank Bezel	TRN7039A Station Control Hardware	TRN7040A Tunked Tone Remote Control Bezel	TRN7188A Antenna Relay	TRN7200A Universal Tray Hardware	TRN7201A PA/PS Universal Hardware	TRN7225A Universal RF Tray Panel Hardware	TRN7247A Universal Blank 3.5" Panel Hardware	TRN7249A Universal Rails Label	TRN7252B UHF/800/900 Universal Peripheral Hardware	TRN7385A RF Interconnect Hardware	TRN7551A Station Access Module Bezel	TRN7717A FCC Label	TRN7754A Trunked Tone Remote Control Logic Board	TRN7794A Digital Tuning Tool Kit	TRN7882A 10.7 MHz IF 40dB RSSI/Loopback	TRN7987A UHF Ltd. Tray Panel Hardware	TRN7988A Label Kit w/ D.O.C.	TRN9512A Straight Coax N-Type Adaptor
6W Data Base Station	C24CXB2106A	1	1	1	1	2	1			1	1	1		1	1	1	1	1		1	1			1
6W Base Station	C24CXB7106B	2	2	1	1		1	1		1	1	1		1	1			1	1	1				1
6W Repeater Station	C24CXB7106BT	1	2	1	1		1	1		1	1	1		1	1	1		1	1	1				1
15W Data Base Station	C34CXB2106A	1	1	1	1	2	1			1	1	1		1	1	1	1	1		1	1			1
15W Trunked Station	C34CXB5103BT	1	1	1	1		1	1		1	1	1		1	1	1		1	1	1				1
15W Base Station	C34CXB7106B	2	2	1	1		1	1		1	1	1		1	1			1	1	1				1
15W Repeater Station	C34CXB7106BT	1	2	1	1		1	1		1	1	1		1	1	1		1	1	1				1
40W Data Base Station	C44CXB2106A	1	1	1	1	2	1			1	1	1		1	1	1	1	1		1	1			1
40W Trunked Station	C44CXB5103BT	1	1	1	1		1	1		1	1	1		1	1	1		1	1	1				1
40W Base Station	C44CXB7106B	2	2	1	1		1	1		1	1	1		1	1			1	1	1				1
40W Repeater Station	C44CXB7106BT	1	2	1	1		1	1		1	1	1		1	1	1		1	1	1				1
25W Canada Conv. Base Station	C44RUB7106A	2	2	1	1		1	1		1	1	1			1				1	1			1	1
25W Canada Repeater Station	C44RUB7106AT	1	2	1	1		1	1		1	1	1			1	1			1	1			1	1
75W Data Base Station	C64CXB2106A	1	1	1	1	2	1			1	1	1		1	1	1	1	1		1	1			1
75W Trunked Station	C64CXB5103BT	1	1	1	1		1	1		1	1	1		1	1	1		1	1	1				1
75W Base Station	C64CXB7106B	2	2	1	1		1	1		1	1	1		1	1			1	1	1				1
75W Repeater Station	C64CXB7106BT	1	2	1	1		1	1		1	1	1		1	1	1		1	1	1				1
100W Ltd. Conv. Repeater Station	C64RLB7106B	2	2	1	1		1	1		1	1			1	1			1	1	1		1		1
100W Ltd. Base Station	C64RLB7106BT	1	2	1	1		1	1		1	1		1	1	1	1		1	1	1		1		1
110W Data Base Station	C74CXB2106A	1	1	1	1	2	1			1	1	1		1	1	1	1	1		1	1			1
110W Trunked Station	C74CXB5103BT	1	1	1	1		1	1		1	1	1		1	1	1		1	1	1				1
110W Base Station	C74CXB7106B	2	2	1	1		1	1		1	1	1		1	1			1	1	1				1
110W Repeater Station	C74CXB7106BT	1	2	1	1		1	1		1	1	1		1	1	1		1	1	1				1
225W Trunked Station	C84CXB5103BT	1	1	2			1	1		1	2	1		1	1	1		1	1	1				1
225W Base Station	C84CXB7106B	2	2	2			1	1	1	1	2	1		1	1			1	1	1				
225W Repeater Station	C84CXB7106BT	1	2	2			1	1		1	2	1		1	1	1		1	1	1				

DESCRIPTION	MODEL	TTE1521A* 40W PA, 403-435 MHz	TTE1522A* 40W PA, 435-475 MHz	TTE1541A* 15W PA, 403-435 MHz	TTE1542A* 15W PA, 435-475 MHz	TTE1591A* Isolation Network, 403-435 MHz	TTE1592A* Isolation Network, 435-475 MHz	TTE1731A* 110W PA Driver, 403-435 MHz	TTE1732A* 110W PA Driver, 435-475 MHz	TTE1741A* 225W Final PA, 403-435 MHz	TTE1742A* 225W Final PA, 435-475 MHz	TTE1811A* Single Circulator and Load, 403-435 MHz	TTE1812A* Single Circulator and Load, 435-475 MHz	TUE2001A* RF Tray, 403-435 MHz	TUE2002A* RF Tray, 435-475 MHz	TUE2131A* UHF WB INT REF RF Tray W/SSI/Loopback, 403-435 MHz	TUE2132A* UHF WB INT REF RF Tray W/SSI/Loopback, 435-475 MHz
6W Data Base Station	C24CXB2106A					@	@									@	@
6W Base Station	C24CXB7106B					@	@							@	@		
6W Repeater Station	C24CXB7106BT					@	@							@	@		
15W Data Base Station	C34CXB2106A			@	@											@	@
15W Trunked Station	C34CXB5103BT			@	@									@	@		
15W Base Station	C34CXB7106B			@	@									@	@		
15W Repeater Station	C34CXB7106BT			@	@									@	@		
40W Data Base Station	C44CXB2106A	@	@													@	@
40W Trunked Station	C44CXB5103BT													@	@		
40W Base Station	C44CXB7106B	@	@											@	@		
40W Repeater Station	C44CXB7106BT	@	@											@	@		
25W Canada Conv. Base Station	C44RUB7106A	@	@											@	@		
25W Canada Repeater Station	C44RUB7106AT	@	@											@	@		
75W Data Base Station	C64CXB2106A															@	@
75W Trunked Station	C64CXB5103BT													@	@		
75W Base Station	C64CXB7106B													@	@		
75W Repeater Station	C64CXB7106BT													@	@		
100W Ltd. Conv. Repeater Station	C64RLB7106B													@	@		
100W Ltd. Base Station	C64RLB7106BT													@	@		
110W Data Base Station	C74CXB2106A															@	@
110W Trunked Station	C74CXB5103BT													@	@		
110W Base Station	C74CXB7106B													@	@		
110W Repeater Station	C74CXB7106BT													@	@		
225W Trunked Station	C84CXB5103BT							@	@	@	@			@	@		
225W Base Station	C84CXB7106B							@	@	@	@	@	@	@	@		
225W Repeater Station	C84CXB7106BT							@	@	@	@	@	@	@	@		

MSFX004
021894JNM

UHF Model Charts

1st ITEM BREAKDOWN CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS

UHF: 403-475 MHz

LEGEND:

= Items Supplied

* = Refer to 2nd Item Breakdown Chart

403-435 MHz = Range 1

435-475 MHz = Range 2

DESCRIPTION	MODEL	TFE6481A	TFE6482A	TFN6056A	TFN6061A	TKN8306A	TKN8486A	TKN8549A	TKN8565A	TKN8599B	TKN8612A	TKN8842A	TKN8953A	TKN8980A	TLE2500A*	TLE5321A	TLE5322A	TLE5391A	TLE5392A	TLE5401A	TLE5402C	TLE5411C	TLE5421B	TLE5422C
	DESCRIPTION	Image Injection Filter, 403-435 MHz	Image Injection Filter, 435-475 MHz	2175 Notch Filter Hybrid	2175 Bandpass Filter Hybrid	Power Amplifier Cable	Power Amplifier Cable	PA DC Power Cable	20A Hi Power Junction Box Cable	Control Tray Cables	Intermeidate Power Amplifier Cable	Intermediate Power Amplifier Feedthru Cable	Power Amplifier Cable	Network Cable	Intermediate Power Amplifier	Injection Amplifier Board, 403-435 MHz	Injection Amplifier Board, 435-475 MHz	Preselector, 403-435 MHz	Preselector, 435-475 MHz	Mixer Pre-Amplifier, 403-435 MHz	Front End Hybrid, 435-475 MHz	PA Final Hybrid Module, 403-435 MHz	Pre-Driver Hybrid Module, 403-435 MHz	Pre-Driver Hybrid Module, 435-475 MHz
110W PA, 403-435 MHz	TLE2511A					1																4	1	
110W PA, 435-475 MHz	TLE2512A					1																		1
75W PA, 403-435 MHz	TLE2521A					1																3	1	
75W PA, 435-475 MHz	TLE2522A					1																		1
110V 15A 60Hz Hi Power Junction Box	TLN2490A																							
110V 20A 60Hz Lo Power Junction Box	TLN3022B								1															
MSF Encode/Decode Secure Module (Option)	TLN3045C																							
Trunked Tone Remote Control Audio Board	TLN3112E			1	1																			
Narrow Band Secure Capable Station Board (Option)	TLN3182A																							
Secure Capable Station Control Board	TLN3189A																							
Transparent Only Secure Module (Option)	TLN3267A																							
VHF/UHF Data Station Control Board	TLN3319A																							
500W 60Hz Power Supply	TPN1186B																							
Trunked Tone Remote Control Logic Board	TRN7754A																							
40W PA, 403-435 MHz	TTE1521A						1															1	1	
40W PA, 435-475 MHz	TTE1522A						1																	1
15W PA, 403-435 MHz	TTE1541A												1										1	
15W PA, 435-475 MHz	TTE1542A												1											1
Isolation Network, 403-435 MHz	TTE1591A													1										
Isolation Network, 435-475 MHz	TTE1592A													1										
110W Driver PA, 403-435 MHz	TTE1731A					1																4	1	
110W Driver PA, 435-475 MHz	TTE1732A					1																		1
225W Final PA, 403-435 MHz	TTE1741A							1														6		
225W Final PA, 435-475 MHz	TTE1742A							1																
Single Circulator and Load, 403-435 MHz	TTE1811A																							
Single Circulator and Load, 435-475 MHz	TTE1812A																							
RF Tray, 403-435 MHz	TUE2001A	1								1	1	1			1	1		1		1				
RF Tray, 435-475 MHz	TUE2002A		1							1	1	1			1		1		1		1			
UHF WB INT REF RF Tray W/SSI/Loopback, 403-435 MHz	TUE2131A	1								1	1	1			1	1		1		1				
UHF WB INT REF RF Tray W/SSI/Loopback, 435-475 MHz	TUE2132A		1							1	1	1			1		1		1		1			

DESCRIPTION	MODEL	TLE5431A	TLE5432A	TLE5441A	TLE5582B	TLE5642A	TLE5652A	TLE5828A	TLE5830C	TLE5831A	TLE5832A	TLE5833A	TLE5834A	TLE5836B	TLE5870A	TLE5880A	TLE5890A	TLE5900A	TRE1321B*	TRE1322B*	TRN5142A	TRN5159B	TRN5204A	TRN5205A
	DESCRIPTION	Splitter Power Amplifier Hybrid, 403-435 MHz	Splitter Power Amplifier Hybrid, 435-475 MHz	Power Amplifier Combiner, 403-435 MHz	Directional Coupler	Splitter Power Amplifier	PA Combiner	Power Combiner Hybrid, 435-475 MHz	Laser Trimmed PA Module Hybrid	RH Final Splitter Hybrid, 435-475 MHz	LH Final Splitter Hybrid, 435-475 MHz	RF Final Combiner Hybrid, 435-475 MHz	LH Final Combiner Hybrid, 435-475 MHz	Directional Coupler Hybrid, 403-475 MHz	RH Final Splitter Hybrid, 403-435 MHz	LH Final Splitter Hybrid, 403-435 MHz	RH Final Combiner Hybrid, 403-435 MHz	LH Final Combiner Hybrid, 403-435 MHz	Receiver VCO, 403-435 MHz	Receiver VCO, 435-475 MHz	RF Tray Hardware	Line Interface Board	PA Distribution Board	Feedthru Plate
110W PA, 403-435 MHz	TLE2511A	1		1																			1	1
110W PA, 435-475 MHz	TLE2512A		1					1	4														1	1
75W PA, 403-435 MHz	TLE2521A					1	1																1	1
75W PA, 435-475 MHz	TLE2522A					1	1		3														1	1
110V 15A 60Hz Hi Power Junction Box	TLN2490A																					1		
110V 20A 60Hz Lo Power Junction Box	TLN3022B																					1		
MSF Encode/Decode Secure Module (Option)	TLN3045C																							
Trunked Tone Remote Control Audio Board	TLN3112E																							
Narrow Band Secure Capable Station Board (Option)	TLN3182A																							
Secure Capable Station Control Board	TLN3189A																							
Transparent Only Secure Module (Option)	TLN3267A																							
VHF/UHF Data Station Control Board	TLN3319A																							
500W 60Hz Power Supply	TPN1186B																							
Trunked Tone Remote Control Logic Board	TRN7754A																							
40W PA, 403-435 MHz	TTE1521A													1										1
40W PA, 435-475 MHz	TTE1522A								1					1										1
15W PA, 403-435 MHz	TTE1541A													1										1
15W PA, 435-475 MHz	TTE1542A													1										1
Isolation Network, 403-435 MHz	TTE1591A				1																			1
Isolation Network, 435-475 MHz	TTE1592A				1																			1
110W Driver PA, 403-435 MHz	TTE1731A	1		1																			1	1
110W Driver PA, 435-475 MHz	TTE1732A		1					1	4														1	1
225W Final PA, 403-435 MHz	TTE1741A														1	1	1	1						
225W Final PA, 435-475 MHz	TTE1742A								6	1	1	1	1											
Single Circulator and Load, 403-435 MHz	TTE1811A																							
Single Circulator and Load, 435-475 MHz	TTE1812A																							
RF Tray, 403-435 MHz	TUE2001A																		1		1			
RF Tray, 435-475 MHz	TUE2002A																			1	1			
UHF WB INT REF RF Tray W/SSI/Loopback, 403-435 MHz	TUE2131A																		1					
UHF WB INT REF RF Tray W/SSI/Loopback, 435-475 MHz	TUE2132A																			1				

DESCRIPTION	MODEL	TRN5207A	TRN5930A	TRN5931A	TRN7008A	TRN7013A	TRN7027A	TRN7044A	TRN7103A	TRN7104A	TRN7105A	TRN7110B	TRN7117A	TRN7169B	TRN7213B	TRN7231A	TRN7242A	TRN7273D	TRN7358A	TRN7365A	TRN7366A	TRN7497A	TRN7564A	TRN7573A
	DESCRIPTION	Balancing Resistor	Balancing Resistor (In) Hybrid	Balancing Resistor (Out) Hybrid	Display Board	225W PA Hardware	PA Driver Hardware	PA Distribution Board	PA 40W Hardware	PA 15W Hardware	Isolation Network Hardware	60Hz Junction Box Hardware	Miscellaneous Hardware	Interconnect Board	500W 60Hz Power Supply Hardware	Uniboard	14V Distribution Board	Trunked Tone Remote Control Board	Secure Capable Station Control Board	110W Single PA Hardware	75W PA Hardware	110V 60 Hz Label	110V 60Hz Lo Power Junction Box Hardware	UHF WB INT REF Uniboard W/SSI/Loopback
110W PA, 403-435 MHz	TLE2511A	2																		1				
110W PA, 435-475 MHz	TLE2512A	2																		1				
75W PA, 403-435 MHz	TLE2521A		1	1																	1			
75W PA, 435-475 MHz	TLE2522A		1	1																	1			
110V 15A 60Hz Hi Power Junction Box	TLN2490A																					1	1	
110V 20A 60Hz Lo Power Junction Box	TLN3022B											1												
MSF Encode/Decode Secure Module (Option)	TLN3045C																							
Trunked Tone Remote Control Audio Board	TLN3112E																	1						
Narrow Band Secure Capable Station Board (Option)	TLN3182A																							
Secure Capable Station Control Board	TLN3189A				1														1					
Transparent Only Secure Module (Option)	TLN3267A																							
VHF/UHF Data Station Control Board	TLN3319A																							
500W 60Hz Power Supply	TPN1186B												1		1		1							
Trunked Tone Remote Control Logic Board	TRN7754A																							
40W PA, 403-435 MHz	TTE1521A							1	1															
40W PA, 435-475 MHz	TTE1522A							1	1															
15W PA, 403-435 MHz	TTE1541A							1		1														
15W PA, 435-475 MHz	TTE1542A							1		1														
Isolation Network, 403-435 MHz	TTE1591A										1													
Isolation Network, 435-475 MHz	TTE1592A										1													
110W Driver PA, 403-435 MHz	TTE1731A	2					1																	
110W Driver PA, 435-475 MHz	TTE1732A	2					1																	
225W Final PA, 403-435 MHz	TTE1741A	4				1																		
225W Final PA, 435-475 MHz	TTE1742A	4				1																		
Single Circulator and Load, 403-435 MHz	TTE1811A																							
Single Circulator and Load, 435-475 MHz	TTE1812A																							
RF Tray, 403-435 MHz	TUE2001A													1		1								
RF Tray, 435-475 MHz	TUE2002A													1		1								
UHF WB INT REF RF Tray W/SSI/Loopback, 403-435 MHz	TUE2131A													1										1
UHF WB INT REF RF Tray W/SSI/Loopback, 435-475 MHz	TUE2132A													1										1

DESCRIPTION	MODEL	TRN7585A	TRN7580A	TRN7606A	TRN7671A	TRN7785A	TRN7857A	TRN9066A	TRN9752A	TRN9959A	TRN9960A	TRN9961A	TTE1471B*	TTE1472B*	TTE6211A	TTE6212A	TTE6281A	TTE6282A	TTF1362B*	TVN6055A	TVN6056A	TVN6057A	TVN6118A
	DESCRIPTION	RF Tray Hardware for Data Station	Universal Power Supply Hardware	VHF/UHF Socketed Display Board	Line Cord Hardware	VHF/UHF Data Station Control Board	Labels	Distribution Board	PS Packing Hardware	2-way Isolation Load	PA Distribution Board	Interconnect Pockets Board	Transmit VCO, 403-435 MHz	Transmit VCO, 435-475 MHz	Small Circulator, 403-435 MHz	Small Circulator, 435-475 MHz	Small Circulator w/ Hardware, 403-435 MHz	Small Circulator w/ Hardware, 435-475 MHz	RF Circulator w/ Load	Station Control Board Firmware	Trunked Tone Remote Control Board Firmware	Secure Module Firmware	Station Access Module Firmware
110W PA, 403-435 MHz	TLE2511A														1								
110W PA, 435-475 MHz	TLE2512A															1							
75W PA, 403-435 MHz	TLE2521A														1								
75W PA, 435-475 MHz	TLE2522A															1							
110V 15A 60Hz Hi Power Junction Box	TLN2490A																						
110V 20A 60Hz Lo Power Junction Box	TLN3022B		1		1		1																
MSF Encode/Decode Secure Module (Option)	TLN3045C																						
Trunked Tone Remote Control Audio Board	TLN3112E																						
Narrow Band Secure Capable Station Board (Option)	TLN3182A																			1			
Secure Capable Station Control Board	TLN3189A																			1			
Transparent Only Secure Module (Option)	TLN3267A																						
VHF/UHF Data Station Control Board	TLN3319A			1		1														1			
500W 60Hz Power Supply	TPN1186B								1								1		1				
Trunked Tone Remote Control Logic Board	TRN7754A																				1		
40W PA, 403-435 MHz	TTE1521A														1								
40W PA, 435-475 MHz	TTE1522A															1							
15W PA, 403-435 MHz	TTE1541A														1								
15W PA, 435-475 MHz	TTE1542A															1							
Isolation Network, 403-435 MHz	TTE1591A							1							1								
Isolation Network, 435-475 MHz	TTE1592A							1								1							
110W Driver PA, 403-435 MHz	TTE1731A																						
110W Driver PA, 435-475 MHz	TTE1732A																						
225W Final PA, 403-435 MHz	TTE1741A									2	1	1											
225W Final PA, 435-475 MHz	TTE1742A									2	1	1											
Single Circulator and Load, 403-435 MHz	TTE1811A																1		1				
Single Circulator and Load, 435-475 MHz	TTE1812A																	1	1				
RF Tray, 403-435 MHz	TUE2001A												1										
RF Tray, 435-475 MHz	TUE2002A													1									
UHF WB INT REF RF Tray W/SSI/Loopback, 403-435 MHz	TUE2131A	1											1										
UHF WB INT REF RF Tray W/SSI/Loopback, 435-475 MHz	TUE2132A	1												1									

MSFX005
021894JNM

2nd ITEM BREAKDOWN CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS

UHF: 403-475 MHz

LEGEND:

= Items Supplied

403-435 MHz = Range 1

435-475 MHz = Range 2

DESCRIPTION	MODEL	Transmit VCO Hardware TLE5371B	Transmit VCO Hardware TLE5372B	Receiver VCO Hardware TLE5381B	Receiver VCO Hardware TLE5382B	UHF Omni TLE5920A	UHF Interconnect Board TLE5930A	RF Load Hardware TRN9458B	RF Circulator Hybrid TRN9867B	Intermediate Power Amplifier Hardware TRN9930A
Intermediate Power Amplifier	TLE2500A					1	1			1
Receiver VCO, 403-435 MHz	TRE1321B			1						
Receiver VCO, 435-490 MHz	TRE1322B				1					
Transmit VCO, 403-435 MHz	TTE1471B	1								
Transmit VCO, 435-475 MHz	TTE1472B		1							
Transmitter RF Circulator w/ Load	TTF1362B							1	1	

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021894JNM

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MODEL COMPLEMENT CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS 800 MHz

LEGEND:
= Items Supplied
* = Refer to 1st Item Breakdown Chart

DESCRIPTION	MODEL	TFF6072B Low Pass Filter	TKN8487A Watt Meter Cable	TKN8492A Interface Line Cable	TKN8498B 25' Trunking Central Controller Cable	TKN8499A Receiver Station Cable	TKN8500C Secure Smartnet System Cable	TKN8543A Trunked Tone Remote Control Board/J-Box Trunking Cable	TKN8573A Power Supply to Fan Cable	TKN8579A Low Power Power Supply to PA Interconnect Cable	TKN8580A Hi Power Power Supply to PA Interconnect Cable	TKN8710A RX Loopback Cables	TKN8713A 26 Pin Ribbon Cables for SAM to Base Station Control	TKN8720A SAM to RLC Board Cable Kit	TKN8993A Expansion Cables	TLF1550A* 35W Power Amplifier	TLF6890A Watt Meter	TLN2490A* 110V 15A 60Hz Lo Power Junctiuon Box	TLN3022B* 110V 20A 60Hz Hi Power Junction Box	TLN3045C* MSF Encode/Decode Secure Module (Option)	TLN3112E* TTRC Audio Board	TLN3204A* Secure Capable Station Control Board	TLN3221B* Station Acces Module (SAM)	TLN3320A* 800 MHz Data Station Control Board	TLN3267A* Transparent Only Secure Module (Option)	TPN1186B* 500W 60Hz Power Supply	TRN5177A Expansion Tray Hardware	TRN5178B Expansion Tray Power Supply Board
35W Data Base Station	C45CXB2106A	1	2			1			1	1		1	1	1	1	1	2	1					1	1		1	1	1
35W Trunked Station	C45CXB5103BT	1	1	1	1	1	1	1	1	1						1	1	1			1	1				1		
35W Repeater Station	C45CXB7106BT	1		1		1	1		1	1						1		1			1	1				1		
75W Data Base Station	C65CXB2106A	1	2			1			1	1		1	1	1	1	1	2	1					1	1		1	1	1
75W Trunked Station	C65CXB5103BT	1	1	1	1	1	1	1	1	1							1	1			1	1				1		
75W Repeater Station	C65CXB7106BT	1		1		1	1		1	1								1			1	1				1		
150W Data Base Station	C85CXB2106A	1		1		1	1		1	1								1			1	1				1		
150W Trunked Station	C85CXB5103BT	1	1	1	1	1	1	1	1		1						1		1		1	1				2		
150W Repeater Station	C85CXB7106BT	1		1		1	1		1		1								1		1	1				2		

DESCRIPTION	MODEL	TRN5200A Blank Bezel	TRN5352A RF Connector Plug	TRN5353A Auxiliary Connector Plug	TRN5355A Battery Connector Plug	TRN5427A 110V AC Power Cord	TRN5954A Blank Bezel	TRN7039A Station Control Hardware	TRN7040A Trunked Tone Remote Control Board Bezel	TRN7200A Universal 9" Slides Tray Hardware	TRN7201A Universal PA/PS Hardware	TRN7225A Universal RF Tray Panel Hardware	TRN7249A Universal Rails Label Kit	TRN7252B UHF/800/900 Universal Peripheral Bracket	TRN7385A RF Interconnect Hardware	TRN7551A Station Access Module Bezel	TRN7586A 21.4 MHz IF RSSI/Loopback Div Board	TRN7717A FCC Label	TRN7754A* Trunked Tone Remote Control Logic Board	TRN7794A Tuning Tool Kit	TRN9512A Straight Coax N-Type Adaptor	TRN9871B 2 Fan Kit	TRN9892B 3 Fan Kit	TTF1440C* 75W Power Amplifier	TTF1460B* Final Power Amplifier	TTF1490A* Single Circulator w/ Load	TUF1780B* Universal Chassis RF Tray	TUF1860A* 800 WB INT REF RF Tray W/RSSI/Loopback
35W Data Base Station	C45CXB2106A	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1		1				1		1
35W Trunked Station	C45CXB5103BT		1	1	1	1		1	1	1	1	1	1	1	1			1	1	1		1				1	1	
35W Repeater Station	C45CXB7106BT		1	2	1	1		1	1	1	1	1	1	1	1			1	1	1		1				1	1	
75W Data Base Station	C65CXB2106A	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1		1				1		1
75W Trunked Station	C65CXB5103BT		1	1	1	1		1	1	1	1	1	1	1	1			1	1	1		1		1		1	1	
75W Repeater Station	C65CXB7106BT		1	2	1	1		1	1	1	1	1	1	1	1			1	1	1		1		1		1	1	
150W Data Base Station	C85CXB2106A		1	2	1	1		1	1	1	1	1	1	1	1			1	1	1		1		1		1	1	
150W Trunked Station	C85CXB5103BT		1	1	2			1	1	1	2	1	1	1	1			1	1	1	1		1	1	1	1	1	
150W Repeater Station	C85CXB7106BT		1	2	2			1	1	1	2	1	1	1	1			1	1	1	1		1	1	1	1	1	

MSFX007
021894JNM

800 MHz Model Charts

1st ITEM BREAKDOWN CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS 800 MHz

LEGEND:

= Items Supplied

* = Refer to 2nd Item Breakdown Chart

DESCRIPTION	MODEL	TFF6204A Preselector Filter	TFF6205A Image Injection Filter	TFN6056A 2175 Hybrid Notch Filter	TFN6061A 2175 Hybrid Bandpass Filter	TKN8342C PA Coax Cable	TKN8486A PA Cable	TKN8562A Intermediate Power Amplifier Cable	TKN8565A 20A Hi Power Junction Box Cable	TKN8599B Control Tray Cables	TKN8602A PA Output Deck Cable	TKN8842A Intermediate Power Amplifier Feedthru Cable	TKN8975C PA Coax Cable	TLF1511C* Intermediate Power Amplifier	TLF6820A Final Hybrid Module	TLF6830A Predriver Hybrid Module	TLF6880A DC RF Board	TRE1321B* Receiver VCO	TRF6520A RF Amplifier Mixer Hybrid	TRF6530A Injection Doubler Amplifier	TRN5142A RF Tray Hardware
35W Power Amplifier	TLF1550A						1				1				1	1	1				
110V 15A 60Hz Low Power Junction Box	TLN2490A																				
110V 20A 60Hz Hi Power Junction Box	TLN3022B								1												
MSF Encode/Decode Secure Module (Option)	TLN3045C																				
Trunked Toned Remote Control Audio Board	TLN3112E			1	1																
Secure Capable Station Control Board	TLN3204A																				
Station Access Module (SAM)	TLN3221B																				
800 MHz Data Station Control Board	TLN3320A																				
Transparent Only Secure Modele (Option)	TLN3267A																				
500W 60Hz Power Supply	TPN1186B																				
Trunked Toned Remote Control Logic Board	TRN7754A																				
75W Power Amplifier	TTF1440C					1									4	1					
Final Power Amplifier	TTF1460B												1		6						
Single Circulator w/ Load	TTF1490A																				
Universal Chassis RF Tray	TUF1780B	1	1					1		1		1		1				1	1	1	1
800 WB INT REF W/RSSI/Loopback	TUF1860A	1	1					1		1		1		1				1	1	1	

DESCRIPTION	MODEL	TRN5159B Line Interface Board	TRN5205A Feedthru Plate	TRN7008A Display Board	TRN7110B 60Hz High Power Junction Box Hardware	TRN7117A Miscellaneous Hardware	TRN7142B RF Tray Interconnect Board	TRN7174A PA Deck Hardware	TRN7199C Uniboard w/ INT REF Oscillator	TRN7213B PS Hardware	TRN7242A 14V Distribution Board	TRN7272A Trunked Tone Remote Control Logic Board	TRN7273D Trunked Tone Remote Control Audio Board	TRN7422A Secure Capable Station Control Board	TRN7497A 110V 60 Hz Label	TRN7537B Station Access Board	TRN7564A 110V 60Hz Junction Box Hardware	TRN7577A 800 MHz WB INT REF Uniboard W/SSI/Loopback	TRN7580A Universal Power Supply Hardware	TRN7585A RF Tray Hardware for Data Station	TRN7606A Socketed Display Board
35W Power Amplifier	TLF1550A		1					1													
110V 15A 60Hz Low Power Junction Box	TLN2490A	1			1										1		1				
110V 20A 60Hz Hi Power Junction Box	TLN3022B	1			1														1		
MSF Encode/Decode Secure Module (Option)	TLN3045C																				
Trunked Toned Remote Control Audio Board	TLN3112E												1								
Secure Capable Station Control Board	TLN3204A			1										1							
Station Access Module (SAM)	TLN3221B															1					
800 MHz Data Station Control Board	TLN3320A																				1
Transparent Only Secure Modele (Option)	TLN3267A																				
500W 60Hz Power Supply	TPN1186B					1				1	1										
Trunked Toned Remote Control Logic Board	TRN7754A											1									
75W Power Amplifier	TTF1440C																				
Final Power Amplifier	TTF1460B																				
Single Circulator w/ Load	TTF1490A																				
Universal Chassis RF Tray	TUF1780B						1		1												
800 WB INT REF W/RSSI/Loopback	TUF1860A						1											1		1	

DESCRIPTION	MODEL	TRN7671A 15A Line Cord Hardware	TRN7786A 800 Mhz Control Board	TRN7827A Standoff Hardware	TRN7857A 110V 60Hz 14V Power Labels	TRN9060A Balancing Resistor Hybrid	TRN9062B Final PA Distribution Board	TRN9064A Balancing Resistor Board	TRN9191A 75W PA Deck Feedthru Plate Hybrid	TRN9386A Thermistor Board	TRN9929B 75W Final PA Hardware	TRN9958A Final PA Hardware	TTE1471B* Transmit VCO	TTF1362B* Transmitter Circulator w/ Load	TTF6420B Combiner w/ Directional Coupler Hybrid	TTF6480A Single Circulator	TTF6450A 6-way Power Combiner	TVN6055A Station Control Board Firmware	TVN6056A Trunked Toned Remote Control Module Firmware	TVN6057A Secure Module Firmware	TVN6118A Staion Access Software
35W Power Amplifier	TLF1550A																				
110V 15A 60Hz Low Power Junction Box	TLN2490A																				
110V 20A 60Hz Hi Power Junction Box	TLN3022B	1			1																
MSF Encode/Decode Secure Module (Option)	TLN3045C																				
Trunked Toned Remote Control Audio Board	TLN3112E																				
Secure Capable Station Control Board	TLN3204A																	1			
Station Access Module (SAM)	TLN3221B			1																	1
800 MHz Data Station Control Board	TLN3320A		1															1			
Transparent Only Secure Modele (Option)	TLN3267A																				
500W 60Hz Power Supply	TPN1186B																				
Trunked Toned Remote Control Logic Board	TRN7754A																		1		
75W Power Amplifier	TTF1440C						1	2	1	1	1				1						
Final Power Amplifier	TTF1460B					2	1	4	1	1		1					1				
Single Circulator w/ Load	TTF1490A													1		1					
Universal Chassis RF Tray	TUF1780B												1								
800 WB INT REF W/RSSI/Loopback	TUF1860A												1								

MSFX008
021894JNM

2nd ITEM BREAKDOWN CHART FOR MSF 5000 DIGITAL CAPABLE STATIONS 800 MHz

LEGEND:

= Items Supplied

DESCRIPTION	MODEL	TLE5371B Transmit VCO Hardware	TLE5381B Receiver VCO Hardware	TLF6840C Intermediate Power Amplifier Hybrid	TLF6850A Intermediate Power Amplifier Hybrid Module	TRN9458B RF Load Hardware	TRN9867B RF Circulator Hybrid	TRN9930A Intermediate Power Amplifier Hardware
Intermediate Power Amplifier	TLF1511C			1	1			1
Receiver VCO	TRE1321B		1					
Transmit VCO	TTE1471B	1						
Transmitter Circulator w/ Load	TTF1362B					1	1	

MSFX009
021894JNM

800 MHz Model Charts

MODEL COMPLEMENT CHART FOR MSF 5000 ANALOG PLUS BASE STATIONS 900 MHz

LEGEND:

= Items Supplied

* = Refer to 1st Item Breakdown Chart

DESCRIPTION	MODEL	TFF6072B Lowpass Filter	TKN8487A Watt Meter Cable	TKN8492A Wire Line Interface Cable	TKN8496A Reference Synthesizer Power Supply Cable	TKN8497A HSO Synthesizer to Power Supply Cable	TKN8498B 25' Trunking Central Controller Cable	TKN8499A Station Receiver Cable	TKN8500C Secure Smartnet System Cable	TKN8543A Trunked Tone Remote Control/J-box Trunking Cable	TKN8573A Power Supply to Fan Cable	TKN8579A Lo Power Power Supply to PA Interconnect Cable	TKN8580A HI Power Power Supply to PA Interconnect Cable	TKN8710A RX Loopback Cables	TKN8713A 26 Pin Ribbon Cables for SAM to Base Station Control	TKN8720A SAM to RLC Board Cable Kit	TKN8741A Driver Power Monitor Cable	TKN8993A Expansion Cables	TLF6890A Watt Meter	TLN2490A* 110V 15A 60Hz Low PowerJunction Box
75W Data Base Station	C65GFB2206A	1	2			1		1			1	1		1	1	1		1	2	1
75W Analog Plus Trunked Repeater	C65GFB5203AT	1	1	1	1		1	1	1	1	1	1							1	1
75W Analog Plus Conventional Repeater	C65GFB7206AT	1		1		1		1	1		1	1								1
150W Data Base Station	C85GFB2206A	1	2			1		1			1		1	1	1	1	1	1	2	1
150W Analog Plus Trunked Repeater	C85GFB5203AT	1	1	1	1		1	1	1	1	1		1						1	
150W Analog Plus Conventional Repeater	C85GFB7206AT	1		1		1		1	1		1		1							

DESCRIPTION	MODEL	TLN3022B* 110V 20A 60Hz Hi Power Junction Box	TLN3024B* Reference Synthesizer	TLN3025C* HSO Synthesizer	TLN3112E* Trunked Tone Remote Control Audio Board	TLN3205A* Analog Plus Station Control Board	TLN3221B* Station Access Module (SAM)	TLN3342A* 900 MHz Data Station Control Board	TPN1186B* 500W 60Hz Power Supply	TRN5177A Expansion Tray Hardware	TRN5178B Expansion Tray Power Supply Board	TRN5200A Blank Bezel	TRN5352A RF Connector Plug	TRN5353A Auxiliary Connector Plug	TRN5355A Battery Connector Plug	TRN5427A 110V Power Cord	TRN5954A Blank Bezel	TRN7039A Control Hardware	TRN7040A Trunked Tone Remote Control Bezel	TRN7200A Universal 9" Slides Tray Hardware
75W Data Base Station	C65GFB2206A			1			1	1	1	1	1	1	1	1	1	1	2	1		2
75W Analog Plus Trunked Repeater	C65GFB5203AT		1		1				1					1	1	1		1	1	2
75W Analog Plus Conventional Repeater	C65GFB7206AT			1	1	1			1				1	2	1	1		1	1	2
150W Data Base Station	C85GFB2206A	1		1			1	1	2	1	1	1			2		2	1		2
150W Analog Plus Trunked Repeater	C85GFB5203AT	1	1		1	1			2					1	2			1	1	2
150W Analog Plus Conventional Repeater	C85GFB7206AT	1		1	1	1			2				1	2	2			1	1	2

DESCRIPTION	MODEL	TRN7201A Universal PA/PS Hardware	TRN7224A Synthesizer Tray Panel Hardware	TRN7225A RF Tray Panel Hardware	TRN7249A Universal Rails Label	TRN7252B UHF/800/900 Station Peripheral Hardware	TRN7385A RF Interconnect Hardware	TRN7551A Station Access Module Bezel	TRN7586A 21.4 MHz IF RSSI/Loopback Div Board	TRN7717A FCC Label	TRN7754A* Trunked Tone Remote Control Logic Board	TRN7794A Tuning Tool Kit	TRN9512A Straight Coax N-Type Adaptor	TRN9871B 2 Fan Kit	TRN9892B 3 Fan Kit	TTF1212C* Final Power Amplifier, 928-944 MHz	TTF1242D* 70W Power Amplifier Driver, 928-944 MHz	TTF1480A* Single Circulator w/ Load, 928-960 MHz	TUF1790A* RF Tray Chassis w/ High Stability Oscillator	TUF1920A* 900MHz EXT REF RF Tray W/RSSI/Loopback
75W Data Base Station	C65GFB2206A	1	1	1	1	1	1	1	1	1		1	1	1			1	1		1
75W Analog Plus Trunked Repeater	C65GFB5203AT	1	1	1	1	1	1			1	1	1	1	1			1	1	1	
75W Analog Plus Conventional Repeater	C65GFB7206AT	1	1	1	1	1	1			1	1	1	1	1			1	1	1	
150W Data Base Station	C85GFB2206A	2	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	
150W Analog Plus Trunked Repeater	C85GFB5203AT	2	1	1	1	1	1			1	1	1	1		1	1	1	1	1	
150W Analog Plus Conventional Repeater	C85GFB7206AT	2	1	1	1	1	1			1	1	1	1		1	1	1	1	1	

MSFX010
120893JNM

1st ITEM BREAKDOWN CHART FOR MSF 5000 ANALOG PLUS BASE STATIONS 900 MHz

LEGEND:

= Items Supplied

* = Refer to 2nd Item Breakdown Chart

DESCRIPTION	MODEL	TFF6202A Preselector Filter	TFF6203A Image Injection Filter	TFN6056A 2175 Hz Notch Hybrid Filter	TFN6061A 2175 Hz Bandpass Hybrid Filter	TKN8342C Driver PA Deck Cabling	TKN8525A Reference Synthesizer Cables	TKN8562A IPA Cable	TKN8565A 20A Hi Power Junction Box Hardware	TKN8599B SSCB Power Cable	TKN8655A Synthesizer Cable	TKN8842A IPA Feedthru Cable	TKN8975C PA Cabling Kit	TLF1521B* Intermediate Power Amplifier	TLF6633A PA Final Mode Hybrid, 928-944 MHz	TLF6692A Predriver Mode Hybrid	TRE1322B* Receiver VCO:435-490 MHz	TRF6512B PA RF Mixer Hybrid, 896-915 MHz	TRF6513A Injection Double Amplifier Board	TRN5159B Line Interface Board	TRN7008A Display Board	TRN7110B 60Hz Hi Power Junction Box Hardware
110V 15A 60Hz Lo Power Junction Box	TLN2490A																			1		
110V 20A 60Hz Hi Power Junction Box	TLN3022B								1											1		1
Reference Synthesizer	TLN3024B						1															
HSO Synthesizer	TLN3025C										1											
Trunked Toned Remote Control Audio Board	TLN3112E			1	1																	
Analog Plus Station Control Board	TLN3205A																				1	
Station Access Module (SAM)	TLN3221B																					
900 MHz Data Station Control Board	TLN3342A																					
500W 60Hz Power Supply	TPN1186B																					
Trunked Toned Remote Control Logic Board	TRN7754A																					
Transmitter Final Power Amp, 928-944 MHz	TTF1212C												1		6							
70W Driver Power Amp, 928-944 MHz	TTF1242D					1									4	1						
Single Circulator w/ Load	TTF1480A																					
RF Tray Chassis w/ High Stability Osc, 896-944 MHz	TUF1790A	1	1					1		1		1		1			1	1	1			
900 MHz EXT REF RF Tray W/RSSI/Loopback	TUF1920A	1	1					1		1		1		1			1	1	1			

DESCRIPTION	MODEL	TRN7117A Miscellaneous Hardware	TRN7142B RF Tray Interconnect Board	TRN7144A RF Tray w/ EXT REF Hardware	TRN7173A PA Final Hardware	TRN7197B Uniboard	TRN7213B 500W 60Hz Power Supply Hardware	TRN7242A 14V Distribution Board	TRN7273D Trunked Tone Remote Control Audio Board	TRN7304A Synthesizer Hardware	TRN7423A 900 MHz Analog Plus Staiton Control Board	TRN7497A 110V 60Hz Label	TRN7537B Station Access Board	TRN7564A 110V 60Hz Lo Power Junction Box Hardware	TRN7580A Universal Power Supply Hardware	TRN7587A RF Tray Hardware for Data Station	TRN7606A Socketed Display Board	TRN7671A 15A Line Cord Hardware	TRN7827A Standoff Hardware	TRN7857A 10V 60 Hz 14V Labels	TRN7881A 900 MHz EXT REF Uniboard W/RSSI/Loopback	TRN7913A Hybrid Flutter Attenuator
110V 15A 60Hz Lo Power Junction Box	TLN2490A											1		1								
110V 20A 60Hz Hi Power Junction Box	TLN3022B														1			1		1		
Reference Synthesizer	TLN3024B																					
HSO Synthesizer	TLN3025C									1												
Trunked Toned Remote Control Audio Board	TLN3112E								1													
Analog Plus Station Control Board	TLN3205A										1											
Station Access Module (SAM)	TLN3221B												1						1			
900 MHz Data Station Control Board	TLN3342A																1					1
500W 60Hz Power Supply	TPN1186B	1					1	1														
Trunked Toned Remote Control Logic Board	TRN7754A																					
Transmitter Final Power Amp, 928-944 MHz	TTF1212C				1																	
70W Driver Power Amp, 928-944 MHz	TTF1242D																					
Single Circulator w/ Load	TTF1480A																					
RF Tray Chassis w/ High Stability Osc, 896-944 MHz	TUF1790A		1	1		1																
900 MHz EXT REF RF Tray W/RSSI/Loopback	TUF1920A		1																		1	

DESCRIPTION	MODEL	TRN9060A Balancing Resistor Hardware	TRN9062B Final PA Distribution Board	TRN9064A Balancing Resistor Hybrid	TRN9191A 70W Driver PA Deck Feedthru Plate	TRN9256A External Reference Connector	TRN9386A Thermistor Board	TRN9458B RF Board Hardware	TRN9812B HSO Power Supply	TRN9837A Hybrid Flutter Attenuator	TRN9840B Driver PA Deck Hardware	TRN9867B RF Circulator Hybrid	TRN9910B Reference Synthesizer Board	TRN9932A Reference Synthesizer Hardware	TTE1472B* Transmit VCO: 435-475 MHz	TTF1362B* Transmitter Circulator w/ Load	TTF6203A 6-way Power Combiner Board	TTF6273B Hybrid 3-way Combiner/Directional Coupler Board	TTF6470A Single Circulator	TVN6055A Station Control Board Firmware	TVN6056A TTRC Module Firmware	TVN6118A Secure Module Firmware
110V 15A 60Hz Lo Power Junction Box	TLN2490A																					
110V 20A 60Hz Hi Power Junction Box	TLN3022B																					
Reference Synthesizer	TLN3024B												1	1								
HSO Synthesizer	TLN3025C								1				1									
Trunked Toned Remote Control Audio Board	TLN3112E																					
Analog Plus Station Control Board	TLN3205A									1										1		
Station Access Module (SAM)	TLN3221B																					1
900 MHz Data Station Control Board	TLN3342A									1										1		
500W 60Hz Power Supply	TPN1186B																				1	
Trunked Toned Remote Control Logic Board	TRN7754A																					
Transmitter Final Power Amp, 928-944 MHz	TTF1212C	2	1	4	1		1										1					
70W Driver Power Amp, 928-944 MHz	TTF1242D		1	2	1		1				1							1				
Single Circulator w/ Load	TTF1480A															1			1			
RF Tray Chassis w/ High Stability Osc, 896-944 MHz	TUF1790A					1									1							
900 MHz EXT REF RF Tray W/RSSI/Loopback	TUF1920A					1									1							

MSFX011
021894JNM

2nd ITEM BREAKDOWN CHART FOR MSF 5000 ANALOG PLUS BASE STATIONS 900 MHz

LEGEND:

= Items Supplied

DESCRIPTION	MODEL	TLE5372B – Transmit VCO Hardware	TLE5382B – Receiver VCO Hardware	TLF6840C – Intermediate Power Amplifier Hybrid	TLF6850A – Intermediate Power Amplifier Hybrid Module	TRN9458B – RF Load Hardware	TRN9867B – RF Circulator Hybrid	TRN9930A – Intermediate Power Amplifier Hardware
Intermediate Power Amplifier	TLF1521B			1	1			1
Receiver VCO	TRE1322B		1					
Transmit VCO	TTE1472B	1						
Transmitter Circulator w/ Load	TTF1362B					1	1	

MSFX012
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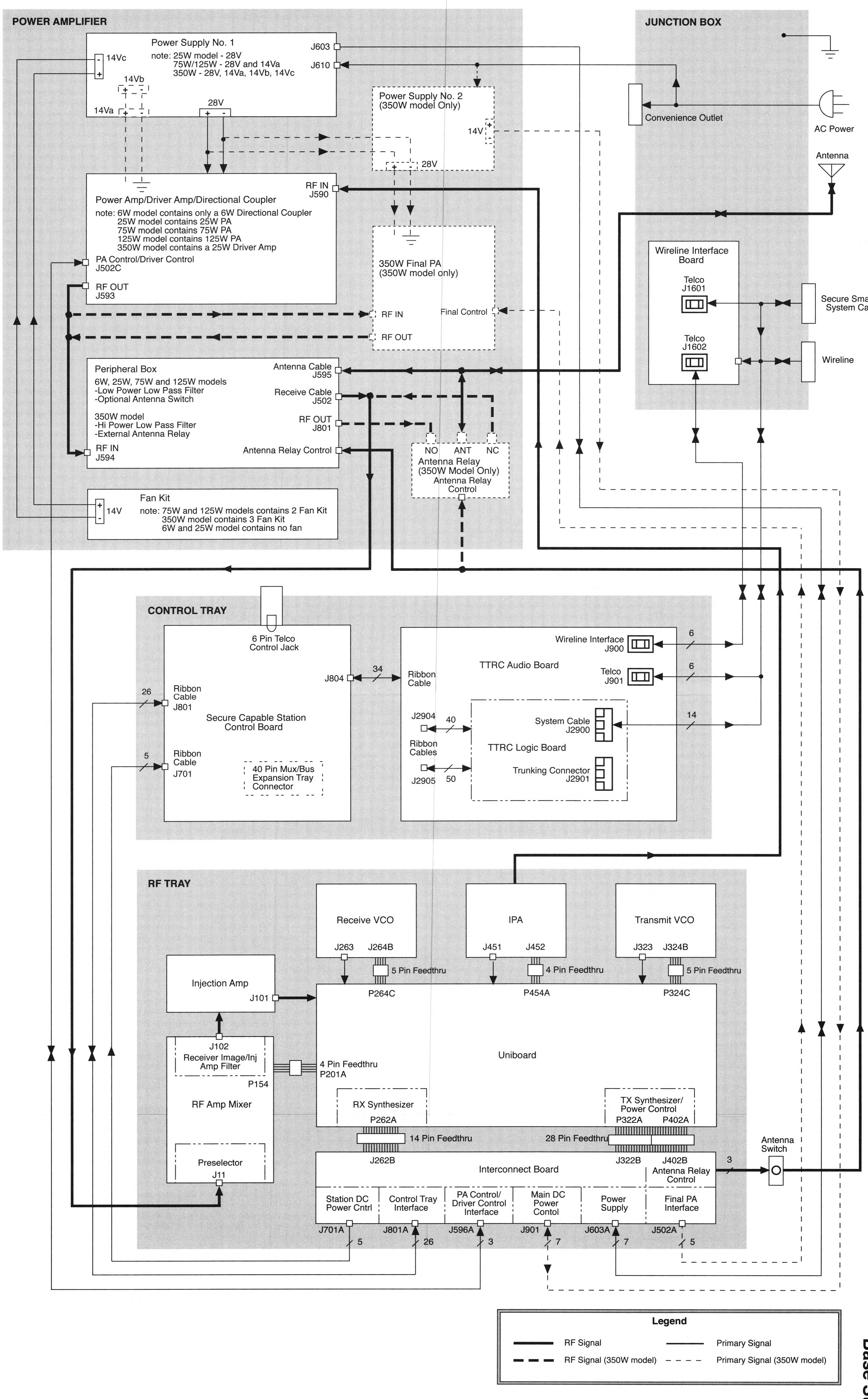
900 MHz Model Charts



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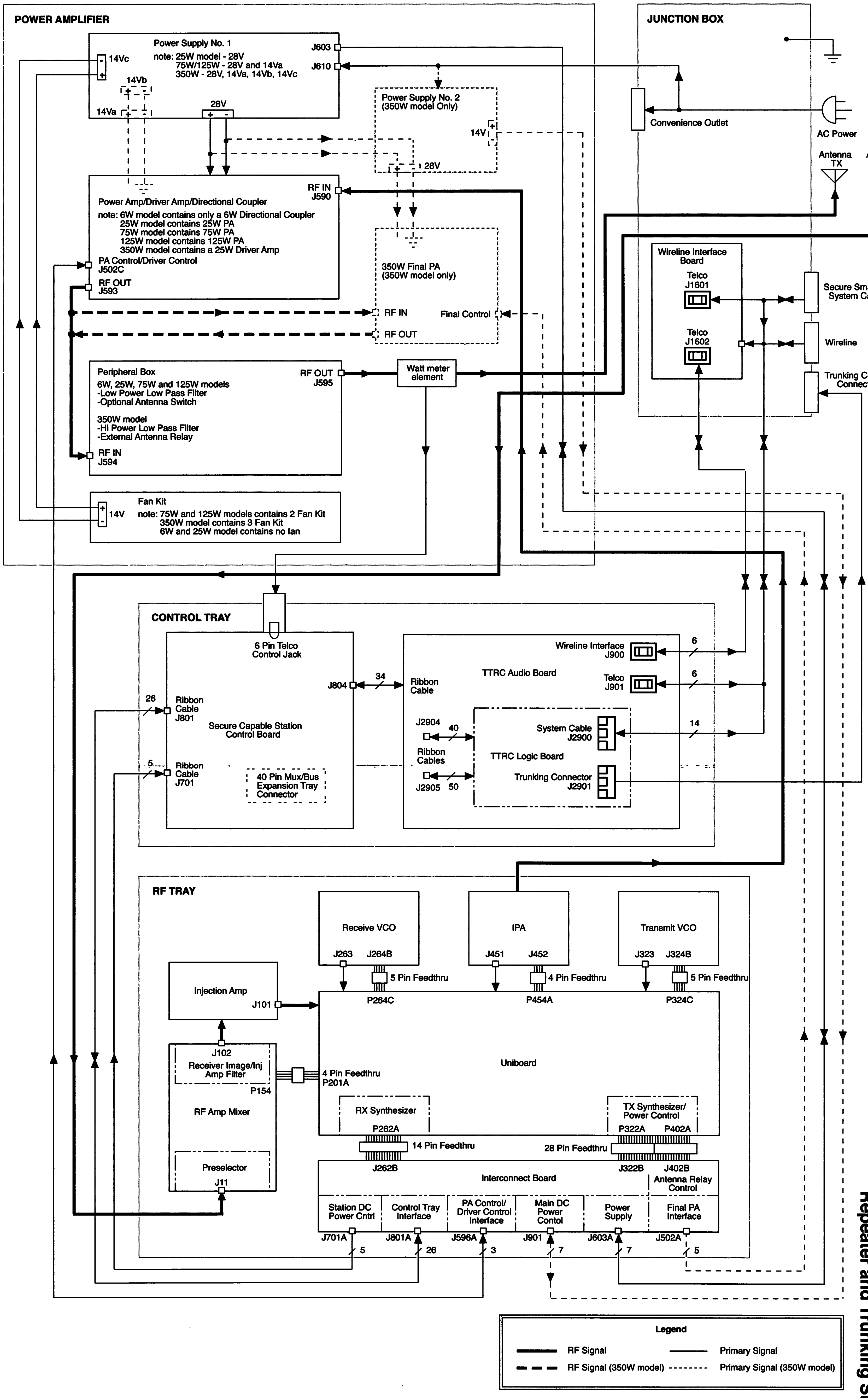
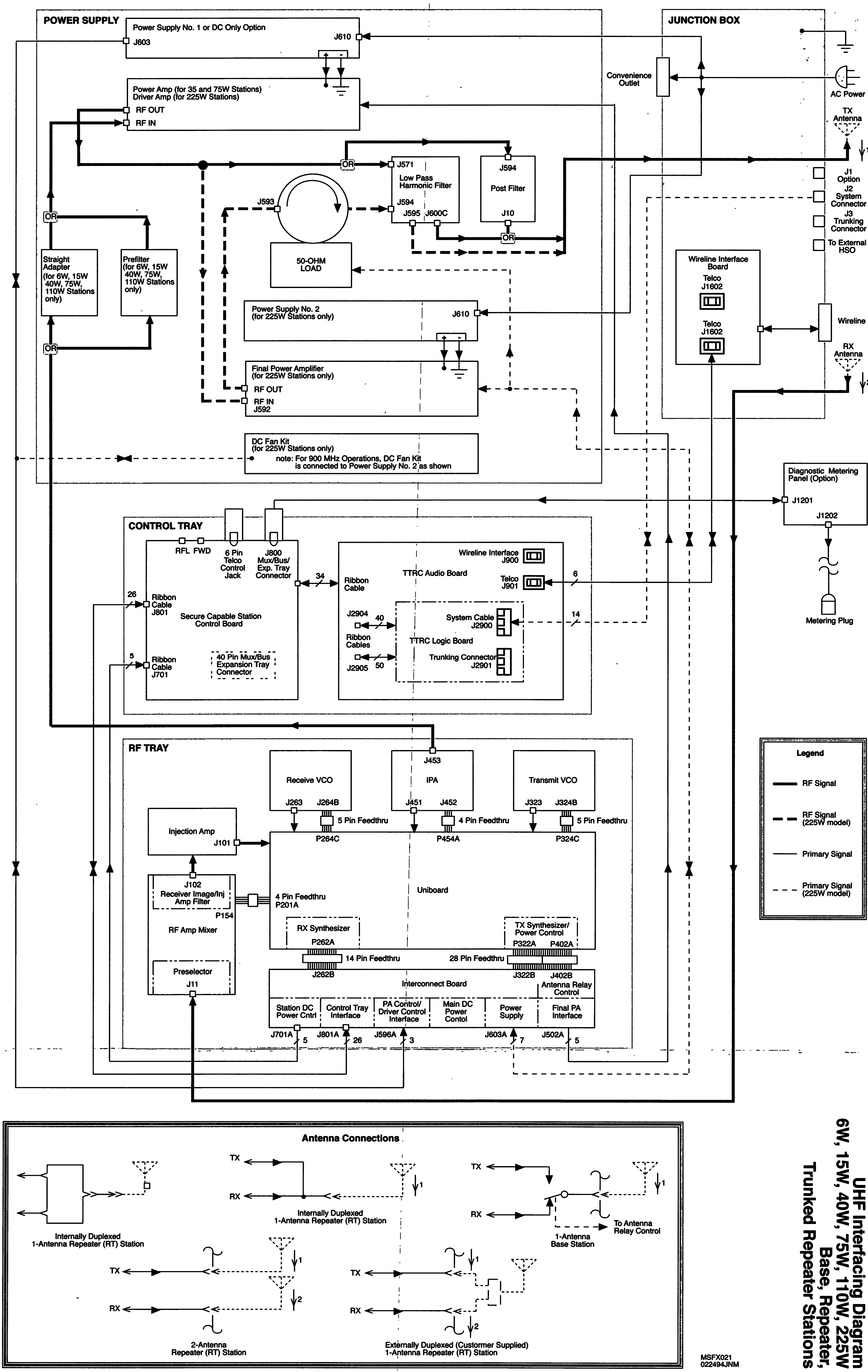
MSF 5000
VHF Interfacing Diagram
6W, 25W, 75W, 125W, 350W
Base Stations



MSF 5000
VHF Interfacing Diagram
6W, 25W, 75W, 125W, 350W
Repeater and Trunking Stations

MSFX015
022494JNM

MSF 5000 UHF Interfacing Diagram 6W, 15W, 40W, 75W, 110W, 225W Base, Repeater, Trunked Repeater Stations



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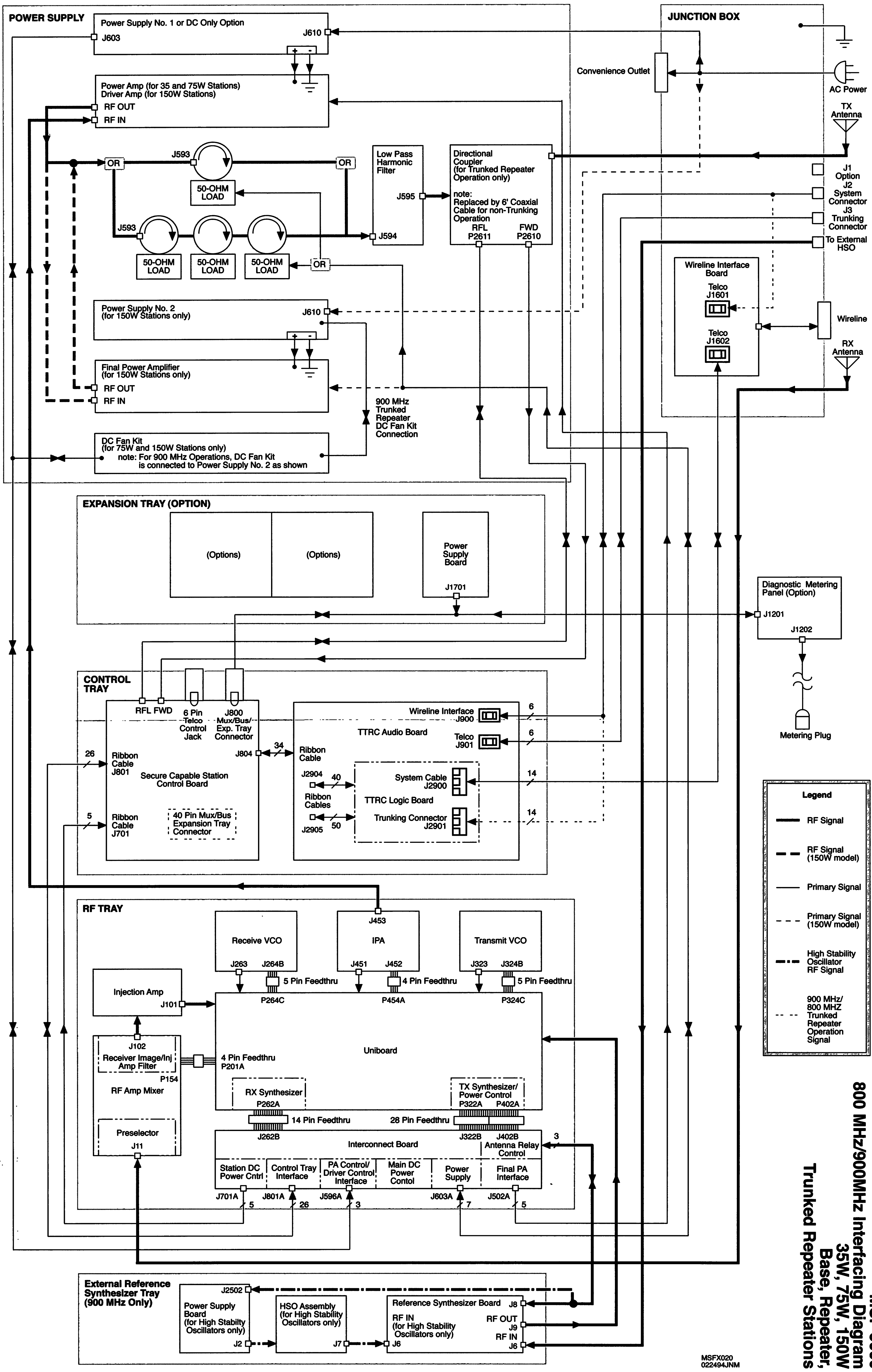
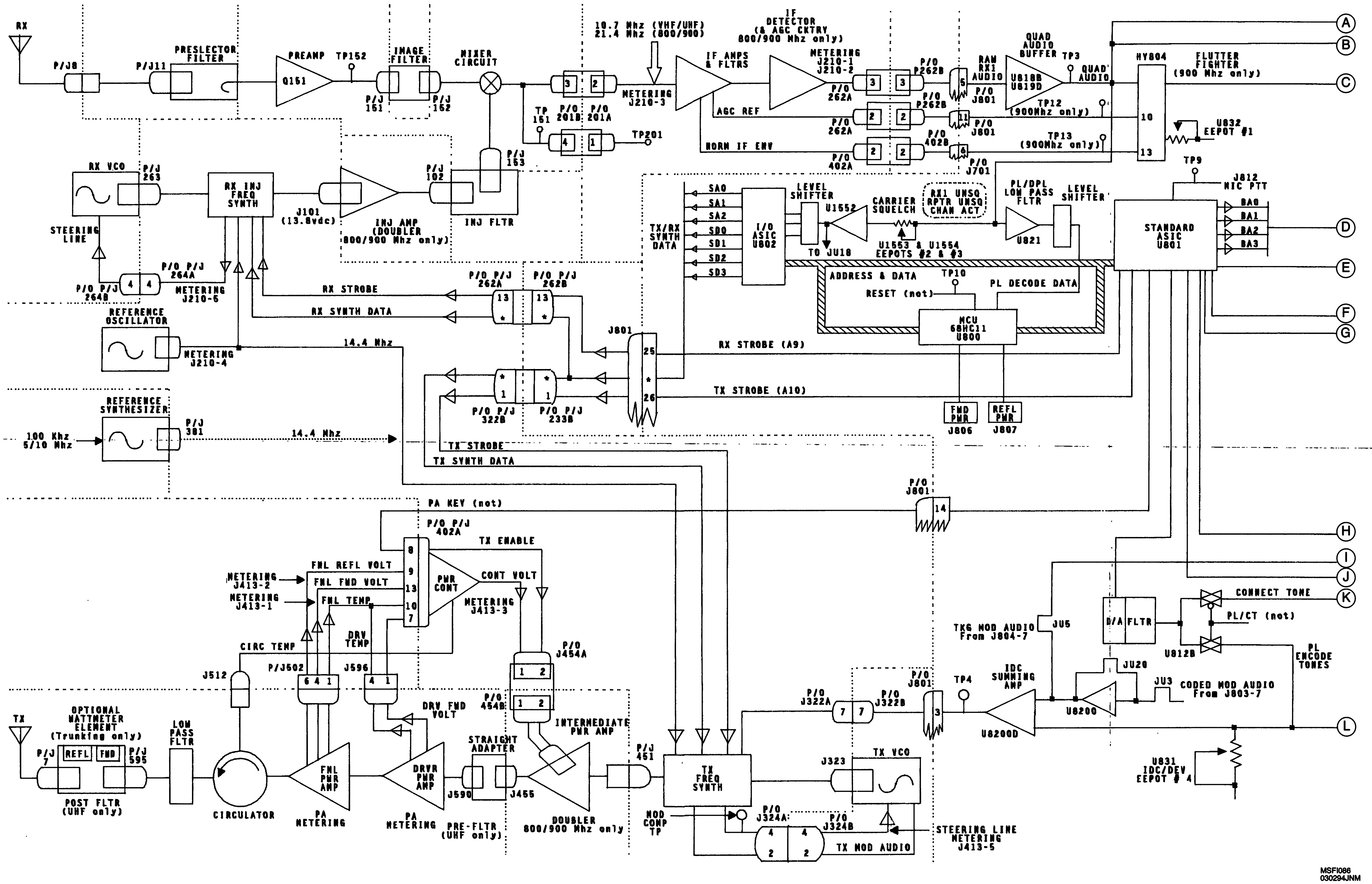
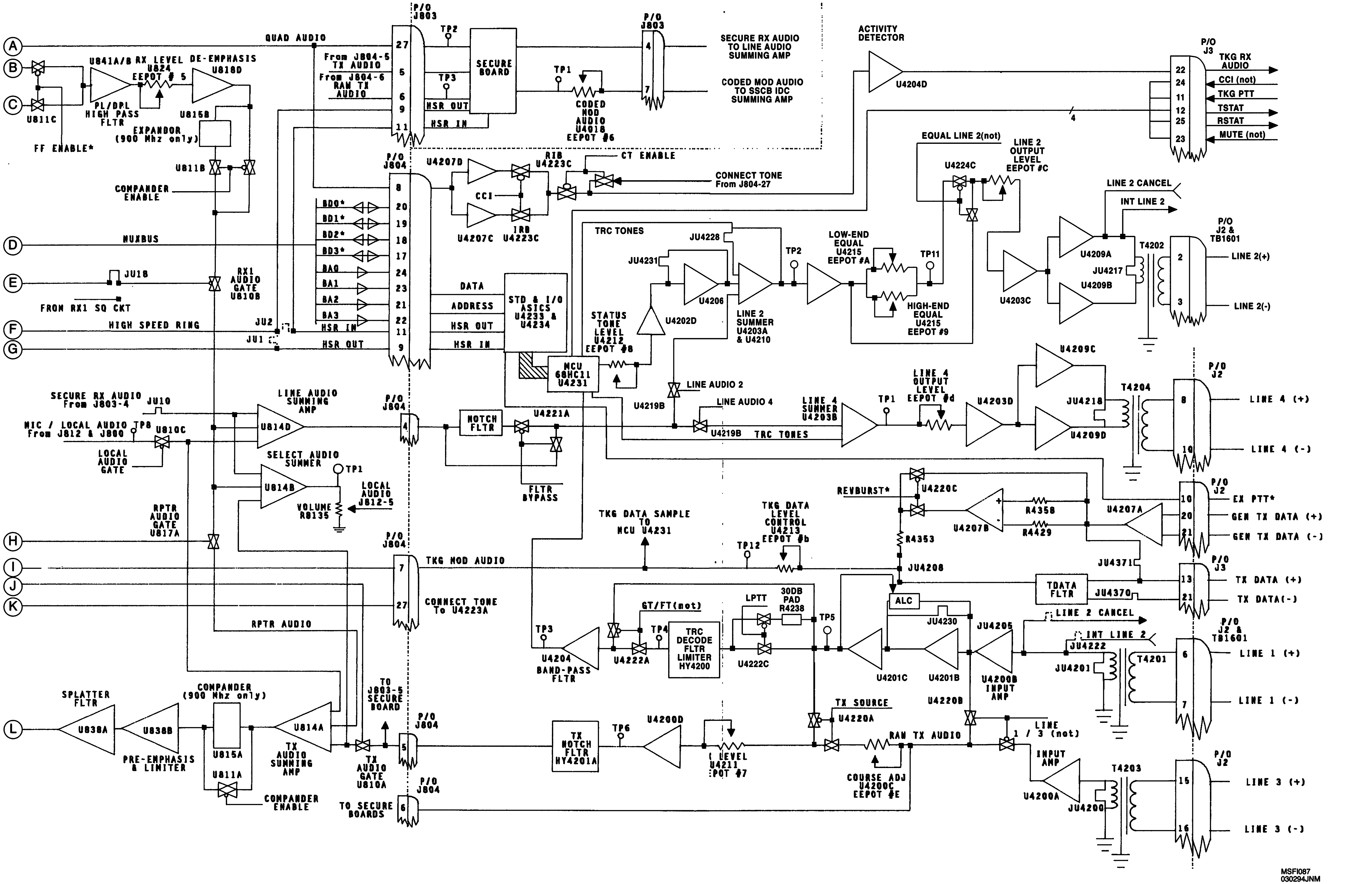


MSF 5000
800 MHz/900MHz Interfacing Diagram
35W, 75W, 150W
Base, Repeater,
Trunked Repeater Stations

MSF 5000 Block Diagram
(Sheet 1 of 2)



MSF 5000 Block Diagram
(Sheet 1 of 2)



Description

Chapter Overview

This chapter describes the architecture and major assemblies of the *MSF 5000* station. Table 1-1 describes each section of this chapter and with starting page number. Each of these sections are identified by a thumb tab.

Table 1-1 **Chapter Contents**

Section	Page	Description
Control Tray	1-5	Discusses the operation and functions of the Secure capable Station Control Board (SSCB), Trunked Tone Remote Control (TTRC) board, and the optional Secure board.
RF Tray	1-49	Discusses the operation and functions of the Uniboard, Receive and Transmit VCOs, Intermediate Power Amplifier, Interconnect Board, Receiver circuitry, and Power Control circuitry.
Power Supply	1-67	Briefly discusses the functions of the Power Supplies.
Power Amplifier	1-69	Discusses the operation and functions of the Power Amplifier.
Junction Box	1-73	Discusses the functions of the Junction Box.

Station Architecture

The *MSF 5000* station is versatile enough to allow a variety of applications and future enhancements. The standard *MSF 5000* is available in four different bands: VHF, UHF, 800 MHz, and 900 MHz (Analog Plus). Each band is available in several different power level configurations.

In most bands, a station may be configured as a repeater or as a base station. It may also be configured as a conventional station or as a trunked station. Many other options are available to further enhance and expand station capabilities. Refer to Appendix F - *MSF 5000* Options for additional information.

The standard *MSF 5000* station is configured to provide maximum flexibility. Most station parameters (such as transmit and receive frequencies) are programmed into non-volatile memory that resides in station control circuitry. These parameters are altered through the use of Radio Service Software (RSS).

The *MSF 5000* station includes these standard features:

- microprocessor control
- transmit/receive frequency synthesis
- wide operating temperature range (-30 to +60° C)
- station design to support easy servicing
- built-in station diagnostic tests
- standard hardware platform to support conventional, repeater, trunking, Spectra-TAC™, secure SMARTNET™ trunking, and secure operation
- high-performance continuous duty transmitter
- 1200/4800 baud rate for data transmission
- central location for all system interconnections via the Junction Box
- RF shielding and filtering to meet domestic FCC Industrial Class A requirements
- power supplies with enhanced power-line transient protection

Frequency and Power Configurations

The *MSF 5000* is available in the frequencies and power ratings listed in Table 1-2. Refer to the model chart at the front of this manual for additional information.

Table 1-2 ***Available Frequencies and Power Ratings***

Band	Tx Range (MHz)	Rx Range (MHz)	High Power (Watts)	Low Power (Watts)
VHF	132-174	132-174	350	6, 25, 75, and 125
UHF	403-475	403-475	225	6, 15, 40, 75, and 110
800 MHz	851-870	806-825	150	35 and 75
900 MHz	935-941	896-902	150	75

The *MSF 5000* Cabinet

The standard *MSF 5000* is housed in a cabinet configuration with these standard features:

- wide body frame
- vinyl covered steel skin
- non-corrosive polycarbonate covers - top and bottom
- removable front door
- rack mount internal frame
- front only access for easy servicing

The standard cabinet is designed exclusively for indoor installation. However, optional outdoor cabinets and rack configurations are available. Cabinets may also be safely stacked through the use of optional stacking hardware. Refer to Chapter 3 - Installation for additional information relating to the stacking of cabinets.

Easy access to station modules is gained via the front of the cabinet, making rear access unnecessary. Each module either rotates or slides outward for easy access.

External connections are made through a Junction Box. In the standard configuration, the Junction Box is flush-mounted to the right side of the cabinet. In the optional rack configuration, the Junction Box is mounted within the equipment rack.

At a minimum, each cabinet or rack contains a Power Supply(s), Power Amplifier(s), Control Tray, and RF Tray. Each of these major assemblies are described in the following sections. Other options are also mounted within the cabinet or rack as necessary.

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Control Tray Overview

The Control Tray is mounted to the top of the RF Tray, as shown in Figure 1-1. The three modules within the Control Tray include:

- Secure capable Station Control Board (SSCB)
- Trunked Tone Remote Control (TTRC) board
- Secure board (optional for VHF, UHF, and 800 MHz)

The Control Tray is hinged to the right side of the RF Tray. Access to the modules occurs by pulling the RF Tray outward and raising the Control Tray upward to the right, as shown in Figure 1-2. This allows for easy access and repair of the modules within the Control Tray. Figure 1-3 shows the location of the boards within the Control Tray. Each board is controlled by common control logic circuitry.

The controls and indicators on the front of the Control Tray are described in detail in the Chapter 2 - Operation.

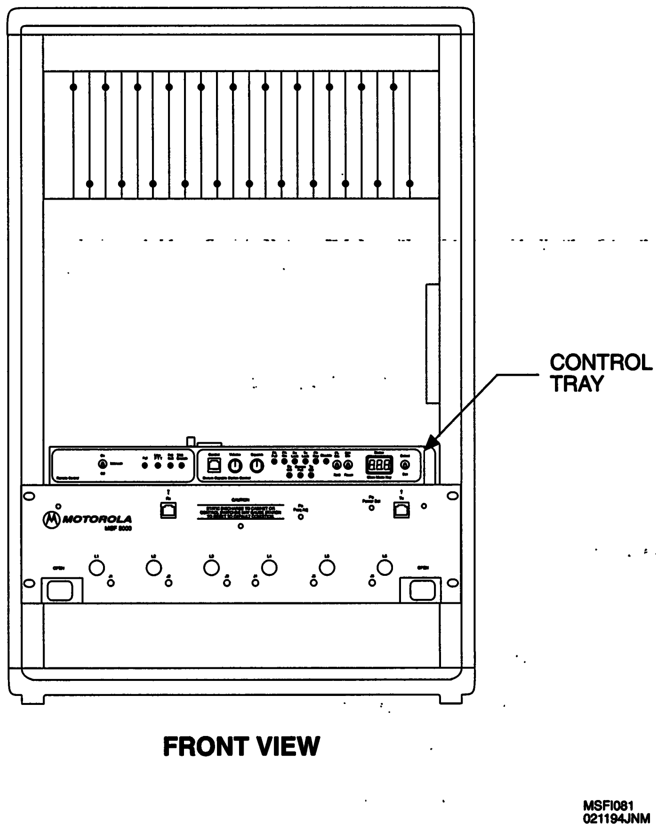

Figure 1-1 ***Control Tray Location***

Control Tray Overview

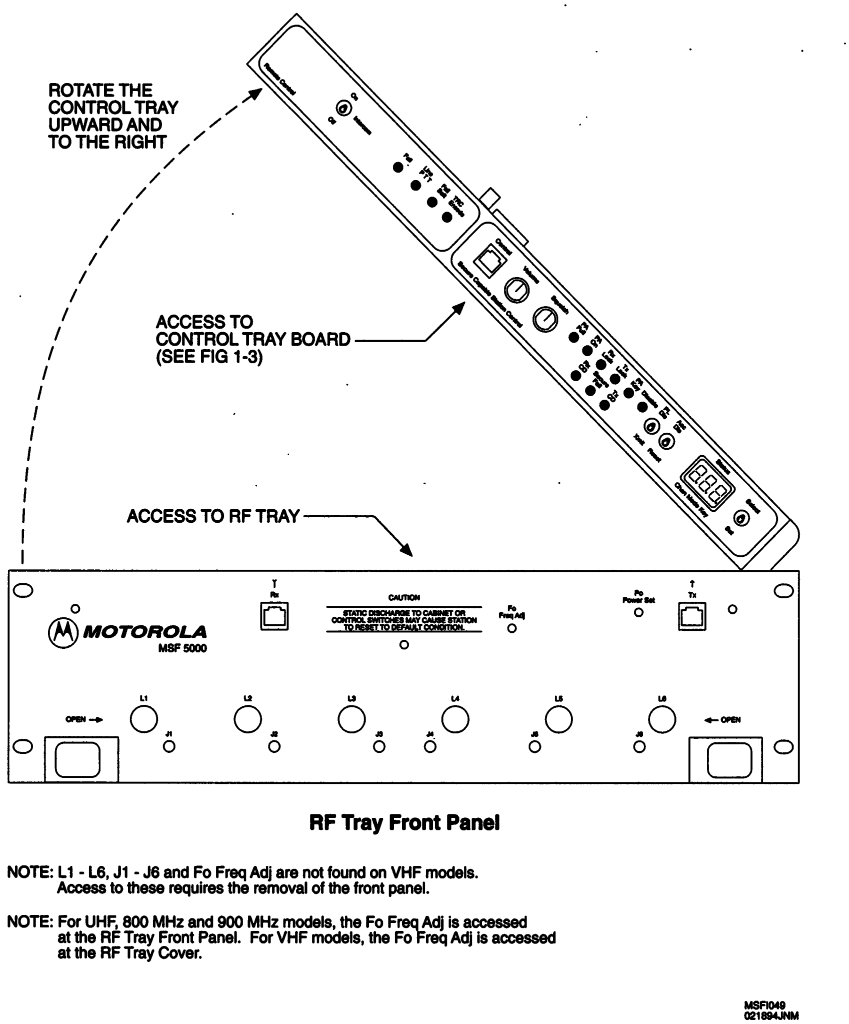

Figure 1-2 ***Control Tray Access***

Control and Logic Circuitry

The control and logic circuitry includes:

- Microprocessor Core
- Data Communications Circuitry
- General Input/Output
- Tone Processing (encode/decode)
- Reset Circuitry

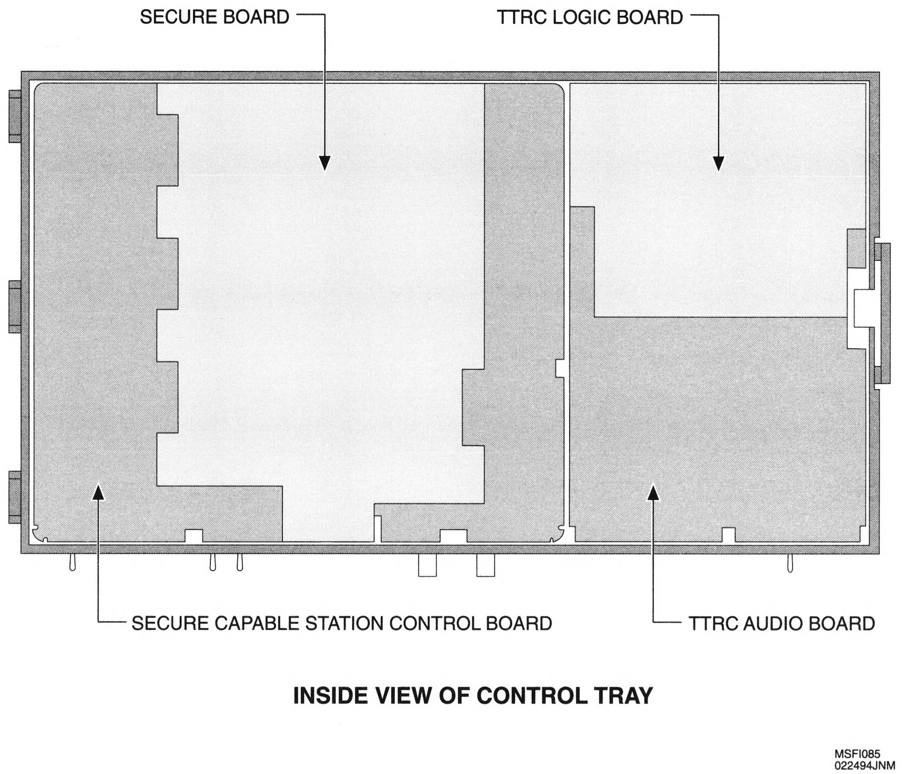

Figure 1-3 ***Control Tray Board Location***

Many of the functions of the control and logic circuitry are implemented with Application Specific Integrated Circuits (ASICs). The SSCB and TTRC each use two ASICs; a standard mode ASIC and an I/O mode ASIC. Both are custom designed for this product. The operating mode is dependent on the state of the input.

The standard mode ASIC serves as a specialized microprocessor support chip with additional I/O and data communication features. Major functions include control of the seven-segment Status display, High Speed Ring (HSR) data bus, MUXbus, RAM read/write enable, memory addressing, audio gate control, and various transmit and receive control signals.

The I/O mode ASIC serves as an addressable collection of input buffers and output latches. Major functions include:

- control of PL/connect and alert tones
- Motorola Radio Telephone Interface (MRTI) control lines
- data from RF Tray
- EEPOT control
- monitoring various control lines throughout the station
- driving front panel transmit LEDs

(PA FULL, PA ON, Tx LOCK, PA KEY, and Tx CD)

- interfacing with front panel switches
(PL Dis/Xmit, Acc Dis/Reset, and Select/Set)

Microprocessor Core

The microprocessor core runs the software that controls the station operation. Most of the core functions are carried out using integrated circuits.

Data Communications Circuitry

The SSCB logic circuitry communicates with various modules of the station through three primary channels: the Inter-Processor Communications Bus (IPCB), the MUXbus, and the HSR data bus.

The IPCB is a low speed serial link shared among all Control Tray boards and optional expansion modules. Status and control signals are routed through this bus.

The MUXbus is a time-multiplexed address and data bus capable of carrying 64 bits of control and status information between modules. The TTRC acts as a MUXbus slave, while the SSCB acts as the master.

The HSR bus is a unique multiprocessor communication mechanism. A 40 bit packet is circulated between the TTRC, SSCB, and the Secure board. Sixteen bits are written to by the TTRC, 16 bits are reserved for writes by the SSCB, and 8 bits are reserved for writes by the Secure board. The SSCB acts as the HSR master by driving the clock and sync signals.

General Input/Output

The logic control circuitry contains extensive input/output (I/O) capabilities needed to control the station functions and monitor station status. The I/O circuitry allows a local user to change the station configuration, as well as observe status conditions. This is accomplished by using MIC PTT, Xmit, Acc/Dis, PL Dis, Select/Set, and Display change via the front panel of the Control Tray.

Tone Processing, (SSCB only)

Two encoders driven by the I/O ASIC provide tone processing. The tone decoding capabilities are complementary to the encoding function. In a conventional coded squelch station, incoming PL tones or DPL codewords are detected. In a trunked station, connect tones are detected. These tones and/or codewords are part of the receiver modulation.

Reset Circuitry

The power-up reset circuitry triggers the delayed reset generator during self-diagnostic, over-voltage/low-voltage conditions, or a hard reset from the front panel. The delayed reset generator outputs a DELAYED RESET signal. This signal is inverted to form the EXPANSION RESET signal, which holds the other Control Tray boards and expansion modules in reset mode.

During self-diagnostics, the station is held in reset mode until the diagnostics are complete. The microprocessor may also activate the EXPANSION RESET signal at various times during normal operation using a general purpose output. Refer to the Chapter 2 - Operation for information on diagnostic modes.

Secure Capable Station Control Board (SSCB)

The Secure capable Station Control Board (SSCB) is located in the Control Tray. The SSCB is the heart of the *MSF 5000* which provides control circuits for various components of the station.

The SSCB is compatible with the TT board and the Secure board. It is also compatible with all optional expansion modules housed within an Expansion Tray attached to the top of the Control Tray.

Models Covered

This section describes the operation of the SSCB designed for the *MSF 5000* station. The kit number of the SSCB is dependent upon the frequency band of the station. The kit numbers include:

- TLN3182 (VHF/UHF Narrow Band)
- TLN3189 (VHF, UHF)
- TLN3204 (800 MHz)
- TLN3205 (900 MHz Analog Plus)

Functions of SSCB

The major functions and circuits of the SSCB include:

- DC-DC Converter
- Audio Processing
- Squelch Circuitry
- Control and Logic Circuitry (previously described)
- Station Diagnostics and Alarms

Each is described in the following paragraphs.

SSCB Functional Description

DC-DC Converter

The DC-DC converter provides reference voltages for the SSCB and other circuits of the Control Tray. The DC-DC converter also provides various self and system protection circuits. Figure 1-4 shows a block diagram of the DC-DC converter.

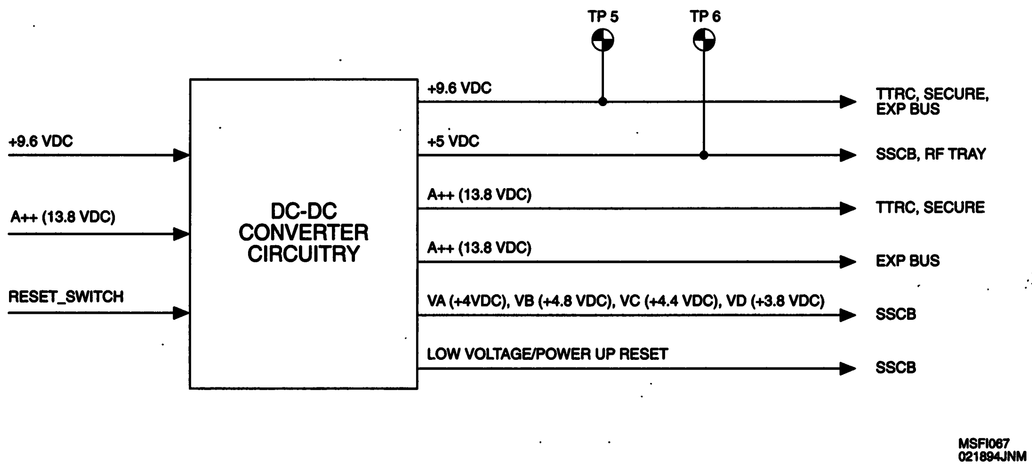

Figure 1-4 ***DC-DC Converter Block Diagram***

Reference Voltages

The station Power Supply generates an unfiltered Aux +13.8 Vdc (A++) routed to the SSCB, TTRC, and Expansion Tray. It is then filtered within the SSCB to +13.8 Vdc (A+). The voltage regulator in the RF Tray generates +9.6 Vdc also routed to the SSCB.

The DC-DC converter circuitry generates and/or routes:

- +9.6 Vdc (measured at TP5) to the TTRC, EXP Bus, and Secure board
- +5.0 Vdc (measured at TP6) to the SSCB and RF Tray
- +13.8 Vdc (A++) to the TTRC, EXP Bus, and Secure board
- +4.6 Vdc (VA), +4.4 Vdc (VC), +3.8 Vdc (VD) reference voltages to the squelch circuitry
- +4.8 Vdc (VB) to the audio processing circuitry

The SSCB utilizes the station ground to form the audio ground (TP7 and TP11), static ground, and logic ground (TP2).

Protection Circuits

Station protection features provided by the DC-DC converter include over-voltage and under-voltage protection. Protection against insufficient A++ voltage is also provided by the DC-DC converter to prevent over-discharge of batteries during battery revert. The Reset switch located on the front panel of the Control Tray generates the RESET_SWITCH logic signal. This signal allows the DC-DC converter to run regardless of the input voltage, and at the same time resets the station.

An insufficient A++ or under-voltage condition does not shut down the station, but holds it in reset mode. However, an over-voltage condition forces the DC-DC converter to shut down. If this occurs, the converter shuts down and allows the +5 Vdc reference to discharge to approximately +2 Vdc before attempting to restart. For a hard fault (i.e., a hardware failure that doesn't correct itself), the DC-DC converter supply continuously turns off and attempts to restart while holding the station in a reset mode. Over-current protection for the Power Supply is also provided.

Audio Processing

The audio processing circuitry of the SSCB consists of:

- Receive Audio Processing
- Transmit Audio Processing
- Tone Generating
- Audio Routing

Receive Audio Processing

The input to the receive audio processing circuitry is FM audio, demodulated from the RF signal by the receiver in the RF Tray. Refer to Figure 1-5 for a block diagram of the receive audio processing circuitry.

The receive audio input (RAW RX1 AUDIO) is fed to an audio buffer which processes the signal and provides a buffered output signal (QUAD 1 AUDIO). The QUAD 1 AUDIO is supplied to the loop-back switch. The loop-back switch usually passes the QUAD 1 AUDIO through TP3 as QUAD AUDIO.

QUAD 1 AUDIO is also routed to the optional expansion boards. When an optional second receiver is used, RAW RX2 AUDIO is routed to an audio buffer which supplies QUAD 2 AUDIO to the expansion boards for processing.

QUAD AUDIO is supplied to the TTRC board and to the Secure board. QUAD AUDIO is routed to the audio gate circuit accessed at TP3.

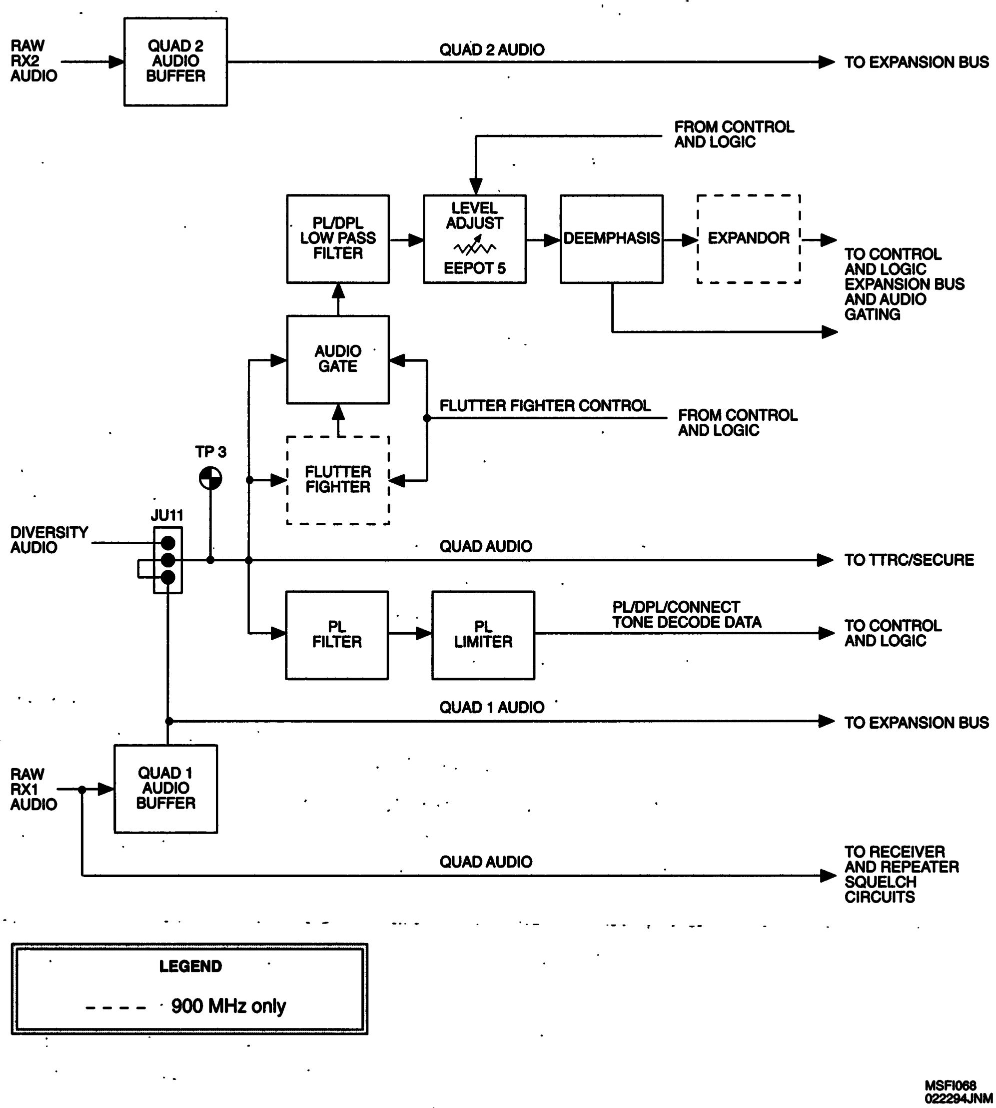

Figure 1-5 ***Receive Audio Processing Circuitry***

For 900 MHz stations, QUAD AUDIO is also routed to the flutter fighter circuit. The flutter fighter circuit attenuates receive audio during fading to eliminate audio pops and weak or noisy signals to improve quality. The audio gate circuits determine whether QUAD AUDIO or FLUTTER FIGHTER AUDIO is being sent to the next stage.

NOTE

The flutter fighter circuitry is available only in 900 MHz stations.

The output signal of the audio gate circuits is routed to the Private Line (PL) low-pass filter circuits which filters out unwanted low frequency audio components. The filtered signal is input to EEPOT 5 (RX level adjust) to adjust the level of receive audio for use throughout the station.

The output is the final output of the receive audio processing circuitry (RX1 AUDIO). If the station is properly aligned, during normal operation, an RF signal at 60% deviation of a 1 kHz tone applied to the receiver should result in an RX1 AUDIO level of about 350mV rms at TP1 of the SSCB.

Transmit Audio Processing

The transmit audio processing circuitry performs various functions on the transmit audio signal before it is sent to the modulator. This circuitry contains several inputs that originate from the SSCB audio routing circuitry. Refer to Figure 1-6 for a block diagram of the transmit audio processing circuitry.

For 900 MHz stations, the transmit audio signal is compressed, gated, and routed through a pre-emphasis and limiter circuit, summed (SUMMED TX AUDIO), and filtered by a low-pass splatter filter.

The output of the splatter filter is routed to the maximum deviation adjust circuit. The PL ENCODE AUDIO from the PL/connect tone encoder is also sent to the maximum deviation adjust circuit. This circuit contains EEPOT 4 (maximum deviation level), adjusted to limit maximum transmit deviation to reduce over-deviation. The adjusted level must be set while incorporating PL/DPL codes, failsoft codeword, connect tone, etc. The FCC and system design requirements must also be considered.

Other audio signals are also input to the final output stage of the transmit audio processing circuitry. Refer to the Audio Routing section for additional information on these signals.

The final output of the transmit audio processing circuitry is TX MOD AUDIO. This signal is sent directly to the modulator within the transmitter before transmitted and amplified.

Tone Generating

The SSCB generates various tones for different purposes. The tones are:

- Transmit audio alarm tones - audible alarms sent over the air during a specific failure (refer to Chapter 2 - Operation)
- PL/DPL - Private Line/Digital Private Line for use in conventional stations
- Failsoft codeword - connect tone used in Trunked systems and is sent when the station enters the Failsoft mode
- Connect tone - used in Trunked systems

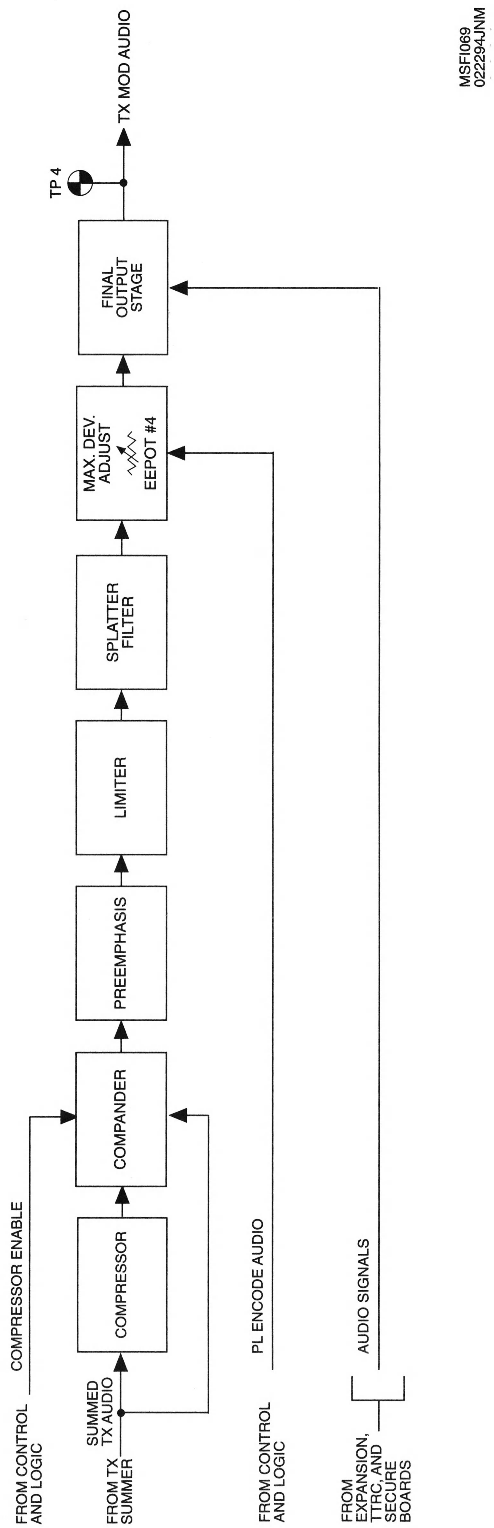

Figure 1-6 ***Transmit Audio Processing Circuitry***

Audio Routing

The primary function of the audio routing circuitry is to properly distribute audio signals to and from all sources connected to the SSCB. Various audio inputs are enabled using jumper settings and RSS parameters. Refer to Appendix G - Jumper Settings for configuring jumpers.

Refer to Figure 1-7 for a block diagram of the audio routing circuitry. The audio routing circuitry consists of the audio input signals listed in Table 1-3 and the audio output signals listed in Table 1-4.

Table 1-3 ***Audio Input Signal Description***

Input Signal	Description
RX1 AUDIO	Audio from receive audio processing circuitry
TX AUDIO	Audio from the TTRC wireline
IN MRTI AUDIO †	Audio from the MRTI phone patch
LOCAL AUDIO †	General purpose audio to/from the expansion boards (also common with MIC AUDIO signal)
MIC AUDIO	Audio from the local user microphone
ALERT TONE AUDIO	Audio from the alert tone encoder on the SSCB
RX2 AUDIO †	Processed audio from the optional 2nd receiver
SECURE RX AUDIO †	Audio from the Secure board for speaker/wireline
SEC ALERT TONES †	Tones from the Secure board (encode/decode only)
CODED MOD AUDIO †	Audio from the Secure board to the transmitter
TKG MOD AUDIO	TDATA/Simulcast Trunking audio from the TTRC to the transmitter
TX DATA AUDIO †	General purpose data from the expansion modules
GCC DATA AUDIO †	1200 or 4800 baud data from the optional General Communications Controller (GCC)
RAW TX AUDIO	Unfiltered audio from the TTRC wireline
PL ENCODE AUDIO	Audio from the PL/connect tone encoder on SSCB
SAM_LN_AUD †	Encoder output of optional Station Access Module (SAM) expansion board
† This signal is present only if the required optional equipment is installed.	

The RX1 AUDIO, TX AUDIO, IN MRTI AUDIO, LOCAL AUDIO, and MIC AUDIO are summed together at the first stage of the transmit audio processing circuitry. Each of these inputs are enabled using audio gates that respond to various Push-To-Talk (PTT) and squelch conditions. The audio gates are controlled by the logic and control circuitry of the SSCB. The RX1 AUDIO signal is only gated to the transmit audio processing circuitry if the station is configured as a repeater.

Each of these signals are also summed together at the line audio, select audio, and MRTI summing circuitry.

Table 1-4 ***Audio Output Signal Descriptions***

Input Signal	Description
SUMMED TX AUDIO	Audio to the transmit audio processing circuitry
LINE AUDIO	Audio to the TTRC wireline
SELECT AUDIO †	Volume adjusted audio to the expansion boards, such as the Diagnostic Metering Panel (DMP) speaker
OUT MRTI AUDIO	Audio to the MRTI phone patch
SPKR AUDIO †	Audio to the local user speaker
TX AUDIO †	Wireline audio to the Secure board for encryption and to the expansion boards
RAW TX AUDIO †	Unfiltered wireline audio to the Secure board
LOCAL AUDIO †	Local audio to the Secure board for encryption
IN MRTI AUDIO †	Audio from the MRTI phone patch to the Secure board for encryption
† This signal is present only if the required optional equipment is installed.	

The line audio summing circuitry sums these signals plus the ALERT TONE AUDIO, RX2 AUDIO, SECURE ALERT TONES, and SECURE RX AUDIO. The output of the line audio summing circuitry is the LINE AUDIO signal routed to the wireline.

The select audio summing circuitry sums the same signals as the line audio summing circuitry. One of the outputs of the select audio summing circuitry is the SELECT AUDIO signal routed to the optional expansion module, local speaker of a Radio Metering Panel (RMP) or a Diagnostic Metering Panel (DMP). The SPEAKER AUDIO signal is another output of the select audio summing circuitry. This signal is amplified and then routed to a local speaker of a DMP/RMP.

The MRTI audio summing circuitry sums the same signals as the line and select audio summing circuits. The OUT MRTI AUDIO signal is the output for the MRTI audio summing circuitry and routed to the MRTI board.

If a Secure board is installed, CODED MOD AUDIO is routed to the final output stage via JU3 jumper.

If the station is a Trunked system, TKG MOD AUDIO is routed to the modulator via the JU5 jumper.

If the optional General Communications Controller (GCC) is installed, GCC DATA AUDIO is routed from the expansion bus to the input of the limiter (for 1200 baud) via the JU14 jumper setting or to the final output stage (for 4800 baud) via the JU6 jumper setting.

For data station configurations (using the Expansion Tray), TX DATA AUDIO is routed via the expansion bus to the input of the maximum deviation adjust circuit or to the final output stage via the JU4 jumper setting.

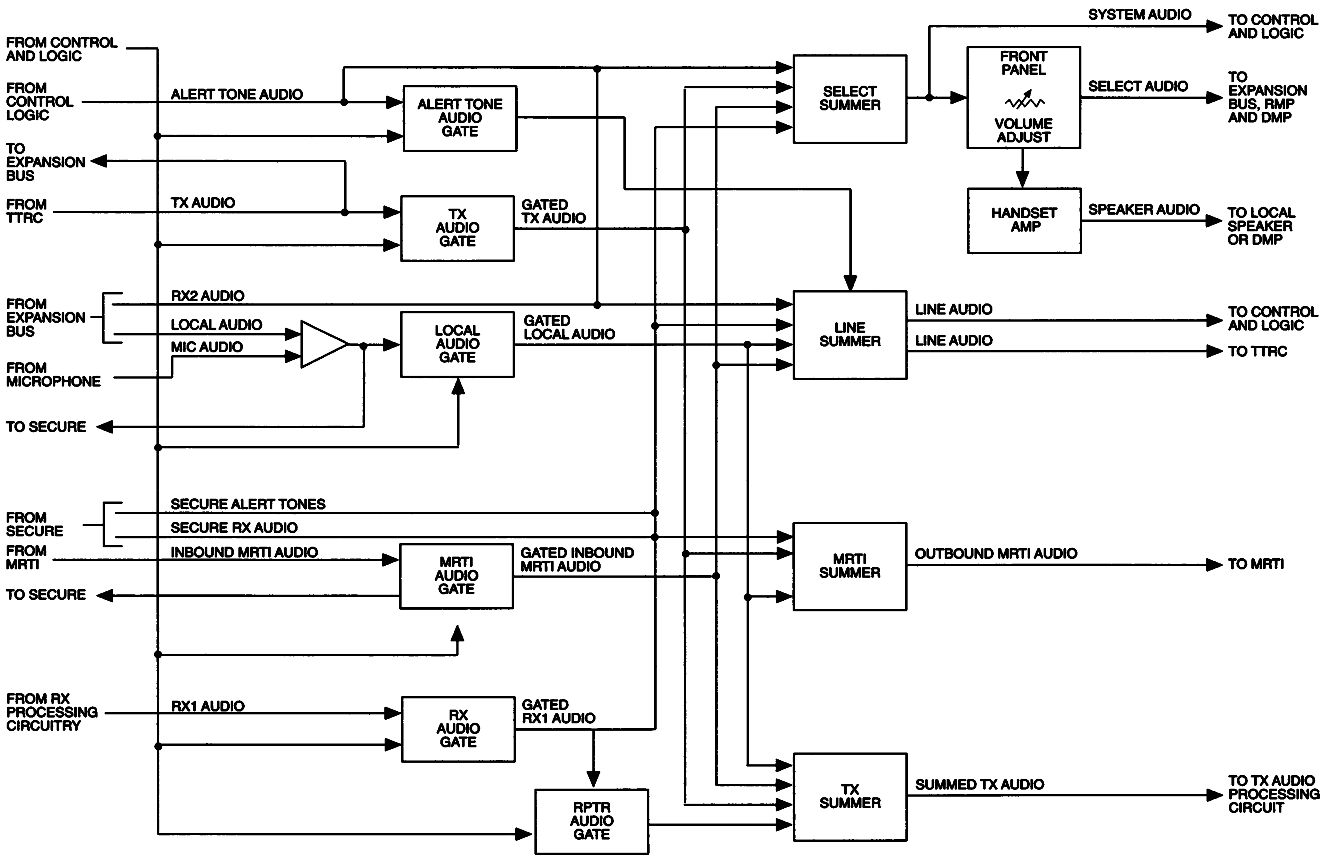

Figure 1-7 Audio Routing Circuitry

Squelch Circuitry

The squelch circuitry responds to the signal (noise level) strength of the incoming receive audio. The squelch detectors drive control lines to the control and logic circuitry, which are used in key-up and gating arbitration.

The QUAD AUDIO signal from the output of the QUAD 1 audio buffer is routed to a noise amplifier that boosts the noise content of the input signals above 5 kHz. The noise amplifier limits the audio signals to provide protection against audio signals squelching the receiver. The output of the noise amplifier drives both the receiver and the repeater squelch detectors. Refer to Figure 1-8 for a block diagram of the squelch circuitry.

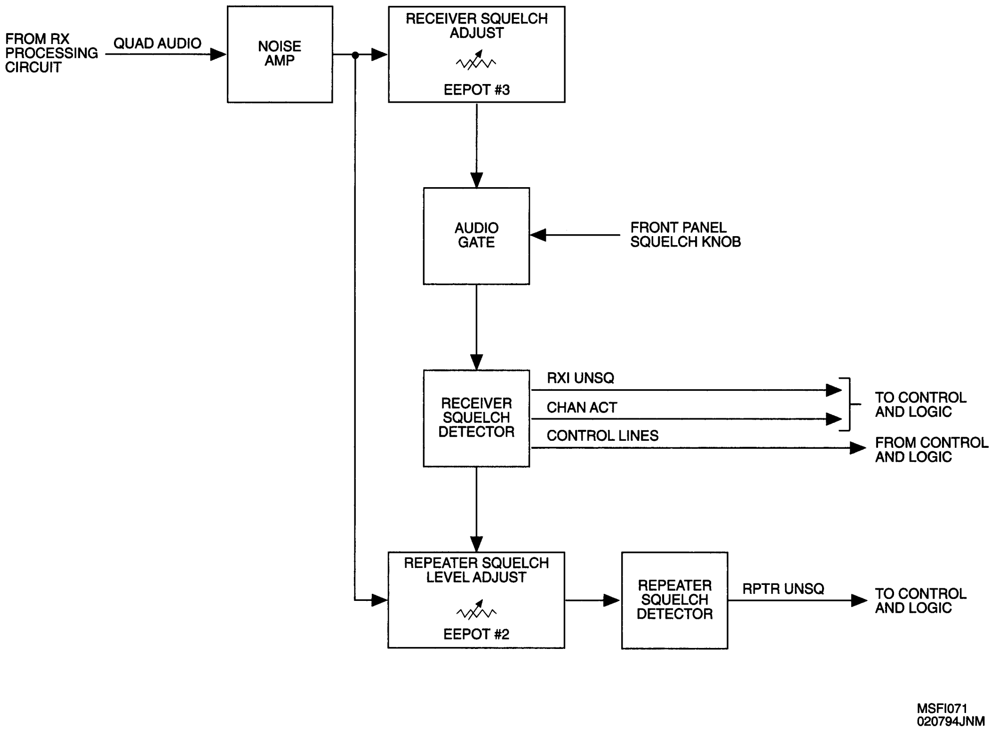

Figure 1-8 ***Squelch Circuitry***

Receiver/Repeater Squelch Circuitry

For the receiver squelch circuitry, EEPOT 3 (receiver squelch level adjust) is adjusted to gate the audio for processing. For the repeater squelch circuitry, EEPOT 2 (repeater squelch level adjust) is adjusted to activate the repeater PTT. The squelch knob on the front panel of the Control Tray adjusts the local speaker squelch only.

The squelch detector attenuates the audio signal and any generated harmonics. A noise detector produces an average DC voltage proportional to the received signal strength. A weak and noisy signal produces a low average DC voltage. A strong and quieted signal produces a higher average DC voltage.

The squelch switching circuit operates in two modes: slow or immediate squelch closing. A slow squelch closing occurs when a signal is received just above opening sensitivity. An immediate squelch closing occurs when a strong signal is received.

The receiver squelch circuitry produces two separate outputs: RX1 UNSQ and CHANNEL ACT. The repeater squelch circuitry produces the RPTR UNSQ signal. The signals are routed to the control and logic circuitry.

Trunked Tone Remote Control Boards (TTRC)

The Trunked Tone Remote Control (TTRC) is located in the Control Tray. The TTRC consists of a TTRC Audio board and a TTRC Logic board. The TTRC allows control of the *MSF 5000* from a remote location.

The TTRC is compatible with the SSCB, as well as the optional Secure board. It is also compatible with all expansion modules housed in the optional Expansion Tray attached to the top of the Control Tray.

Models Covered

The TTRC is divided into two separate sections, audio and logic. Each section is contained on a dedicated circuit board and collectively referred to as the TTRC board. The TTRC Audio board processes the TTRC audio and audio gates. The TTRC Logic board provides the logic and control functions.

The following TTRC kit numbers are covered in this section:

- ❒ TLN3112 - TTRC Audio board
- ❒ TRN7754 - TTRC Logic board
- ❒ The Logic board functions are described in the control and logic section.

Functions of TTRC

The major functions of the TTRC include:

- ❒ Tone Remote Control
- ❒ DC Remote Control
- ❒ Trunking Control
- ❒ Simulcast
- ❒ System Interface

Each function is described in the following paragraphs.

TTRC Functional Description

Tone Remote Control

The Tone Remote Control (TRC) allows control of an *MSF 5000* station from a remote location through the use of a non-DC continuous wireline. The transmit wireline can be configured as a 2-wire or a 4-wire system. The wireline inputs for the station are configured through the jumper settings on the TTRC Audio board. Refer to Appendix G - Jumper Settings for jumper information.

Station control is accomplished through a remote device that sends a High Level Guard Tone (HLGT) followed by a single Function Tone (FT) or two FTs (positive mode control). The FT(s) is interpreted by the TTRC board, which initiates the appropriate station function via the MUXbus, IPCB, and HSR.

Figure 1-9 shows the typical TRC signaling format. The format shown is a relative relationship between the various tones, actual levels may vary.

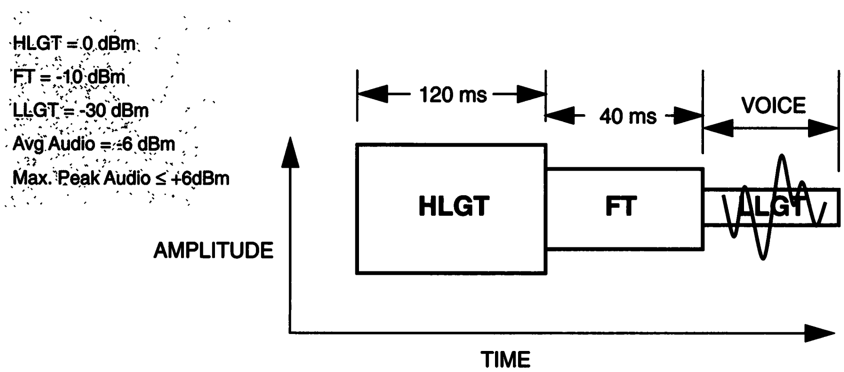

Figure 1-9 ***Typical TRC Remote Key-up***

The HLGT is sent as a wake-up signal to the station. This activates the tone detector which alerts the station that a FT(s) will be received. The level of the HLGT is approximately equal to the peak levels of the voice audio on the wireline.

The HLGT is followed by a FT, a tone that generally causes a specific action in the station. For example, the FT may cause a channel change, mode change, station key, etc. The level of the FT is 10 dB lower than the HLGT level. Refer to Table 1-5 for frequencies and uses.

During audio transmission, a Low-Level Guard Tone (LLGT) follows the FT(s). The transmitter is kept active until the LLGT is no longer detected. Voice audio is mixed on top of LLGT during transmission. The LLGT frequency is equal to the HLGT, but is 30 dB lower.

In a wireline PTT function, audio to be transmitted is summed with the LLGT signal. The LLGT is notched out at the station to prevent it from being transmitted. Average audio is typically 6 dB below the HLGT and max peak audio is typically no greater than 6 dB above the HLGT. The station remains keyed when the LLGT is present. Once the LLGT is no longer detected, the station dekeys.

Other FTs are available to perform various functions. These FTs are programmed via RSS. Table 1-5 provides a list of TRC tones and their defaults. The RSS can program any FT to any command. Refer to the RSS manual for additional information.

Table 1-5 ***TRC Tone Frequencies and Defaults***

Tone Frequency	Tone #	Default	Description
2175	F0	MORE	Reset function tone buffer and look for more functions.
2050	F1	MON	Monitor channel. Disables receiver PPL until next key.
1950	F2	CHN 1; KEY	Select channel 01, key transmitter until LLGT is removed.
1850	F3	CHN 2; KEY	Select channel 02, key transmitter until LLGT is removed.
1750	F4		
1650	F5		
1550	F6		
1450	F7		
1350	F8	CHN 3; KEY	Select channel 03, key transmitter until LLGT is removed.
1250	F9	CHN 4; KEY	Select channel 04, key transmitter until LLGT is removed.
1150	F10	MORE	Reset function tone buffer and look for more functions.
1050	F11	MORE	Reset function tone buffer and look for more functions.
950	F12		
850	F13		
750	F14		
650	F15		

DC Remote Control

DC remote control is a software-enabled option that allows control of an *MSF 5000* station from a remote location using a DC continuous wireline pair. This option may be used in place of the standard TRC. The major difference is that the TRC decoder is disabled and the DC current decoder is enabled. The DC remote control option is not compatible with any trunking or secure equipped stations.

The transmit wireline can be configured as a 2-wire or 4-wire system. The wireline inputs for DC remote control are configured through jumper settings on the TTRC Audio board. Refer to Appendix G - Jumper Settings.

Station control is accomplished via the remote device sending a continuous Direct Current (DC), known as the function signal. The function signal level is interpreted by the TTRC Logic board. In response to the function current, the TTRC board then initiates the station function via the MUXbus, Inter-Processor Communications Bus (IPCB), and High Speed Ring (HSR).

Six different direct currents provide six different uses. Table 1-6 provides a list of these currents and their uses.

Table 1-6 ***Standard DC Control Currents and Defaults***

Direct Current (mA)	ON/OFF	Default	Description
-12.5	Detect	CHN 4; KEYON	Select channel 4, key the station until the KEY OFF command is issued.
-12.5	Undetect	KEYOFF	Dekey the station that was keyed via the KEY ON command.
-5.5	Detect	CHN 3; KEYON	Select channel 3, key the station until the KEY OFF command is issued.
-5.5	Undetect	KEYOFF	Dekey the station that was keyed via the KEY ON command.
-2.5	Detect		
-2.5	Undetect		
+2.5	Detect		
+2.5	Undetect		
+5.5	Detect	CHN 1; KEYON	Select channel 1, key the station until the KEY OFF command is issued.
+5.5	Undetect	KEYOFF	Dekey the station that was keyed via the KEY ON command.
+12.5	Detect	CHN 2; KEYON	Select channel 2, key the station until the KEY OFF command is issued.
+12.5	Undetect	KEYOFF	Dekey the station that was keyed via the KEY ON command.

Trunking Control

The trunking control sets up a communications link between the Trunking Central Controller and a trunked station. The trunking interface connection incorporates inbound transmit audio, outbound receiver audio, and digital control signals. The interface connection originates on the TTRC Logic board via the Junction Box of the station. The Junction Box allows the station to connect to the Trunking Central Controller. Refer to the System Interface section for connector pin-outs.

The Trunking Central Controller determines the state of a trunking system by verifying the control handshaking between the station and Trunking Central Controller. The handshaking signal from the Trunking Central Controller to a trunked station is the TDATA signal. The handshaking signal to the Trunking Central Controller from a trunked station is the TSTAT signal.

Depending on the state of the system, one of three functions are performed: voice channel, control channel, or failsoft. When handshaking between the station and the Trunking Central Controller is functioning properly and station diagnostics are not signifying a problem, the voice channel or control channel are available modes. If handshaking is interrupted (broken or bad connection, malfunctioning Trunking Central Controller, etc.), the station enters failsoft mode.

If the station enters failsoft mode, a codeword and an audible tone are transmitted over the air from the SSCB. This causes the subscriber units to automatically revert to preassigned failsoft channels and begin conventional repeater operation. If the station is in failsoft mode and proper central controller to station handshaking resumes, the station resumes normal trunking operation based on the Trunking Central Controller.

System Interface

The TTRC board allows the *MSF 5000* to interface in a large number of systems. The station interfaces include a trunking connector (J2901), a systems connector (J2900), and a wireline interface. The connectors and wireline interface are externally accessed through the Junction Box. Refer to Figure 1-10 for connector pinouts.

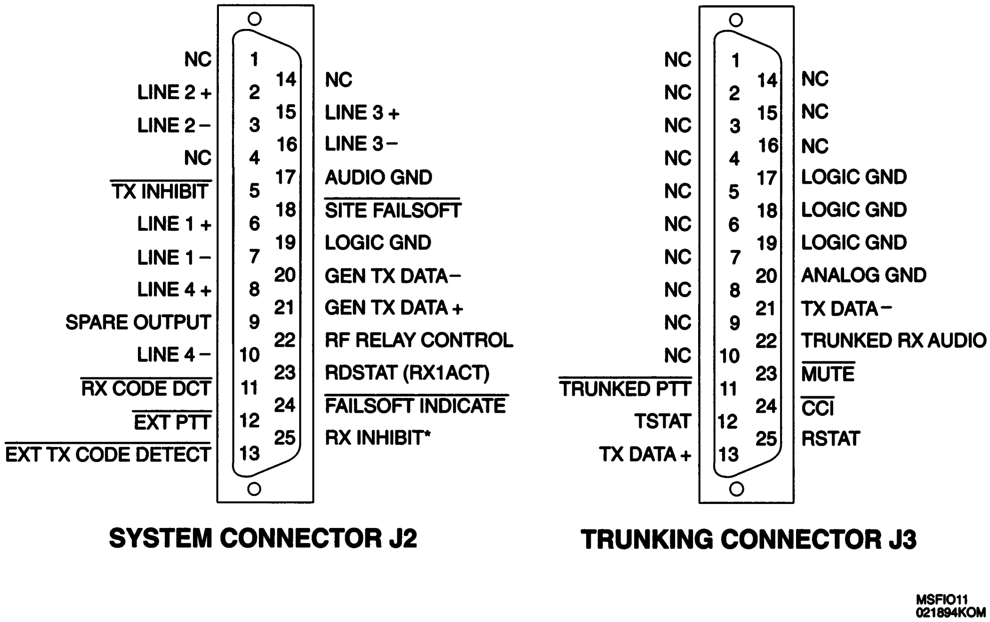

Figure 1-10 ***System Interface Connectors***

TTRC Audio Board

Functions of TTRC Audio Board

The major functions of the TTRC Audio board include:

- ❒ Transmit Audio
- ❒ TRC Decode Audio
- ❒ DC Remote Current Detection
- ❒ Receive Audio
- ❒ Trunking Modulation and Receive Audio
- ❒ Simulcast Modulation Audio

Each is described in the following paragraphs.

Transmit Audio

The transmit audio section transfers wireline audio originating at a console or other remote device to the SSCB for transmission. Figure 1-11 shows a block diagram of the transmit audio circuitry.

NOTE

Secure operation is not compatible in 900 MHz Analog Plus stations.

The transmit audio is input to the SSCB though two paths. Path l is RAW TX AUDIO sent to the Secure board via the SSCB for transparent coded transmissions. Path 2 is TX AUDIO for clear transmissions. If the Secure board is installed, TX AUDIO is also routed to it via the SSCB for transparent encrypted coded transmissions. Transmit audio is input to the station via a wireline interface.

Wireline Interface

The wireline interface network connects the TTRC board to external wirelines. The wireline is connected to the station via the Junction Box. Two six-conductor telco cables provide the connection between the Junction Box and TTRC board. Jumpers must be correctly set for proper operation of the station. Refer to Table 1-7.

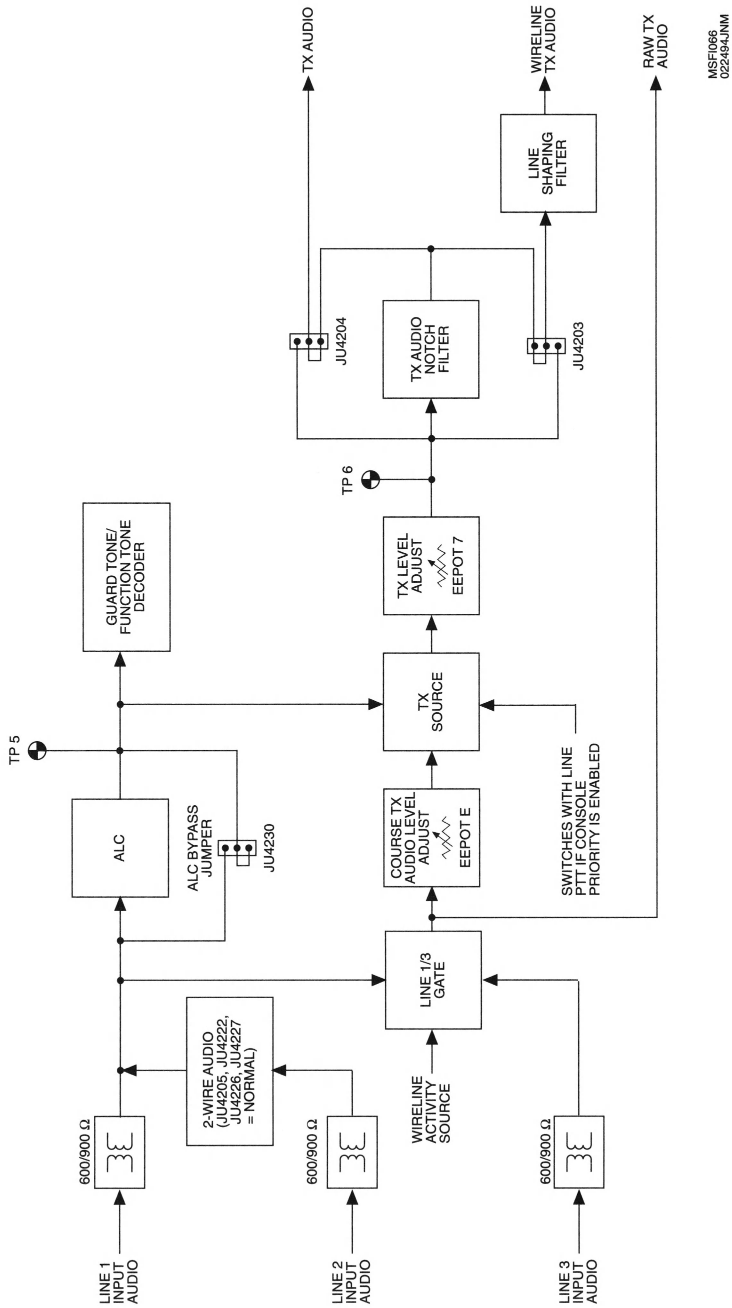

Figure 1-11 ***Transmit Audio Circuitry***

TX Level Adjust

Wireline audio can take two separate paths before being sent as TX AUDIO to the SSCB for transmission. Line 1 or Line 2 input audio (depending on wireline configuration) is either sent to the Automatic Level Control (ALC) circuit or to the

Table 1-7 ***Wireline Configuration***

2-Wire Operation	4-Wire Operation	Receive Audio	Transmit Audio	Line
X		X		2 +/-
X			X	2 +/-
	X	X		2 +/-
	X		X	1 +/-
	X	X		4 +/-
	X		X	3 +/-
NOTE: For proper jumper configuration, refer to Appendix G - Jumper Settings.				

Non-ALC path with the course level adjust circuit. Line 3 input audio is always sent directly to the Non-ALC path with the course level adjust circuit. The system configuration and RSS programming determine whether the inputs are sent to the ALC or Non-ALC path with the course level adjust circuit.

The course level adjust circuit is a microprocessor-controlled gain stage consisting of analog switches and an inverting amplifier. The gain of this amplifier stage is determined by the combination of the two logic lines sent from EEPOT E on the TTRC Audio board.

The ALC circuit consists of two gain adjust stages. The maximum gain of the first stage results in approximately 13.5 dB. The TTRC Logic board adjusts the gain of this stage. The lowest gain of this stage is -32 dB.

The audio signal is then routed to an inverting amplifier where it is amplified by a constant level of 27 dB. The output (TP5) drives the tone processing circuitry and is a source for the TX audio fine level adjust circuit.

The TX audio level adjust stage follows the ALC/Non-ALC transmit source gate. The transmit source gate consists of an inverting amplifier and EEPOT 7 (TX level adjust). Depending on the setting of EEPOT 7, the gain of this stage can vary from -13 dB to -2 dB (ALC) or -11 dB to 10 dB (course adjust). The nominal audio level expected at the output of the level adjust circuit at TP6 is approximately 315 mV rms.

When both paths are used (Non-ALC/ALC) in a console priority configured system, EEPOT 7 stores two values. One value is for the ALC path; the other for the Non-ALC path. Therefore, EEPOT 7 must be adjusted twice, once while the ALC path is active, and once while the Non-ALC path is active.

Activity Detector

The main function of the activity detector is to support LLGT detection. The input to the activity detector is ALC audio (TP5) which first passes through a bandpass filter. The bandpass filter is followed by a comparator combination. If the signal entering the activity detector is greater than or equal to -15 dBm at approximately 1900 Hz, the ALC output is considered activity by the circuit. This voltage level is read by the microprocessor on the TTRC Logic board to detect the presence of the LLGT audio activity.

Transmit Notch Filter

Audio from the TX audio level adjust circuit is also sent to the transmit notch filter hybrid. Only one of the two filters on the hybrid is being used in the transmit audio path, the second filter is in the receive audio path. This filter notches out the Guard Tone (GT) frequency area of the voice spectrum before it is transmitted.

The transmit notch filter may be removed from the transmit audio path for special applications, such as simulcast, by placing JU4204 for transmit audio and JU4203 for wireline transmit audio in the alternate position. For other applications, transmit audio can be summed into inverting amplifier (Line 2 Sum or Line 4 Sum) via the transmit notch filter and a line shaping filter.

Jumpers JU4228 (Line 2 output level), and JU4229 (Line 4 output level) are used to center EEPOT C and D around 0 or -10 dBm depending on their position. The notch filter can also be removed from this path by placing JU4203 in the alternate position.

TRC Decode Audio

The TRC decode audio is directed to the ALC circuit. The output of the ALC circuit is sent to the tone processing circuit, the interface for tone decoding between the analog decode audio section and the microprocessor. The TRC decode audio circuit is responsible for bandpass filtering and limiting the audio signal before passing it to the microprocessor on the TTRC Logic board for tone detection. Figure 1-12 shows a block diagram of the TRC decode audio circuitry.

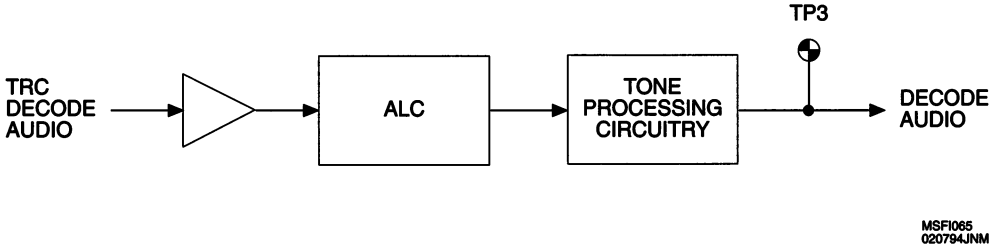

Figure 1-12 ***TRC Decode Audio Circuitry***

ALC Control Description

> **NOTE**
>
> To bypass the ALC control circuit, place jumper JU4230 in the alternate position. This requires a fixed level of the HLGT at -12.5 ±2.5 dBm for proper operation.

The ALC circuit is controlled by the microprocessor during tone detection and execution of wireline commands. The ALC adjusts the level of audio to meet the initial HLGT input level.

Tone Processing Section

The ALC audio from TP5 enters the tone processing section and is bandpass filtered at the guard tone frequency of 2175 Hz.

After the HLGT detection, the bandpass filter is bypassed to allow detection of function tones which usually are in the range of 650 Hz to 2050 Hz. Detection is accomplished in the microprocessor on the TTRC Logic board. A bandpass filter/limiter attenuates signals outside of the software detector range, and transforms the tone signals into digital signals.

The output (TP3 on the TTRC Audio board) is a square wave which is sent into the microprocessor for analysis.

DC Remote Current Detection

The function currents sent from a remote device down the wireline are converted to DC voltage levels by two optical isolators and their associated circuitry. One detects positive line currents; the other detects negative line currents. Both provide electrical isolation between the wireline and other circuitry on the TTRC Audio board to protect the circuits against lightning or high voltage surges. Figure 1-13 shows a block diagram of the DC remote control circuitry.

Receive Audio

The Receive Audio circuitry is responsible for transferring LINE AUDIO from the SSCB to the wireline on Line 2 or Line 4. The circuitry consists of a receive notch filter, summing and level adjust circuits, a Spectra-TAC™ equalizer filter, line drivers, and wireline interfaces. Figure 1-14 shows a block diagram of the receive audio circuitry.

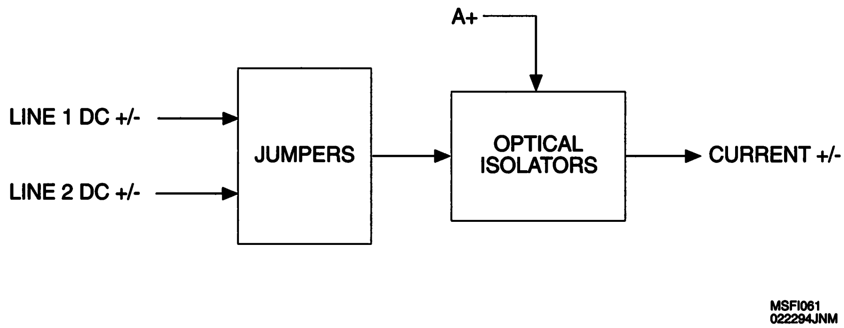

Figure 1-13 ***DC Remote Control Circuitry***

Receive Notch Filter

LINE AUDIO from the SSCB enters the TTRC board at a nominal level of 325 mV rms.

The notch filter output is routed through a line shaping filter before going to the Line 2 or Line 4 summing amps. This line shaping filter is identical to that described in the transmit audio circuitry.

In secure systems, the receive notch filter and line shaping filter should be bypassed. This is automatically accomplished by a transmission gate controlled via the RSS codeplug parameters for the TTRC Logic board.

Summer/line Adjust

Notched or un-notched receive audio from the transmission gate is sent to the summing amp for Line 2 or Line 4 audio. These stages also sum the tones generated by the TTRC Logic board.

For Line 2, the output audio signal is sent over two paths. Path 1 is directed to the audio gate; path 2 is routed through a Spectra-TAC™ equalizer filter.

Spectra-TAC™ Equalizer Filter

This path is activated with a RSS programmable field and when the station is configured and programmed as a Spectra-TAC™ system. Two EEPOTs equalize the high and low end line levels compensating for phone line loss.

Line Driver and Cancellation Circuit

The Line 2 wireline line driver uses two operational amplifiers to drive a push-pull arrangement.

The cancellation circuit is used in only 2-wire systems, when both incoming and outgoing wireline audio is on Line 2. This circuit can be disabled by moving JU4205 and JU4222 to their alternate position for a 4-wire system.

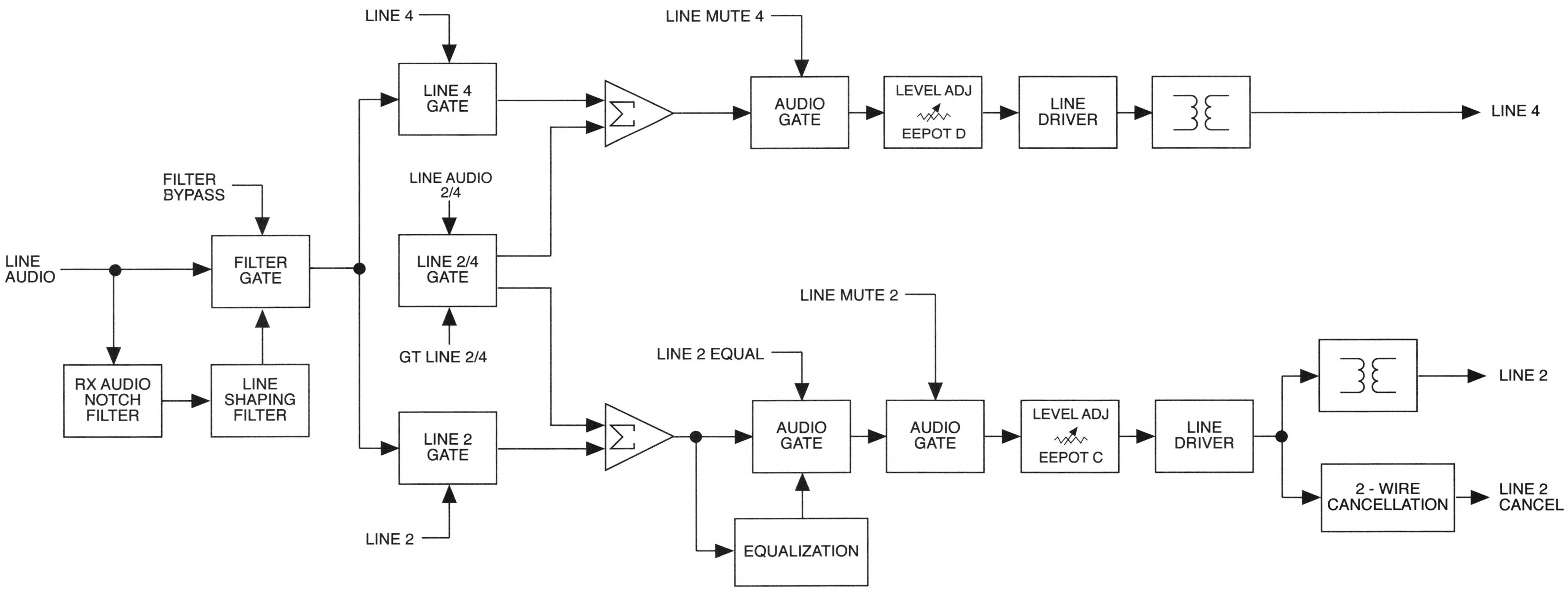

Figure 1-14 **Receive Audio Circuitry**

Trunking Modulation and Receive Audio

Trunking modulation audio (TKG MOD AUDIO) sent to the SSCB for transmission is sourced from two separate paths. Path 1 is from the trunking central controller via TX DATA (+) and TX DATA (-). Figure 1-15 shows a block diagram of the trunking modulation and receive audio circuitry.

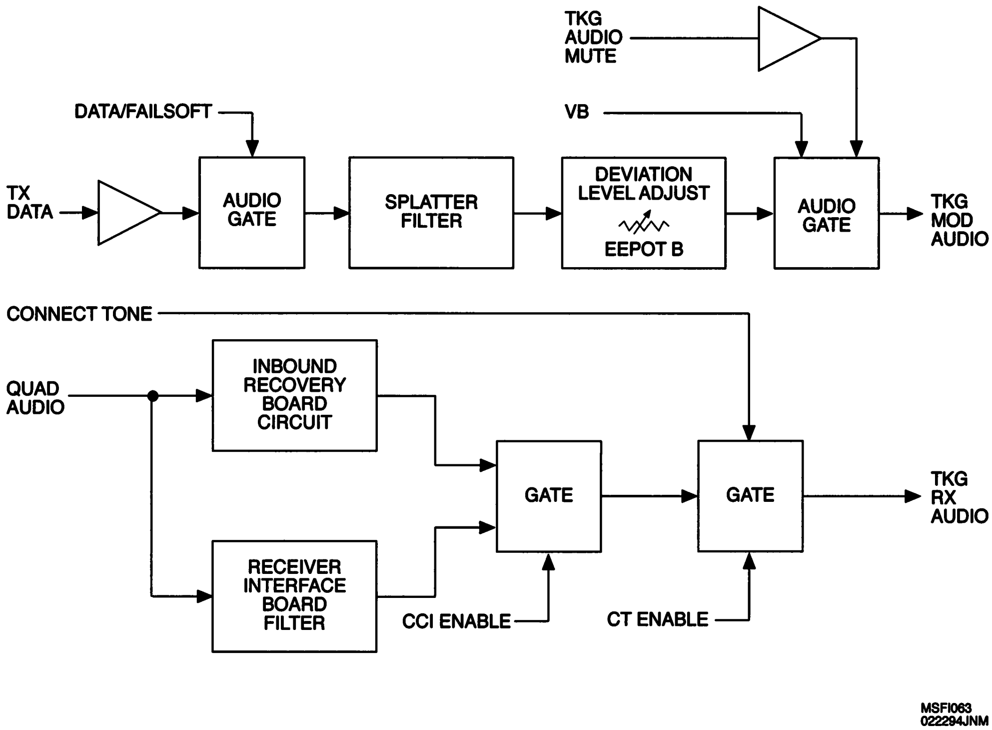

Figure 1-15 **Trunking Modulation and Receive Audio Circuitry**

Path 2 is trunking receive audio (TKG RX AUDIO) that is sourced from two separate paths, both of which originate on the SSCB. Path 1 is receive audio (QUAD AUDIO) and path 2 is connect tone (CONNECT TONE) audio. Connect tone audio is used only in coded trunked systems during a receive code detect.

Simulcast Modulation Audio

Simulcast transfers audio or data originating at a Remote Delay Module (RDM) or Wide Band Modem (WBM) to the SSCB for transmission. Figure 1-16 shows a block diagram of the simulcast modulation audio circuitry.

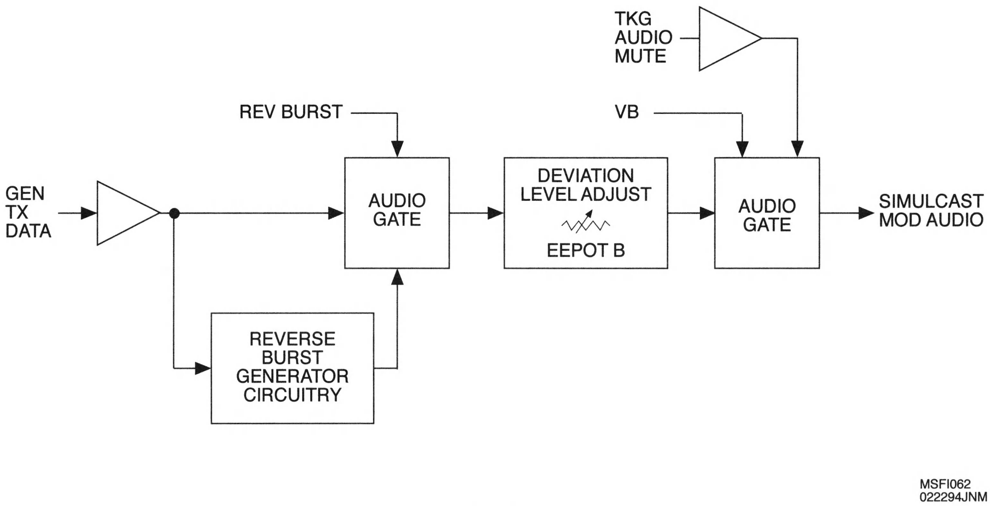

Figure 1-16 **Simulcast Modulation Audio Circuitry**

Differential Amplifier

Simulcast modulation audio enters the TTRC Logic board connector J2900 and is passed to the TTRC Audio board at connector J2904 as GEN TX DATA (+ /-) (600 Ω load). GEN TX DATA (+ /-) is then superimposed on VB by a differential amplifier. Audio or data leaving the differential amplifier is directed down two paths, one of which is selected by an audio gate. Path 1 goes directly to the audio gate; path 2 goes through a reverse burst generator circuit. Signals leaving the audio gate are sent to the data deviation adjust stage.

Reverse Burst Generator

Reverse burst is phase shifting of the PL tone signal upon termination of a line PTT in a PL distribution simulcast station. The reverse burst generator consists of a differential amplifier and associated circuitry.

Data Deviation Adjust Stage

Audio leaving the simulcast audio gate is routed to the same deviation level adjust stage described in the trunking modulation audio section. The level adjust stage consists of an inverting amplifier and EEPOT b (trunking data level). Audio leaving the inverting amplifier is sent to trunking data level audio gate. This gate acts as a switch between simulcast modulation audio and VB. Simulcast modulation audio only passes through the gate if TKG AUDIO MUTE is in a logic low state.

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Secure Board

The optional Secure board (option C514) is located in the Control Tray and provides secure capability to the station. The Secure board is compatible with the SSCB. The secure capability is software controlled and not available for 900 MHz.

This section describes the operation of the Secure board. The following Secure board kit numbers are covered in this section:

- TLN3045 - Secure board (encode/decode operation)
- TLN3267 - Secure board (transparent only operation)

The Secure board mounts to the SSCB as a stand-off daughter board. Refer to Figure 1-17. The Secure board option is enabled from jumpers on the SSCB and RSS programming.

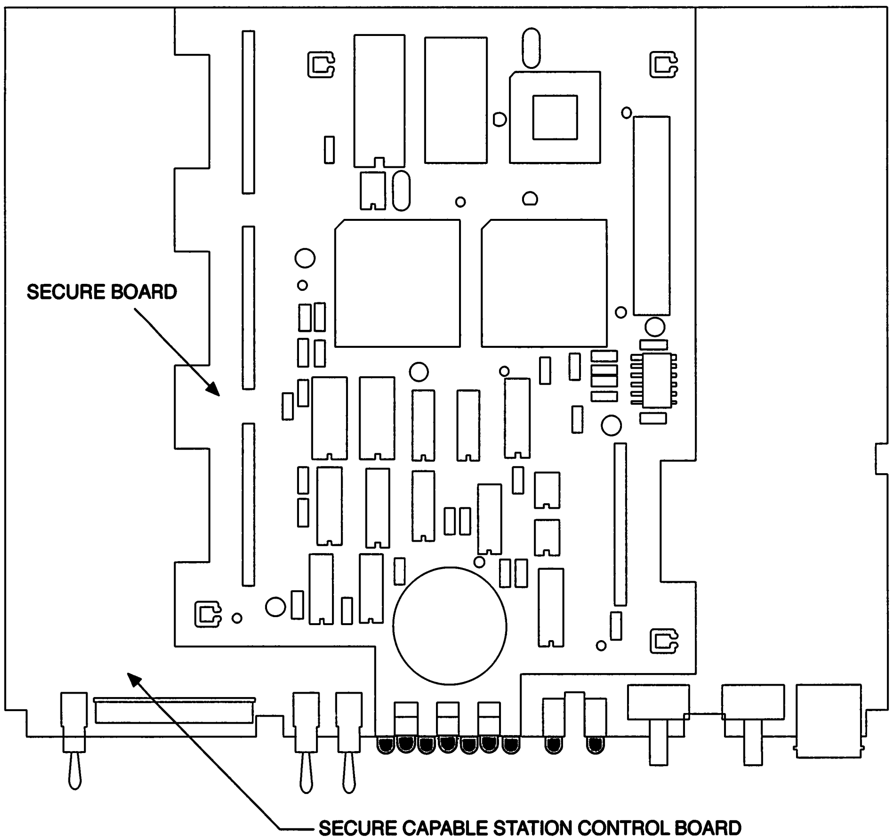


Figure 1-17 **Secure Board Location and Mounting**

Secure Board

The Secure board offers several encryption options. These options are available through the use of various hybrids. Refer to the Secure Hybrids section for additional information on secure encryption options.

The Secure board operates in one of two programmable modes of operation. The first mode of operation is the transparent mode where secure code is detected and passed directly through the station. The Secure board monitors the receiver and wireline signals until valid secure code (12 kB/Sec data) is detected. In response, the Secure board generates a receive or transmit code detect.

During a code detect, audio paths on the SSCB are switched so the secure data is routed through the Secure board for re-clocking, buffering, and filtering before being transmitted and/or sent out via the wireline. A Console Interface Unit (CIU) can be interfaced to the station via the wireline to provide the encrypt/decrypt capability.

The second mode of operation is the encrypt/decrypt mode. The encryption/decryption method is determined by the secure hybrid option used. The Secure board provides encryption and decryption of audio signals in half or full-duplex. During transmission, audio is A/D converted into a 12 kB/Sec digital bit stream and encrypted. The resultant bit stream is splatter filtered and transmitted.

During reception, the signal is decoded through a reverse process. The received encrypted signal is filtered, limited, and re-clocked to produce a digital data bit stream. The bit stream is decrypted to produce a digital signal. The digital signal is D/A converted into audio. The Full-duplex Wireline option (C332), in conjunction with one of the secure hybrid options, allows simultaneous encrypt and decrypt operation.

The encryption/decryption process is performed by one of several different hybrids, as specified by the desired encryption algorithm. Each hybrid is loaded with a different key variable to make it different from any other hybrid. The loading process requires a Key Variable Loader (KVL) that interfaces to the Secure board through the use of two cables.

NOTE

The DVP™ is capable of handling four keys maximum in half or full-duplex mode. In half/full-duplex modes, a hybrid is required for encode/decode operation.

The internal secure interface cable (TKN8597) connects between the Secure board (J4001) and the Junction Box. The external KVL cable (TKN8531) connects between the KVL and the station. When the board is in half-duplex operation, up to eight hybrids with different key variables can be selected to perform the encrypt/decrypt function. In full-duplex operation, the hybrids are combined in pairs to provide up to four different encryption/decryption keys.

Functions of Secure Board

The major functions and circuits of the Secure board include:

- Transmit Audio Circuitry
- Receive Audio Circuitry
- Secure Hybrids
- Key Variable Loader Interface
- Control and Logic Circuitry - described in the SSCB Control and Logic section
- Software Diagnostics
- Internal Digital Diagnostics
- External Digital Diagnostics
- Audio Diagnostics
- Secure Module Enabling

Each function and circuit is described in the following paragraphs.

Secure Board Functional Description

Transmit Audio Circuitry

The Transmit Audio circuitry is divided into two sections which provide two different modes of operation:

- Transparent operation
- Transmit audio encryption

Figure 1-18 shows a block diagram of the transmit audio circuitry.

Transparent Operation

The input to the transmit audio circuitry is via the SSCB. The input signal (RAW TX AUDIO) consists of audio or filtered data. The RAW TX AUDIO signal is routed through a noise filter which band-limits the line data. This removes high frequency noise components from the transmission channel that could cause spurious code detections.

The RAW TX AUDIO is then limited by a comparator to transform the signal into discrete logic level data. A single pole low-pass filter determines the average DC value of the input signal and provides a bias to set the comparator threshold.

The RAW TX AUDIO is also checked for a Beginning-Of-Message (BOM) or an End-Of-Message (EOM) bit stream, consisting of alternating one-zero patterns which are used to signal the beginning or end of encrypted messages. Whenever a valid 12 kBit/Sec transmit code, BOM, or EOM is detected, the SSCB front panel Tx CD LED lights.

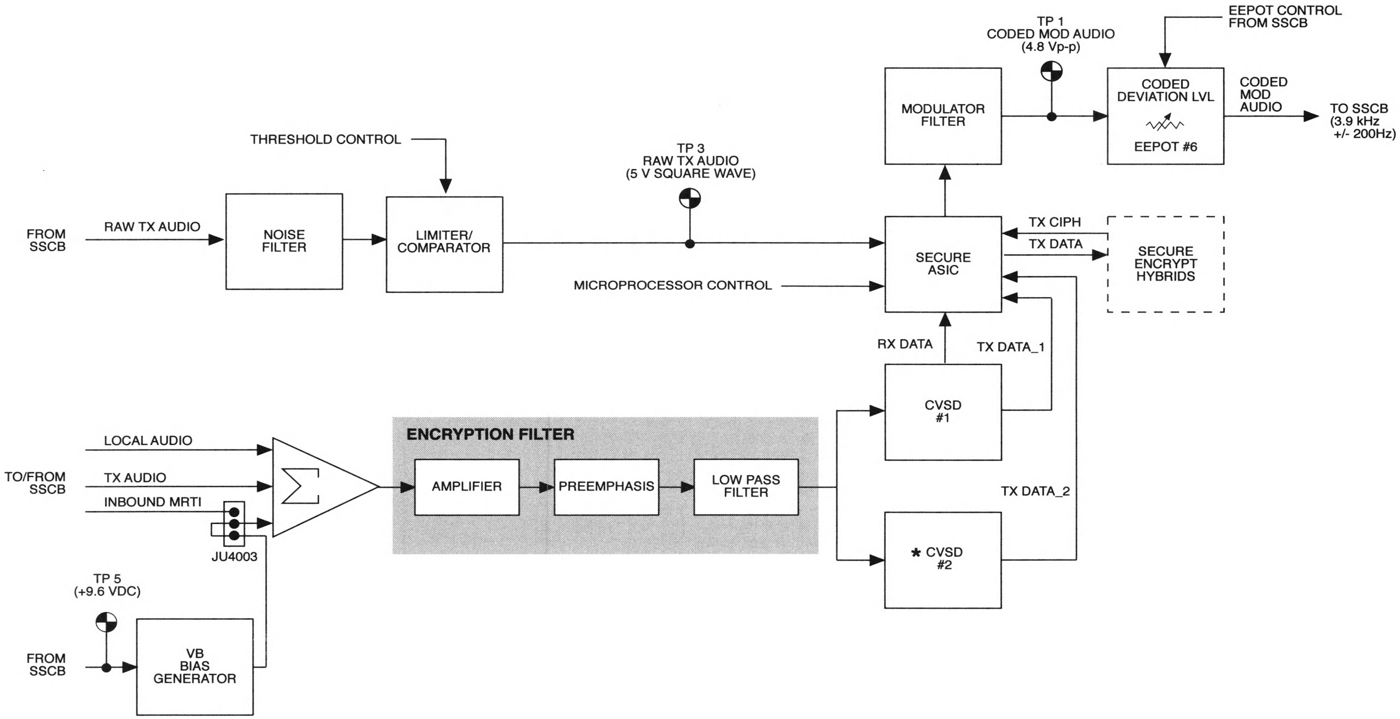
The RAW TX AUDIO is continually reclocked, buffered, and converted by the on-chip circuitry of the secure ASIC. Once valid code is detected, the serial transmit data at the output of the secure ASIC is sent to the low-pass splatter filter.

The splatter filter band-limits the data to 6 kHz, eliminating the higher frequency noise which could otherwise cause interference on adjacent channels.

In addition, a filter attenuates high frequency components above 50 kHz. This circuit also limits the peak-to-peak voltage of the data signal. A low pass filter element is used to filter out switching noise at the output and change the DC bias of the signal.

The output level of the splatter filter is adjusted via EEPOT 6 (coded deviation level). The Secure board EEPOTs are controlled by the Control Tray front panel.

The CODED MOD AUDIO output of the Secure board is sent to the SSCB to be routed to the modulator. During alignment, an internal 1 kHz square-wave generator sets the coded deviation level.



NOTE: * CVSD #2 is not present in half-duplex operation.
CVSD #2 is required for DVP half duplex.

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Figure 1-18 **Transmit Audio Circuitry**

Audio Encryption Operation

Audio to be encrypted and transmitted can originate from the TX AUDIO, LOCAL AUDIO, or INBOUND MRTI inputs to the Secure board. The selected audio source is amplified, pre-emphasize, low-pass filtered, and routed to the Continuously Varying Slope Delta (CVSD) devices to be digitized. When jumper JU4003 is in its alternate position, INBOUND MRTI audio is always summed with the selected encryption audio source. Refer to Appendix G - Jumper Settings for additional information.

Depending on the system and the type of encryption hybrids used, a secure coded message may be preceded by a BOM bit stream and/or followed by an EOM bit stream. The EOM and BOM bit streams consist of a variable length alternating 12 kHz bit pattern (i.e. 101010....) which is generated by the Secure board software.

Receive Audio Circuitry

Receive audio circuitry is divided into two sections providing two different modes of operation:

- Transparent operation
- Receive audio decryption

Figure 1-19 shows a block diagram of the receive audio circuitry.

Transparent Operation

The input to the receive audio circuitry is from the wireline (P803-27). The input signal (QUAD AUDIO) consists of the demodulated signal from the receiver. This signal has been buffered by the SSCB and routed to the Secure board equalizer filter.

For special applications, the equalizer filter can be bypassed by placing jumper JU4004 in its alternate setting. Refer to Appendix G - Jumper Settings for additional information.

The filtered signal is digitized by a comparator to translate the signal into discrete logic level data. An Rx Code Detect test is performed on the data stream. Whenever a valid 12 kBit/Sec code, BOM, or EOM is detected, the SSCB front panel Rx CD LED lights.

The on-chip circuitry of the secure ASIC can route the reclocked and buffered received data to the transmit splatter filter, and/or to the wireline, depending on the station type. In a conventional base station, the received data is routed to the secure ASIC, where the data is pulled up, attenuated, and filtered by a low-pass filter. This filter band-limits the signal to 6 kHz for the wireline. When the wireline is in close proximity to other conductors, eliminating the higher frequencies with this filter reduces the potential for crosstalk.

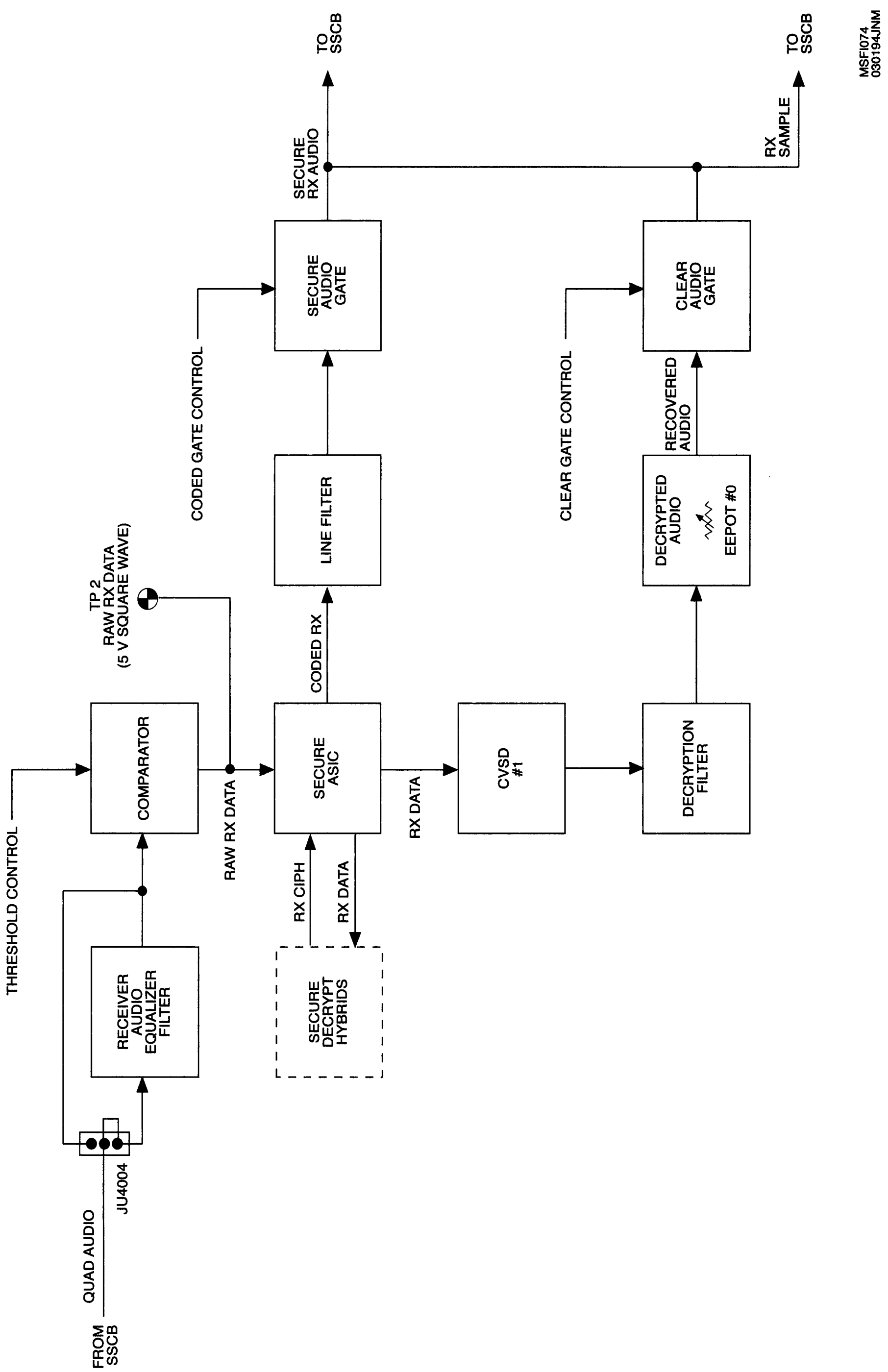


Figure 1-19 **Receive Audio Circuitry**

The output of this filter is sent to the SSCB, where it is summed with other signals to be sent down the wireline. If the station is configured as a transparent repeater, the reclocked received data is routed to the transmit path as well as to the wireline.

Receive Audio Decryption Operation

Audio for decryption originates at the station receiver and enters the Secure board at the QUAD AUDIO input. This signal is re-clocked, buffered, and routed to secure hybrids for decryption. The recovered clock is supplied to the rest of the circuitry processing the signal. Any secure hybrid operating in the receive mode attempts to decrypt the received signal.

In half-duplex operation, any one of eight secure hybrids can be selected for decryption. In full-duplex operation, only four secure hybrids can be selected for decryption. Refer to Table 1-8.

Table 1-8 **Local Control Key/Hybrid Selection**

Front Panel Status Display	Half-Duplex Operation	Full Duplex Operation or DVP Operation (half-duplex)	
Key Digit	**Encrypt & Decrypt**	**Encrypt**	**Decrypt**
1	HY4001A	HY4001A	HY4001B
2	HY4002A	HY4002A	HY4002B
3	HY4003A	HY4003A	HY4003B
4	HY4004A	HY4004A	HY4004B
5	HY4001B	-	-
6	HY4002B	-	-
7	HY4003B	-	-
8	HY4004B	-	-

The RX DATA signal, DECRYPT AUDIO, is sent to a D/A converter, reproduce the original audio signal. The D/A conversion is performed for half and full-duplex operations. The proper code detect function is also performed. This function indicates if the coded transmission being received used the same encryption key as stored in the Secure board encryption hybrid.

The recovered audio output is routed through an active bandpass filter to improve audio quality and remove out-of-band noise. This signal may be amplified or attenuated +/- 10 dB by adjusting the gain stage with EEPOT No. 0 on the front panel Status display. Normally, the level of the decrypted audio should be set 4 dB higher than clear audio. Finally, the signal is gated and sent to the SSCB where it is summed with other signals to be sent down the wireline.

Secure Hybrids

Secure Hybrid Operation

In the encrypt/decrypt mode of operation, the Secure board supports up to eight hybrids. A single hybrid can operate in the encrypt (transmit) or decrypt (receive) mode, but not in both modes at the same time. Control signals configure the hybrids to either encrypt or decrypt. Figure 1-20 shows a block diagram of the hybrids and how they interact with the Secure board.

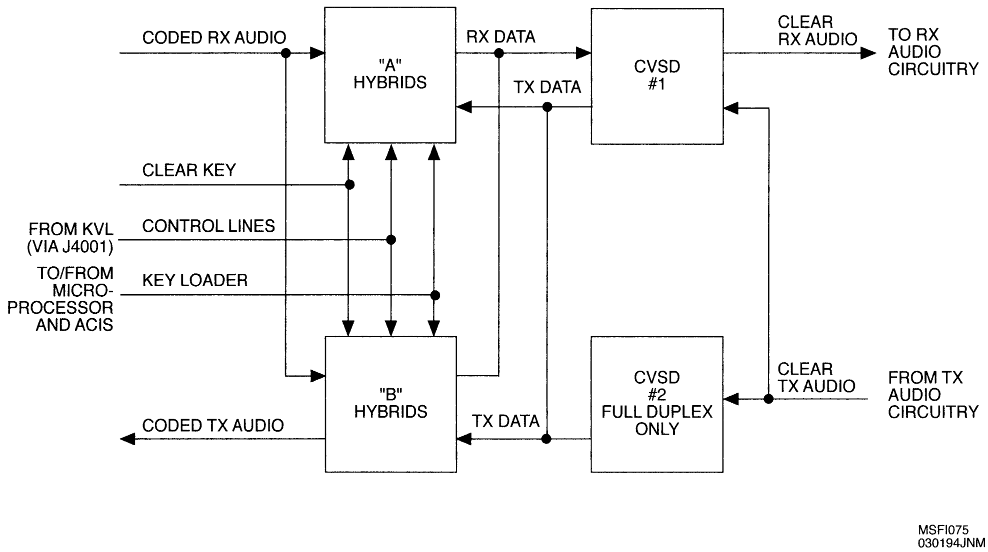


Figure 1-20 **Secure Hybrid**

During full-duplex or *DVP* half-duplex operation, the "A" hybrids are configured to encrypt. These hybrids are located in the upper half of the hybrid sockets. The lower portions of the sockets contain the "B" hybrids, which share common control lines and operate independently from the "A" hybrids. The "B" hybrids are configured to decrypt during full-duplex or *DVP* half-duplex operation.

The current hybrid selection is displayed in the Key digit on the Status display. Hybrid selection is accomplished through software control, based on information provided by the HSR signal. The hybrid selection originates with user definable function tones on the station wireline; or locally, via the Control Tray front panel Select/Set switch, when the station is in access disable.

The current hybrid selection is displayed on the Key digit of the SSCB front panel Status display. The key selection is used to select the hybrids shown in Table 1-9. Refer to the Key Variable Loader Interface section for key insertion and loading information.

Table 1-9 **Hybrids**

Option	Description	Field Mod Kit No.	Use	Quantity
C331	Secure Encryption		Full duplex Half-duplex	
C388	DES Encryption	TRN9843	Full duplex Half-duplex	1 2
C794	*DVP* Encryption	TRN6777	Full duplex Half-duplex	2 2
C795	DES-XL Encryption	TRN7036	Full duplex Half-duplex	1 2
C797	DVP-XL™ Encryption	TRN7038	Full duplex Half-duplex	1 2

Alert Tones

Six types of codeplug selectable (field programmable) alert tone sequences can be generated by the Secure board to signal various conditions in an encrypt/decrypt station. Normally, all six types are enabled at the factory. All tones have a frequency of 750 Hz, but are of varying duration. These tones are gated to the wireline and local speaker, but not over the air. The six types of alert tones are:

- CLEAR XMIT - If enabled, a single 87 ms beep is encoded at the start of any clear line or local PTT. This serves as a warning to the operator that transmission is not secure.
- CLEAR RECEIVE - If enabled, a single 87 ms beep is encoded at the start of any clear receive activity. This serves to notify the console operator that transmission is in the clear mode.
- CROSS-MODE - If enabled, a single 87 ms beep is encoded at the start of any clear receive activity ONLY if the wireline mode is coded.
- KEY RESET ALERT - If enabled, the 750 Hz tone is encoded as long as the key erase signal is active.
- XMIT KEY FAIL - If enabled, the 750 Hz tone is encoded with an 87 ms on and an 87 ms off duty cycle, if a coded Line/Local PTT occurs and the selected hybrid has a corrupted/erased key. This tone sequence is only generated while the PTT is active, and the key is lost.

NOTE

A secure hybrid indicates a corrupted key by pulling its KEY line low whenever the PTT and transmit (encrypt) states are active. The secure ASIC monitors the KEY lines to check for corrupted and/or erased keys among the hybrids. The C794 *DVP* secure hybrid option does not provide this key fail indication.

- RCV KEY FAIL: If enabled, the 750 Hz tone is encoded with an 87 ms on and an 87 ms off duty cycle, if coded receive activity occurs when the receive decryption hybrid has lost its key. The tone sequence is generated as long as these two conditions exist.

Key Variable Loader Interface

Key Insertion

The Key Variable Loader (KVL) is an external optional device to transfer encryption keys from its own memory into other SECURENET equipment containing secure hybrids. A KVL is only compatible with hybrids of the same type, as specified on the back of the KVL unit.

The station internal Secure Interface cable connects between the Secure board connector J4001 to the Junction Box. The station external KVL cable connects between the KVL and the Junction Box.

NOTE

When a KVL is connected to the station, the station is placed in access disable mode.

Refer to Chapter 2 - Operation for the procedure to load encryption keys.

A synchronized clock signal (the KVL clock synchronization signal) is generated by the secure ASIC and phase-locked to the Key Insertion Device signal. After all keys have been loaded, the KVL connector must be disconnected to take the station out of access disable mode. A successful key transfer is indicated in the KVL display for all hybrid types, with the exception of option *DVP* Hybrid.

Key Variable Battery Backup

A key variable battery backup is provided with all secure hybrid options to allow the hybrids to retain their encryption/decryption keys in case of power loss. If the +5 Vdc supply drops out, the Vcs supply to the hybrids must be maintained above +2 Vdc for key data retention. The 3.6 Vdc, 1Ahr lithium battery provides a minimum of 4 years of key retention time for eight hybrid installations, and up to 10 years of key retention time for two hybrid installations. The Encode/Decode Secure board kit number is TNN6005, part number 6082452R02.

Key Clearing

The Key Reset (KR) signal (active low pin 7) of the secure hybrids provides a means to erase all of the hybrid keys simultaneously, which prevents any further encryption or decryption. This function is provided for all hybrid options, with the exception of option C794 *DVP* Hybrid.

The Secure board provides two methods to generate the KR signal to clear the keys. The first method uses the external key reset signal (J4001-5). This interface allows the key reset line to be activated by switches or push buttons located on or near the station.

The second method is controlled by the microprocessor in the control and logic circuitry. When jumper JU4002 is in its alternate setting, via the C683 option, an active high signal from the secure ASIC grounds the key reset signal line. The source of the key reset request is commonly a wireline function tone, which is communicated to the Secure board via the HSR signal.

RF TRAY

RF Tray Overview

The RF Tray is an aluminum casting that provides mounting cavities and shielding for each of the following circuits:

- Uniboard
- Receive and Transmit VCOs
- Intermediate Power Amplifier (IPA)
- Interconnect Board
- Receiver

These circuits and assemblies of the RF Tray interact with other station assemblies. Various signals, data, and control functions are routed through the RF Tray.

The RF Tray is located in the bottom portion of the *MSF 5000* cabinet, as shown in Figure 1-21. It is mounted on slide rails for easy access. Latches on each side of the front panel secure the tray to the cabinet frame.

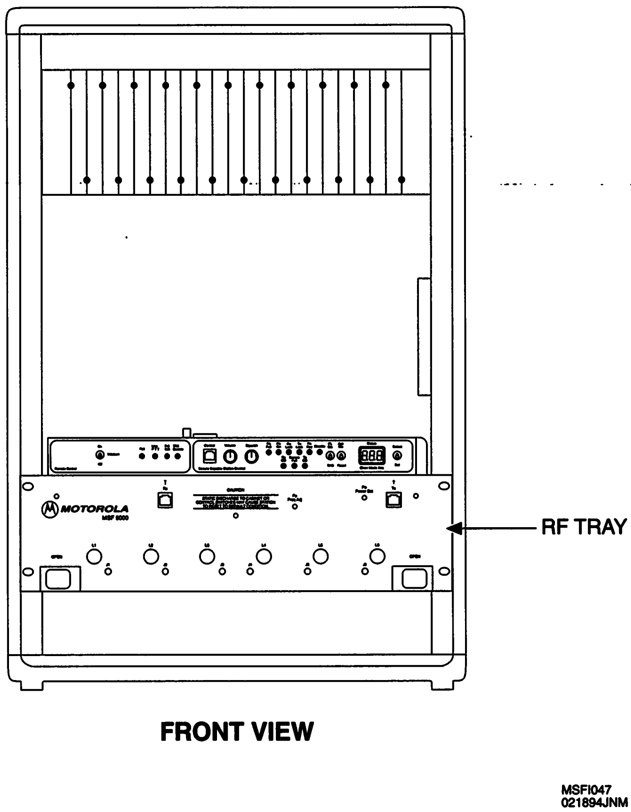


Figure 1-21 ***RF Tray Location***

The Control tray is mounted to the top of the RF Tray. Access to the top of the RF Tray is gained by rotating the Control Tray up and out of the way. The top cover of the RF Tray must also be removed to gain access to the assemblies within the RF Tray.

❒ Figure 1-22 shows a top view of the RF Tray.

❒ Figure 1-23 shows a right side view of the RF Tray.

❒ Figure 1-24 shows a left side view of the RF Tray.

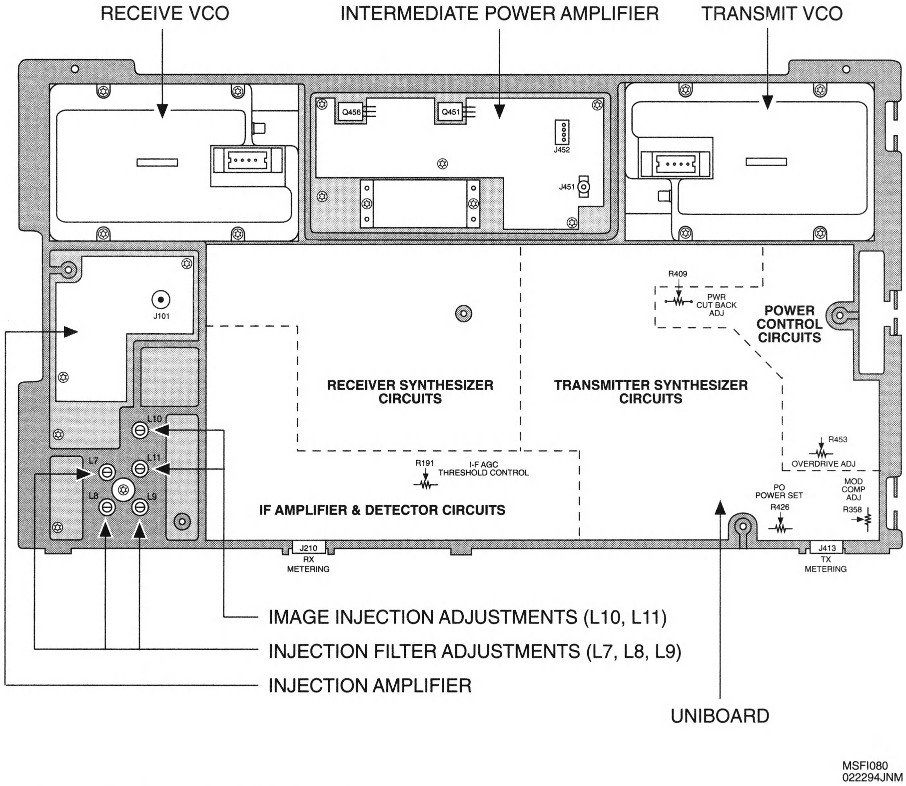


Figure 1-22 ***RF Tray (Top View)***

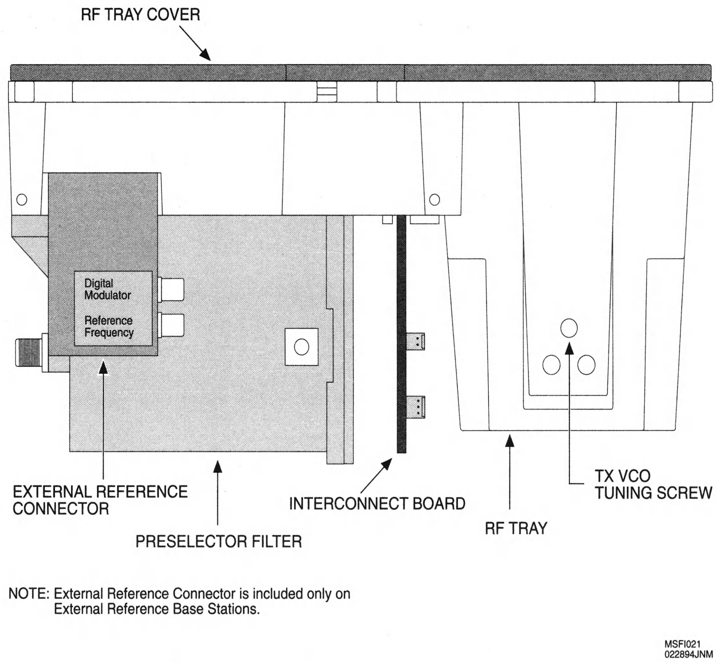


Figure 1-23 ***RF Tray (Right Side)***

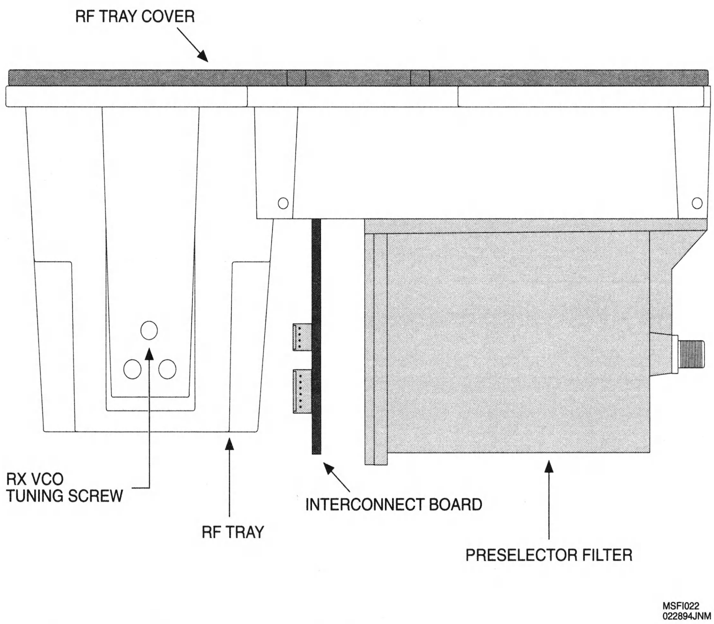


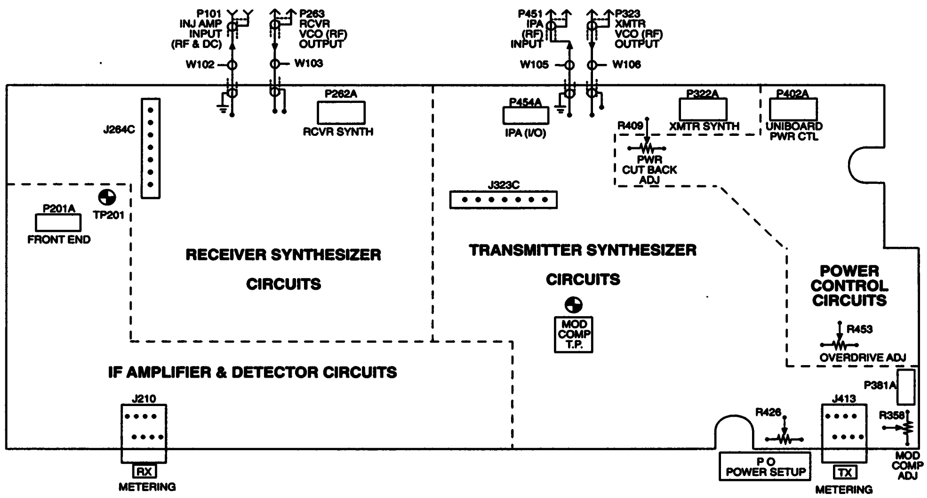
Figure 1-24 ***RF Tray (Left Side)***

Uniboard

The Uniboard is mounted in the top of the RF Tray. It contains portions of four major station circuits, including:

- Transmit Synthesizer Circuitry
- Receive Synthesizer Circuitry
- Receiver I-F Amplifier/Detector
- Power Control Circuitry

Figure 1-25 shows the top view of the Uniboard with circuit location and interconnect detail.



NOTE: Reference Oscillator Circuits are found on all bands except for 900 MHz and bands with the External or High Stability Oscillator Option.

MSFI050
022294JNM

Figure 1-25 ***Uniboard Circuit Location***

Transmit Synthesizer Circuitry

The transmit and receive synthesizer are of the same basic design. The major difference is that the transmit synthesizer contains a modulation circuit to generate the transmit carrier signal.

The transmit synthesizer contains a Phase-Locked Loop (PLL) circuit which locks the output of the Transmit VCO. The resultant frequency is the reference for the transmitter to produce the programmed transmit frequency. The Transmit VCO is a separate assembly located within the RF Tray.

The functional circuits of the transmit synthesizer include the following:

- Phase-Locked Loop Circuitry
- Super Filter
- Isolation Buffer
- Modulation Compensation Circuit

Refer to Figure 1-26 for a functional block diagram of the transmit synthesizer.

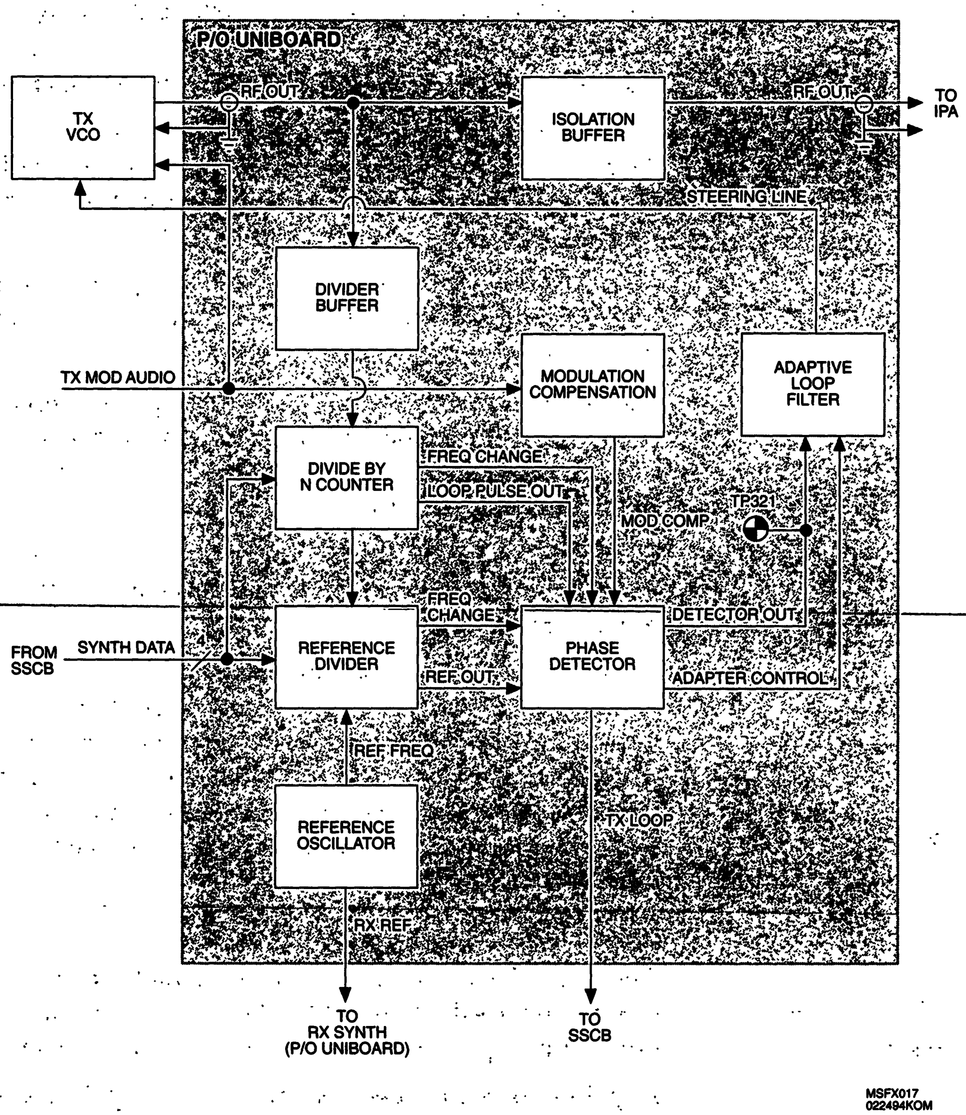


Figure 1-26 ***Transmit Synthesizer Block Diagram***

Phase-Locked Loop Circuitry

Various output frequencies are generated by the synthesizer through the use of a single negative feedback loop. The phase difference between two signals at the phase detector input controls the VCO output frequency. The two signals being compared are the reference frequency signal and the loop pulse signal.

A stable 14.4 MHz reference signal is generated by a crystal oscillator element. The reference divider divides the 14.4 MHz signal down to a 6.25 kHz square wave.

A loop pulse signal is the negative feedback signal from the PLL. This signal is created by dividing the VCO output via the programmable loop counter/divider. The frequency divides the signal by the programmed factor of "N".

The microprocessor on the SSCB reads divider data from the code plug. This divider data is multiplexed into six 4 bit data words. Each data word is loaded into the divider through four separate lines (SD0 through SD3) with three corresponding address lines (SA0 through SA2).

All six data words are demultiplexed in the appropriate divider. This data provides the divider with the appropriate divide-by-number to obtain the desired PLL output frequency.

The loop pulse and reference signals are applied to inputs of the phase detector. The phase detector monitors the phase difference between the signals. A DC control voltage is generated that is proportional to the phase difference between the loop and reference frequencies.

The control voltage is routed through the adaptive loop filter. The adaptive loop filter damps the loop transient response and attenuates noise and spurs. The resultant signal drives the VCO steering line.

The steering line signal increases or decreases the VCO output frequency as voltage level of the DC control voltage varies. If the VCO output frequency increases, the loop signal frequency increases. This causes a phase change at the phase detector. The phase detector then lowers the DC control voltage in accordance with the phase slippage. The DC control voltage causes the adaptive loop filter to adjust the steering line so it moves the VCO frequency back down.

Super Filter

Since the VCO requires a very pure DC supply voltage, an ultra low-pass filter (U325) provides the Transmit VCO with a very low noise supply voltage. The IPA provides an input voltage of +9.6 Vdc to the super filter.

Any ripple or noise present on the +9.6 Vdc supply line is removed by the super filter, preventing unwanted modulation of the VCO. The filter causes a voltage drop of +1 Vdc to occur, which results in an output voltage of +8.6 Vdc. The +8.6 Vdc is used on the Uniboard and is also routed to the Transmit VCO via J342.

Isolation Buffer

The isolation buffer stage ensures isolation between the VCO output and the IPA, and prevents pulling of the VCO output frequency during transmitter key-up. The Transmit VCO RF signal is passed through the isolation buffer prior to being applied to the first stage of the IPA. The isolation buffer consists of input and output matching circuits and an active device (Q326) that is biased for class A operation.

Modulation Compensation Circuit

The modulation compensation circuit enables low frequency modulation to be transmitted without being "tracked out" by the loop. When the VCO is modulated by data, it is divided down and compared to the reference signal. The modulation appears as an error signal at the phase detector. Unless compensated, this error signal passes through the loop filter and modulates the steering line, distorting the intended data modulation. The sensitivity of the modulation compensation is set via R358. Refer to Chapter 4 - Alignment to adjust R358.

Receive Synthesizer Circuitry

The receive synthesizer is of the same basic design as the transmit synthesizer. The major difference is that the receive synthesizer generates the receive injection signal. It does not contain the modulation compensation circuitry or isolation buffer as the transmit synthesizer.

The functional circuits of the receive synthesizer include the following:

- Phase-Locked Loop Circuitry
- Super Filter

Refer to Figure 1-27 for a functional block diagram of the receive synthesizer.

Receiver I-F Amplifier/Detector

The balanced output of the mixer is connected to the Intermediate Frequency (I-F) amplifier/detector circuit. This I-F signal is applied first to a crystal filter before being applied to the I-F amplifier. The signal is further amplified and filtered before being applied to the limiter/detector.

NOTE

Refer to the Receiver Circuitry section for a description of the receiver front end, prior to reaching the I-F amplifier/detector.

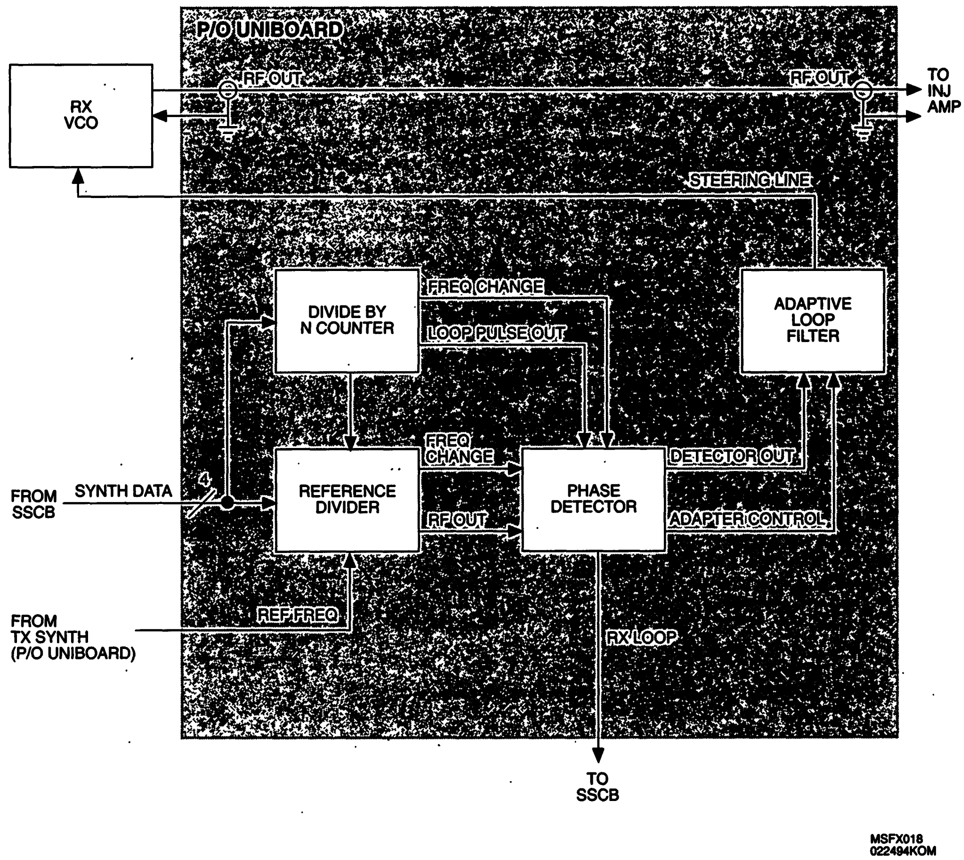


Figure 1-27 ***Receive Synthesizer Block Diagram***

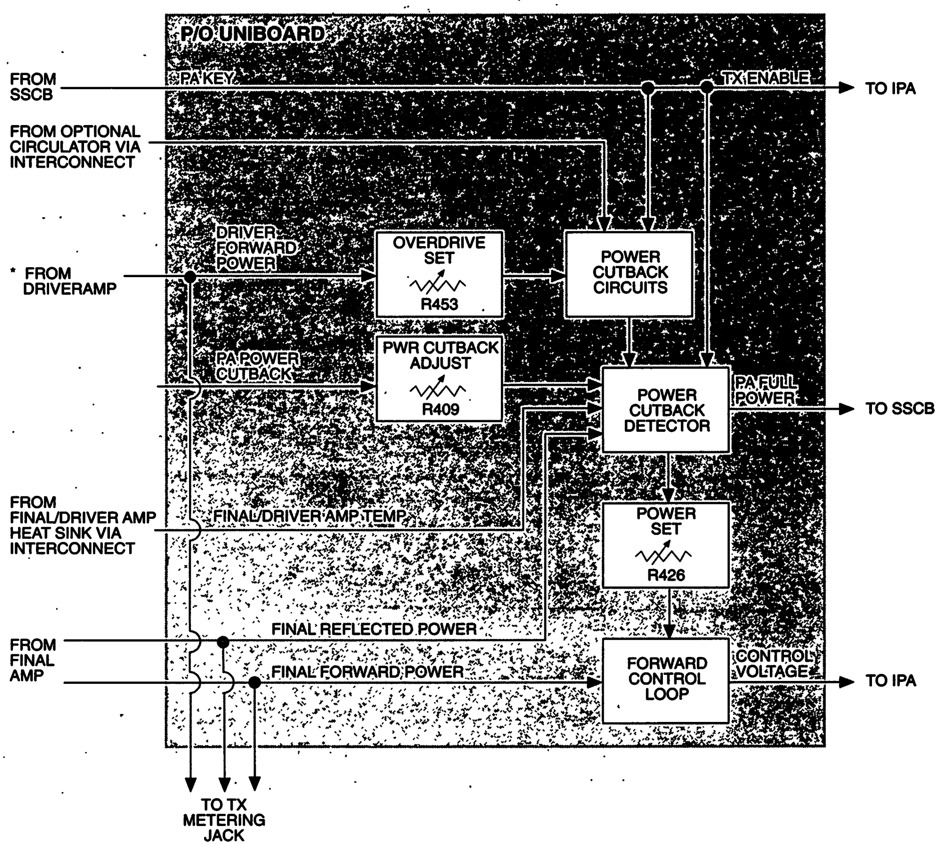
The limiter/detector includes three stages of I-F amplification; quadrature FM detector, audio preamplifier, and signal level metering output. The recovered audio output is applied to a discrete audio buffer amplifier. This amplifier provides a low impedance source to drive circuitry in the power control section.

Power Control Circuitry

The power control circuit provides the following circuits:

- RF Power Leveling Circuit
- Power Cutback Circuit
- Transmitter Shut-down Circuit

Refer to Figure 1-28 for a functional block diagram of the power control circuitry.



* Only used in High Power Stations

MSFX019
022494KOM

Figure 1-28 ***Power Control Circuitry Block Diagram***

RF Power Leveling Circuit

During normal operation, the station output power is controlled by the RF power leveling circuit. This circuit maintains station output power constant over variations in supply voltage and PA temperature. This circuit disables the IPA during standby (receive) mode and prevents uncontrolled station output if the power control loop should fail.

When a PTT signal is generated, the IPA is enabled for transmission via an RF switch. The IPA output is low-pass filtered to drive the PA. The PA contains a forward power sensor to detect PA output. The PA output supplies a DC voltage proportional to the power output for the control circuit.

The power control circuit varies its control output until the forward power sense voltage is equal to the power set voltage. During normal operation, the PA On and PA Full LEDs on the SSCB are illuminated.

Power Cutback Circuit

The power cutback circuit reduces the station output power under conditions of high temperature, high VSWR, or as directed by power control circuitry. The cutback level of the output can vary from 20 to 50% of the rated station output power. This is set by the PWR CUTBACK ADJ (R409) on the Uniboard.

If the power control circuitry is unable to level the station output power, potential damage may occur to the station. Any time the power output varies by more then 50% of its set value, the PA Full LED on the SSCB turns off and the SSCB is notified of the reduced power level.

Each stage of the PAs contain a thermistor to measure the operating temperature of the PA heat sink. If the internal temperature exceeds 100° C, the power set voltage decreases and causes an adjustment in the control voltage.

If the station contains a circulator, whenever high VSWRs are applied to the circulator load at high ambient temperatures, the power set voltage decreases resulting in a control voltage adjustment. This causes the station output power to drop below 20% of the power setting.

Transmitter Shut-down Circuit

The transmitter shut-down circuit senses this condition and signals the station control circuitry to turn off the transmitter. This circuit contains two comparators to detect conditions when the power control circuit cannot level the station output power.

If the station output power is greater than its set value or the power control circuit is at full drive, the microprocessor is signaled that a control loop failure has occurred. The power set voltage is also pulled down, reducing station output power by 50% in an attempt to correct the leveling problem. If this condition remains, the transmitter is shut-down.

Voltage Controlled Oscillators

The receive and transmit Voltage Controlled Oscillators (VCO) are mounted in separate cavities within the RF Tray, as shown in Figure 1-29.

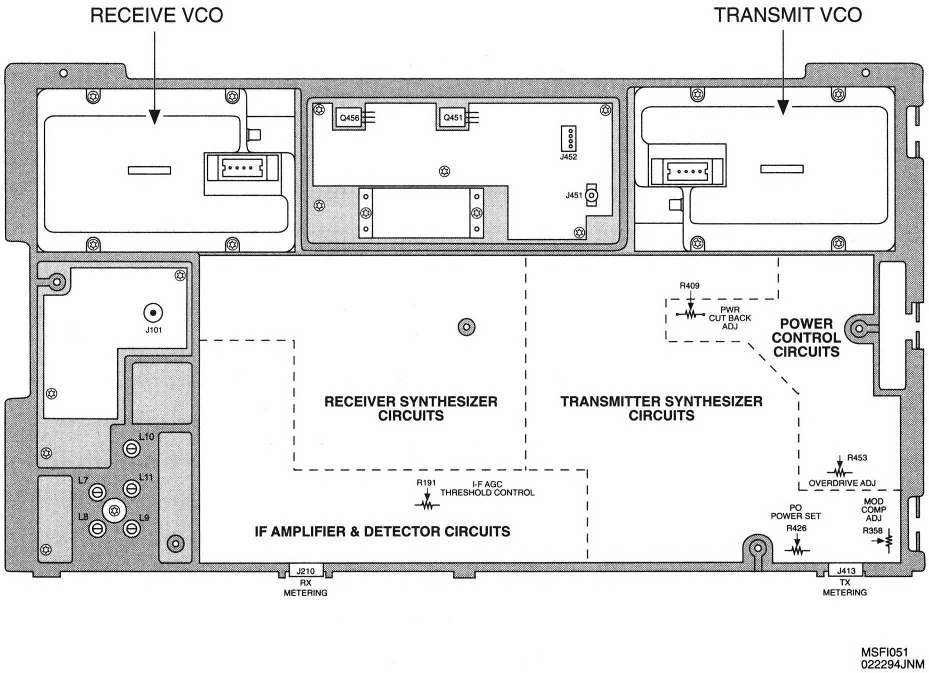


Figure 1-29 ***Receive and Transmit VCOs***

Receive VCO

The Receive VCO produces the receiver injection frequencies. The steering line voltage of the transmit reference circuit determines the VCO operating frequency within a given sub-band. Two frequency sub-bands are provided via a bandshift switch circuit within the VCO. Figure 1-30 shows a block diagram of the Receive VCO.

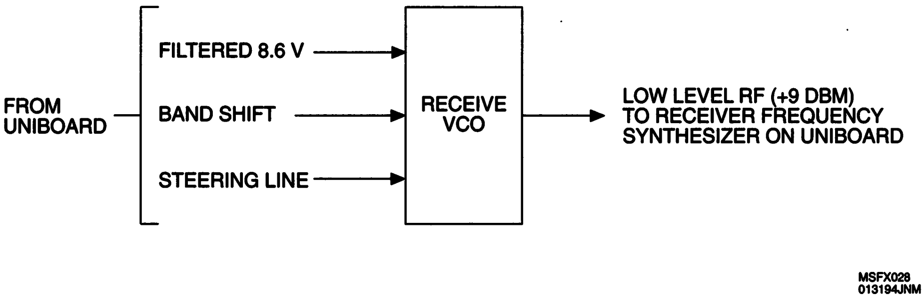


Figure 1-30 ***Receive VCO Block Diagram***

Transmit VCO

The Transmit VCO produces the Frequency Modulated (FM) exciter frequencies. Similar to the Receive VCO, the steering line voltage of the transmit reference circuit determines the VCO operating frequency within a given sub-band. Two frequency sub-bands are provided via a bandshift switch circuit within the VCO. Figure 1-31 shows a block diagram of the Transmit VCO.

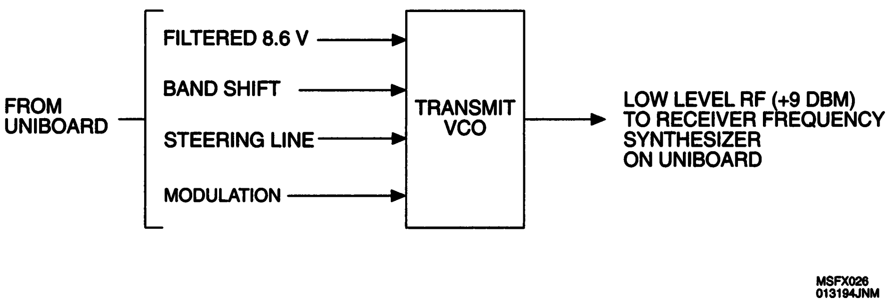


Figure 1-31 ***Transmit VCO Block Diagram***

The Transmit VCO is frequency modulated by the transmit audio signal on the SSCB. The modulation circuit is coupled with the steering line circuit to maintain constant modulation as the steering line voltage changes for different operating frequencies.

Intermediate Power Amplifier

The Intermediate Power Amplifier (IPA) is mounted in the top of the RF Tray, as shown in Figure 1-32. A block diagram of the IPA is shown in Figure 1-33. The IPA consists of the following circuits:

- ❒ +9.6 Voltage Regulator
- ❒ Power Amplifier Circuit

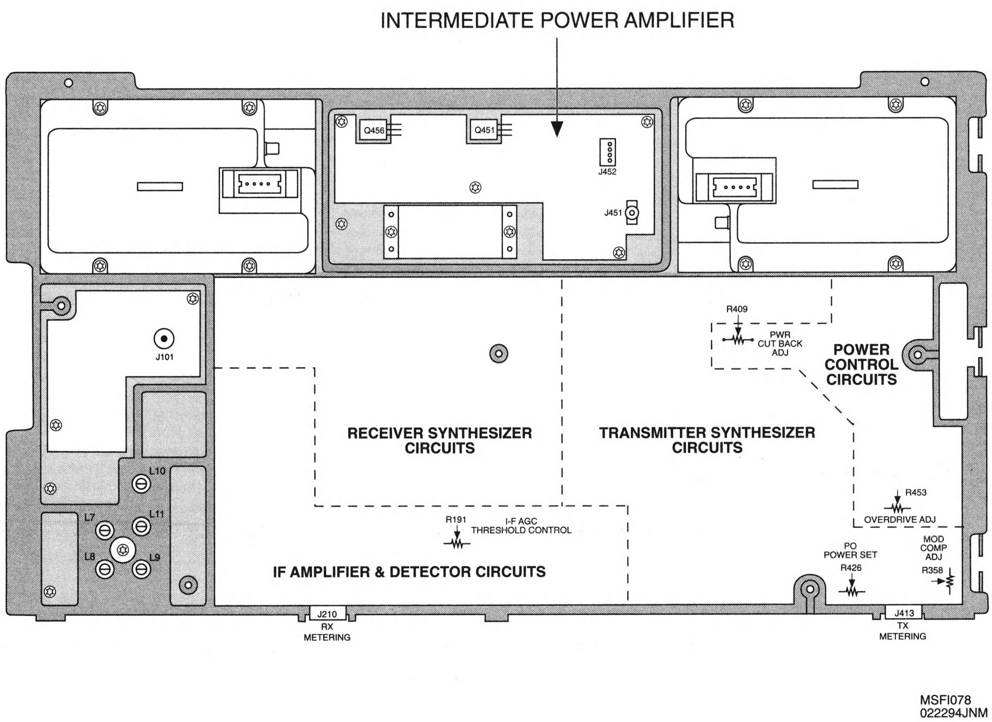


Figure 1-32 ***Intermediate Power Amplifier***

+9.6 Voltage Regulator

The +9.6 voltage regulator operates independently from the other sections of the IPA. The series regulator circuit provides the station with a clean +9.6 Vdc.

The filtered +13.8 Vdc (A+) Power Supply output is the source voltage for generating the +9.6 Vdc. The +9.6 Vdc is filtered again by the Uniboard.

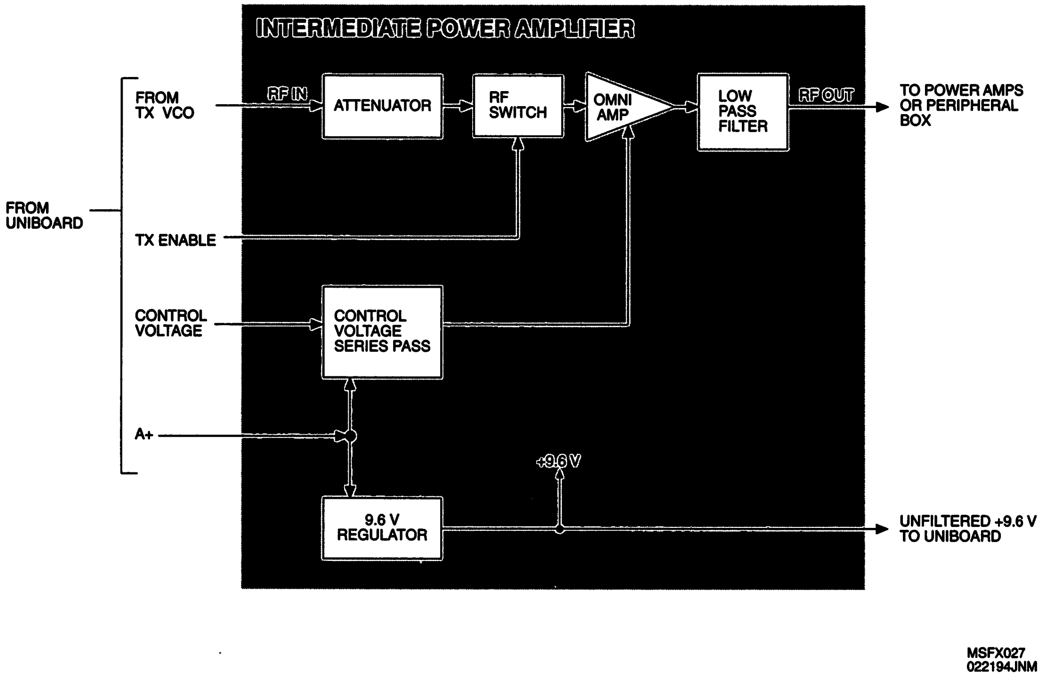


Figure 1-33 ***Intermediate Power Amplifier Block Diagram***

Power Amplifier Circuit

During station transmission, the RF signal generated by the transmit synthesizer is applied to the IPA. The RF signal is routed to the OMNI amplifier when the power control circuit enables an RF switch.

The OMNI amplifier is a two stage class C amplifier. The first stage is powered by the A+ from the Power Supply. The second stage is powered and controlled via the series pass circuit.

The RF signal is amplified between 0 to 8 Watts, dependent on the control loop feedback voltage at the input of the series pass circuit. When this voltage is varied, the IPA output power and the station output power can be varied to any desired level within its operating limits.

During standby (receive) mode, a specified minimum RF signal is allowed to conduct to the station output. This is due to the continuous operation of the transmit synthesizer circuit. However, the RF switch is turned off during standby mode, preventing transmission of any significant output power.

Interconnect Board

The Interconnect board is mounted to the bottom of the RF Tray, as shown in Figure 1-34. It provides connections between the RF Tray, PA s, Power Supply, and Control Tray. The Interconnect board also provides part of the power control circuitry, as well as a linear voltage regulator which supplies the RF Tray with + 5Vdc.

Feedthrough plate assemblies mounted in the RF Tray provide RF isolation between the Interconnect board and other circuits of the RF Tray.

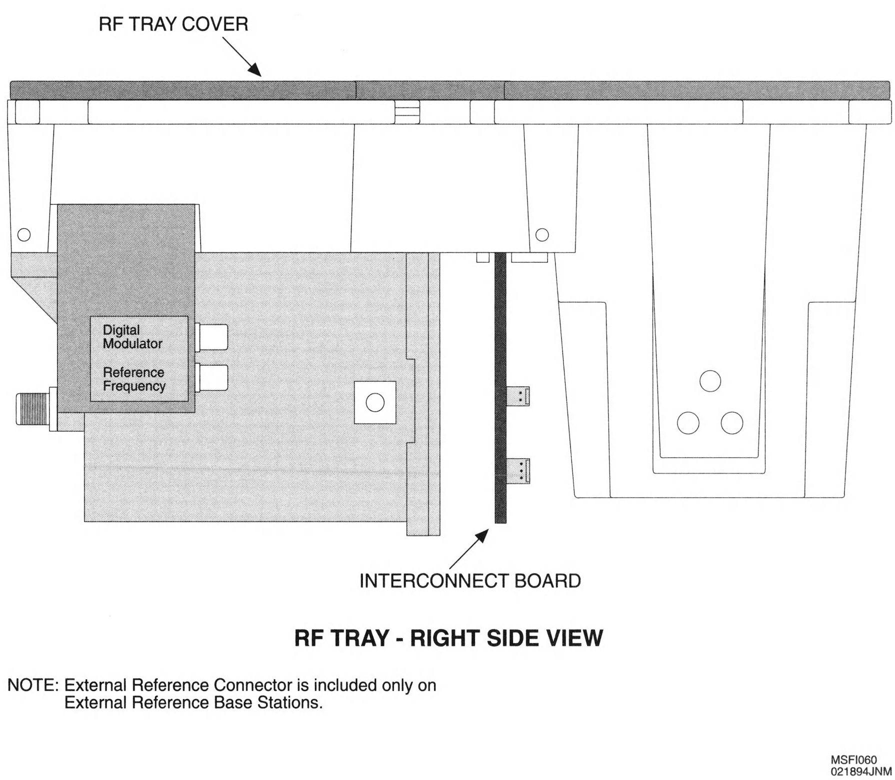


Figure 1-34 ***Interconnect Board***

Receiver Circuitry

The station Receiver is comprised of several replaceable modules located within the RF Tray, as shown in Figure 1-35. These modules include:

- Preselector Filter
- Preamplifier/Mixer
- Injection Amplifier
- Image/Injection Filter
- I-F Circuitry (part of Uniboard)

Each of the above circuits are defined within this section, with the exception of the I-F circuitry. Refer to the Uniboard section for information relating to the I-F circuitry. Figure 1-35 shows a functional block diagram of the receiver circuitry.

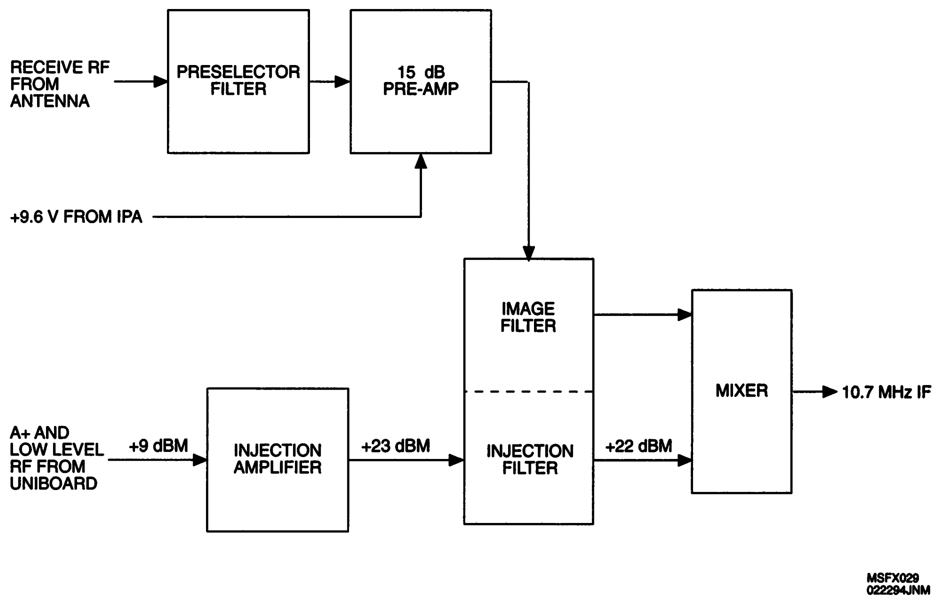


Figure 1-35 ***Receiver Block Diagram***

Preselector Filter

The RF preselector filter is a mechanical filter located along the bottom of the RF Tray. The received RF signal from the antenna is applied to the preselector via the receive antenna port on the Junction Box.

Preamplifier/Mixer

The preamplifier/mixer is a circuit board located between the preselector casing and the casting of the RF Tray, next to the image/injection filters. The preamplifier is a single stage, common emitter amplifier. The received RF signal is passed through the preamplifier. The output of the preamplifier is connected to the image filter before being passed onto the mixer.

The mixer has an input port for the received RF signal and an input port for the Local Oscillator (LO) signal. The LO port is driven by the injection amplifier. The mixer is double-balanced with a low pass filtered output. The output filter allows the difference between the received RF signal and the LO signal to be applied to the I-F amplifier.

Injection Amplifier

The injection amplifier is located on the left-hand side of the RF Tray between the Receive VCO and the injection filters. The injection amplifier boosts the VCO output to sufficiently reduce mixer intermodulation products.

Image/Injection Filter

The image/injection filter is located in the front left-hand corner of the RF Tray. The image filter portion is used to filter the received RF signal between the output of the preamplifier and the mixer. The injection filter portion filters the LO signal between the output of the injection amplifier and the mixer. Each of the filters have tuning screws which extend through the front of the RF Tray casting.

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Power Supply

The station Power Supply is mounted in the upper half of the cabinet behind the Power Amplifier (PA). The Standard Power Supply is a ferro-resonant type that operates from a nominal 110 volt, single-phase, 60 Hz AC power source. Options are available for 220 Vac, 50 Hz operation, as well as different power levels and DC supplies on selected models.

The Power Supply accepts an AC input voltage and generates DC voltages for the station. Each PA requires a dedicated Power Supply. Low power stations require one Power Supply and high power stations require two Power Supplies. A Battery Charger Power Supply is also available.

The following available power supply options are:

- 110 or 220 Vac inputs
- 50 or 60 Hz operating frequencies
- 250, 500, 575, or 675 watts
- various output voltages

Refer to the Power Supply manual for a more detailed explanation of power supplies and options.

Standard Power Supply

The Standard Power Supply receives AC power from the Junction Box via the line cord. Refer to Figure 1-36. The Standard Power Supply provides high current A+ to the PA (if installed) and two unfiltered +13.8 Vdc (A++) outputs to the station RF Tray.

The Standard Power Supply provides the following features:

- output regulation
- filtering
- short circuit protection
- current limiting
- overvoltage protection

Battery Charger Power Supply

The Battery Charger Power Supply receives AC power from the Junction Box via the line cord. Refer to Figure 1-37. The battery charger circuitry permits the station to operate from AC power normally, but provides continued operation from external batteries (emergency power) if the AC power should fail. The Power Supply provides high current A+ to the PA (if installed) and two +13.8 Vdc unfiltered outputs to the RF Tray.

In addition to the features of the standard Power Supply, the Battery Charger Power Supply provides:

- battery equalization
- AC line failure detection
- temperature compensation (option)
- low voltage battery disconnect (option)

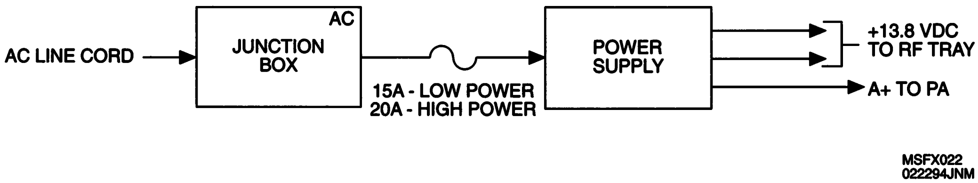

Figure 1-36 ***Standard Power Supply***

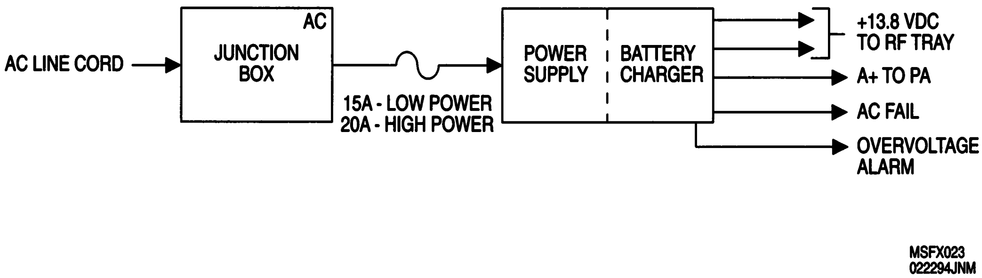

Figure 1-37 ***Battery Charger Power Supply***

Power Amplifier

The Power Amplifier (PA) is mounted in the front portion of the cabinet directly in front of the Power Supply. Two models of PAs are described: low and high power. For high power models, two separate PAs and Power Supplies are required. One PA is the driver PA and the other is the final PA. The driver PA is mounted directly below the final PA.

The driver PA receives an intermediate level modulated RF signal from the IPA. It amplifies the signal for transmission via the site transmit antenna. Refer to Figure 1-38. Forward and reflected voltages are detected by the directional coupler and routed to the power control circuitry on the Uniboard. PA temperature is detected by a heatsink temperature thermistor. The temperature is converted into a voltage and routed to the power control circuitry on the Uniboard.

The final PA receives a modulated RF signal from the driver PA. Refer to Figure 1-38. The signal is split up to six ways, amplified, and combined. The output is fed to a directional coupler. Outputs from the directional coupler are the same as those for the driver PA. The design of the final PAs allows the transmitter to continue to safely operate at a reduced power output if one of the final amplifier stages fail.

Both the driver and final PAs feature metering jacks for measurement of amplifier module current to facilitate servicing of the PA.

Several types and power ratings of PAs are available for the different frequency bands. The following lists the various types of PAs:

- 6 Watt, VHF, UHF - No PA is used in this configuration. The RF output path is directly from the IPA module to the site antenna, via the directional coupler and a low-pass filter.
- 15 Watts, UHF
- 25 Watts, VHF - may be used as a final amplifier for the 25 watt configuration or as a driver amplifier in the 350 watt configuration
- 35 Watts, 800 MHz
- 40 Watts, UHF
- 75 Watts, VHF, UHF, 800 MHz, 900 MHz
- 110 Watts, UHF
- 125 Watts, VHF
- 150 Watts, 800 MHz, 900 MHz
- 225 Watts, UHF
- 350 Watts, VHF

The PA can be tilted outward after removing the screws securing it to the cabinet frame. All PA connections are made at the right or left end of the PA heat sink, beneath a cover plate.

Peripheral Devices

Several peripheral devices are used to improve transmitter performance and protection.

Single Circulator

The single circulator is standard on all models except VHF. The circulator is mounted beneath or internal to the final PA and provides protection for the final PA modules against transmitter intermodulation and antenna mismatch.

Triple Circulator

The triple circulator is available for some models to provide better isolation and protection against intermodulation.

Duplexer

The duplexer is available on all models except high power VHF. The duplexer combines the transmitter and receiver into one RF port. The duplexer option can be combined with a single or triple circulator, depending on the station model.

RF Low-Pass Filter

The low-pass filter is provided with all stations not having the duplexer option to attenuate transmitter harmonics. On VHF models, the low-pass filter is in the peripheral box. The peripheral box mounts in the same location as the low-pass filter. The peripheral box also contains the antenna relay when required. Other models use a separate antenna relay mounted between the low-pass filter and the Junction Box.

Wattmeter Element

A wattmeter element is available on trunking stations and is mounted between the low-pass filter and the Junction Box.

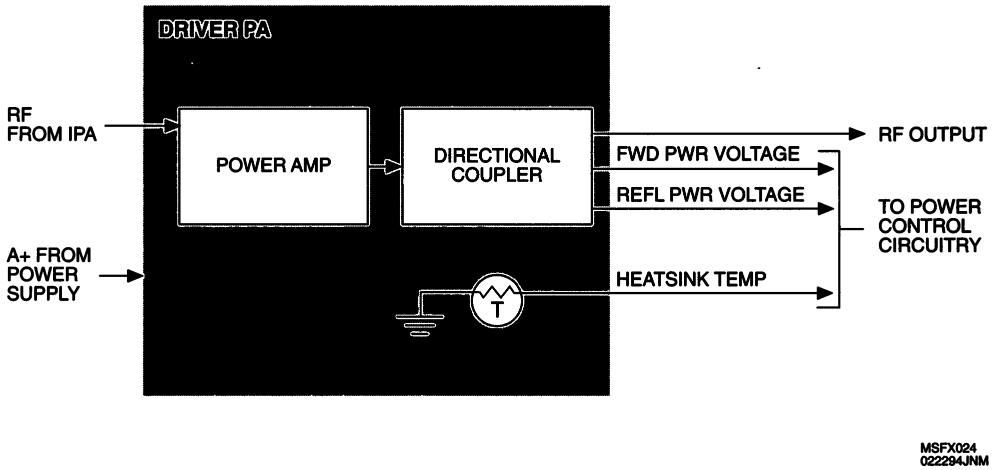

Figure 1-38 ***Driver PA***

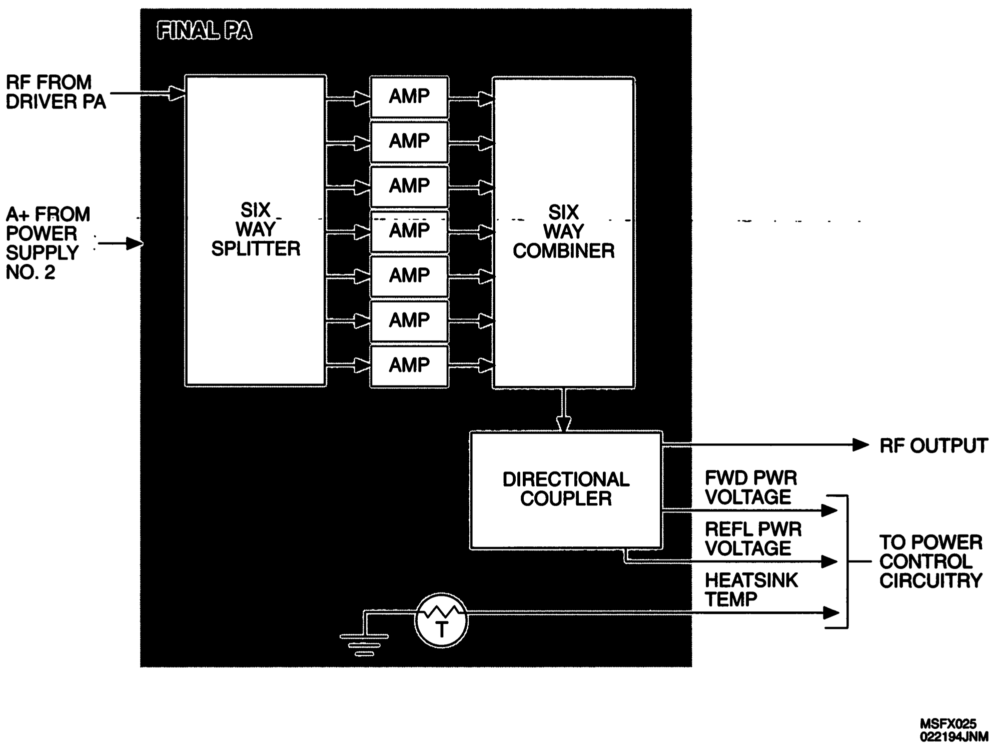

Figure 1-39 ***Final PA***

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Junction Box

The Junction Box provides facilities for all external connections to the station. The low or high power Junction Box is flush-mounted in the right side of the cabinet. Refer to Figure 1-40. The rack mounted Junction Box is mounted in the front of the cabinet rack. Refer to Figure 1-41. Unused station connections on the Junction Box are plugged.

Antennas

- antenna connector 1 (low power) - used to connect an external reference connector
- antenna connector 1 (high power) - used to connect a transmit antenna or a relay/duplexer
- antenna connector 2 (low power) - used to connect the transmitter or antenna relay/duplexer
- antenna connector 2 (high power) - used to connect a receive antenna for a high power station
- antenna connector 3 (low power) - used to connect a receive antenna
- antenna connector 3 (high power) - used to connect an external frequency reference

Grounding

- station ground terminal - used to connect the earth ground wire

DC Power

- J605 DC power connector - used to connect the external battery (optional with battery revert) or DC only power input (Option C32)

AC Power

- AC power connector J604 (low power) - used to connect the AC line cord
- AC power connector (rack mount) - used to connect the AC line cord
- AC line cord W600 - provides AC input power on high power Junction Boxes only

Fuses

- fuses (rack mount) - provides overcurrent protection

On/Off Switch

- ON/OFF switch (rack mount) - provides power on/off switching capability

Options

- J1 options I/O connector - 25-pin D-type connector used to connect an optional board such as an RS-232 interface or other wildcard I/O

System

- J2 system connector - 25-pin D-type connector used to connect the system connector from the station

Trunking

- J3 trunking central I/O connector - 25-pin D-type connector used to connect the trunking controller connector on trunked stations

Wireline

- TB1601 wireline interface connections
  - used to connect the audio and control wireline (internal circuitry provides line transient protection)
  - in standard 2-wire simplex configuration, Line 2 is used for both transmit and receive audio connections (Line 1 not used)
  - for 4-wire simplex configuration, Line 1 is the transmit connection and Line 2 is the receive connection. Both lines are not active at the same time. The receiver is muted if the transmitter is active.
  - in repeater stations with an optional 4-wire tone remote control module (4-wire duplex), Line 1 is used for transmit audio and Line 2 for receive audio. Both lines can be active at the same time.
  - in trunked repeater stations, Line 1 and Line 2 are used for console connections. Line 3 and Line 4 are used for telephone interconnect connections (found on the trunking connector).
  - all audio wireline(s) must meet certain specifications for acceptable communications. Refer to Chapter 3 - Installation for specifications.
  - Lines 3 and 4 are not transient protected. The trunking interconnect provides the protection.

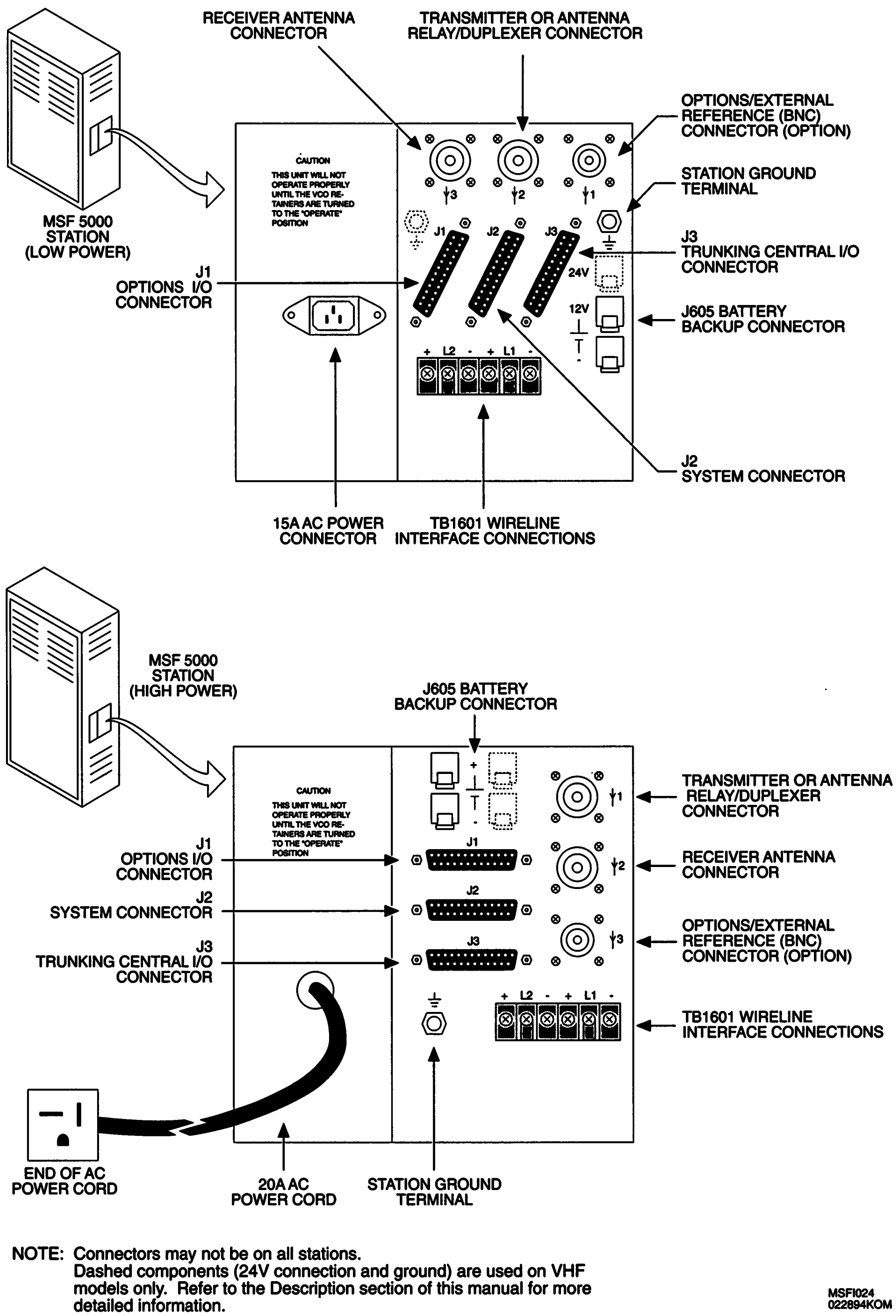

Figure 1-40 ***Low and High Power Junction Boxes***

Junction Box

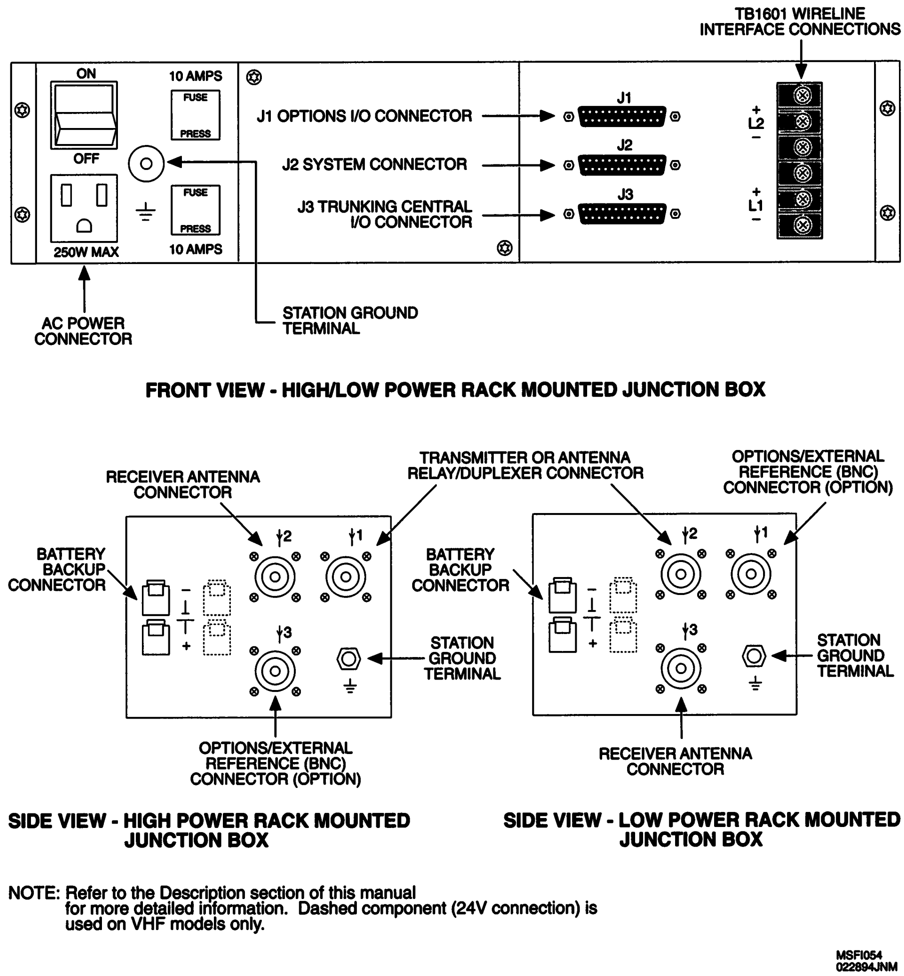

Figure 1-41 ***Rack Mounted Junction Box***

OPERATION

MOTOROLA

2

Operation

Chapter Overview

This chapter contains a detailed description of the operating modes and station diagnostics. Chapter contents are listed in Table 2-1.

Table 2-1 **Chapter Contents**

Section	Page	Description
Station Operation	2-2	How to use the controls and indicators on the front of an *MSF 5000* station.
Special Service Modes	2-11	Used in troubleshooting, testing, and aligning the station.
Station Diagnostics	2-18	A description of the station diagnostics.

Station Operation

This section describes the operation of the controls and indicators located on the Control Tray front panel.

- ❒ standard controls and indicators are defined under the SSCB Controls and Indicators section
- ❒ controls and indicators associated with secure operation are defined under the Secure Controls and Indicators section
- ❒ controls and indicators associated with trunking operation are defined under the TTRC Controls and Indicators section

Refer to this section when performing adjustments, during installation, or when servicing the station.

SSCB Controls and Indicators

The controls and indicators associated with the SSCBs are shown in Figure 2-1.

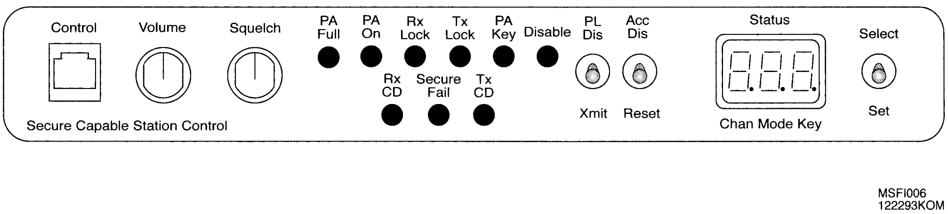

Figure 2-1 **SSCB and Secure Board Controls and Indicators**

PL Dis/Xmit Switch

When **PL Dis** (Private Line Disable) is selected:

- ❒ receiver audio gating qualifiers are set to the carrier squelch operation
- ❒ repeater squelch qualifiers are not affected
- ❒ receiver audio signals are gated to the wireline and local speaker when an on-channel carrier is detected
- ❒ front panel **Disable** LED lights

When **Xmit** (transmit) is selected and held in the momentary position:

- ❒ station transmitter is keyed with a local PTT
- ❒ failsoft codeword, PL tone, DPL code, or TDATA is not present in the transmitted signal
- ❒ station strips any failsoft codeword, PL tone, DPL code, or TDATA from the transmitted signal. The codeword is stripped even if another PTT occurs that normally generates PL, DPL, etc.

Acc Dis/Reset Switch

When **Acc Dis** (Access Disable) is selected, the station is put into access disable mode. Access disable mode disables the following operations:

- transmitter key requests from the wireline and repeater activity
- PTT time-out timers, any remote control including channel, mode, and encryption key changes from the wireline
- auto station ID timer is reset and inhibited

While in access disable mode:

- station tuning channel, mode, and encryption key can be selected using the **Select/Set** switch
- station receiver squelch control potentiometer on the front panel is enabled for local audio squelch adjustments
- **Disable** warning LED lights

When the switch is returned to the center (off) position:

- previously disabled operations are re-enabled
- station resumes operation on the channel last selected by the wireline command, even if the wireline command occurred while the station was access disabled

When **Reset** is held in it's momentary position:

- reset mode is entered
- station's control processors are reset
- station operation is inhibited

When the switch is returned to the center position:

- self-diagnostics routine is initiated
- fatal errors display
- audio diagnostics display
- firmware version numbers of SSCB, TTRC, Secure, MCS, and SAM display in order

The station is operable after the self-diagnostic routine is completed if no fatal errors are detected.

Status Display - Chan Mode Key

A three digit 7-segmented display that indicates the following information:

- **Chan** digit indicates the current operating channel
- **Mode** digit indicates the current operating mode
- **Key** digit indicates the selected encryption key only when the system is equipped and configured for encode/decode operation

The decimal point to the right of the digit indicates that digit is selected.

Select/Set Switch

The **Select/Set** switch allows local changes to channels, modes, keys, and EEPOT settings.

When **Select** is chosen, one of three digits in the **Status** display is selected. The digit can be changed by using the **Set** switch.

When **Set** is chosen, the selected digit in the **Status** display is incremented by one. If the display times out and **Set** is selected, the system exits the status display mode.

Volume Control Knob

Rotate the volume control knob clockwise to increase or counterclockwise to decrease the local speaker audio volume. The local audio is available on the optional Radio Metering Panel (RMP) or Diagnostic Metering Panel (DMP).

Squelch Control Knob

Rotate the squelch control knob to adjust the local receiver squelch. Local squelch control is active only when the **Acc Dis/Reset** switch is set to **Acc Dis**.

Control Jack

Used to plug in a local test microphone or handset for local keying of the intercom or transmitter. The test microphone recommended is HMN1001, available through Motorola National Parts.

PA Full LED

A green light indicates a PA key request is active and the PA (set level) is providing full adjusted power out.

PA On LED

A green light indicates the PA is responding to a key request.

Rx Lock LED

A green light indicates the receive synthesizer is locked and functioning correctly.

Tx Lock LED

A green light indicates the transmit synthesizer is locked and functioning correctly.

PA Key LED

A yellow light indicates the PA key is requested from the SSCB to the power control circuit in the RF Tray. May not result in PA activity if the power control circuit senses a PA failure and disallows a key-up.

Disable LED

A steady red light indicates the **Acc Dis/Reset** switch is set to **Acc Dis** or the **PL Dis/Xmit** switch is set to **PL Dis**.

A flashing red light indicates the power control service mode is active.

Secure Controls and Indicators

The controls and indicators associated with secure operation are also shown in Figure 2-1. These are only present on stations containing the Secure board.

Rx CD (receive code detect)

SECURE (optional board) ONLY; A yellow light indicates a secure receive code has been detected.

Secure Fail

SECURE (optional board) ONLY; A red light indicates the secure board is held in reset or a failure is detected in the Secure board.

Tx CD (transmit code detect)

SECURE (optional board) ONLY; A yellow light indicates the secure transmit code has been detected at the transmitter wireline input.

TTRC Controls and Indicators

The controls and indicators associated with trunking operation are shown in Figure 2-2. These are only present on stations containing the TTRC board.

Intercom On/Off Switch

The Intercom On/Off switch enables service personnel at the station to communicate with the remote control console operator without keying the station.

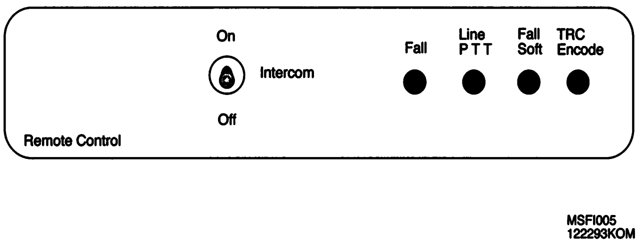

Figure 2-2 **TTRC Board Controls and Indicators**

When **On** is selected, the transmit wireline audio from the console is gated to the local speaker. A Line PTT signal is not required. The transmitter cannot be keyed with a Local or Mic PTT, and mic audio is routed to the receive audio of the console.

When toggled **On** then **Off**, the failsoft disable mode is entered on trunked stations only.

When **Off** is selected, the transmitter may be keyed with a Local or Mic PTT.

Fail LED

A red light indicates the TTRC reset mode is enabled.

A flashing red light indicates a failed TTRC board.

Line PTT LED

A yellow light indicates the wireline is sending a line PTT key command.

Fail Soft LED

A steady yellow light indicates the trunking failsoft mode is enabled.

A flashing yellow light indicates the trunking failsoft mode has been disabled locally (by toggling the **Intercom** switch).

TRC Encode LED

A yellow light indicates TRC tones are being generated by the station and sent to the console or other stations through the wireline.

Selecting Channels, Modes, and Keys

The station is programmed by the RSS to allow channel and mode selection in one of three ways:

- locally - the SSCB drives the channel/mode number on the MUXbus
- remotely - the TTRC board drives the channel/mode number on the MUXbus
- externally - the external channel/mode control source, typically a wildcard or station access module (SAM), drives the channel/mode number on the MUXbus

Refer Appendix C - MUXbus Descriptions for additional information.

Selecting and Changing Channels

To locally select or change a channel:

1. Repeatedly press (or continuously hold) the **Select** switch until the decimal point to the right of the **Chan** digit lights.
2. Repeatedly press (or continuously hold) the **Set** switch until the desired channel number appears in the **Status** display.
3. If the **Chan** mode has timed-out and more channel changes are desired, momentarily press the **Select** switch.

   The **Chan** mode is re-selected.

> **NOTE**
>
> If the channel does not select, the station is programmed for remote control. Set the **Acc Dis/Reset** switch to **Acc Dis** and change the channel.

Channel 0 is the station tuning channel. The tuning channel is programmed with the optimum frequency for tuning the RF sections and conducting audio tests in the station. The tuning channel frequency is determined by averaging the highest and lowest programmed channel frequencies. The channel 0 transmit signal consists of an audio signal encoded with DPL code 031.

> **NOTE**
>
> The station should never be keyed over the air while channel 0 is selected. The transmit frequency may not be on an authorized channel.

The only properties unique to the channel number are:

- mode slaving
- receive and transmit frequencies
- transmit idle frequency
- station call sign
- default operating mode (if any)

Channels and modes are separated in order to conserve code plug space. From the user's point of view, they can be considered the same, since a mode is usually slaved to a channel. This means that when a channel is changed, the mode is also changed. This slaving property can be disabled for special applications by using the RSS.

Selecting and Changing Modes

Selecting and changing modes is the same as for channels. The SSCB may be programmed via the RSS to provide several modes for each channel, a separate mode for each channel (channel-slaved modes), or one mode common to all of the channels.

The mode defines many of the following parameters associated with a given channel:

- receive and transmit PL/DPL codes
- PTT priority
- time-out timers
- receive squelch qualifiers
- repeater squelch qualifiers
- repeater drop out delay
- alarm tone routing
- transmit audio mixing (during external data detect)
- MRTI phone patch mode
- station ID qualifiers
- PA cutback qualifiers
- mode power level
- RPT TOT DOD Reset
- TX code line qualifiers
- MCS table number

When a station is programmed, identical modes are automatically deleted but not identical channels. For example if a station is programmed for four channels. Each channel has a different transmit and receive frequency, but all other information is the same. Only one mode exists.

Selecting and Loading Encryption Keys

NOTE

The secure options are only available for VHF, UHF, and 800 MHz models.

The **Status** display **Key** digit is illuminated only in stations equipped and programmed with a secure encode/decode option.

The secure encode/decode option requires the secure hybrids to be loaded with an encode/decode key variable. A Key Variable Loader (KVL) is a device that transfers encode/decode keys from its memory into other Securenet equipment containing secure hybrids. A KVL only loads a hybrid of the same type, as specified on the back of the KVL unit.

The station is automatically placed in the access disable mode whenever a KVL is connected to the station. Use the **Select/Set** switch to choose the desired hybrid for key loading. Verify the KVL is properly programmed before selecting a key. To select the proper Key for the station:

1. Repeatedly press (or continuously hold) the **Select/Set** switch to **Select** until the **Key** digit is selected.
2. Repeatedly press (or continuously hold) the **Select/Set** switch to **Set** until the desired **Key** digit appears in the **Status** display.
3. If the **Key** mode has timed-out and additional key loading is needed, momentarily press the **Select/Set** switch to **Select**.

   The **Key** mode is now re-selected.

For half-duplex operation, up to eight possible hybrids may be selected. Each hybrid is used for encryption and decryption, but only one operation can be selected at a time.

NOTE

When using Digital Voice Protection (*DVP*) hybrids in half-duplex operation, they operate the same as full-duplex.

For full-duplex operation, up to four pairs (eight total) of hybrids may be selected. Each pair contains an encrypt hybrid and a complimentary decrypt hybrid. The encrypt/decrypt pairs are usually loaded with the same encryption key, but may differ. Refer to Table 2-2.

To select and load encryption keys for each hybrid:

1. Plug the KVL cable into the station.

   Verify the Control Tray **Dis** LED lights.

Table 2-2 **Full-duplex Hybrid Pairs**

Encrypt	Decrypt
Key 1	Key 5
Key 2	Key 6
Key 3	Key 7
Key 4	Key 8

2. Select **Key 1** on the **Status** display using the **Select/Set** switch.
3. Press the program switch on the KVL.
   Verify PASS shows on the KVL display.

> **NOTE**
>
> Omit steps 4 through 6 if the station is configured for a remaining half-duplex or *DVP*. Repeat steps 2 and 3 for the remaining keys.

4. Select **Key 5** using the **Select/Set** switch.
5. Press the program switch on the KVL. Verify PASS shows on the KVL display.
6. Repeat step 2 through step 5 for the remaining keys.
   To select the next key, use the **Select/Set** switch.
7. Disconnect the KVL cable.
   Verify the **Dis** LED is not lit.

The **Key** digit can be selected and changed during normal station operation to select another secure hybrid.

If the key does not select, the station is programmed for remote control. Set the **Acc Dis/Reset** switch to **Acc Dis** and choose the key. When selecting hybrid pairs in a full-duplex wireline station, choose only keys 1 through 4 to designate the encrypt/decrypt pair. Selecting keys 5 through 8 is the same as choosing keys 1 through 4, respectively.

Special Service Modes

Special service modes are provided for troubleshooting, testing, and aligning the station. The modes are:

- Trunking Failsoft Disable Mode
- Power Control Service Mode
- EEPOT Adjustment Mode
- High Speed Ring Display Mode
- Forward/Reflected Power Trip Point Set Mode

NOTE

All active special service modes terminate when the station resets (toggling the **Reset** switch).

Trunking Failsoft Disable Mode

NOTE

The failsoft disable mode applies only to stations configured for trunking operation.

The failsoft disable mode disables the failsoft automatic key-up. While aligning Trunking Stations, it may be necessary to disconnect the trunking cable from the TTRC board at J2901 or at the Junction Box. This prevents the TDATA or MUTE signal from reaching the station. The station goes into failsoft and keys with failsoft data. The TTRC board **Fail Soft** LED also lights.

To enable the failsoft disable mode:

- Quickly set the **Intercom On/Off** switch to **On**, then **Off**.

  Verify the **Fail Soft** LED flashes and the station de-keys.

To exit the failsoft disable mode:

- Set the **Acc Dis/Reset** switch to **Reset** and release the switch.

  Verify the TTRC board **Fail Soft** LED lights after the reset sequence is complete.

NOTE

When the central controller cable is reconnected to the Junction Box, TDATA is restored to the station and the **Fail Soft** LED goes out.

Power Control Service Mode

While servicing the station, it may be necessary to override the power control circuits and key the station. While the power control service mode is enabled, all power control failure indications to the transmitter are disregarded. This allows the user to bypass the safety of the power control circuit during servicing.

NOTE

During the power control service mode, the transmitter is allowed to operate although a potentially damaging condition may exist. Therefore, key the transmitter for only short periods of time during servicing. Never leave the station in the power control service mode during normal, unattended operation.

To enable the power control service mode:

1. Press and hold the **Select/Set** switch to **Set**.

   Verify the decimal point is not displayed.

2. Press and hold the **PL Dis/Xmit** switch to **Xmit**.

   Verify the **Status** display indicates **tSt**. This indicates the PA test mode is enabled.

3. Release the **Select/Set** switch.

4. Release the **PL Dis/Xmit** switch.

   Verify the station unkeys, the **Dis** LED flashes, and the RW2 PA (A12/D1) MUXbus bit is active. The power control is disabled for PA testing purposes.

To exit the power control service mode:

❒ Set the **Acc Dis/Reset** switch to **Reset** and release the switch.

   Verify the **Dis** LED is not lit after the reset sequence is complete.

EEPOT Adjustment Mode

The primary level setting potentiometers (EEPOTs) in the station may be adjusted by using the Control Tray front panel switches or the RSS. Table 2-3 lists the EEPOTs of the MSF 5000 by number, function, and location.

Table 2-3 **EEPOT Numbers**

EEPOT #	Function	EEPOT Location
0	coded RX level	Secure board
1	flutter fighter level (900 MHz only)	SSCB
2	repeater squelch level	SSCB
3	receiver squelch level	SSCB
4	maximum deviation level	SSCB
5	RX level (for repeater deviation)	SSCB
6	coded deviation level	SSCB
7	TX wireline audio level	TTRC board
8	status tone level	TTRC board
9	high-end equalization level	TTRC board
A	low-end equalization level	TTRC board
b	trunking data level	TTRC board
C	line 2 output level	TTRC board
d	line 4 output level	TTRC board
E	coarse line level adjust	TTRC board
F	SAM encoder level	SAM

Control Tray Front Panel Switches EEPOT Adjustment

To adjust the EEPOTs:

1. Press and hold the **Select/Set** switch to **Set**.
2. Set the **PL Dis/Xmit** switch to **PL Dis**.

   Verify the **Status** display shows **EEP**. This indicates the EEPOT mode is being accessed.
3. Release the **Select/Set** switch.
4. Set the **PL Dis/Xmit** switch to the center position.

   After a few seconds, a three-digit number appears in the **Status** display. Refer to Figure 2-3.

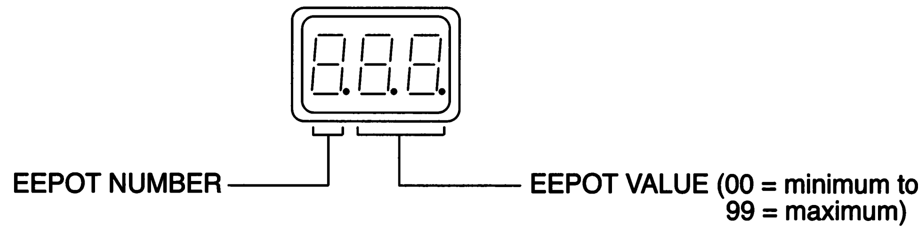

Figure 2-3 **Status Display - EEPOT Adjustment Mode**

5. To select a different EEPOT, press and release the **Select/Set** switch to **Select**.

   Verify the decimal point shows on the **Status** display.

6. Repeatedly press the **Select/Set** switch to **Select** until the decimal point moves to the right of the leftmost digit.

> **NOTE**
>
> If more than 5 seconds pass between step 7 and step 8, the select mode has timed-out and the decimal point disappears. To reactivate the select mode, press the **Select/Set** switch to **Select**. If the **Select/Set** switch is moved to **Set** after the decimal point disappears, the station exits the EEPOT adjust mode.

7. Repeatedly press the **Select/Set** switch to **Set** until the number of the EEPOT requiring adjustment appears in the left position.

   Table 2-3 lists the numbers of the EEPOTs.

> **NOTE**
>
> If the desired EEPOT number is passed by, continue toggling the **Set** switch until the number appears again. The EEPOTs are accessed sequentially.

8. Repeatedly press the **Select/Set** switch to **Select** until the decimal point moves to the right of the second digit.

9. Repeatedly press the **Select/Set** switch to **Set** until the desired EEPOT coarse level adjustment appears in the **Status** display.

10. Repeatedly press the **Select/Set** switch to **Select** until the decimal point moves to the right of the third digit.

11. Repeatedly set the **Select/Set** switch to **Set** until the desired EEPOT fine level adjustment appears in the **Status** display.

12. Wait until the **Status** display times-out, then set the **Select/Set** switch to **Set**.

    Verify the **Status** display returns to the **Chan/Mode/Key** mode.

    Adjustment is complete.

MSF 5000 Radio Service Software (RSS) EEPOT Adjustment

The RSS allows for the adjustment of a station using a standard IBM-compatible personal computer. The minimum requirements for the computer are: IBM PC or XT, DOS 3.0, 512K RAM, and one RS-232 port.

Verify the Radio Service Software (RSS) is properly loaded in the personal computer. Refer to the *MSF 5000* Field Programmer User Reference Manual, part number 68P81125E68, for software loading instructions. Connect the equipment as shown in Figure 2-4 before adjusting the EEPOTs.

CAUTION

Do not use the Control Tray front panel adjustment or disconnect the computer during the adjustment procedure to prevent the loss of EEPOT changes.

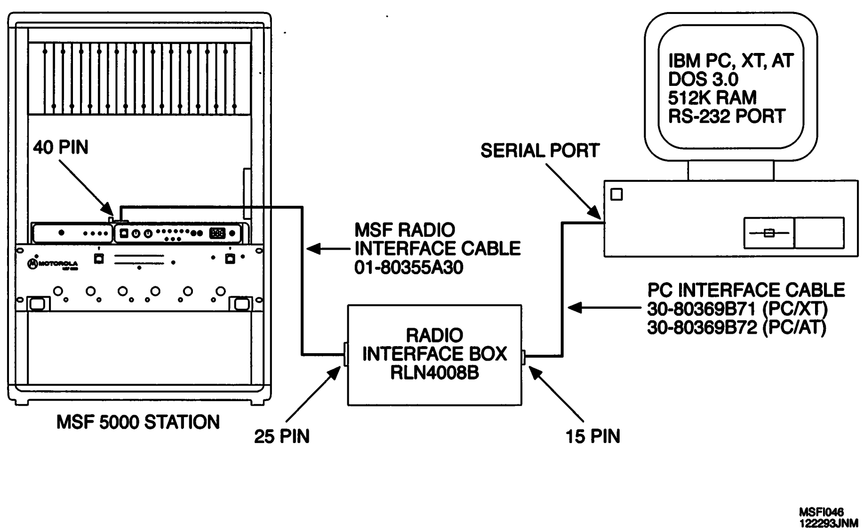

Figure 2-4 **Field Programmer and Equipment Connections**

1. From the Main Menu, press the F3 key.

   The Get/Save/Program Menu appears.

2. Press the [F2] key.

   The RSS reads the codeplug data. After a few seconds, the Get/Save/Program Menu appears again.

3. Press the [F10] key.

   The Main Menu appears.

4. Press the [F2] key.

   The Service and Alignment Menu appears.

5. Press the [F3] key.

   The Individual Station Alignments screen appears.

6. Use the up and down arrow keys ([↑] and [↓]) to scroll through the menu and highlight the EEPOT desired for adjustment.

7. Press the [Enter] key to select the highlighted EEPOT.

   The Alignment Field Setting screen appears.

8. To set the EEPOT's value, use the up and down arrow keys and the [PgDn] and [PgUp] keys to move the sliding bar.

9. Press the [F4] key.

   The EEPOT value is saved.

> **NOTE**
>
> Make sure the EEPOT value is saved before exiting.

10. Use the function keys described in the RSS user reference manual to perform the required functions.

High Speed Ring Display Mode

To aid in troubleshooting of the Control Tray, refer to the **Status** display to read the five HSR data bytes that circulate between the Control Tray modules. The HSR data bytes are read only. The data must be decoded from hex to binary to determine which data signals are active. Refer to Appendix A - High Speed Ring Bytes for additional information.

To enable the HSR display mode:

1. Press and hold the **Select/Set** switch to **Set**.

   Verify the decimal point is not lit and the mode and channel is displayed.

2. Press the **Acc Dis/Reset** switch to **Acc Dis.**

   Verify the **Status** display shows **HSr.** This indicates the station is in the HSR mode.

3. Release the **Select/Set** switch.

4. Set the **Acc Dis/Reset** switch to the center position.

   Verify the **Status** display indicates a **1** in the left position and a two digit hexadecimal value in the center and right positions. This number represents the eight-bit data of the first HSR data byte.

To verify the values of the remaining four HSR data bytes:

1. Press and release the **Select/Set** switch to **Select.** Verify the decimal point is to the right of the leftmost digit.

2. Repeatedly press the **Set** switch and scroll through the remaining four HSR data bytes.

To exit the HSR display mode, set the **Select/Set** switch to **Set** and release the switch.

Forward/Reflected Power Trip Point Set Mode

CAUTION

The Forward / Reflected Power Trip Point Set Mode should only be performed on Trunking and Data stations. Do not attempt to enter or adjust this mode if a wattmeter is not present in the station (i.e., conventional stations). The codeplug may be corrupted which causes constant alarms.

The forward / reflected trip point adjust mode reads and adjusts the forward and reflected trip point settings of the station. Trunking stations are equipped with a wattmeter that monitors forward and reflected power. TSTAT is deactivated when either the forward power drops below a pre-determined trip point or when the reflected power exceeds a pre-determined trip point. If this occurs, a station malfunction signal is sent to the trunking central controller. Refer to Chapter 4 - Alignment for the procedure to adjust the trip point settings.

Station Diagnostics

The system contains extensive diagnostic capabilities. The two basic categories of diagnostics are the Power-up/Reset Diagnostics and Continuous Diagnostics.

Power-Up/Reset Diagnostics

Upon station power-up or reset, a variety of diagnostic tests are performed to verify the hardware is functional, and firmware and code plug devices are correctly programmed. The hardware diagnostic tests encompass both digital and audio tests. These tests can detect a faulty device or group of components. In some instances (i.e., the ASICs), the faulty circuit within a component can be identified.

The faulty components are indicated to the user via the **Status** display on the Control Tray and the **Fail** LEDs on the TTRC and Secure Boards. There are three forms of power-up/reset diagnostic failure indications:

- ❒ Flashing Control Tray Status Display Failure Indication
- ❒ Flashing TTRC LED or Secure Fail LED Failure Indications
- ❒ Control Tray Status Display Error Code Indication

Flashing Control Tray Status Display Failure Indication

The entire **Status** display may flash **8.8.8.** two or four times in a sequence to indicate a specific error. Refer to Appendix B - Error Codes for more information. This indicates the **Status** display may not be able to display normal error codes.

Flashing TTRC LED or Secure Fail LED Failure Indications

These LEDs may flash two, four, or six times in a sequence to indicate a specific error. Refer to Appendix B - Error Codes for more information. This indicates the TTRC or Secure board has determined that it is unable to communicate to the SSCB via the IPCB. Normally, the remote modules pass self-diagnosed failures to the SSCB over the IPCB so the Control Tray can display the appropriate error codes on the **Status** display.

Control Tray Status Display Error Code Indication

A detected failure is indicated when an error code appears on the **Status** display. The first letter (left-most) defines the error code class. The letters xx define the specific error code within the error code class. The error code classes and **Status** display indications are:

- audio error - A.x.x.
- digital error - d.x.x.
- operational error - E.x.x.
- special test mode error - o.x.x.
- undefined error - U.x.x.

The error code display in hexadecimal format.

NOTE

All non-fatal error codes display for two seconds. All fatal error codes display for five seconds.

If the error code is greater than or equal to hexadecimal $80, the error is fatal and the station will reset after the error code displays. When the station resets, the **Status** display momentarily shows **8.8.8.**. Do not confuse this single flash with flashing **Status** display error code indications. When this occurs, the **Status** display blinks two or four times, then one, then two or four times again, etc.

Non-fatal errors allow the station to continue with diagnostics and eventually operate after all of the error codes and firmware version numbers display.

NOTE

All three **Status** display decimal points are it when showing error codes. This differentiates error codes from other display modes.

Power-Up/Reset Sequence

The following describes the sequence of events upon a station power-up/reset:

- The SSCB activates the expansion reset during the SSCB self-test. While the expansion reset is active, TTRC, Secure, and any Expansion Tray boards are held in reset.
- The Control Tray **Status** display-driving circuitry is tested. All of the **Status** display digits light (**8.8.8.**) as a lamp test to determine if error codes display. If this test fails, the entire **Status** display flashes two times.
- The SSCB external and internal RAM are tested. The **Status** display blanks for approximately 1.5 seconds while digital and software diagnostic tests are performed. If this test fails, the entire **Status** display flashes four times.

- ❐ The SSCB firmware checksum, the SSCB Standard mode, and the I/O Mode ASICs are tested. This includes output latch and input buffer loopback, MUXbus circuitry, and HSR circuitry. The SSCB code plug is tested for proper module ID, version number, and checksum. The SSCB IPCB ports are tested. If any of these tests fail, the corresponding error code appears on the **Status** display.
- ❐ The audio diagnostics is performed. The **Status** display indicates a test-in-progress dash (-) during the SSCB audio diagnostic test. If any of these tests fail, the corresponding error code is displayed on the **Status** display.
- ❐ The expansion reset is disabled.
- ❐ The SSCB firmware version number displays.
- ❐ The TTRC diagnostic routines are enabled (if a TTRC board is present) with an IPCB wake-up command. The **Status** display indicates a test-in-progress dash (-) during the TTRC digital and audio diagnostic tests. All TTRC failures are reported at this time. When the TTRC board completes the diagnostics, the TTRC firmware version number displays.
- ❐ The Secure board diagnostic routines are enabled (if a Secure module is present) with an IPCB wake-up command. The **Status** display indicates a test-in-progress dash (-) during the Secure board digital and audio diagnostic tests. All Secure failures are reported at this time. When the Secure board completes the diagnostics, the Secure board firmware version number displays.
- ❐ The normal station operating mode is entered. The **Status** display reverts to the **Chan/Mode/Key** indication. If several non-fatal errors are detected during diagnostics, they may queue up. If so, they appear on the **Status** display, in order, until the error queue is emptied.

NOTE

In the event that multiple errors display, always resolve the first error displayed before trying to debug other errors. Often the other failures are the result of the first failure.

Audio Diagnostics

Extensive audio-path diagnostic tests are implemented on all modules to detect defective components and circuit blocks. This capability enables the station to diagnose itself and indicate which component or group of components is faulty. As a result, users can be alerted to potential problems before they experience them, reducing station down time and service costs.

Typically, the audio tests are performed during the power-up sequence. After the digital circuits have been verified, audio tests are performed.

Most audio diagnostic tests are implemented using closed-circuit stimulus-response techniques. A test signal is generated on-board and is routed to the circuit-under-test. The output of the circuit-under-test is then monitored using the analog-to-digital converter on the MC68HC11 processor or certain logic inputs.

NOTE

All audio errors are non-fatal.

A faulty audio circuit does not shut down the station, as other station functions may be operational. Consequently, graceful degradation of station performance is achieved in the event of a marginal or defective audio circuit.

All audio diagnostic errors are reported via the Control Tray **Status** display in the format of A.x.x., where xx is a hexadecimal error code. If an audio test should fail, the error code displays for two seconds. During this brief time, the service person may freeze the test configuration by setting the front panel **Acc Dis/Reset** switch to **Acc Dis**. The tests are suspended until two seconds after **Reset** is selected.

Freezing the audio diagnostic routine after an error is necessary to set up the proper gating required to find the problem circuit, which may be difficult to do under normal operating conditions.

All EEPOTs are fully exercised during audio tests. They are returned to their original settings as indicated by the code plug. As a result, if the code plug values are not accurate (i.e., the code plug was recently replaced or the station was reset during code plug re-programming), the EEPOTs are not be returned to their original positions, and station realignment may be necessary.

Continuous Station Diagnostics

The continuous class of diagnostics always monitors the status of the station. One part of the continuous diagnostics monitors the software program controlling the station. If abnormal operation is encountered, an error code displays in the Control Tray **Status** display. Refer to Appendix B - Error Codes for additional information.

The other part of continuous diagnostics operates by reading the eight reverse wildcard (RW) bits on the station MUXbus. These bits are on addresses 12 and 13. If any of these bits are active, a corresponding number of alarm tones generate. The alarm tones can be routed to the wireline and/or over the air, and are always heard in the local speaker.

Alarm tone beeps generate every ten seconds, and if more than one alarm is active, the beep messages are sent one after the other (separated by two seconds). There are eight pre-defined alarms provided as standard in the station.

RW1 - One Beep - Battery Revert Alarm

Indicates the station has lost AC line power and has reverted to battery backup (if equipped). The alarm is cleared as soon as the station receives AC line voltage.

RW2 - Two Beeps - PA Alarm

Indicates a PA failure. It is set when the station's power control circuit detects a PA problem or if the power control service mode is entered. The alarm is cleared only by a successful key-up of the station. It is not reset during the same key-up which sets the alarm.

RW3 - Three Beeps - Synthesizer Alarm

Indicates the transmit or receive synthesizer is out of lock. The alarm clears as soon as both synthesizers lock.

RW4 - Four Beeps - Overvoltage Alarm

Indicates the battery charging voltage (if equipped) is too high. The alarm clears when the voltage assumes a normal level.

RW5 - Five Beeps - TSTAT Alarm

Indicates a TSTAT failure in a trunking station. The alarm clears when the station is successfully keyed. The TSTAT generation requires:

- locking VCO/synthesizer
- trunking TDATA to be detected by the station
- no PA alarm present
- no forward or reflected alarms present

RW6 - Six Beeps - Reflected Alarm

Indicates the station has incorrect reflected power as determined by the reflected power trip point. The alarm clears when the station is successfully keyed.

RW7 - Seven Beeps - Forward Alarm

Indicates the station has incorrect forward power as determined by the forward power trip point. The alarm clears when the station is successfully keyed.

RW8- Eight Beeps - Redundant Station Alarm

Indicates a problem exists with one or both of the redundant stations. The alarm clears when both stations are cleared of all errors. A redundant station is an optional configuration. This error is only present when using this configuration.

INSTALLATION

Installation

Chapter Overview

This chapter provides hardware installation procedures required for a *MSF 5000* station. The information described in this chapter assumes the field technician or installer has knowledge of the installation techniques contained in the Quality Standards FNE Installation Manual R56. It is also assumed the site has been previously prepared for installation including all associated antennas, power requirements, and other related site equipment.

Chapter contents are listed in Table 3-1.

Table 3-1 ***Chapter Contents***

Section	Page	Description
Preinstallation	3-2	Identifies requirements prior to installing a station. Lists typical procedures to follow for installing a cabinet.
Installation	3-10	Lists procedures required to install a station.
Other Options	3-25	Lists procedures required to install station options.

Preinstallation

The following information should be considered prior to installing a station.

! WARNING !

Always use two or more persons when moving an *MSF 5000* cabinet. A fully configured cabinet weighs approximately 500 pounds.

Inspection

CAUTION

The station contains CMOS devices. Proper grounding precautions are required by personnel prior to handling equipment, or damage to equipment may result.

Inspection of the *MSF 5000* equipment must be performed as soon as all equipment is unpacked. Check for loose or damaged equipment. Check all sides of each cabinet for damage from shipment.

Observe guidelines for safe handling or electrostatic sensitive equipment, such as CMOS devices, to prevent electrostatic damage to equipment. An anti-static wrist strap should be worn when handling any electrical equipment.

Thoroughly inspect the equipment after delivery. Contact the shipping company immediately if damage has occurred. Then contact your Motorola representative.

If obvious damage has occurred to the shipping containers before unpacking, contact the shipping agent and ask that a representative of their company be present while the equipment is unpacked.

Ventilation and Spacing

The radio equipment is operated with forced or passive ventilation. The cabinets contain vents that allow outside air to be drawn in through louvered openings in the door and expelled through an opening in the cabinet sides.

When installing a cabinet, allow a minimum of:

- 6″ from all air vents
- 12″ in front of the cabinet for servicing.

AC Source

All stations must have a separate power circuit from the 120 or 220 Vac, 50 or 60 Hz power source. The circuit current rating is determined by the number of power supplies contained in the station. This circuit must be capable of 15-ampere (minimum) per power supply for low power stations and 20-ampere (minimum) for high power stations.

Use High Magnetic (HM) circuit breakers to prevent unnecessary tripping. The power lines should be installed in accordance with local electrical codes.

Site Grounding and Lightning Protection

A major consideration 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. Examples are AC or DC electrical power used as the power source for equipment at the site, telephone lines, and wires or cables connected to alarms or sensors at the site. A substantial earth ground must be as close to, and in as straight a line, as possible with the ground terminal on the Junction Box.

CAUTION

Do not consider the electrical outlet box as a substantial ground. Install a separate, sturdy ground.

- RF Ground - Pertains to the transmission of radio frequency energy to earth ground. Example is shielding to prevent (or at least minimize) the leakage of unwanted RF transmission from communications equipment and cables.
- Lighting Ground - The supply of adequate lightning protection is critical to a safe communications site. Telephone lines, RF transmission cables, and AC and DC power lines must be protected to prevent lightning energy from entering the site building.

Refer to the Motorola Quality Standards FNE Installation Manual R56 for detailed information on site grounding techniques and lightning protection.

Antennas

Antennas and transmission lines are not part of the station. Refer to the instructions shipped with the antenna for installation instructions and other applicable information.

Audio and Control Wirelines

Before installing the equipment, verify the characteristics of leased telephone lines with the company providing the service. The audio wireline(s) for nonsecure stations must meet the following specifications for acceptable radio communications.

- Frequency response: 500-2750 Hz +1 dB to -8 dB referenced to 1000 Hz
- Impedance: 600 or 900 Ω nominal, balanced
- Frequency offset: +5 Hz maximum
- Line Loss: Less than 30 dB from 600 to 2200 Hz for line impedance tolerance of +100% to -50% from nominal impedance of 600 or 900 Ω. The impedance tolerance only applies to two-wire tone remote control stations in which the level from the remote console is lower than 22 dB below the level of outgoing receiver line audio (e.g., line loss greater than 22 dB).

The audio wireline(s) for secure stations require a 3002, D-conditioned phone line.

The control wireline may be installed prior to cabinet installation and terminated near the location chosen for the station. Conduit or two-wire cable can be used from this termination to the Junction Box wireline interface connections.

Required Tools

The following special tools are required during installation.

- TORX™ model T-45 driver (Motorola part no. 66-84071N02)
- Hoist
- 1/4″ flat blade screwdriver

Cabinet Information

The following information may be helpful in planning the installation of the station. Different size cabinets may be stacked together, however, total combined height should not exceed 111″. The 46″ cabinets are available in depths of 10″, 15″, and 20″. Refer to Appendix F - MSF 5000 Options.

26" Cabinets

- Tip feet are not required. The cabinet is stable if other cabinets are not stacked on top.
- The welded nut under the top plastic cap center hole is used as an anchor point for stacking.
- The bottom plastic cap center hole is used:
  - to anchor the cabinet to the floor.
  - to secure the cabinet when it is stacked on top of another cabinet.
- Up to four 26″ cabinets may be stacked.

37" Cabinets

- Tip feet are not required. The cabinet is stable providing other cabinets are not stacked on top.
- The welded nut under the top plastic cap center hole is used as an anchor point for stacking.
- The bottom plastic cap center hole is used:
  - to anchor the cabinet to the floor.
  - to secure the cabinet when it is stacked on top of a 37″, 46″, or 51″ cabinet.
- Up to three 37″ cabinets may be stacked.

46" Cabinets

- Tip feet are shipped and required in a stand-alone configuration. The cabinet is highly unstable without tip feet.
- Each tip foot contains two mounting holes to anchor the cabinet to the floor.
- When stacking or anchoring the cabinet to the floor, the tip feet must be removed.
- The welded nut under the top center plastic cap is used as an anchor point for stacking.
- The welded nut on top of the bottom plastic cap:
  - is used for anchoring when stacked on top of a 51″ cabinet.
  - must be broken off and discarded when used for anchoring the cabinet to the floor.
- Up to two 46″ cabinets may be stacked.

51" Cabinets

- Tip feet are shipped and required in a stand-alone configuration. The cabinet is highly unstable without tip feet.
- Each tip foot contains two mounting holes to anchor the cabinet to the floor in a stand alone configuration.
- When stacking or anchoring the cabinet to the floor, the tip feet must be removed.
- The bendable weld-nut tab under the top plastic cap center hole:
  - allows hoisting of the cabinet.
  - provides a bolt feed-thru, when bent down, for stacking 26″, 37″, 46″, or 51″ cabinets on top.
- The center feed-thru hole in the bottom plastic cap:
  - used for anchoring the cabinet to the floor.
  - is used for anchoring when stacking on top of a 51″ cabinet.
- Up to two 51″ cabinets may be stacked.

Cabinet Dimensions and Details

Cabinet dimensions are shown in Figure 3-1. The recommended floor mounting patterns for nonstacked and stacked cabinets are shown in Figure 3-2.

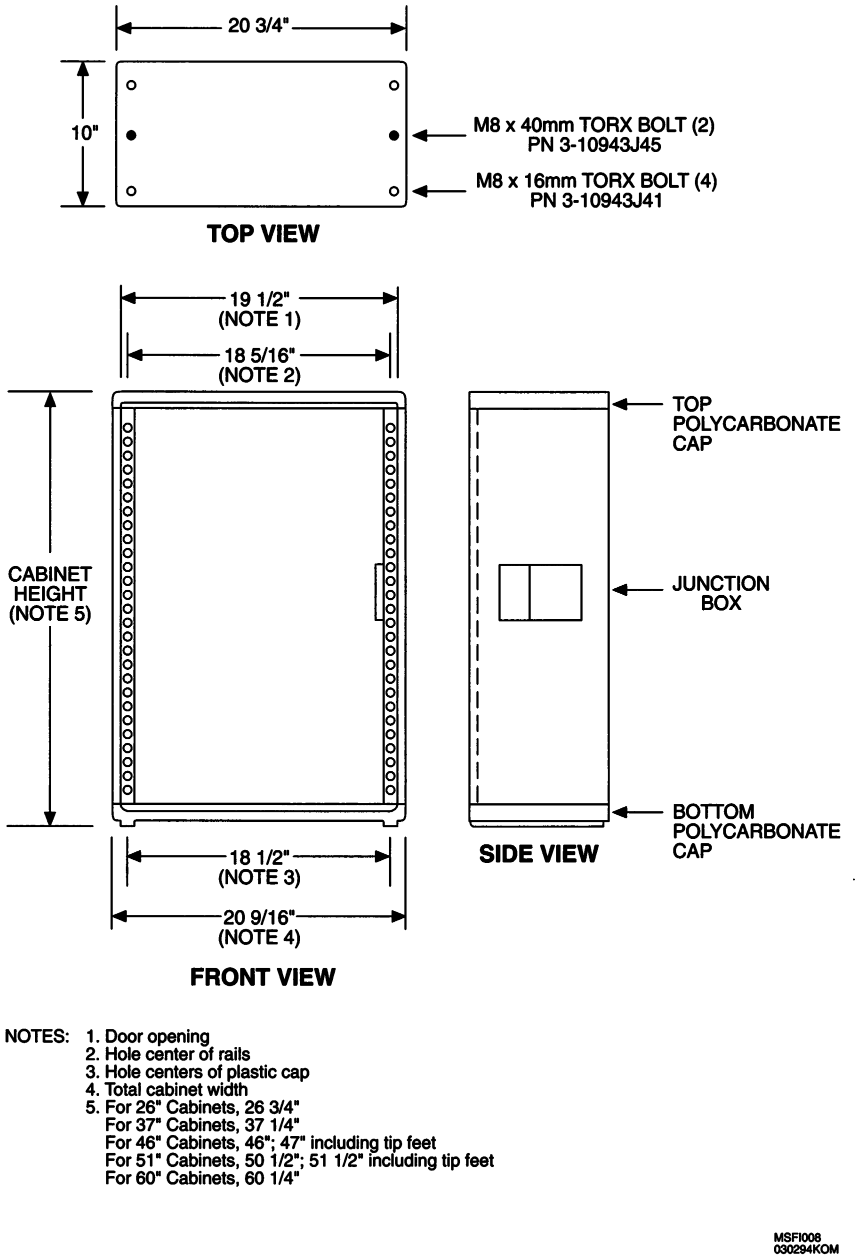

Figure 3-1 ***Cabinet Dimensional Details***

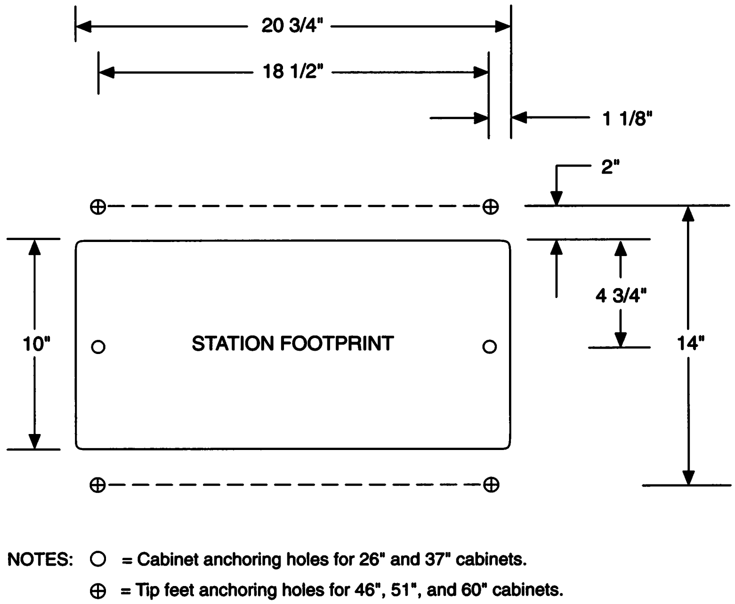

Figure 3-2 ***Recommended Mounting Patterns***

Before Installing a Cabinet

Carefully plan the installation of the cabinet to ensure the best possible performance and maintainability of the station. The cabinet should be located on a solid, level surface convenient to the power source and the RF transmission line.

Cabinet installation is nonstacked or stacked. A nonstacked cabinet may be installed free standing or anchored to the floor (recommended method). A stacked cabinet must be anchored to the floor and wall or overhead support.

Table 3-2 lists available kits used to install a station.

Table 3-2 ***Installation Kits***

Model	Description	Recommended Use
TRN5757	Stacking bracket kit	Stacking and bracing cabinets
TRN5155	10-foot external battery cable	Connecting optional DC input power
TKN8498	25-foot cable	Connecting trunked repeater
TKN8501	50-foot cable	Connecting trunked repeater
TKN8502	75-foot cable	Connector trunked repeater
TKN8548	100-foot cable	Connecting trunked repeater

CAUTION

Do not drill additional holes into the cabinet or damage to the structure may result.

NOTE

All hardware used to mount the cabinet to the floor or existing structure is supplied by the customer.

Typical Cabinet Installation Procedures

The following procedures including the paragraph reference are used to install a cabinet.

1. Determine the type, location, and how to mount the cabinet. Refer to "Cabinet Information" on page 3-4 and "Before Installing a Cabinet" on page 3-7.

2. Prepare the cabinet(s) for floor mounting if required. Refer to "Cabinet Dimensions and Details" on page 3-6.

3. Mount or support the cabinet(s), if required. Choose the type of support or mount procedure for nonstacked or stacked cabinet. Refer to "Nonstacked Cabinet Mounting" on page 3-10 and "Supporting of Cabinets" on page 3-14.

4. Stack the cabinet(s) if required. Refer to "Before Stacking Cabinets" on page 3-11 and "Stacking a Cabinet" on page 3-12.

5. Connect the antenna. Refer to "Connecting an Antenna" on page 3-20.

6. Connect the control wireline. Refer to "Connecting the Control Wireline" on page 3-20.

7. Connect the line cord or optional DC power to the Junction Box if required. Refer to "Installing the Line Cord" on page 3-23 or "Installing the DC Input Power Option" on page 3-25.

8. Connect the external site frequency standard if required. Refer to "Connecting the Optional External Site Frequency Standard" on page 3-26.

Installation

The following procedures describe how to install a station into the permanent site building. The procedures include installation of nonstacked and stacked cabinets.

Nonstacked Cabinet Mounting

The following procedures are for flush wall, staggered back-to-back, and perfect back-to-back mounting of nonstacked cabinets.

Flush Wall Mounting

1. Remove tip feet if required. Refer to "Tip Feet Removal" on page 3-18.
2. Secure the cabinet to the floor. Refer to "Bottom Anchoring" on page 3-19.
3. Secure the top of the cabinet to the adjacent wall. Refer to "Wall Support of Cabinet" on page 3-14.

Staggered Back-to-Back Mounting

NOTE

Stagger 46" or 51" cabinets by 1.5" to allow for tip feet clearance.

1. Position the first cabinet. Refer to Figure 3-3.
2. Secure the cabinet to the floor using all four holes in the tip feet. Refer to "Bottom Anchoring" on page 3-19.
3. Position the other cabinet.
4. Anchor the cabinet to the floor.

Perfect Back-to-Back Mounting

1. Remove the tip feet if required. Refer to "Tip Feet Removal" on page 3-18.
2. Secure one cabinet to the floor. Refer to "Bottom Anchoring" on page 3-19.
3. Place the backs of the cabinets 1.5" apart and secure the other cabinet to the floor.

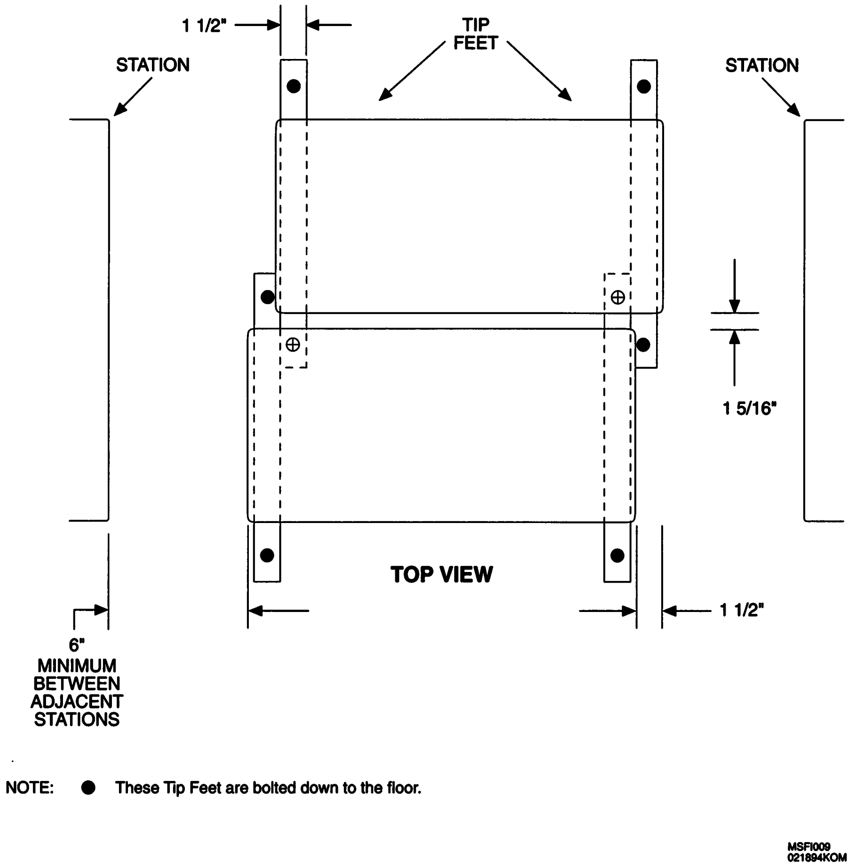

Figure 3-3 ***Staggered Back-to-Back Installation***

Before Stacking Cabinets

Cabinets stacked against a wall must be anchored at the top and the bottom. Cabinets not stacked against a wall should be stacked back-to-back and stabilized by using the brackets provided in the TRN5757 Stacking Bracket Kit.

The kit provides the necessary hardware to safely secure the cabinets to the wall, overhead structure, or each other. More than one kit may be required, depending upon the type of installation.

! WARNING !

Always use two or more persons when moving an *MSF 5000* cabinet. A fully configured cabinet weighs approximately 500 pounds.

Always secure the tallest, and usually the heaviest, cabinet at the bottom of the cabinet stack to prevent tipping of the cabinet.

NOTE

For proper ventilation, allow a minimum of 6″ clearance between louvered side panels. Allow a minimum of 12″ of access space at the cabinet door.

On some stations, access to the bottom or top center holes of the plastic cap is blocked. Slide out or remove the piece of equipment blocking access, if required.

Stacking a Cabinet

Perform the following to stack 26, 37″, 46″, and 51″ cabinets. The procedures assume that the lower cabinet is secured to the floor.

! WARNING !

Do not exceed the maximum stacked cabinet height of 111″ or the cabinets may tip.

26", 37", 46", and 51" Cabinets

To stack 26″, 37″, 46″, and 51″ cabinets on top of other cabinets:

1. Remove the two middle bolts from the top plastic cap of the lower cabinet. Refer to Figure 3-4.
2. For 46″ cabinets only, use a flat tip screw driver and remove the break-away weld-nut tabs from the bottom plastic cap center hole of the upper cabinet.
3. For back-to-back installations, place the cross strapping on top of the lower cabinet.
4. Using a hoist, carefully lift and position the upper cabinet on top of the lower cabinet.
5. Secure the cabinets together by inserting the two bolts removed in step 1 into the bottom rail center holes of the upper cabinet. Tighten both screws.

Dual 51" Cabinet

To stack a 51″ cabinet on top of a 51″ cabinet:

1. Tilt the driver PA deck in the bottom cabinet forward to access the mounting holes from inside the top of the lower cabinet. Refer to Figure 3-5.
2. Remove and discard the two middle bolts from the top plastic cap of the lower cabinet.

3. Bend the lifting bracket tab nut away from the middle bolt hole.

4. For back-to-back installation, place the cross strapping on top of the lower cabinet. Refer to Figure 3-4 for the cross strapping location.

NOTE

For flush wall mounting, two stacking bracket kits are required. One pair of brackets used between the upper and lower cabinets; the other pair used on top of the upper cabinet.

5. For flush wall mounting, place the two brackets on top of the lower cabinet and secure the brackets to the wall.

6. Using a hoist, carefully lift and position the upper cabinet on the lower cabinet.

7. Insert and tighten the self-threading bolts (part of stacking bracket kit) from the middle bolt holes of the lower cabinet upward into the bottom rail of the upper cabinet.

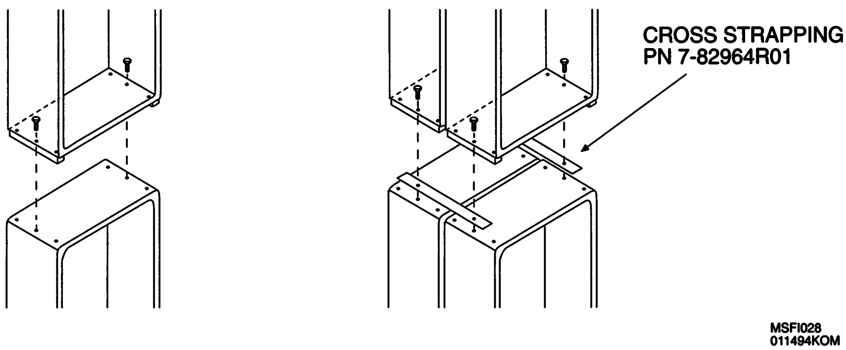

Figure 3-4 ***Cabinet Stacking***

Supporting of Cabinets

Stacked cabinets must be supported by the wall, adjacent cabinets, or an overhead structure. Choose the applicable cabinet support procedure for the specific installation. The following procedures assume the cabinet is stacked and secured to the floor.

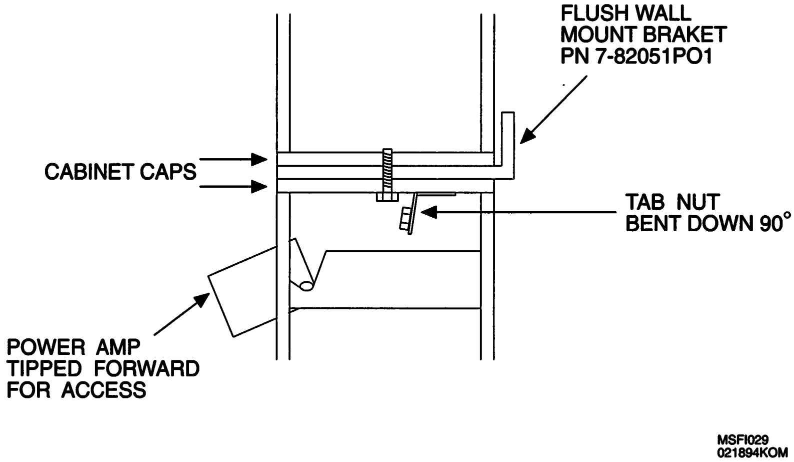

Figure 3-5 ***Cabinet Stacking, 51" Cabinets Only***

Wall Support of Cabinet

1. Remove and retain four screws from the top plastic cap of the upper cabinet. Refer to Figure 3-6.
2. Position the two brackets supplied with the stacking kit over the top plastic cap screw holes of the upper cabinet.
3. Install and tighten the four screws (removed in step 1) through the brackets into the top plastic cap.
4. Install and tighten the four customer supplied screws through the brackets into the wall.

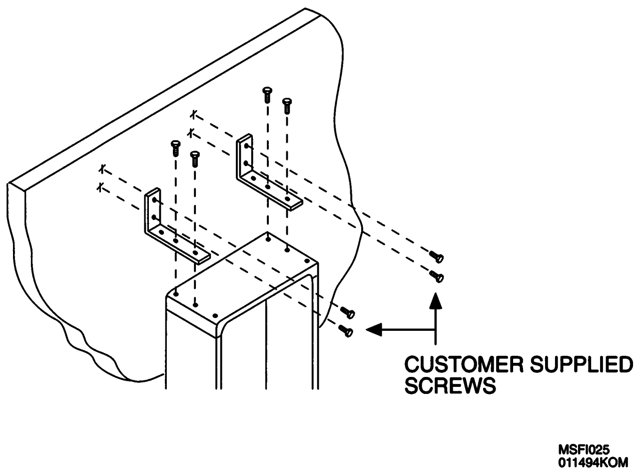

Figure 3-6 ***Bracket Installation for Wall Support***

Overhead Support of Single Cabinet Stacks

1. Remove and retain the four screws from the top plastic cap of the upper cabinet. Refer to Figure 3-7.
2. Position the two brackets supplied with the stacking kit over the top plastic cap screw holes of the upper cabinet.
3. Install and tighten the four screws (removed in step 1) through the brackets into the top plastic cap.
4. Install and tighten the four customer supplied screws through the brackets into the overhead support.

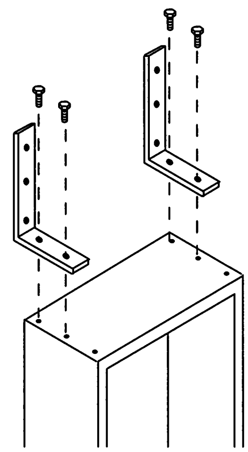

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Figure 3-7 ***Bracket Installation for Overhead Support of Single Cabinet Stacks***

Overhead Support of Adjacent Cabinet Stacks

1. Remove and retain two screws from each of the adjacent top plastic caps of the stacked cabinets. Refer to Figure 3-8.
2. Position the two brackets supplied with the stacking kit between the top plastic cap screw holes of the adjacent stacked cabinets.
3. Install and tighten the four screws (removed in step 1) through the brackets into the top plastic caps.
4. Install and tighten the four customer supplied screws through the bracket into the overhead support.

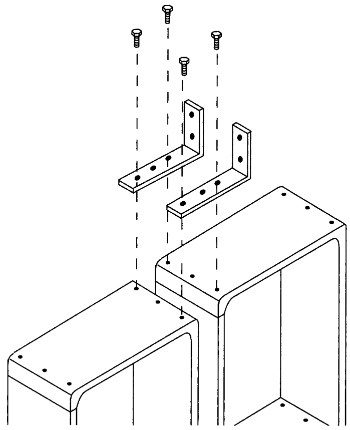


Figure 3-8 ***Bracket Installation for Overhead Support of Adjacent Cabinet Stacks***

Overhead Support of Back-to-Back Cabinets

1. Remove and retain two screws from each of the back-to-back top plastic caps of the upper cabinets. Refer to Figure 3-9.
2. Position the two brackets supplied with the stacking kit between the top plastic cap screw holes of the back-to-back upper cabinets.
3. Install and tighten the four screws (removed in step 1) through the brackets into the top plastic caps.
4. Install and tighten the four customer supplied screws through the brackets into the overhead support.

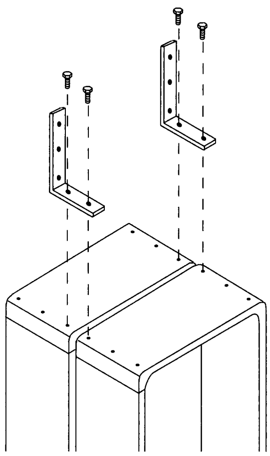


Figure 3-9 ***Bracket Installation for Overhead Support of Back-to-Back Cabinets***

Tip Feet Removal

Perform the following procedures to remove the tip feet.

! WARNING !

Always use two or more persons when moving an *MSF 5000* cabinet. A fully configured cabinet weighs approximately 500 pounds.

The lifting brackets should only be used with a hoist to apply upward force to the cabinet. The lifting brackets may bend and fail if inward force is applied. A hoist bar should be used.

1. For cabinets with lifting brackets, carefully lift the cabinet with a hoist. Refer to Figure 3-10.

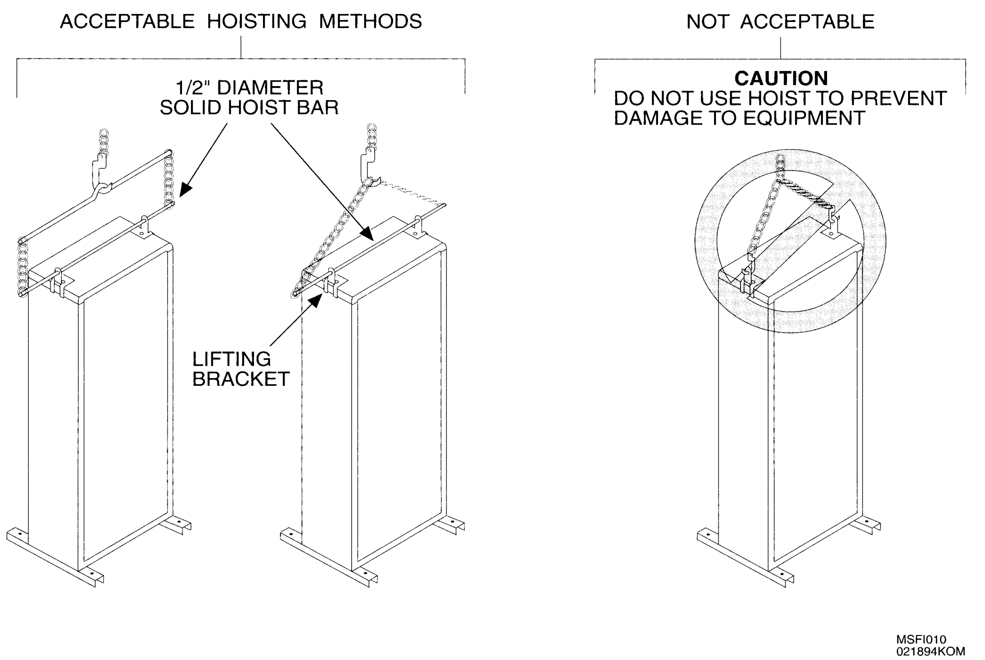


Figure 3-10 ***Recommended Hoisting Methods***

2. For any other cabinet, carefully lay the cabinet on one side. Make sure the VCOs are locked into position and shipping screws are not removed.

3. Remove the tip feet. Refer to Figure 3-11.

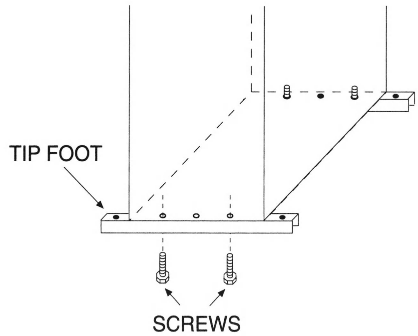


Figure 3-11 ***Tip Foot Removal***

Bottom Anchoring

Perform the following procedures to secure a nonstacked or stacked cabinet to the floor.

Nonstacked Cabinets

On some stations, access to the bottom center holes of the plastic cap is blocked. Slide out or remove the piece of equipment blocking access, if required. Refer to Figure 3-12.

- ❒ 26″ and 37″ cabinets - Insert the two customer supplied M8 (or 5/16″) shank diameter screws or bolts of suitable length through the two bottom center holes of the plastic cap into the floor.
- ❒ 46″ and 51″ cabinets - Insert the two customer supplied M8 (or 5/16″) shank diameter screws or bolts of suitable length through the two holes of the tip feet into the floor.

Slide in or install the piece of equipment blocking access, if required.

Stacked Cabinets

Make sure the tip feet are removed, if required. On some stations, access to the bottom center holes of the plastic cap is blocked. Slide out or remove the piece of equipment blocking access, if required. Refer to Figure 3-12.

- ❒ 26″, 37″, and 51″ cabinets - Insert the two customer supplied M8 (or 5/16″) shank diameter screws or bolts of suitable length through the two bottom center holes of the plastic cap into the floor.
- ❒ 46″ cabinet -
  - ❍ Using a flat blade screwdriver, remove the break-away weld-nut tab from the bottom plastic cap center hole.
  - ❍ Insert the two customer supplied M8 (or 5/16″) shank diameter screws or bolts of suitable length through the two center holes of the plastic cap into the floor.

Slide in or install the piece of equipment blocking access, if required.

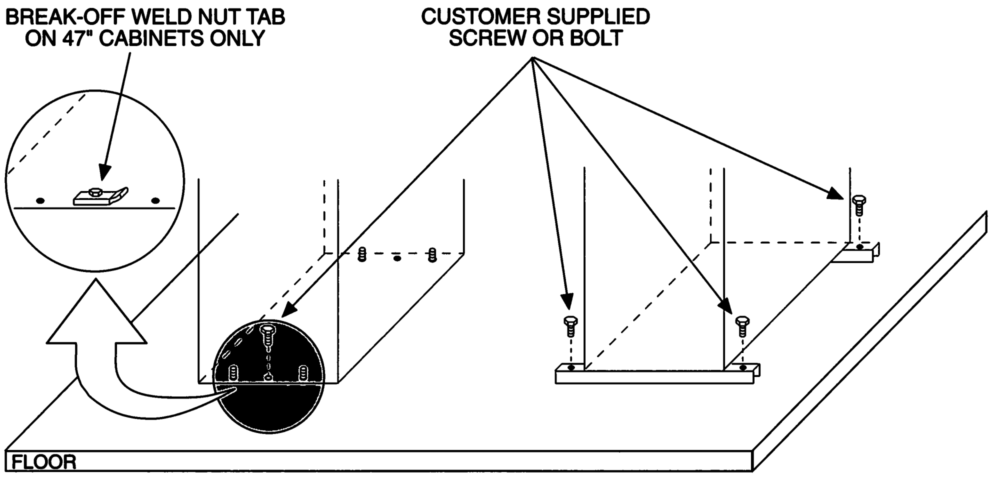


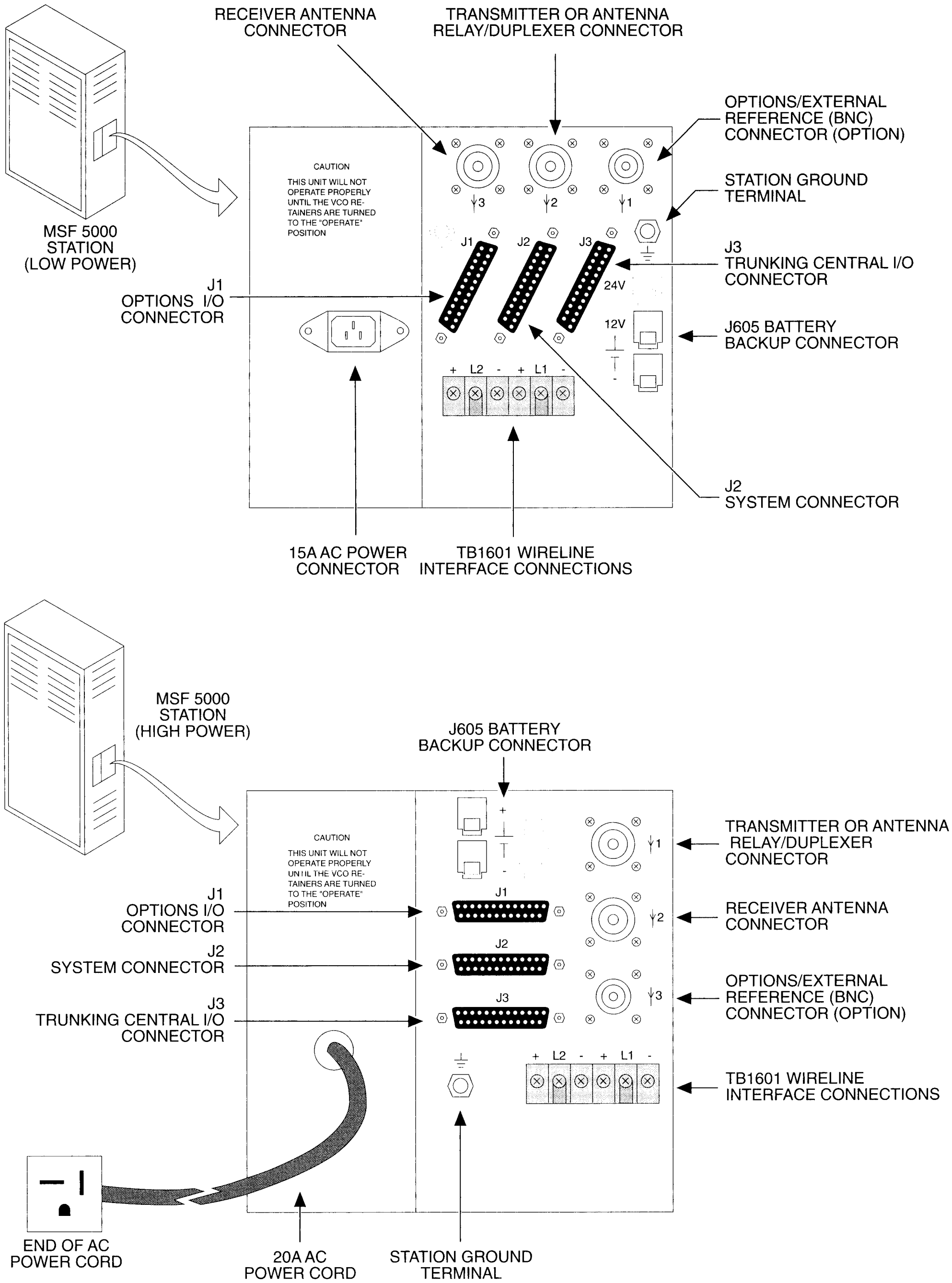
Figure 3-12 ***Bottom Anchoring***

Connecting an Antenna

All coaxial antenna cables connect to the RF connectors on the Junction Box. Refer to Figure 3-13 and Figure 3-14. Two antennas are required for a repeater: one for the transmitter; the other for the receiver. Only one antenna is required for a base station. Type "N" connectors are used for all stations.

Connecting the Control Wireline

The control wireline is connected to the Junction Box. Refer to Figure 3-13 and Figure 3-14. Refer to Figure 3-15 for details on the system and trunking connectors.



NOTE: Connectors may not be on all stations.
Dashed components (24V connection and ground) are used on VHF models only. Refer to the Description section of this manual for more detailed information.

Figure 3-13 ***Connections for Low and High Power Junction Boxes***

Installation

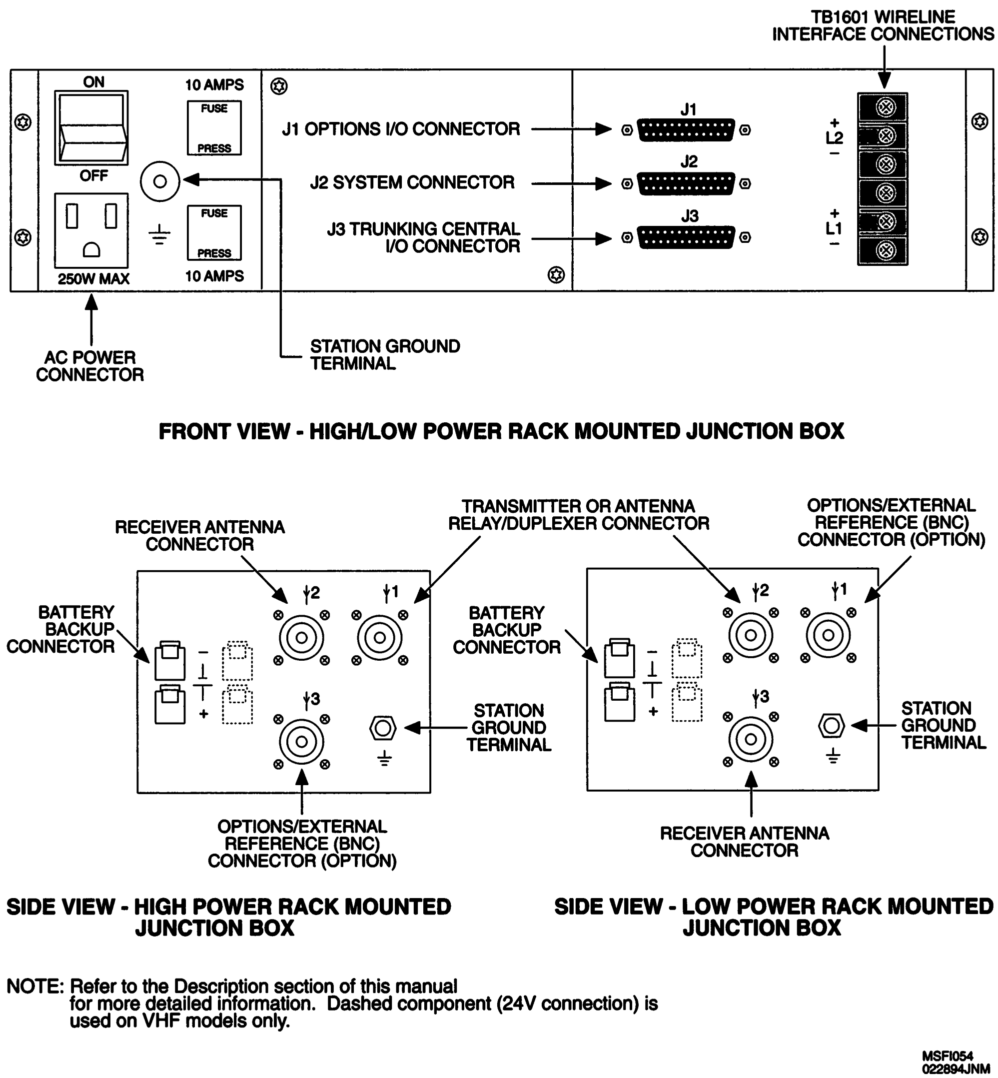


Figure 3-14 ***Connections for Rack Mounted Junction Box***

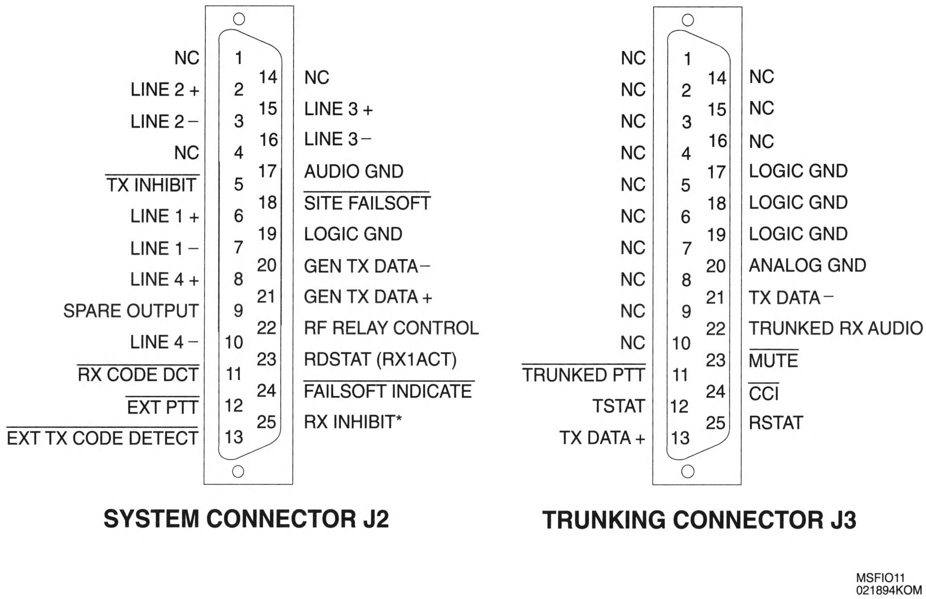


Figure 3-15 ***System Connector and Trunking Connector Pin-Out Details***

Installing the Line Cord

The following procedures are required to install the line cord.

CAUTION

Some stations can immediately key up when power is applied. The transmit antenna connections should be properly terminated prior to installing the line cord.

NOTE

The primary AC power line may be installed prior to installing the cabinet. The power line must be terminated near the location chosen for the station.

1. Connect the ground terminal on the Junction Box to a substantial earth ground. Refer to Figure 3-13 and Figure 3-14. Refer to the Motorola Quality Standards FNE Installations Manual R56 for grounding information.

2. On low power Junction Boxes, connect the AC line cord to the AC power connector.

3. Connect the male plug of the three-wire AC line cord to the wall outlet provided near the station.

Other Options

The following procedures are required to install station options: DC input power option and optional external site frequency standard.

Installing the DC Input Power Option

The TRN5155 External Battery Cable Kit is required to install the optional DC input power or battery bank. Perform the following procedures:

1. Determine the length of black 8-gauge wire required from the Junction Box to the negative terminal of the battery.
2. Connect the black 8-gauge wire from J605 on the Junction Box to the negative terminal of the battery.

NOTE

The TRN5155 External Battery Cable Kit contains 10′ of red and black 8-gauge wire. Runs longer than 10′ are not recommended for efficient battery operation. If longer runs are necessary, increase the wire gauge by 3 AWG for each increase of 10′ in run length.

Use the minimum amount of wire to make the run.

3. Connect the black wire to the battery using the ring tongue lug (part of kit).
4. Make sure all power is disconnected from the station.

! WARNING !

Refer to Chapter 4 - Alignment for the proper battery charge voltage setting before connecting the station to the battery.

5. Connect P605 into the optional battery power connector (J605) on the Junction Box. Refer to Figure 3-13 and Figure 3-14.
6. Remove the fuse from the fuse holder (part of kit).
7. Mount the fuse holder to the battery rack, as close as possible to the battery using the two 8 X 1-1/4″ tapping screws.
8. Determine, route, and cut the red 8-gauge wire required to run from P605 to the fuse block.

9. Attach the red wire to the fuse block.
10. Connect the fuse block to the battery using the cut off piece of red wire.
11. Connect the red wire to the battery using the ring tongue lug.

Connecting the Optional External Site Frequency Standard

If the optional external site frequency standard is used, attach a BNC type connector to the site frequency standard coaxial cable. Connect the cable connector to the RF connector on the Junction Box. Refer to Figure 3-13 and Figure 3-14.

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Alignment

Chapter Overview

This chapter describes how to align an *MSF 5000* base station. The chapter contents are listed in Table 4-1.

Table 4-1 **Chapter contents**

Section	Page	Description
Recommended Test Equipment	4-1	A list of recommended tools and test equipment needed to properly align an *MSF 5000* station.
General Guidelines	4-2	Things to consider before aligning a station.
Alignment Procedures	4-4	Detailed procedures for aligning a station.

Recommended Test Equipment

The following test equipment is required to align the *MSF 5000* station:

- R2000 Service Monitor (or equivalent)
- Diagnostic Metering Panel or Radio Metering Panel (both are referred to as *metering panel*)
- HP3552A Transmission Test Set (or equivalent)
- 50 Ω RF terminating load (two times the rated power; dependent on transmitter output)
- Wattmeter (two times the rated power; dependent on transmitter output)
- Voltmeter
- Frequency measuring device
- Tuning tool kit (supplied with statio n)
- Torx driver

The following test equipment is optional:

- Radio Service Software (RSS)
- Service computer

General Guidelines

The following procedures require the service technician or installer to have a basic knowledge of the *MSF 5000* operation. Refer to Chapter 2 - Operation for additional information.

NOTE

Most of the following procedures apply to stations containing the *Simulcast Option (C777)*, however, specific Simulcast procedures are included in Appendix H - Simulcast. Refer to the trunked station dual path and digital path simulcast manual (68P81081E60) for system setup information using this option.

MSF 5000 Alignment Requirements

- Check all deviation levels by measuring the highest positive or negative peak deviation.
- Terminate all 600 Ω/900Ω wireline inputs and outputs with a 600 Ω/900Ω terminating load before taking measurements.
- *For trunking stations*, if the *MSF 5000* is connected to an operational Trunked Radio Central Controller, disable the station from the system only through the central controller.
- To activate/deactivate Muxbus bits, either use the DMP and RSS or the equivalent jumper settings provided throughout the procedure.
- Most adjustments in the alignment procedure are made from the tuning channel (channel 0/mode 0).

  Channel 0 is the tuning channel. This is the average of the highest and lowest programmed frequencies. The channel is displayed in the **Chan** digit (i.e., last digit on the left-hand side) of the **Status** display.

  Mode 0 disables PL/DPL and opens squelch. The mode is displayed in the **Mode** digit (center) of the **Status** display.
- If available, use RSS to determine the programmed receive and transmit frequencies for each channel.
- While tuning filters for a maximum or minimum reading, adjust the tuning screw an additional 1\2 turn to ensure a true maximum or minimum level.
- When using a frequency measuring device, ensure the accuracy rating is equal to at least 10 times that of the station stability.
- The typical maximum phone line input level is from 0 dBm to -10 dBm.
- The *MSF 5000* EEPOTs provide the functions listed in Table 4-2. Refer to Chapter 2 - Operation for additional information on adjusting EEPOTs.

Table 4-2 ***EEPOT Definitions***

EEPOT #	Function	EEPOT Location
0	coded RX level †	Secure board
1	*Flutter Fighter* level (900 MHz only)	SSCB
2	repeater squelch level	SSCB
3	receiver squelch level	SSCB
4	maximum deviation level	SSCB
5	RX level (for repeater deviation)	SSCB
6	coded deviation level	SSCB
7	TX audio level	TTRC board
8	status tone level	TTRC board
9	high-end equalization level	TTRC board
A	low-end equalization level	TTRC board
b	trunking data level	TTRC board
C	line 2 output level	TTRC board
d	line 4 output level	TTRC board
E	coarse line level adjust	TTRC board
F	SAM encoder level ‡	SAM

† Only with optional Secure board.
‡ Only with optional SAM board.

Alignment Procedures

Motorola recommends performing alignment procedures after installing the *MSF 5000*, six months after installation, and every twelve months thereafter. If the *MSF 5000* is equipped with the *Battery Revert Option (C28)*, verify its performance as well.

Always perform the procedures in the order presented. Some of the adjustments are presented for stations containing specific options. Perform only those procedures applying to the specific *MSF 5000* configuration.

Power Supply Voltage

The following procedure is only performed when a station is equipped with the *Battery Revert Option (C28)*. This procedure adjusts the voltage set potentiometer which sets the battery charge voltage at the Junction Box battery connection.

1. Verify the station is dekeyed.
2. On the Junction Box, disconnect the battery cable from the station.
3. Set the **FL ↓/EQ ↑** switch (S650) to **FL ↓** (Float).

   The **FL ↓/EQ ↑** switch is located on the Power Supply board. Refer to Figure 4-1 for the location of this switch.

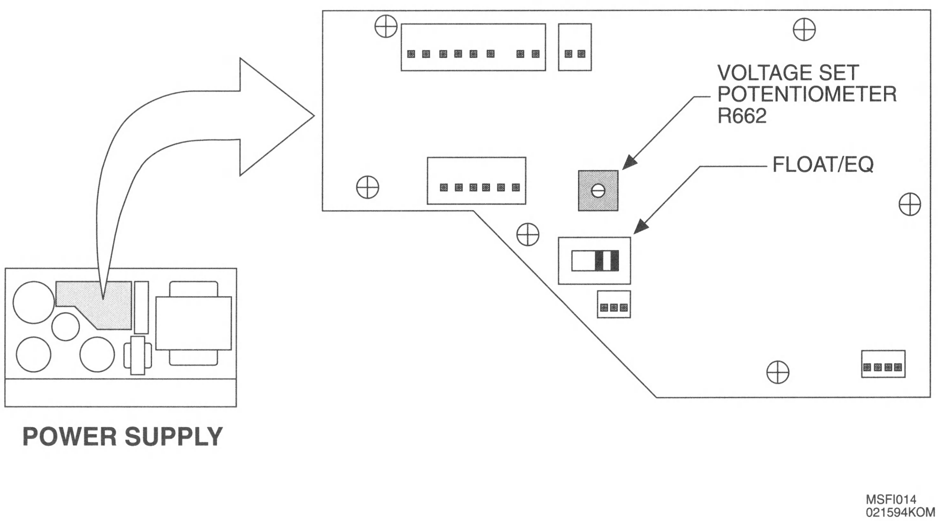


Figure 4-1 ***Power Supply Board (top View)***

4. Adjust the **VOLTAGE SET** potentiometer (R662) to set the battery charge voltage at the battery connector on the Junction Box.

For optimum performance, set R662 to the manufacturer's recommended battery charging voltage listed in Table 4-3.

Table 4-3 ***Recommended Battery Charging Voltages***

Battery Type	Voltage
Lead Acid	13.25 Vdc (26.5 Vdc)
NI-CAD™	14.25 Vdc (28.5 Vdc)
GEL-CELL™	13.5 Vdc (27 Vdc)
No Batteries	14.25 Vdc (28.5 Vdc)

Note: Voltages represented in parenthesis ( ) are for *VHF stations* using the 24 Vdc output post. All voltages represented are at room temperature conditions.

NOTE

Only connect fully charged batteries to the station. Allow discharged batteries to charge for at least three hours before connecting them to the station. Keying the station without fully charged batteries reduces station performance.

NOTE

Motorola recommends periodically setting the **FL** ↓/ **EQ** ↑ switch to **EQ** ↑ (i.e., every 3 - 4 months or after heavy usage). Leave this switch in the **EQ** ↑ (equalize) position until the batteries' cells are fully equalized.

5. Connect the batteries to the Junction Box. Observe polarity of the connector.

VCO Adjustments

The following procedure adjusts the Transmit and Receive Voltage Controlled Oscillators (VCOs). The VCOs are adjusted through the use of the **Rx Lock** and **Tx Lock** LEDs, the VCO locking cams, and a metering panel. This procedure does not apply to VHF stations since they do not require fine tuning for proper operation.

NOTE

The Transmit and Receive VCO adjustment should only be performed for *UHF, 800 MHz, and 900 MHz Analog Plus stations*. This procedure does not apply to *VHF stations*.

1. On the top of the RF Tray, rotate both VCO locking cams to **Transit**.

   The **Transit** position secures the VCOs in place while adjusting or moving the station. Refer to Figure 4-2 for the location and rotation of the VCO locking cams.

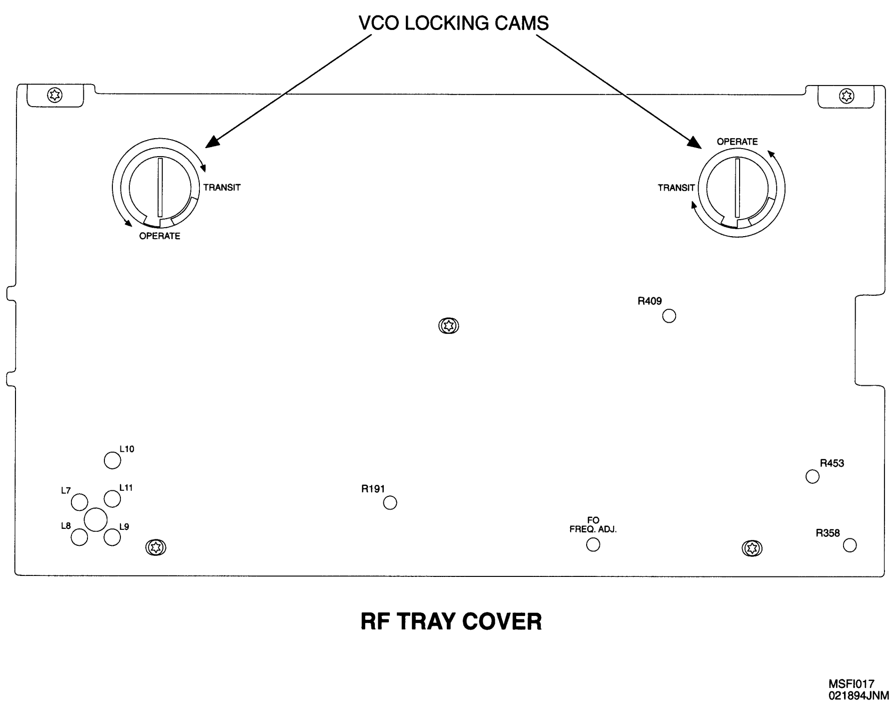


Figure 4-2 ***VCO Locking Cams***

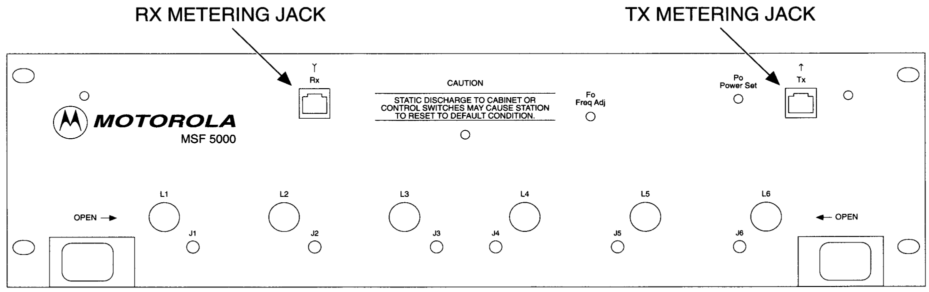
2. On the control tray, set the station to the channel with the highest programmed operating frequency.

   The channel is displayed in the **Chan** digit (i.e., last digit on the left-hand side) of the **Status** display.

Transmit VCO Adjustment

3. Connect a metering panel to the **Tx** metering jack located on the front right-hand side of the RF Tray using the metering cable.

   Refer to Figure 4-3 for the location of the RF Tray metering jacks.



RF TRAY FRONT PANEL

NOTE: L1 - L6, J1 - J6 and Fo Freq Adj are not found on VHF models.
Access requires the removal of the front panel.

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Figure 4-3 ***Metering Jacks***

4. On the metering panel, set the Meter switch to 5 and set the reversing switch (±) to + (positive).

   Meter 5 should read 38 ±2 μA. If the meter indicates this value, proceed to the Receive VCO Adjustment.

5. Adjust the TX VCO tuning screw until the **Tx Lock** indicator on the control tray illuminates.

   Access the TX VCO tuning screw from the upper hole on the right-hand side of the RF Tray. Turning the TX VCO clockwise (CW) increases the level; turning it counter-clockwise (CCW) decreases the level. Refer to Figure 4-4 for the location and rotation of the VCOs.

6. Adjust the TX VCO tuning screw until Meter 5 on the metering panel indicates 38 ± 2 μA.

Receive VCO Adjustment

7. Connect a metering panel to the **Rx** metering jack on the front left-hand side of the RF Tray using the metering cable.

   Refer to Figure 4-3 for the location of the RF Tray metering jacks.

8. On the metering panel, verify Meter 5 is selected and the reversing switch (±) is set to + (positive).

   Meter 5 should read 38 ± 2 μA. If the meter indicates this value, proceed to step 11.

9. Adjust the RX VCO tuning screw until the **Rx Lock** indicator on the control tray illuminates.

   Access the RX VCO tuning screw from the upper hole on the left-hand side of the RF Tray. Turning the RX VCO clockwise (CW) increases the level; turning it counter-clockwise (CCW) decreases the level. Refer to Figure 4-5.

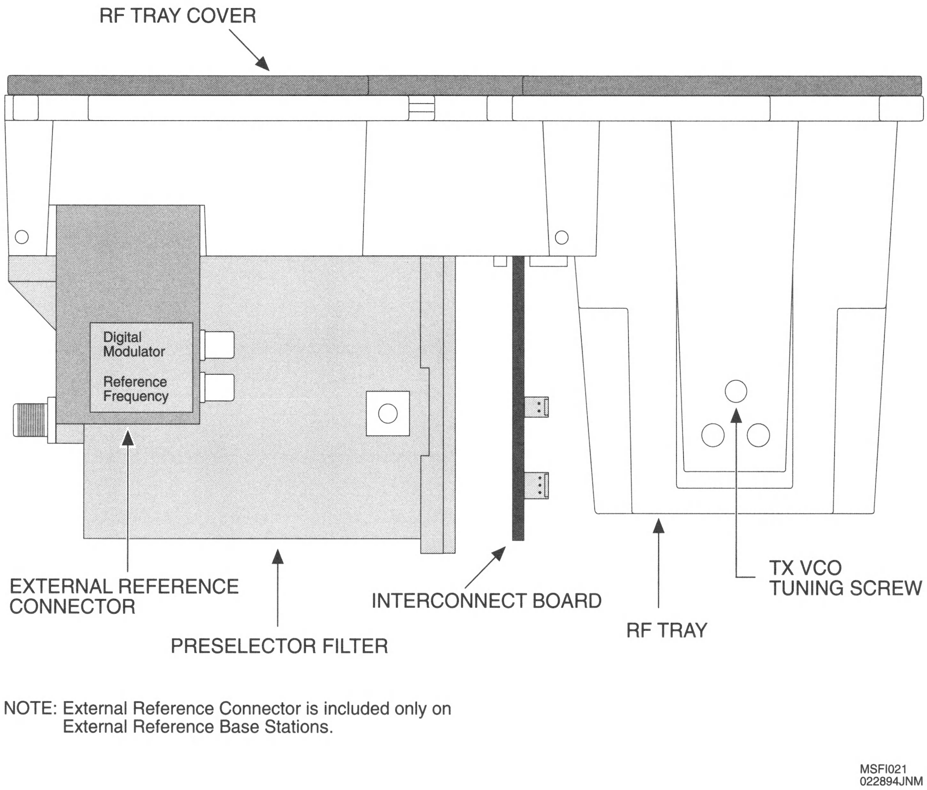


Figure 4-4 ***TX VCO Tuning Screw***

10. Adjust the RX VCO tuning screw until Meter 5 on the metering panel indicates 38 ± 2 µA.

11. Rotate both VCO locking cams to **Operate**.

Injection Filter Adjustment

The following procedure aligns the Injection Filter for the tuning channel frequency (channel 0/mode 0). By adjusting the Injection Filter to the tuning channel, the station is tuned for a all programmed frequencies.

The Injection Filter tuning screws are accessed through the RF Tray cover. The tuning screws are adjusted until a maximum reading is obtained on the metering panel.

1. Connect a metering panel to the **Rx** metering jack on the front left-hand side of the RF Tray using the metering cable.

2. On the metering panel, set the Meter switch to 3 and verify the reversing switch (±) is set to the + (positive).

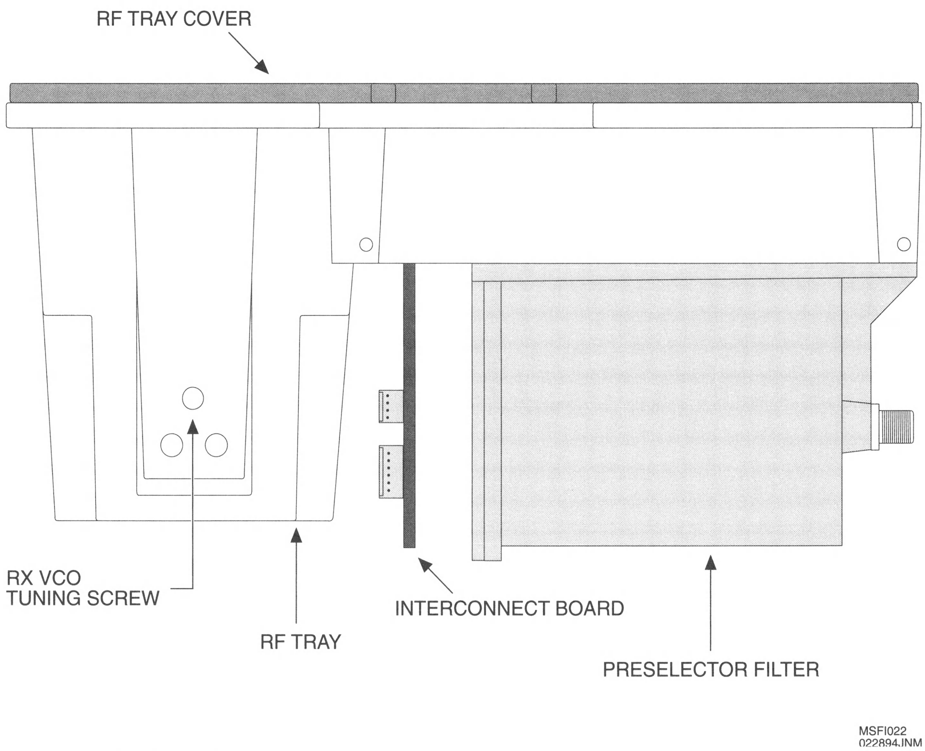


Figure 4-5 ***RX VCO Tuning Screw***

3. On the control tray, set the **Acc Dis/Reset** switch to **Acc Dis**.
4. Using the **Select/Set** switch, set the station to tuning channel.
5. Using a tuning screwdriver, adjust L7 until Meter 3 on the metering panel indicates a maximum level.

   Refer to Figure 4-6 for the location of the Injection Filter tuning screws.
6. Using a tuning screwdriver, adjust L8 until Meter 3 on the metering panel indicates a maximum level.
7. Using a tuning screwdriver, adjust L9 until Meter 3 on the metering panel indicates a maximum level.
8. Repeat steps 5 through 7 until a maximum level is obtained.

Preselector / Image Filter Adjustment

The following procedure aligns the Preselector and Image Filters for the tuning channel frequency (channel 0/mode 0). By adjusting the Preselector and Image Filters to the tuning channel, the station is tuned for all programmed frequencies.

Alignment Procedures

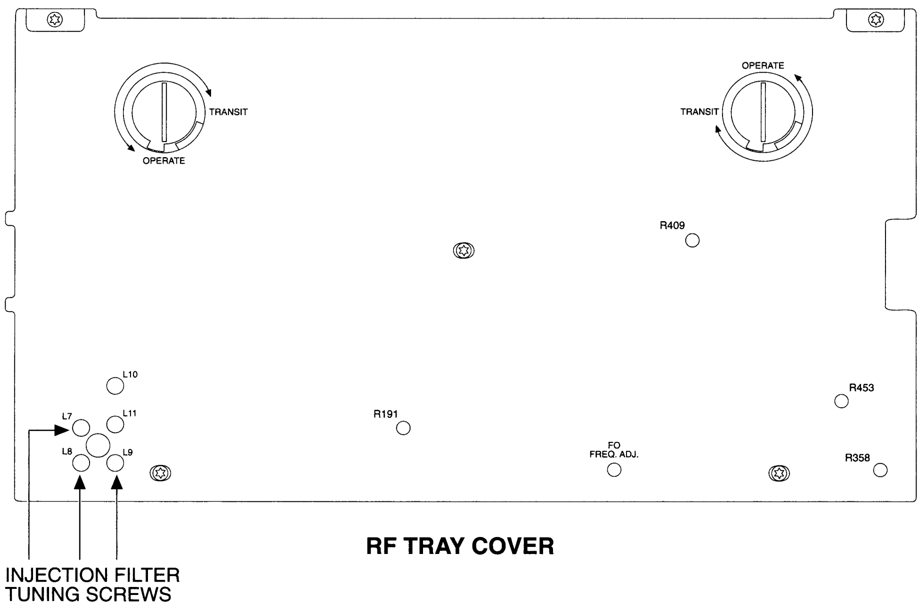


Figure 4-6 ***Injection Filter Tuning Screws (RF Tray Cover)***

The Preselector Filter tuning screws are accessed through the RF Tray front panel. There are a total of six Preselector tuning screws, except for VHF stations which contain only five tuning screws. For VHF stations, the RF Tray front panel must be removed. The Preselector Filter tuning screws are adjusted until the proper reading is obtained on the metering panel.

The Image Filter tuning screws are accessed from the top of the RF Tray cover. The Image Filter tuning screws are adjusted until the proper reading is obtained on the metering panel.

Typically, the Preselector and Image Filter require only a fine adjustment. However, if the station requires a major tuning adjustment, the coarse adjustment must be performed initially. Coarse adjustments are usually required after frequency changes, filter replacements, and servicing.

Coarse Adjustment

1. If adjusting a *VHF station*, remove the RF Tray front panel. Otherwise, proceed to step 2.

2. Using the **Select/Set** switch, set the station to the tuning channel.

3. Terminate the Preselector by connecting a 50 Ω load to the Preselector input.

   For non-duplex repeaters and base stations, connect the load to the receive antenna connection on the Junction Box.

> **NOTE**
>
> When tuning for a minimum or maximum reading on the meter, adjust the tuning screws an additional half-turn. This ensures that the true minimum or maximum level.

4. On the front of the RF Tray, adjust all the Preselector tuning screws CCW as indicated below. Refer to Figure 4-7.

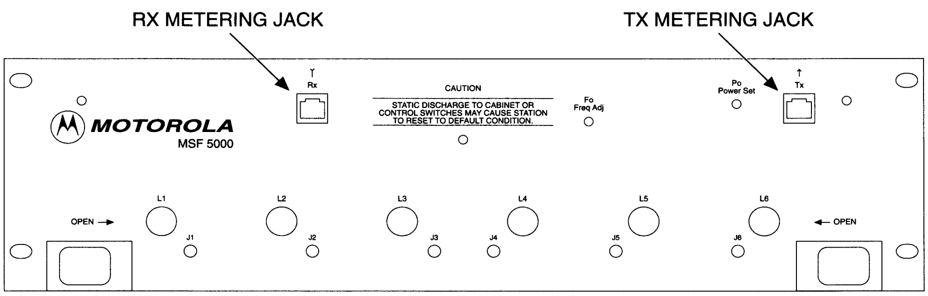
   On *800 MHz stations*, adjust the tuning screws until they extend approximately 1/8″ from the front panel.

   On *UHF and 900 MHz Analog Plus stations*, adjust the tuning screws until they extend approximately 1/4″ from the front panel.

   On *VHF stations* using *VHF Range 1 Option (C367)*, adjust the tuning screws until they extend approximately 3/4″ from the tension nut.

   On *VHF stations* using *VHF Range 2*, adjust the tuning screws until they extend approximately 1/8″ from the tension nut.

> **NOTE**
>
> On *VHF stations* at frequencies near 158 MHz (Range 1) or near 174 MHz (Range 2), the meter indication may not decrease after tuning for a maximum level. If this happens, stop adjusting the tuning screw.



RF TRAY FRONT PANEL

NOTE: L1 - L6, J1 - J6 and Fo Freq Adj are not found on VHF models.
Access requires the removal of the front panel.

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Figure 4-7 ***Preselector Filter Tuning Screws***

5. Connect the Preselector probe from the output of a signal generator to J1 of the Preselector located on the front panel of the RF Tray.

6. Set the signal generator to output a 1 mV on-channel signal.

7. On the metering panel, set the Meter switch to 2 and verify the reversing switch (±) is set to the + (positive).

   Verify a level between 25 and 35 µA on the metering panel. Adjust the signal generator output, as necessary, to meet the required level.

8. On the top of the RF Tray, adjust the Image Filter (L10 and L11) until Meter 2 indicates a maximum level.

   Refer to Figure 4-8 for the location of the Image Filter tuning screws.

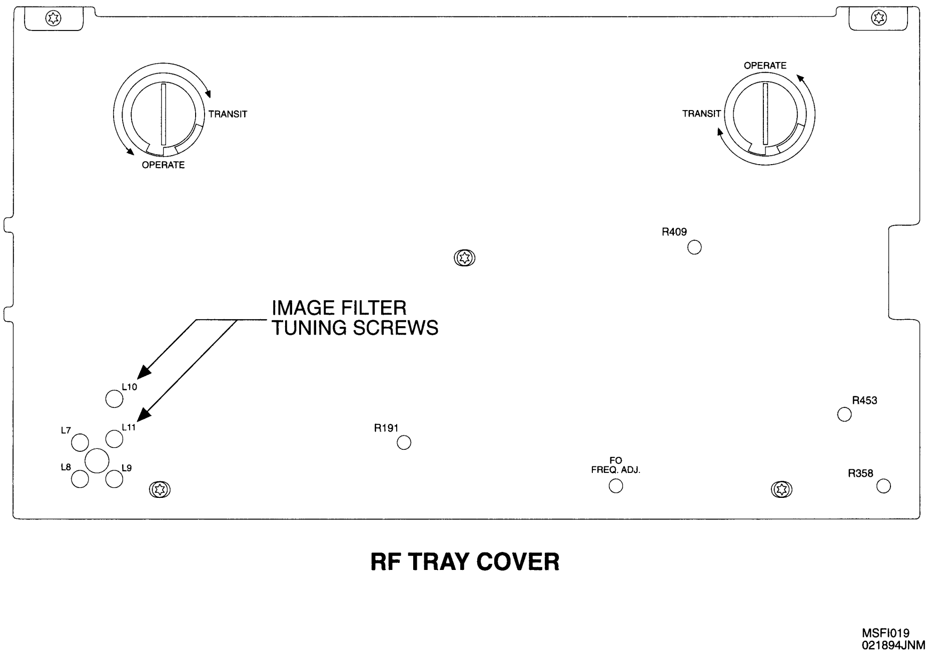


Figure 4-8 ***Image Filter Tuning Screws (top View of RF Tray)***

9. On the front of the RF Tray, adjust L1 on the Preselector until Meter 2 indicates a maximum level.

10. Adjust L2 on the Preselector until Meter 2 indicates a minimum level.

11. Move the probe to J2 and adjust L3 on the Preselector until Meter 2 indicates a minimum level.

12. Move the probe to J3 and adjust L4 on the Preselector until Meter 2 indicates a minimum level.

13. Move the probe to J4 and adjust L5 on the Preselector until Meter 2 indicates a minimum level.

NOTE

Perform step 14 only if aligning *UHF, 800 MHz, and 900 MHz Analog Plus stations*. Otherwise, proceed to Fine Adjustment.

14. For *UHF, 800 MHz, and 900 MHz Analog Plus stations*, move the probe to J5 and adjust L6 on the Preselector until Meter 2 indicates a minimum level.

Fine Adjustment

15. Using the **Select/Set** switch, set the station to the tuning channel.

16. Use a signal generator to inject a 1 mV on-channel signal into the receiver antenna connector on the Junction Box.

17. Alternately adjust L10 and L11 on the Image Filter until Meter 2 indicates a maximum level.

18. Alternately adjust L1 on the Preselector and L11 on the Image Filter until Meter 2 indicates a maximum level.

19. Adjust L6 on the Preselector (L5 for *VHF stations*) until Meter 2 indicates a maximum level.

NOTE

Perform step 20 only if aligning a *VHF station*. Otherwise, proceed to Adjusting the Transmit Filter (Duplexer).

20. On *VHF stations* only, reinstall the RF Tray front panel.

Adjusting the Transmit Filter (Duplexer)

The following procedure is only performed for *UHF stations* equipped with the *Duplex Filter Option (C597, C675, or C677)*. This procedure aligns the prefilter and postfilter of the Duplex Filter.

The prefilter and postfilter are aligned for the tuning channel frequency (channel 0/mode 0). By adjusting the prefilter and postfilter to the tuning channel, the station is tuned for all programmed frequencies.

The prefilter and postfilter tuning screws are easily accessed within the station cabinet. The tuning screws are adjusted until the proper reading is obtained on the metering panel.

CAUTION

Never attempt to adjust the Prefilter or Postfilter for the purpose of obtaining maximum station output power.

1. On the control tray, set the **Acc Dis/Reset** switch to **Acc Dis**.
2. Disconnect the PA input cable from the output of the Prefilter (J501). Refer to Figure 4-9 for the location of J501.

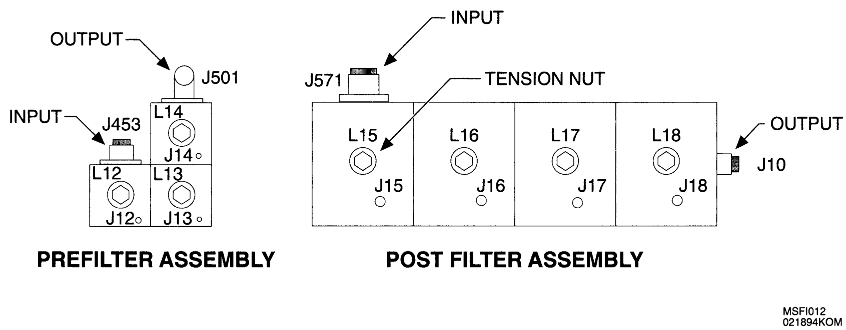


Figure 4-9 ***Duplexer Tuning Screws***

3. Connect a 50 Ω load to J501.
4. Set the signal generator to the transmitter tuning channel frequency.
5. Adjust the signal generator output to 0 dBm (225 mV).

   If the Preselector is properly aligned, connect the signal generator to the transmit antenna connector on the Junction Box. Otherwise, connect the signal generator to the Postfilter output (J10).
6. Detune the Postfilter by turning L15 through L17 CCW until they extend approximately 1/2" from the tension nut.
7. Connect the tuning probe to J18 on the Postfilter.
8. Adjust L18 for maximum indication on the millivoltmeter.
9. Adjust L17 for minimum indication on the millivoltmeter.
10. Move the tuning probe to J17 on the Postfilter.
11. Adjust L16 for minimum indication on the millivoltmeter.
12. Move the tuning probe to J16 on the Postfilter.
13. Adjust L15 for minimum indication on the millivoltmeter.

14. Remove the IPA output cable from the Prefilter input (J453).
15. Connect a signal generator to the Prefilter input (J453).
16. Detune the Prefilter by turning L13 and L14 CCW until they extend approximately 1/2″ from the tension nut.
17. Move the tuning probe to J12 on the Prefilter.
18. Adjust L12 for maximum indication on the millivoltmeter.
19. Adjust L13 for minimum indication on the millivoltmeter.
20. Move the tuning probe to J13 on the Prefilter.
21. Adjust L14 for minimum indication on the millivoltmeter.
22. Disconnect all test equipment.
23. Connect the PA input cable to the Prefilter (J501).
24. Connect the IPA cable to the IPA (J453).
25. Set the **Acc Dis/Reset** switch to the center (normal) position.

Forward/Reflected Power Trip Point Set

The following procedure is only performed for *trunked station*s or *data stations*. This procedure adjusts the forward and reflected power trip points to a user specified level.

This procedure requires adjustment of the station output power level, setting the trip point, and then readjusting the station for the appropriate output power level. The trip point value appearing in the **Status** display is a relative value. This value cannot be converted to the actual power level adjustment.

CAUTION

Do not attempt to enter or adjust the forward and reflected power trip set mode if a wattmeter is not present in the station (i.e., it is a conventional station). The codeplug may be corrupted which causes constant alarms.

1. Connect the station transmit antenna connector on the Junction Box to a wattmeter terminated with a 50 Ω load.

   Use a wattmeter capable of handling the full-rated station power.

2. Key the station by setting the LOC PTT MUXbus bit (A1/D1).

   This may also be accomplished by grounding TP9 (or J812-4) on the SSCB.

3. Set and hold the **Select/Set** switch to **Set**.

   Be sure to hold this switch during step 4 and step 8.

4. Set the **PL Dis/Xmit** switch to **PL Dis**.

5. Set the **Acc Dis/Reset** switch to **Acc Dis**.

   The **Status** display indicates "**trP**".

6. Release the **Select/Set** switch.

7. Set the **PL Dis/Xmit** and **Acc Dis/Reset** switches to the center (normal) position.

   The first character of the **Status** display toggles between "**F**" (forward power) and "**r**" (reflected power), as shown in Figure 4-10.

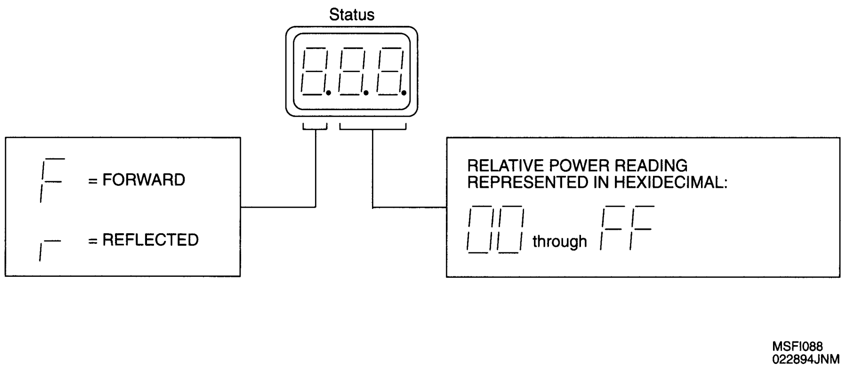


Figure 4-10 ***Forward/Reflected Power Status Display Definitions***

Forward Power Level Adjustment

8. Use the tuning tool to set the power output to the desired forward power level trip point by adjusting **Po Power Set** potentiometer (R426).

   This is typically set to 35% of the rated station power level. Refer to Table 4-4 through Table 4-6.

   The **Po Power Set** potentiometer is part of the Uniboard and is accessed through the opening in the RF Tray front panel, refer to Figure 4-11. Turn the **Po Power Set** potentiometer CW to increase power out; turn it CCW to decrease power out.

9. With the transmitter keyed, set the **Select/Set** switch to **Select** when the first character of the **Status** display shows "**F**".

   The second and third digits indicate the forward power level trip point. This value is represented in hexadecimal.

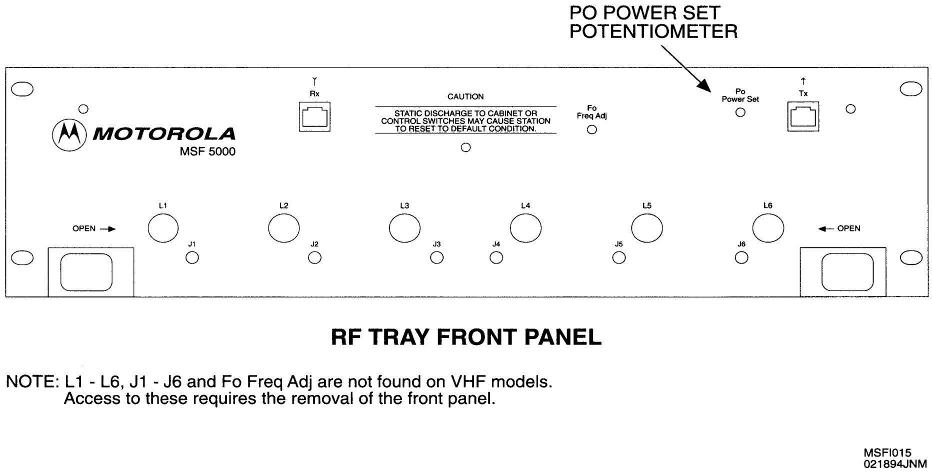


Figure 4-11 ***Po Power Adjustment***

Reflected Power Level Adjustment

10. Use the tuning tool to set the power output to the desired reflected power level trip point by adjusting the **Po Power Set** potentiometer.

The reflected power level trip point is typically set to 20% of the rated station power level. Refer to Table 4-4 through Table 4-7.

11. Toggle the **Select/Set** switch to **Select** when the first character of the **Status** display shows "**r**".

The second and third digits indicate the reflected power level trip point. This value is represented in hexadecimal.

12. Set the **Select/Set** switch to **Set** to exit the power trip point mode.

13. Deactivate all activated MUXbus bits.

RF Power Output Adjustment

The following procedure is divided into three parts:

❒ Overdrive Control

❒ Power Set Control

❒ Battery Cutback Control

The Overdrive Control is only performed on high power stations (i.e., containing two Power Amplifiers). This procedure adjusts the power cut-back if the output power level exceeds a predetermined level set by the user. The Overdrive Control (R453) adjustment is located on the Uniboard, and is accessed from the top of the RF Tray cover.

Alignment Procedures

Table 4-4 ***VHF Station Rated RF Power Levels***

Model	with Duplexer (C182)	with Single Circulator (C265)	with Duplexer & Single Circulator (C182/C265)	Standard
C23CXB	3.5	4.5	3.0	6
C43CXB	15	20	12	25
C63CXB	45	60	35	75
C73CXB	75	100	60	125
C93CXB	n/a	300 (360)	n/a	350 (390)
C93CXB with 220 Vac 50 Hz	n/a	260 (340)	n/a	300 (380)

Notes:
1. All RF power levels are listed in Watts.
2. All power levels are for 110 Vac/60 Hz stations, except where noted.
3. RF power levels in parenthesis are Overdrive Power Levels.

Table 4-5 ***UHF Station Rated RF Power Levels***

Model	with Option C675 or C182	with Option C597	with Option C676	with Option C677	Standard
C24CXB	4	3	3	3	6
C34CXB	10	8	9	8	15
C44CXB	30	22	25	20	40
C64CXB	55	40	45	40	75
C74CXB	85	60	70	55	110
C84CXB	140	n/a	n/a	n/a	225(285)
C84CXB with 220 Vac 50 Hz	125 (160)	n/a	n/a	n/a	200 (260)

Notes:
1. All RF power levels are listed in Watts.
2. All power levels are for 110 Vac/60 Hz stations, except where noted.
3. RF power levels in parenthesis are Overdrive Power Levels.

The Power Set Control (R426) adjusts the RF output power level of the station to the site specified level. The Power Set Control adjustment is located on the Uniboard, and is accessed from the RF Tray front panel.

The Battery Cutback Control (R409) adjusts the RF output power level of the station to 50% of the rated station output power level. This adjustment reduces the station output power level when the station reverts to battery back-up. The Battery Cutback Control adjustment is located on the Uniboard, and is accessed from the top of the RF Tray cover.

Table 4-6 ***800 MHz Station Rated RF Power Levels***

Model	with Duplexer (TDF9680A)	with Triple Circulator (C676)	with Duplexer & Triple Circulator (C676/ TDF9680A)	Standard
C45CXB	23	30	21	35
C65CXB	50	60	45	75
C85CXB	100 (150)	125 (180)	90 (130)	150 (220)
C85CXB with 220 Vac 50 Hz	85 (125)	110 (160)	75 (120)	125 (180)

Notes:
1. All RF power levels are listed in Watts.
2. All power levels are for 110 Vac/60 Hz, stations except where noted.
3. RF power levels in parenthesis are Overdrive Power Levels.

Table 4-7 ***900 MHz Analog Plus Station Rated RF Power Levels***

Model	with Duplexer (TDF6542A)	with Triple Circulator (C676)	with Duplexer & Triple Circulator (C676/ TDF6542A)	Standard
C65GFB	50	60	45	75
C85GFB	100 (150)	125 (180)	90 (130)	150 (220)
C85GFB with 220 Vac 50 Hz	80 (125)	110 (160)	75 (120)	125 (180)

Notes:
1. All RF power levels are listed in Watts.
2. All power levels are for 110 Vac/60 Hz, stations except where noted.
3. RF power levels in parenthesis are Overdrive Power Levels.

1. Connect the station transmit antenna connector on the Junction Box to a wattmeter terminated with a 50 Ω load.

Use a load capable of handling two times the rated station power.

2. Using tuning tool, rotate the **Po Power Set** potentiometer (R426) fully CCW, then CW 1/8 turn.

The **Po Power Set** potentiometer is accessed through the opening in the RF Tray front panel.

Overdrive Control

NOTE

Step 3 through step 8 only apply to *high power stations*, which contain two Power Amplifiers. Otherwise, proceed to Power Set Control.

3. Using the tuning tool, rotate the **Overdrive Control** potentiometer (**R453**) fully CW.

   R453 is part of the Uniboard. Refer to Figure 4-12 for the location of the Overdrive control.

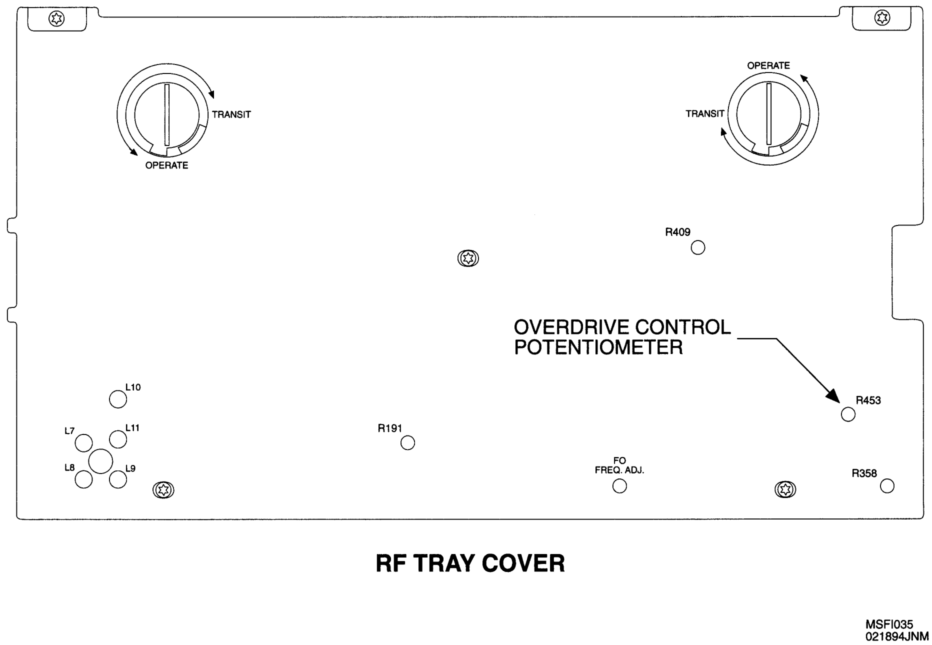


Figure 4-12 ***Overdrive Control Adjustment***

4. Key the station by setting the LOC PTT MUXbus bit (A1/D1) or by setting the **PL Dis/Xmit** switch to **Xmit**.

5. Using the tuning tool, adjust the **Po Power Set** control to obtain the overdrive power level.

   The overdrive power level is shown in Table 4-4 through Table 4-7.

6. Using the tuning tool, adjust the **Overdrive Control** slowly CCW until the **PA Full** LED just turns off.

7. Dekey the station by clearing the LOC PTT MUXbus bit (A1/D1).

8. Using the tuning tool, adjust the **Po Power Set** potentiometer fully CCW, then CW 1/8 turn.

Power Set Control

9. Key the station by setting the LOC PTT MUXbus bit (A1/D1) or by setting the **PL Dis/Xmit** switch to **Xmit**.

10. Using the tuning tool, adjust the **Po Power Set** control to obtain the lowest of either the rated RF Station Power Level, the maximum level allowed by the FCC license, or the site specific power level. Refer to Figure 4-12.

> **NOTE**
>
> The rated RF station power level may not be the recommended site output power level.

11. Dekey the station by clearing the LOC PTT MUXbus bit.

Battery Cutback Control

> **NOTE**
>
> If the station is not equipped with a *Battery Revert Option (C28)*, proceed to step 19. Also, cutback must be programmed to happen while in battery revert mode. Refer to the RSS manual for additional information.

12. Disconnect the AC power cord from the Junction Box.

    The station should continue to operate on battery backup.

13. Key the station by setting the LOC PTT MUXbus bit (A1/D1) or by setting the **PL Dis/Xmit** switch to **Xmit**.

14. Using the tuning tool, adjust the **CUTBACK** control to obtain 50% of the rated station power level.

    The **CUTBACK** control (R409) is part of the Uniboard. Refer to Figure 4-13 for the location of the cutback control. Table 4-4 through Table 4-7 lists the rated station power level for each band.

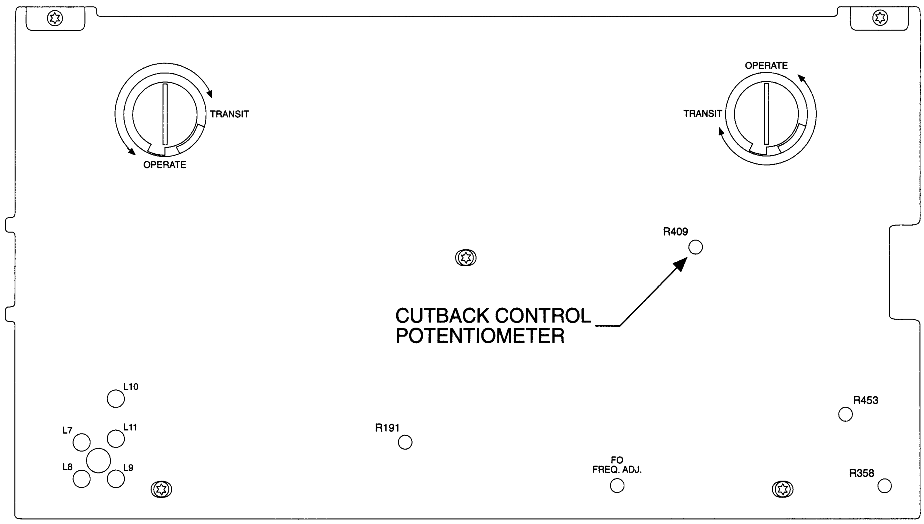
15. Deactivate all activated MUXbus bits and disconnect all test equipment.

16. Apply AC power by connecting the AC power cord to the Junction Box.

Transmit Frequency Adjustment

The following procedure adjusts the Fo Freq Adj to fine tune the transmit frequency. It is assumed the station is programmed with the correct frequencies and hardware. Allow sufficient time for the external reference to warm-up prior to performing this procedure.

Alignment Procedures



RF TRAY COVER

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Figure 4-13 ***Cutback Control Adjustment***

For 900 MHz Analog Plus stations, an High Stability Oscillator (HSO) or an external reference is required. For all other bands, an HSO or an external reference is not required, but optional.

The Fo Freq Adj potentiometer is located on the Uniboard. For VHF stations, the Fo Freq Adj is accessed from the top of the RF Tray cover. For all other bands, the Fo Freq Adj is accessed from the RF Tray front panel.

NOTE

A minimum warmup time of 60 minutes is required if the station is a *900 MHz Analog Plus station* or if it is equipped with a *High Stability Oscillator Option (C573)*. Otherwise, ensure that the frequency reference device is fully warmed up.

1. On *900 MHz Trunking stations* or stations equipped with the *External Reference Option (C574)*, apply the site high stability 5 MHz reference signal to the external reference connector on the Junction Box.
2. Adjust U1 on the reference synthesizer board for 1.5 +/- 0.1 Volts at TP1.
3. Set the **Acc Dis/Reset** switch to **Acc Dis**.
4. If necessary, attenuate the transmitted RF signal from the station to the frequency measuring device.

5. Key the station by setting the LOC PTT MUXbus bit (A1/D1) or by setting the **PL Dis/Xmit** switch to **Xmit**.

6. Measure the transmitter carrier frequency.

NOTE

If the station contains an *External Reference Option (C574)* or a *High Stability Oscillator Option (C573)*, and the frequency is out of alignment, refer to the appropriate alignment procedure. Otherwise proceed to step 8.

7. If necessary, adjust the **Fo Freq Adj** warp control to set the measured transmit frequency to the nominal station transmit frequency.

   For UHF, 800 MHz, and 900 MHz Analog Plus stations, the **Fo Freq Adj** warp control is located on the RF Tray front panel. For VHF stations, the **Fo Freq Adj** warp control is accessed through the top cover of the RF Tray. Refer to Figure 4-14 for the location of the **Fo Freq Adj**.

8. Dekey the station by clearing the LOC PTT MUXbus bit (A1/D1).

9. Set the **Acc Dis/Reset** switch to the center (normal) position.

I-F AGC Threshold Adjustment

The following procedure is only performed on *800 MHz and 900 MHz Analog Plus stations*. This procedure adjusts the I-F AGC Threshold.

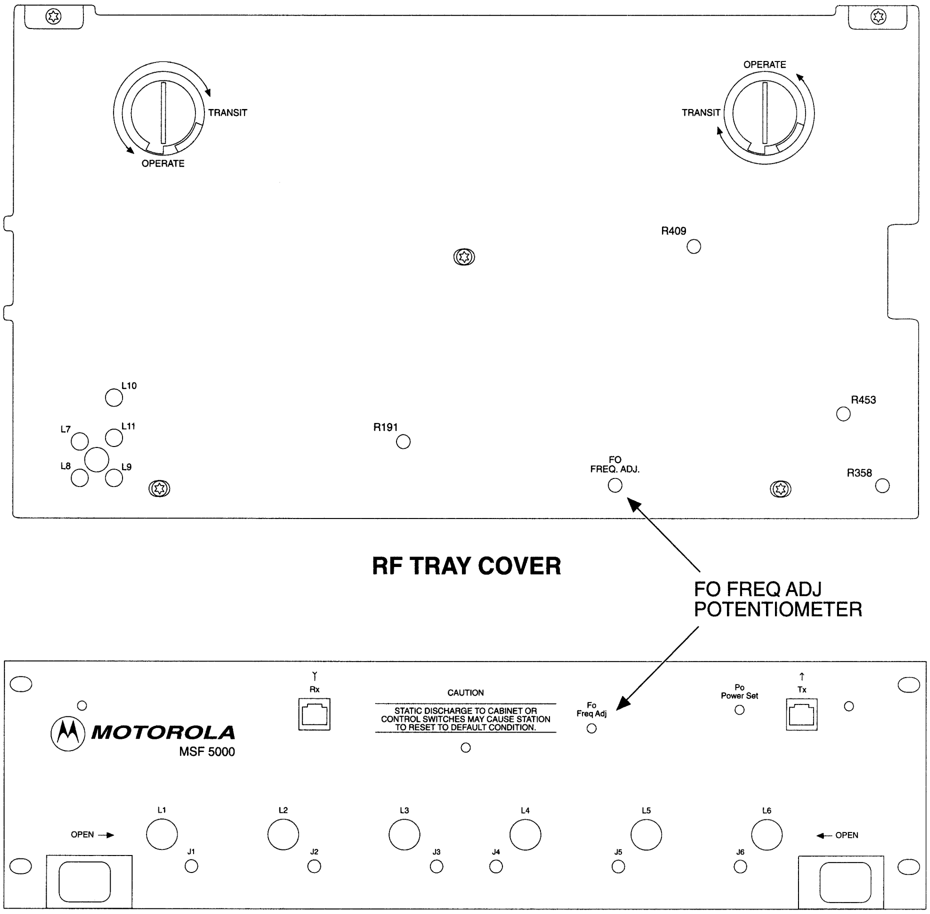
This adjustment is performed by the tuning channel frequency (channel 0/ mode 0). This allows the station to be tuned for all programmed frequencies.

The I-F AGC Threshold adjustment (**R191**) is located on the Uniboard, and is accessed from the top of the RF Tray cover.

1. Set the **Acc Dis/Reset** switch to **Acc Dis**.

2. Using the **Select/Set** switch, set the station to the tuning channel.

Alignment Procedures



NOTE: L1 - L6, J1 - J6 and Fo Freq Adj are not found on VHF models.
Access to these requires the removal of the front panel.

NOTE: For UHF, 800 MHz and 900 MHz models, the Fo Freq Adj is accessed at the RF Tray Front Panel. For VHF models, the Fo Freq Adj is accessed at the RF Tray Cover.

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Figure 4-14 ***Fo Freq Adj Control***

3. Inject an on-channel 1000 µV signal, modulated with a 1 kHz tone at 60% of full station deviation into the receiver connector on the Junction Box.

Station deviation settings are listed in Table 4-8.

Table 4-8 ***Deviation Settings***

	Frequency Range		
Deviation Adjustment	**VHF,UHF, and 800 MHz (kHz)**	**866-869 MHz (kHz)**	**900 MHz Analog Plus (kHz)**
100% Full Station Deviation	5	4	2.5
Maximum Station Deviation	4.6	3.7	2.3
60% Full Station Deviation	3	2.4	1.5
40% Full Station Deviation	2	1.6	1.0
Simulcast Data Deviation	0.85	0.7	0.5
Trunked Data Deviation	0.85	0.7	0.5
Failsoft Data Deviation	1	0.8	0.7
Coded Deviation (+/-) 200 Hz, using a 1 kHz square wave	3.9	2.3	N/A
Note: All deviation measurements and settings must be within +/- 100 Hz except where noted.			

4. Using a digital voltmeter, adjust **R191** for 0.60 Vdc between NORM ENV (TP13 or HY804-13 on the SSCB) and AGC REF (TP12 or HY804-10 on the SSCB).

   Refer to Figure 4-15 for the location of R191 on the Uniboard and Figure 4-16 for the location of NORM ENV and AGC REF on the SSCB.

5. Remove the injected signal from the receiver connector on the Junction Box.

6. Set the **Acc Dis/Reset** switch to the center (normal) position.

Modulation Compensation Adjustment

The following procedure adjusts the modulation compensation circuit on the Uniboard. This adjustment is performed by using the tuning channel frequency (channel 0/mode 0). This allows the station to be tuned for all programmed frequencies.

While in the tuning channel, a 10 Hz waveform should appear whenever the station is keyed via a local push-to-talk (LOC PTT). This gives the technician a

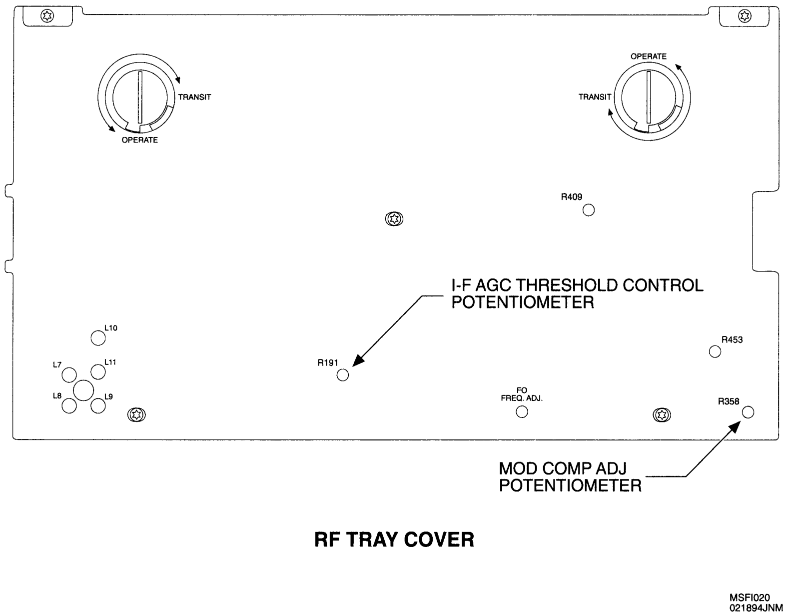


Figure 4-15 ***I-F AGC Threshold Control***

good reference waveform to use to tune and verify proper modulation compensation operation.

The modulation compensation adjustment (**R358**) is located on the Uniboard, and is accessed from the top of the RF Tray cover.

1. Set the **Acc Dis/Reset** switch to **Acc Dis**.
2. Using the **Select/Set** switch, set the station to the tuning channel.
3. Key the station by setting the LOC PTT MUXbus bit (A1/D1).
4. Monitor the transmitter waveform. The waveform should consist of a 10 Hz square wave, as shown in Figure 4-17.
5. Examine the waveform for straight long transitions, however, a slight slant is acceptable.

   If adjustment is required continue with step 6, otherwise, proceed to step 8.
6. Adjust **R358** for the best 10 Hz square wave.

   R358 is part of the Uniboard and is accessed through the RF Tray cover, as shown in Figure 4-15.
7. Dekey the station by clearing the LOC PTT MUXbus bit (A1/D1).
8. Set the **Acc Dis/Xmit** switch to the center (normal) position.

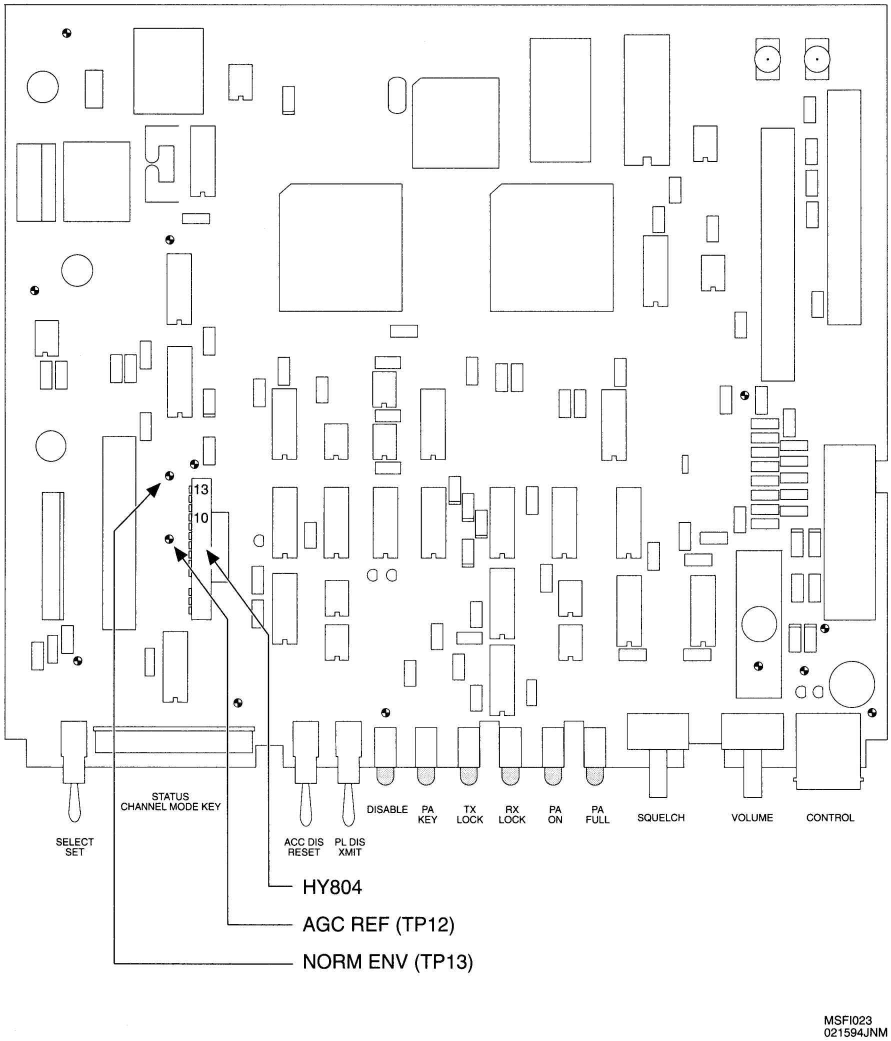


Figure 4-16 ***NORM ENV and AGC REF Measurement Points***

Trunked Data Deviation Adjustment

The following procedure is only performed for *trunked stations*. For optimum performance, perform this procedure with the Central Controller to allow the adjustment to be made with the disconnect word. The disconnect word is equal in deviation to TDATA. The station should not enter failsoft mode during this adjustment.

Alignment Procedures

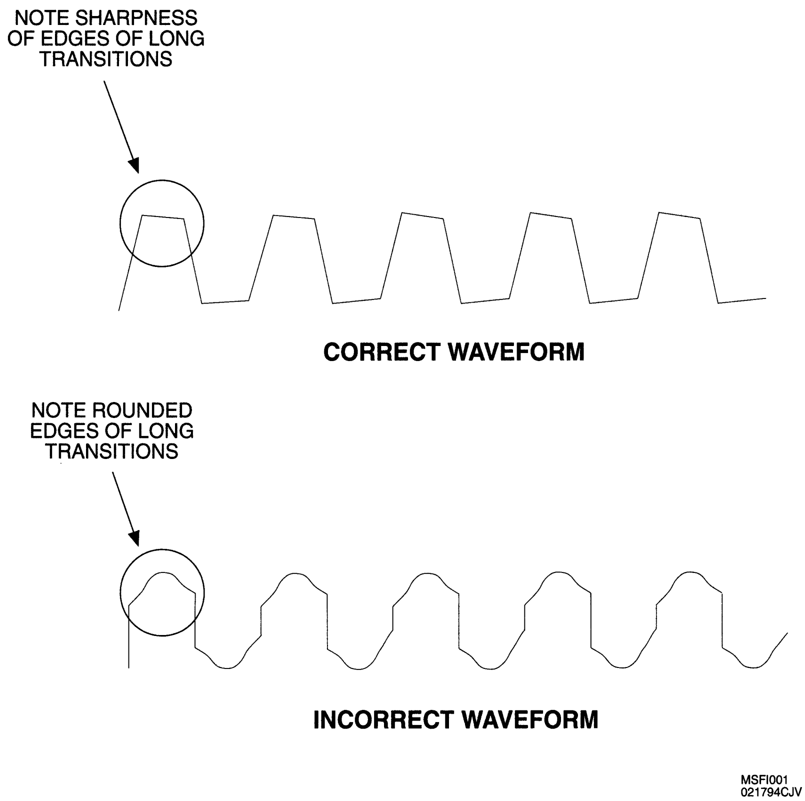


Figure 4-17 ***Modulation Compensation Waveform***

NOTE

Proceed to Transmitter Maximum Deviation Adjustment if this is not a *trunked station*.

1. If a Trunked Radio Central Controller is available proceed to step 3.

NOTE

Perform step 2 only when a Central Controller is not available (i.e., lab or depot). Once the station is installed back into the system, perform the entire procedure again for optimum performance.

2. Inject a 150 Hz tone at 0.9 Vrms (closed circuit level) with 600 Ω termination across pins 4 (-) and 12 (+) of the trunking connector J2901 on the TTRC board. Proceed to step 5.

   This simulates a trunking data (TDATA) signal to perform this alignment procedure. Refer to Figure 4-18 for the location of the trunking connector J2901.

   The **Fail Soft** LED should not be illuminated.

3. Connect an operational Trunked Radio Central Controller to the station.

   This allows the station that is being aligned to receive trunked data (TDATA) from the Trunked Radio Central Controller.

   The **Fail Soft** LED should not be illuminated.

4. Verify the station being aligned is disabled from the Trunked Radio Central Controller.

   This is accomplished by pressing the Transmit Interface Board (TIB) disable switch on the Trunked Radio Central Controller for the channel being adjusted.

5. Key the station by setting the LOC PTT MUXbus bit (A1/D1).

6. Monitor the transmitted deviation level.

7. Measure the Trunked Data Deviation level and compare it to the requirements of Table 4-8.

   If the level is out of adjustment, set it by adjusting EEPOT b. Refer to Chapter 2 - Operation for additional information on adjusting EEPOTs.

   If the station contains the *Simulcast Operation Option (C777)*, measure the simulcast data deviation. EEPOT b is used to adjust the simulcast deviation. Refer to Appendix H - Simulcast Alignment for additional information.

8. Dekey the station by clearing the LOC PTT MUXbus bit (A1/D1).

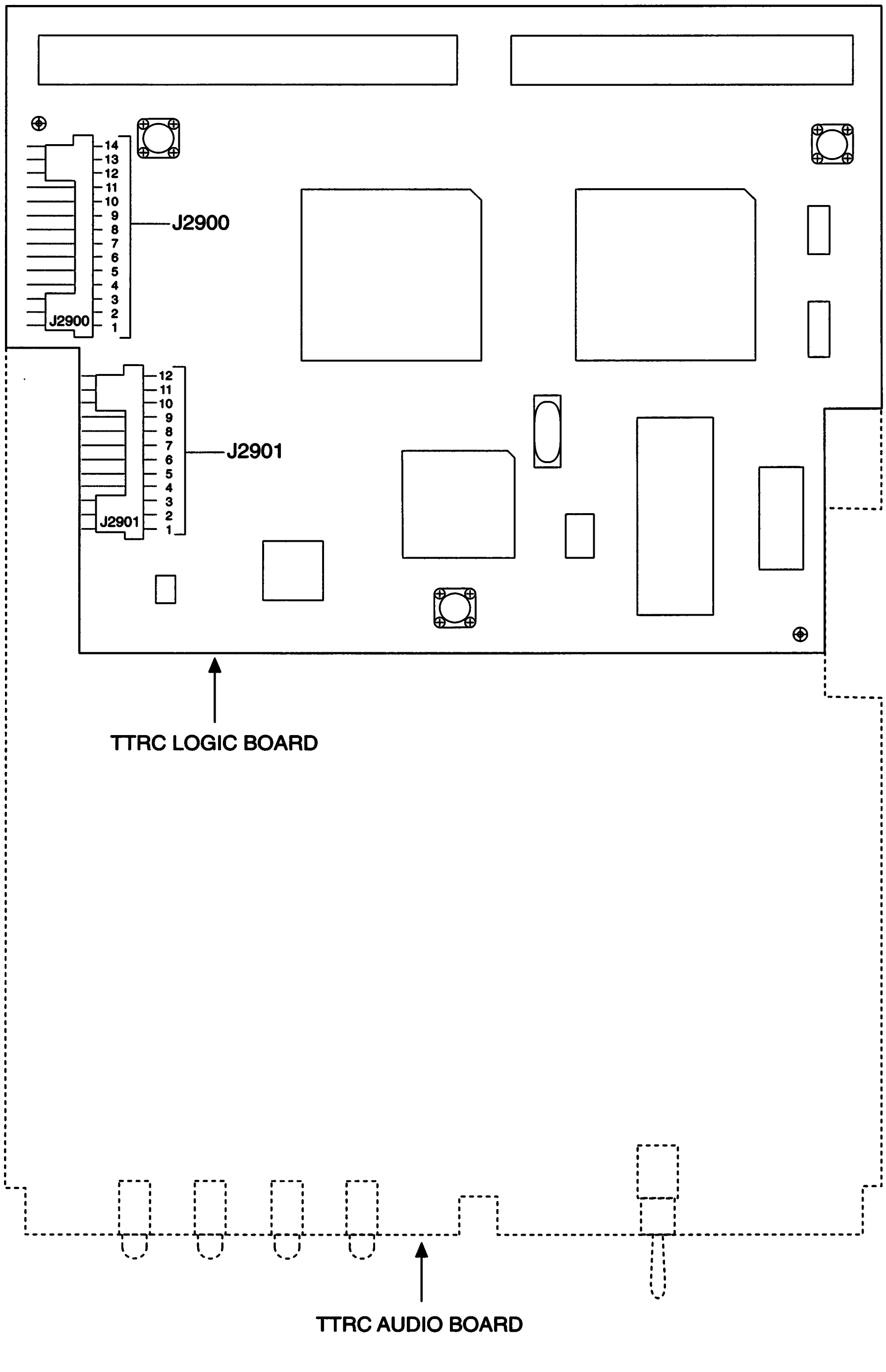


Figure 4-18 ***TTRC Logic Board Showing J2901***

NOTE

If the adjustments cannot be made within +/- 100 Hz, refer to Chapter 5 - Troubleshooting.

Transmitter Maximum Deviation Adjustment

The following procedure adjusts the maximum deviation for the transmitter. This adjustment is required to keep the station within local regulatory agency standards by preventing interference with adjacent channels.

To accurately perform this procedure, make sure all transmitted data is present (e.g., PL, DPL, Connect Tone, TDATA, etc.). Do not use the **Xmit** switch because it strips the PL and other transmitted data from the transmitted signal.

NOTE

Each channel must have the Maximum Deviation measured and set individually, since this level is channel slaved. It is not necessary to check the tuning channel deviation levels.

1. Inject a 1 kHz tone, at 1 Vrms closed circuit level, into the **MIC AUDIO** connector on the front panel or into TP8 on the SSCB. This is a 600 Ω input.

   Refer to Figure 4-19 for the location of TP8.

2. Set the **Acc Dis/Xmit** switch in **Acc Dis** to prevent the station from keying during this procedure.

3. Set the station to channel 1 if the station has multiple channels.

4. Key the station by setting the LOC PTT MUXbus bit (A1/D1).

NOTE

If this is a *trunked station* or if the station is equipped with PL or DPL coded squelch, the transmit signal consists of Mic Audio summed in with TDATA or the coded squelch signal. DO NOT use the **PL Dis/Xmit** switch to key the station; doing so strips the TDATA and coded squelch signals from the transmitted signal and gives a false deviation reading.

5. Measure the Maximum Station Deviation level and compare it to the requirements in Table 4-8.

Alignment Procedures

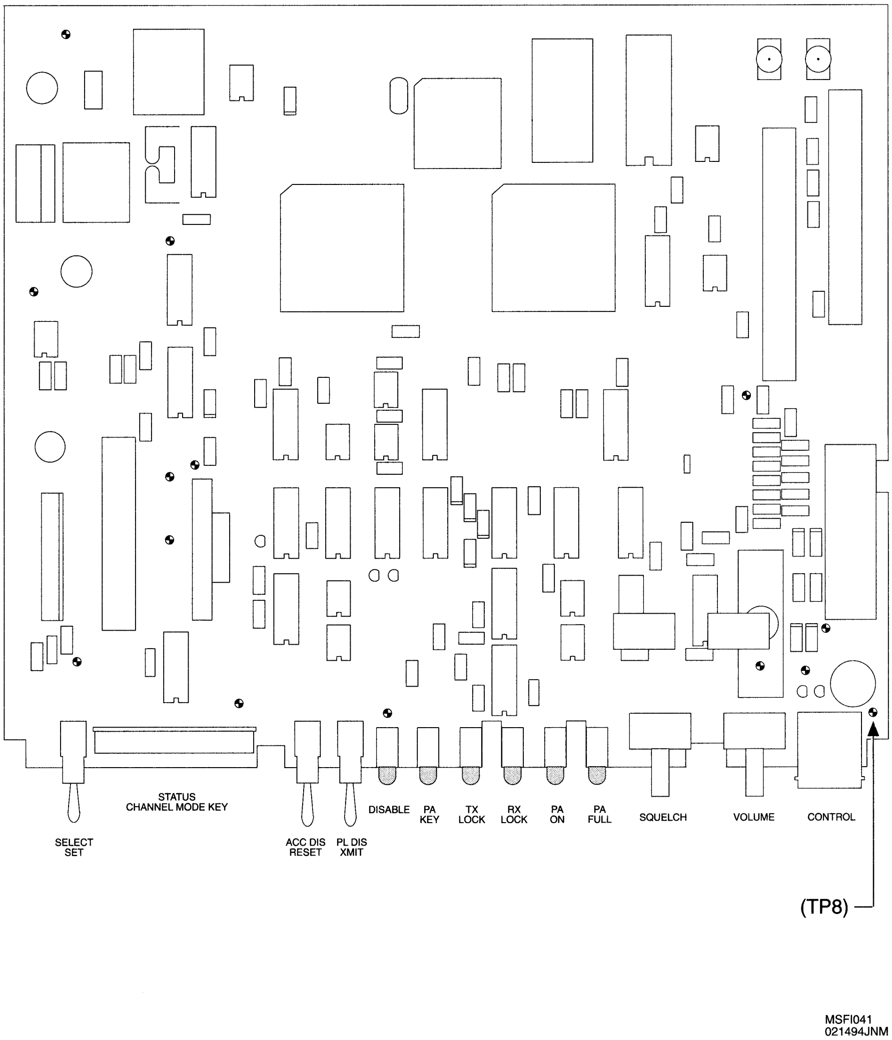


Figure 4-19 ***SSCB Showing TP8***

6. If the level is out of adjustment, set it by adjusting EEPOT 4.

Refer to Chapter 2 - Operation for additional information on adjusting EEPOTs.

7. If the station has multiple channels (excluding channel 0) perform steps 4 through 6 for each one.

8. Dekey the station by clearing the LOC PTT MUXbus bit (A1/D1).

9. Set the **Acc Dis/Xmit** switch to the center (normal) position.

Transmitter Wireline Audio Adjustment

This procedure adjusts the transmitter wireline audio level. When performing this procedure for Tone Remote Control, there are two different paths the transmit audio can take via Line 1 (ALC path) or Line 3 (non-ALC path). For conventional stations, the default is Line 1. *For trunked stations*, the default is Line 3. The only path the audio can take via Line 3 is the non-ALC path. Refer to Figure 4-20 for a block diagram of the ALC circuitry.

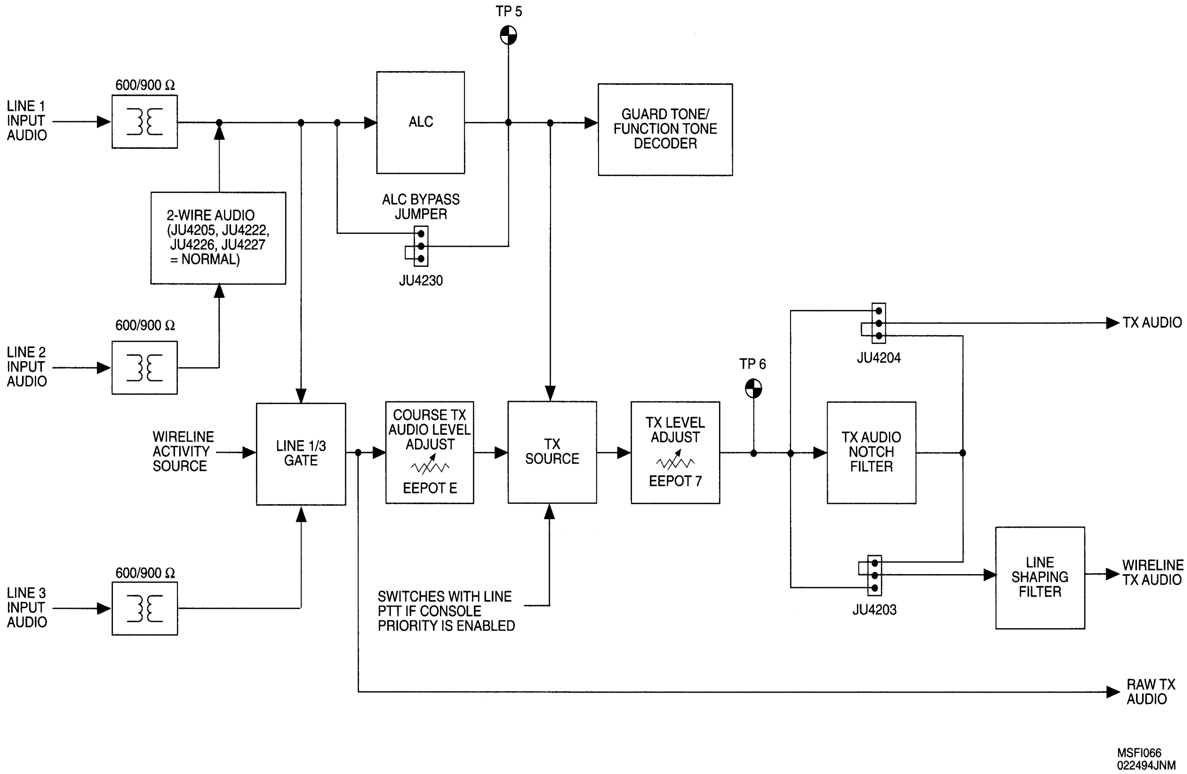


Figure 4-20 ***ALC Circuitry Block Diagram***

For adjusting transmit audio via the ALC path, the standard HLGT/FT/LLGT sequence should be followed for the ALC circuitry to adjust accordingly.

For adjusting transmit audio via the non-ALC path, a 1 kHz tone should be used. There is also a course level adjustment via EEPOT E which compensates for a higher or lower levels of audio. There are four different settings for this EEPOT. EEPOT E should only be used if the level for EEPOT 7 could not be met for audio through the non-ALC path.

For Console Priority Option (C115), the console is connected to Line 1 or Line 2 depending on the wireline setting. The trunking phone interconnect audio is connected to Line 3 and Line 4. The value of EEPOT 7 has two values, one for interconnect audio and one for console audio. EEPOT 7 must be aligned twice in this configuration.

For DC remote control, the audio is always routed through the non-ALC path.

When the TTRC Audio board is jumpered for a four-wire system, the transmit wireline interface is across Line 1 (+) and Line 1 (-) on the Junction Box screw terminal strip. The receive wireline interface is across Line2 (+) and Line2 (-).

When the TTRC Audio board is jumpered for a two-wire system, the transmit/ receive wireline interface is across Line 2 (+) and Line 2 (-) on the Junction Box screw terminal strip.

For two and four-wire systems, these connections are 600 Ω balanced inputs, unless otherwise jumpered for 900 Ω balanced inputs.

NOTE

If the station is a *trunked station without the Console Priority Option (C115)* or is configured for *DC remote control*, proceed to the DC Remote Control/Trunking Adjustment.

If this is a *trunked station with the Console Priority Option (C115)*, proceed to the Trunking/Console Priority Adjustment.

Tone Remote Control Adjustment

1. Using RSS, determine if the transmit audio is being routed to the modulator via the ALC circuit.
   - ❍ **Transmit source = ALC** - Key the station using a High Level Guard Tone (HLGT)/Function Tone (FT) sequence. This allows the ALC circuit to be properly set. Proceed to step 2.
   - ❍ **Transmit source = non-ALC** - Key the station via a LIN PTT (A1/ D2). Proceed to step 4.
2. Set HLGT, FT, LLGT, and the 1 kHz tone to the levels expected from the console, in the following relative relationship:
   - ❍ HLGT to 0 dBm
   - ❍ FT to -10 dBm
   - ❍ LLGT to -30 dBm
   - ❍ Average audio (1 kHz tone @ -6 dBm)

NOTE

These recommended levels are intended for co-located consoles which do not have phone line loss. If other levels are required due to phone line loss, the same relative relationship of signal levels should be maintained.

CAUTION

Do not key the station via RSS or by setting the LIN PTT MUXbus bit since these methods do no set ALC correctly.

3. Inject an HLGT/FT sequence followed by a 1 kHz tone with LLGT across the appropriate transmit wireline terminals, using a console or service monitor.

   Line 1 +/- for four-wire systems or Line 2 +/- for two-wire systems.

   The station should be keyed. Proceed to step 6.

4. Inject a 1 kHz tone across the appropriate transmit wireline terminals at a level matching average audio (-6 dBm), or other levels relative to peak input level.

NOTE

The recommended level is intended for co-located consoles which do not have phone line loss. If other levels are required due to phone line loss, the same relative relationship of signal levels should be maintained.

5. Key the station by setting the LIN PTT MUXbus bit (A1/D2).

6. Set and hold the **PL Dis/Xmit** switch to **Xmit** during step 7.

   This strips any data from being summed with the transmit audio.

7. Adjust transmit audio level via EEPOT 7 until the transmitted deviation level reaches 60% full station deviation, as indicated in Table 4-8.

8. Adjust EEPOT E if the level cannot be set via EEPOT 7 alone.

9. Exit the EEPOT adjust mode.

   Refer to Chapter 2 - Operation for additional information relating to the EEPOT adjust mode.

10. Remove the test tones.

DC Remote Control/Trunking Adjustment

> **NOTE**
>
> The following procedure applies only if the station is configured for *DC remote control* or is a configured as a *trunked station*. Otherwise, proceed to the Receiver Level Adjustment.

1. Inject a 1 kHz tone at the average audio (6 dB below peak audio) phone line level into the transmit wireline interface on the Junction Box.

   Line 1 +/- for four-wire systems or Line 2 +/- for 2 -wire systems.

2. If this is *not a trunked station*, gate the wireline audio to the transmitter by setting the LIN PTT MUXbus bit (A1/D2).

   *For trunked station*s, key the transmitter with a trunked PTT by disconnecting the trunking cable from connector J3 on the Junction Box.

   Key the transmitter by connecting a jumper wire jumper from J2901-8 (TKG PTT) to J2901-1 (LOGIC GND) on the TTRC logic board.

3. Enter the EEPOT adjust mode.

   Refer to Chapter 2 - Operation for additional information relating to the EEPOT adjust mode.

4. Set and hold the **PL Dis/Xmit** switch to **Xmit** for step 5.

   This strips any data from being summed with the transmit audio.

5. Adjust the TX Audio Level (EEPOT 7) until the transmitted deviation level reaches 60% full station deviation as indicated in Table 4-8.

6. Release the **PL Dis/Xmit** switch and remove all tones from the wireline.

7. Clear the LIN PTT MUXbus bit (A1/D2) or the trunked PTT jumper.

Trunking/Console Priority Adjustment

> **NOTE**
>
> The following procedure applies only to *a trunked station* with *the Console Priority Option (C115)*. Otherwise, proceed to the Receiver Level Adjustment.

1. Set HLGT, FT, LLGT, and the 1 kHz tone to the expected input levels:
   - ❍ HLGT to 0 dBm.
   - ❍ FT to -10 dBm

- LLGT to -30 dBm
- 1 kHz tone to -6 dBm (average audio)

NOTE

These recommended levels are intended for co-located consoles which do not have phone line loss. If other levels are required due to phone line loss, the same relative relationship of signal levels should be maintained.

CAUTION

Do not key the station via RSS or by setting the PTT MUXbus bit since these methods do no set ALC correctly.

2. Inject an HLGT/FT sequence followed by a 1 kHz tone with LLGT across the appropriate transmit wireline terminals, using a console or service monitor.

   Line 1 +/- for four-wire systems or Line 2 +/- for two-wire systems.

3. Set and hold the **PL Dis/Xmit** switch to **Xmit** during step 4.

   This strips any data from being summed with the transmit audio.

4. Adjust transmit audio level via EEPOT 7 until the transmitted deviation level reaches 60% full system deviation, as indicated in Table 4-8.

   Refer to Chapter 2 - Operation for additional information relating to the EEPOT adjust mode.

5. Remove the LLGT and 1 kHz test tone.

6. Inject a 1 kHz tone at the average audio phone line level (i.e., 6 dB below peak audio) through the wireline into the Line 3 input on the system connector of the Junction Box.

7. If this is a *trunked station*, disconnect the trunking cable from Junction Box connector (J3).

8. Key the transmitter by connecting a jumper wire jumper from J2901-8 (TKG PTT) to J2901-1 (LOGIC GND) on the TTRC logic board.

9. Set and hold the **PL Dis/Xmit** switch to **Xmit** during step 11.

   This strips any data from being summed with the transmit audio.

10. Scroll completely through the EEPOT numbers once, and then back to EEPOT 7.

11. Adjust EEPOT 7 until the transmitted deviation level reaches 60% full system deviation as indicated in Table 4-8.

    If the deviation level could not be set, adjust EEPOT E to select the appropriate range (0 through 3) of EEPOT 7. Repeat step 11.

12. Remove the test tone.

13. Release the **PL Dis/Xmit** switch.

Receiver Level Adjustment

The following procedure adjusts the receiver level deviation for the repeater mode of operation. For stations configured as base stations, a relative level can be measured on the SSCB which is equivalent to the repeater deviation level. For stations containing the *Spectra-TAC/DIGITAC Encoder Option (C269)*, the receiver level should be adjusted during in-cabinet repeat operation.

1. Inject a 1mV RF receive signal, modulated with a 1 kHz tone at 40% full station deviation, as indicated in Table 4-8, into the receiver antenna connector on the Junction Box.

   Refer to Figure 4-21 for the antenna connector locations.

2. Set the R1 PL DT MUXbus bit (A3/D2).

> **NOTE**
>
> Steps 3 through step 9 apply only to stations configured as repeaters. If the station is configured as a base station (half-duplex with antenna relay or full-duplex base station) or is a *trunked station* with a *Spectra-TAC/DIGITAC Encoder Option (C269)*, proceed to step 10.

3. If this is a *trunked station*, disconnect the trunking cable from Junction Box connector (J3).

4. Key the transmitter by connecting a jumper wire jumper from J2901-8 (TKG PTT) to J2901-1 (LOGIC GND) on the TTRC logic board.

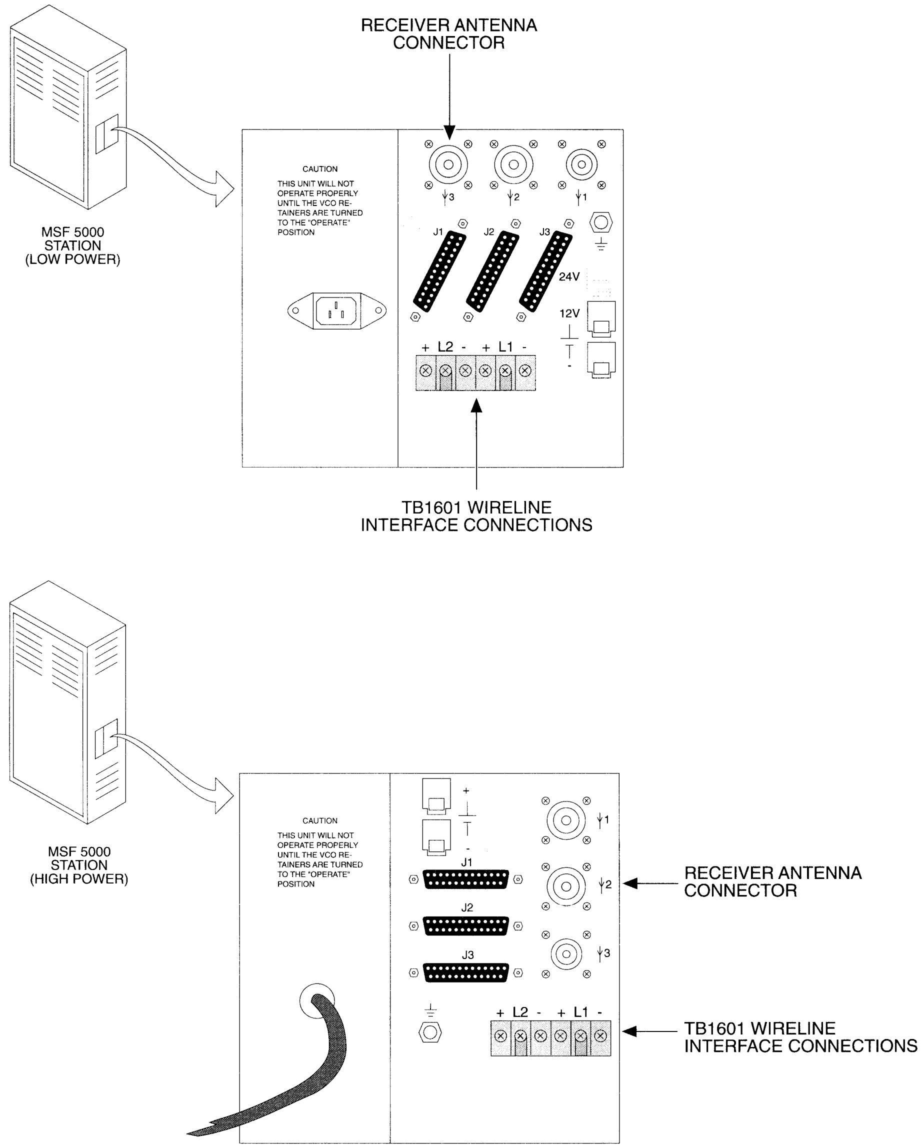
   Refer to Figure 4-22 for the connection locations.

5. Set and hold the **PL Dis/Xmit** switch to **Xmit** to strip off any TDATA or PL/ DPL.

6. Verify the transmitted deviation level is at 60% full station deviation as indicated in Table 4-5.

   This setting provides +3.5 dB of repeater gain. If this level is out of adjustment, set it by adjusting EEPOT 5.

   If unity gain is desired, set for 40% full system deviation.



NOTE: Dashed components (24V connection and ground) are used on VHF models only.

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Figure 4-21 ***Junction Box Antenna Connections***

NOTE

Step 7 through step 9 only apply to *900 MHz Analog Plus stations.*

7. Select EEPOT 1 to enable *Flutter Fighter.*

8. Set and hold the **PL Dis/Xmit** switch to **Xmit**.

Alignment Procedures

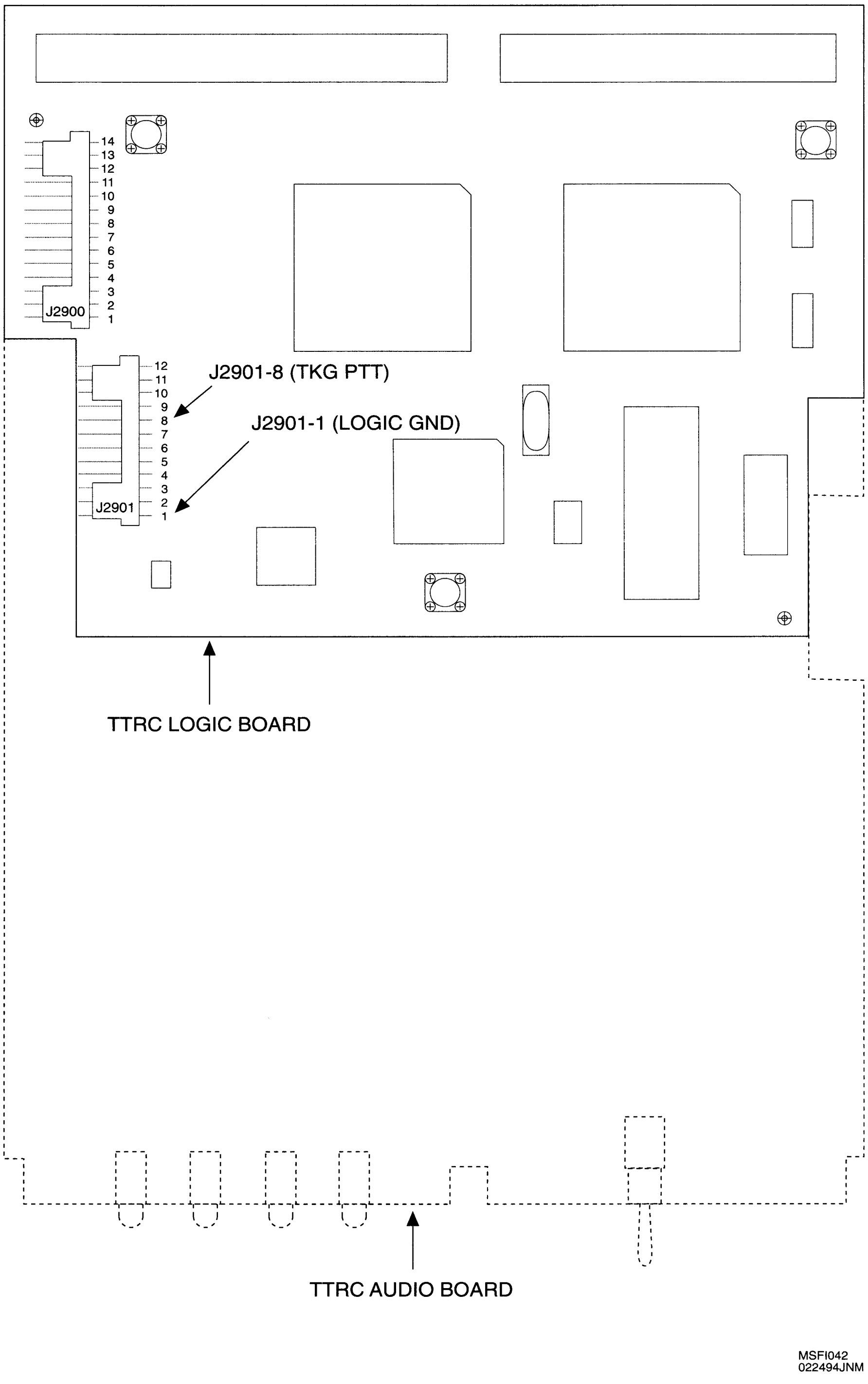

Figure 4-22 ***TTRC Logic Board***

9. Verify the transmit deviation level is at 60% full system deviation as indicated in Table 4-8. If not, adjust EEPOT 1.

NOTE

Perform step 10 only if the station is configured as a base station.

10. For base stations, verify 350±50 mVac is measured at TP1 on the SSCB, as shown in Figure 4-23. If not, adjust EEPOT 5.

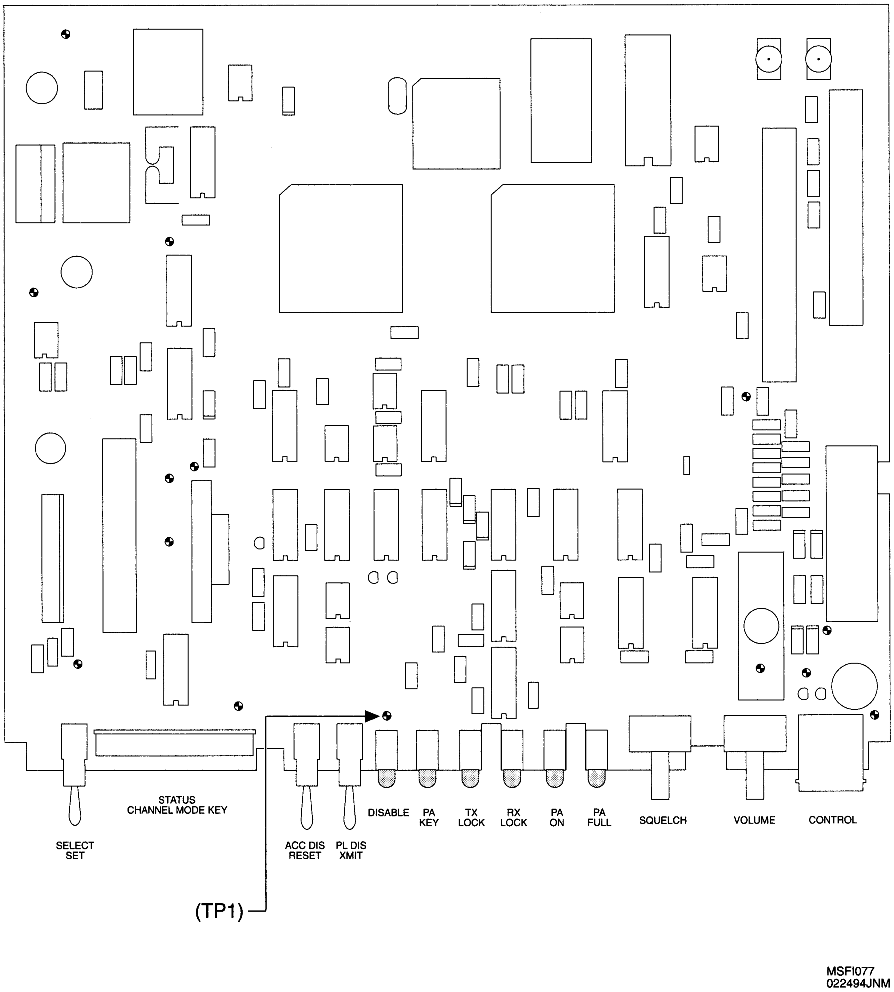

Figure 4-23 ***SSCB Showing TP1***

NOTE

Step 11 and step 12 only apply to *900 MHz Analog Plus stations* with the *Spectra-TAC/DIGITAC Encoder Option (C269) or an antenna relay.*

11. For *Analog Plus stations* equipped with a *Spectra-TAC/DIGITAC Encoder Option (C269)* or *an antenna relay,* select EEPOT 1 to enable the *Flutter Fighter.*

12. Verify the AC voltage at TP1, on the SSCB is 350±50 mVac as shown in Figure 4-23. If not, adjust EEPOT 1.

13. Dekey the station, deactivate any activated MUXbus bits, connect any disconnected cables, and remove any jumper wires that were installed.

Receiver Wireline Audio Adjustment

The following procedure adjusts the receiver wireline audio level for Line 2 and Line 4. The desired audio level is dependent upon the system configuration. If the station is configured for *Spectra-TAC/DIGITAC Encoder Option (C269).* Proceed directly to the High/Low End Adjustment to compensate for line loss.

NOTE

Perform this procedure only if the station is NOT equipped with a *Spectra-TAC/DIGITAC Encoder Option (C269)* to be used in a voting system. If voting will be used, proceed to the High/Low End Adjustment.

1. Inject a 1mV RF receive signal, modulated with a 1 kHz tone at 60% full station deviation into the receiver antenna connector on the Junction Box. Refer to Table 4-8.

2. Set the **PL Dis/Xmit** switch to **PL Dis**.

3. Verify the receive audio between Line 2 (+) and Line 2 (-) on the Junction Box screw terminal strip is at the desired phone line level.

   The typical phone line level is from 0 dBm to -10 dBm.

   If not, set it by adjusting EEPOT C.

NOTE

If the station is a *trunked station* with a *Console Priority Option (C115)* installed, continue with step 4. Otherwise, proceed to step 5.

4. Verify the receive audio at Line 4 on the system connector is at the desired phone line level.

   The typical phone line level is from 0 dBm to -10 dBm.

   If not, set the desired level by adjusting EEPOT d.

5. Deactivate all activated MUXbus bits.

6. Set the **PL Dis/Xmit** switch to the center (normal) position.

Decoded Receive Audio Adjustment

The following procedure adjusts the decoded receive audio level for stations containing the *Secure Encryption Option (C331, C388, C794, C795, or C797)*. Before performing this procedure, make sure the level of Line 2 is adjusted to the same relative level (0 dB) as the clear receive audio level.

NOTE

The Line 2 level must be adjusted before performing this procedure.

1. Inject a 1mV RF receive signal, modulated with a secure (digitally encrypted) 1 kHz tone at 3.9 kHz deviation into the receiver antenna connector on the Junction Box.

NOTE

The encryption source must be programmed with the same encryption key as the station. Refer to Chapter 2 - Operation for additional information.

2. Verify the outbound receiver audio between Line 2 (+) and Line 2 (-) is 0 dB relative to the clear wireline audio level.

   The clear wireline audio level setting was set up in the Receive Wireline Audio Adjustment procedure or the maximum allowable phone line level, whichever is less. If not, adjust EEPOT 0.

3. Remove the RF signal from the antenna connector on the Junction Box.

Squelch Adjustment

The following procedure adjusts the repeater and receiver squelch levels. If the station is configured for *Spectra-TAC/DIGITAC Option (269)* or to generate status tone, proceed directly to the High/Low End Adjustment.

The repeater squelch level is typically set for an RF level corresponding to 15 dB SINAD. The receiver squelch level is typically set for an RF level corresponding to 12 dB SINAD (15 dB SINAD for *trunked stations*). The RF level is measured at the SPEAKER AUDIO on the front panel connector. Both squelch levels can be set to the levels corresponding to system requirements.

For trunked stations, the repeater squelch potentiometer (EEPOT 2) is set to 00.

NOTE

If the station is configured to generate status tone and is not used for voting purposes, proceed to Status Tone Adjustment.

If the station is used for voting purposes, proceed to High/Low End Adjustment.

1. Set the **PL Dis/Xmit** switch to **PL Dis**.

NOTE

EEPOT 2 and EEPOT 3 are set at the factory to the maximum level (99). This fully closes the squelch.

2. Set EEPOT 2 and EEPOT 3 to the minimum level (00) to fully open the squelch.

3. Inject an on channel RF signal, without modulation at the desired repeater squelch threshold level, into the receiver antenna connector on the Junction Box.

NOTE

If this is a *trunked station*, proceed to step 5.

4. Adjust the Repeater Squelch Level (EEPOT 2) to the desired level.

5. Adjust the Receive Squelch Level (EEPOT 3) to the desired level.

6. Set the **PL Dis/Xmit** switch to the center (normal) position.

High/Low End Adjustment

The following procedure is only performed when a station is configured voting purposes. This adjustment provides an increase in level at the high and low end frequency response of the receiver audio to compensate for phone line loss. All voting receivers must be equalized to provide proper voting.

This procedure requires a technician at the comparator end of the phone line and the station being aligned.

NOTE

Perform this procedure only if the station is equipped with a *Spectra-TAC/DIGITAC Encoder Option (C269)* and will be used for voting. Otherwise, proceed to the Status Tone Adjustment.

1. Adjust the STAC Encoder Level (EEPOT 8) to the minimum level (00) to cause a minimum wireline status tone output.
2. With an audio generator, inject a 1 kHz tone at 1 mV into the MIC AUDIO input (J812-4) on the control connector or into TP8 on the SSCB.

NOTE

The generator must remain at a constant output level from 400 Hz to 4 kHz.

3. Set the **Intercom** switch to **On**.
4. Monitor across Line 2 (+) and Line 2 (-) and adjust the Line 2 Output Level (EEPOT C) for -10 dB.
5. Measure and record the level at the input to the comparator (DIGITAC input).

   The difference between the -10 dBm input and measurement at the comparator is the phone line loss at 1 kHz.
6. Set the audio generator frequency to 3 kHz.
7. Adjust the STAC High End Equalization Level (EEPOT 9) so that the level measured at the comparator is the same level recorded in step 5.
8. Repeat steps 5 through 7 until the level difference between 1 kHz and 3 kHz is within +/- 1 dB. The 1 kHz reference level must remain at -10 dB.
9. Set the generator frequency to 400 Hz.

10. Adjust the STAC Low End Equalization Level (EEPOT A) so that the level measured at the comparator is the same level recorded in step 5. Do not readjust EEPOTS C or 9.
11. Adjust the STAC Low End Equalization Level (EEPOT A) to the same level recorded in step 5.
12. Deactivate all activated MUXbus bits.
13. Set the **Intercom** switch to **Off**.
14. Disconnect the audio generator from the MIC AUDIO input.

Status Tone Adjustment

The following procedure is performed when a station is configured to have status tone sent from the station. This adjustment also sets the receiver and repeater squelch EEPOTs.

When completed, the status tone EEPOT is set to provide the required status tone level to be sent down the wireline Line 2. If the station is configured to operate with *Spectra-TAC/DIGITAC Encoder Option (C269)*, the receiver and repeater squelch levels are also adjusted to provide the proper unsquelching level.

NOTE

Only perform this procedure if the station being aligned is configured to generate status tone.

1. Inject an on channel 1mV RF signal, modulated with a 1 kHz tone at 100% full station deviation (60% full station deviation for *trunked stations*), into the receiver antenna connector on the Junction Box.

   Refer to Table 4-8 for values of full station deviation.
2. Set the **PL Dis/Xmit** to **PL Dis**.
3. Monitor the receive audio across Line 2 (+) and Line 2 (-) and adjust the Line 2 Output Level (EEPOT C) for the maximum desired phone line level.

   This is typically in the range of 0 dBm through -10 dBm.
4. Measure and record the level at the input to the comparator or other equipment expecting status tone from the station.
5. Set the **PL Dis/Xmit** to the center (normal) position.
6. Remove the RF signal generator from the receiver and verify the receiver is squelched.
7. Monitor the TAC comparator input and adjust the status tone Level (EEPOT 8) for a 2175 Hz status tone level 13 dB (9 dB for *trunked stations*) below the level recorded in step 4.

NOTE

Perform this procedure only if the station is equipped with a *Spectra-TAC/DIGITAC Encoder Option (C269).* Otherwise, proceed to the Coded Transmit Deviation Adjustment procedure.

8. Set EEPOT 2 and EEPOT 3 to the minimum level (00) to fully open the squelch.
9. Set the **PL Dis/Xmit** switch to **PL Dis**.
10. Measure and record the rms noise voltage level at the Line 2 output.
11. Inject an on channel 0.1 µV RF signal, without modulation into the receiver antenna connector on the Junction Box.
12. Increase the RF level until the Line 2 output level decreases 20 dB from the level recorded in step 10.

NOTE

The 20 dBQ level correlates to a 17 dB SINAD measurement.

13. Adjust the Receiver Squelch Level (EEPOT 3) until the R1 UN SQ MUXbus bit (A5/D0) is disabled.
14. Adjust the Repeater Squelch Level (EEPOT 2) until the RPT USQ MUXbus bit (A3/D0) is disabled.
15. Disconnect all test equipment and set the **PL Dis/Xmit** switch to the center (normal) position.

Coded Transmit Deviation Adjustment

The following procedure is only performed when a station is configured for the *Transparent Operation Option (C514)*. This procedure does not apply to any *900 MHz Analog Plus stations*, due to its incompatibility with secure operation.

When performing this procedure, the EEPOT mode (EEPOT 6) is entered to generate a 1 kHz tone. The station is then keyed via the Xmit switch and the deviation is adjusted.

NOTE

Perform this procedure only if the station is equipped with a *Transparent Operation Option (C514)* for secure operation. This option is not available on *900 MHz Analog Plus stations*.

1. Select EEPOT 6 on the **Status** display.

   After 5 seconds, an internal 1 kHz square wave generator is enabled in the station.

2. Key the station by holding the **PL Dis/Xmit** switch to **Xmit**.

3. With a modulation analyzer, measure the transmitter deviation level and compare it to the settings shown in Table 4-8.

   Adjust EEPOT 6 if required to reach the desired level.

4. Set the **PL Dis/Xmit** switch to the center (normal) position.

5. Reset the station by toggling the **Acc Dis/Reset** switch to **Reset**.

NOTE

If aligning a station that contains the Simulcast Option (C777), perform the procedures in Appendix H - Simulcast.

6. This concludes the *MSF 5000* Alignment procedure.

Troubleshooting

Troubleshooting Description

Diagnostic Descriptions

Troubleshooting the *MSF 5000* is usually performed through extensive diagnostic capabilities. When the station is powered up, a power-up diagnostic routine is initiated. There are three forms of power-up/reset diagnostic failure indications:

- Flashing Control Tray Status display failure
- Control Tray Status display error codes
- Flashing TTRC LED or Secure Fail LED failure

After the power-up diagnostic routine is complete, a continuous diagnostic routine monitors the status of the station during normal operation. There are three forms of continuous diagnostic failure indications:

- Control Tray Status display error codes
- Diagnostic information provided via MUXbus bits
- Generation of eight different audible alarm tones

Refer to Chapter 2 - Operation for diagnostic information.

Troubleshooting Failures

The following tables should be used to assist in the troubleshooting of the *MSF 5000* station. Should a failure occur during normal station operation, check the following tables for possible cause and corrective action before calling for service. If the failure still exists or is not listed, consult a qualified service person. If required, refer to the applicable Service Manual to assist in correcting the failure.

The following troubleshooting tables assume:

- ❒ all external equipment is functional
- ❒ all internal and interfacing cables are fully secure and properly connected
- ❒ all firmware versions are compatible and are correct for the necessary application
- ❒ all programmed parameters have been checked for accuracy and programmed into the station
- ❒ station is configured and jumpered properly for the necessary application

The symptoms may have several possible causes and remedies. If a failure is isolated to the module level, the suspected module can be replaced with a functional module.

Failures Immediately After Power-Up

Table 5-1 ***Failures Immediately After Power-Up***

Symptom	Possible Cause	Remedy
Station does not power-up when AC power is applied	Blown fuse in the Junction Box	Replace fuse
	No +5 Vdc on SSCB	Check regulator circuit; replace SSCB
	No 13.8 Vdc output from the power supply: Connector P602 pin 3 or pin 4 = 13.8 Vdc; pin 5 or pin 6 = ground; pin 8 = 28 Vdc if available	Replace fuse; check Power Supply and replace
	No 13.8 Vdc on the SSCB at connector J701; pin 5 = ground; pin 1 = 13.8 Vdc	Replace Interconnect board Replace SSCB power
Station does not come out of reset sequence	A fatal error has occurred within the station	Check reset sequence for description; Refer to Appendix B - Error Codes for detail and possible cause and remedy
TTRC Fail LED is lit after reset sequence is complete	Faulty board	Check and replace TTRC board
Tx or Rx Lock LED is not lit on Control Tray front panel	Transmit or receive synthesizer is out of alignment	Perform Alignment procedure; refer to Chapter 4 - Alignment
	Illegal frequencies programmed into station Station set to wrong frequency band (Mosaic/non-Mosaic)	Reprogram station via RSS
	FOR TRUNKED STATIONS	
Station enters Failsoft mode (trunking only)	No TDATA detection or mute line activity from central controller	Check trunking cables and central controller

Failures After Alignment

Table 5-2 ***Failures After Alignment***

Symptom	Probable Cause	Remedy
Receiver does not unsquelch	RX front end is detuned	Realign receiver; refer to Chapter 4 - Alignment
	Receiver squelch is too tight (EEPOT 3)	Realign squelch pot; refer to Chapter 4 - Alignment
	Incorrect programmed squelch qualifiers	Reprogram via RSS
Station does not transmit with a Local PTT	Faulty PA Power control problem	Check and replace PA Replace Uniboard
	Faulty SSCB	Check and replace SSCB
	Programming error	Reprogram via RSS
Station does not transmit with a RPT PTT	Faulty PA	Check and replace PA
	Repeater squelch pot (EEPOT 2) improperly aligned	Realign RPTR squelch pot adjustment; refer to Chapter 4 - Alignment
	Incorrect programmed squelch qualifiers	Reprogram via RSS
	Faulty SSCB	Check and replace SSCB
	Programming error	Reprogram via RSS
Station does not transmit with a LINE PTT	Faulty PA	Check and replace PA
	Programming error	Reprogram via RSS
Frequency is off center	Frequency is out of adjustment	Realign Fo frequency adjustment; refer to Chapter 4 - Alignment
	Faulty transmit or receive VCO	Reference is not fully warmed up Check and replace VCO
	Faulty Uniboard	Check and replace Uniboard
Power is not at rated power	Power adjustment incorrect	Realign per Chapter 4 - Alignment
	Overdrive trip point was exceeded	Reset trip point; realign power output per alignment procedure
	Thermal cutback has occurred	Check and replace PA and antenna
	Battery revert has occurred	Replace AC source Adjust cutback control; refer to Chapter 4 - Alignment
	Faulty Uniboard	Check power control circuitry and replace Uniboard
	Faulty PA	Check and replace PA
PA Full LED is not lit when station is given a PA key on	Overdrive trip point was met	Reset trip points; refer to Chapter 4 - Alignment
	Faulty PA	Check and replace PA
	Faulty power control circuit on Uniboard	Check and replace Uniboard

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High Speed Ring Bytes

High Speed Ring Byte Overview

The High Speed Ring (HSR) data word is a window into the station that can be used to help diagnose problems, monitor the status of the station, and verify station operation. The HSR data word is circulated between the modules of the control tray. This data word is broken down into five data bytes. Refer to Chapter 2 - Operation for information on how to view the data bytes in the Status display.

Each of these data bytes may be viewed on the Status display through the use of the front panel controls. The byte being monitored is displayed in the left-most digit on the Status display. The set bits for each data byte is represented as a hexadecimal number in the two right-most digits of the Status display.

Figure A-1 illustrates how the data bytes are presented in the Status display. Table A-1 may be used as a quick reference for converting the data bytes displayed from hexadecimal to binary. Tables A-2 through A-6 define each of the read-only HSR data bytes. This table is used to decode the data bytes from hex to binary to help determine the active data signals.

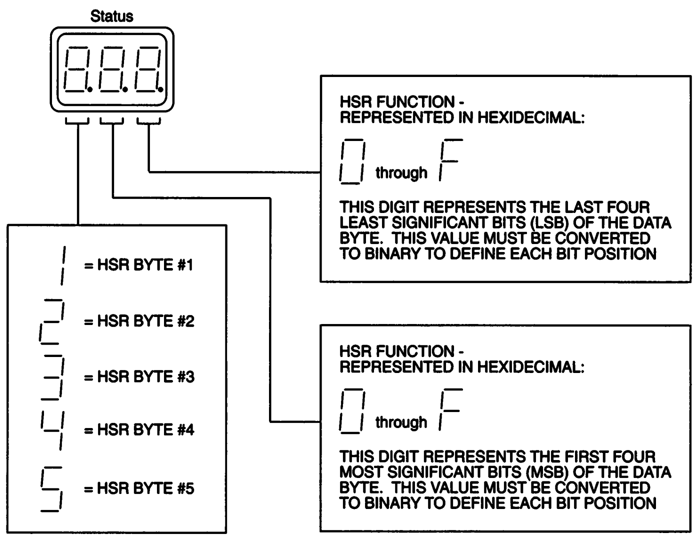

Figure A-1 **HSR Status Display Definitions**

Hexadecimal Conversion Table

Table A-1 ***Hex-Decimal-Binary Conversion***

Hex	Decimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111

Table A-1 ***Hex-Decimal-Binary Conversion***

Hex	Decimal	Binary
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

Byte Definitions

Table A-2 ***HSR Byte #1***

HSR byte	Definition	Bit positions
1	RSTAT	10000000
1	RdSTAT	01000000
1	TSTAT	00100000
1	MRTI DVP Mode	00010000
1	GCC Seize	00001000
1	Keyword Number (0-7 hex)	00000111

Table A-3 ***HSR Byte #2***

HSR byte	Definition	Bit positions
2	Coded Takeover	10000000
2	Ring PL Detect	01000000
2	Gen Simulcast RB	00100000
2	(currently unassigned)	00010000

Table A-3 ***HSR Byte #2 (Continued)***

HSR byte	Definition	Bit positions
2	Line PTT	00000001
2	Local PTT	00000010
2	Repeater PTT	00000011
2	(currently unassigned)	00000100
2	ID PTT	00000101
2	Rx Coded PTT	00000110
2	Tx Coded PTT	00000111
2	Data PTT	00001000
2	Alarm PTT	00001001
2	Xmit PTT	00001010
2	MRTI PTT	00001011
2	Clr_RPT_DOD	00001100
2	Coded_RPT_DOD	00001101
2	Auto Access ACK	00001110
2	(currently unassigned)	00001111

Table A-4 ***HSR Byte #3***

HSR byte	Definition	Bit positions
3	Tx Inhibit	10000000
3	TPTT	01000000
3	Duplex Enable	00100000
3	CCI	00010000
3	Failsoft	00001000
3	WL Key Number (0-7 hex)	00000111

Table A-5 ***HSR Byte #4***

HSR byte	Definition	Bit positions
4	WL Key Erase	10000000
4	MUTE	01000000
4	Ext Code Detect	00100000
4	Site Failsoft	00010000
4	DVP 0=Code 1, 1=Code 2	00001000
4	(currently unassigned)	00000100
4	(currently unassigned)	00000010
4	(currently unassigned)	00000001

Table A-6 ***HSR Byte #5***

HSR byte	Definition	Bit positions
5	EOM Audio Mute	10000000
5	PRE Rx Code Rel	01000000
5	PRE Tx Code Rel	00100000
5	Rx EOM Detect	00010000
5	Int TX CD DT	00001000
5	Int RX CD DT	00000100
5	Int ACC DIS	00000010
5	(currently unassigned)	00000001

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Appendix B

Error Codes

Error Codes

When an error is detected by the station, an error code appears in the Status display. This code is used to aid in the troubleshooting of the *MSF 5000*. Error codes are differentiated from other MSF codes by illuminating all three decimal points of the Status display.

There are five different categories of error codes. The category is displayed in the left-most digit of the Status display. The type of error is represented in hexadecimal format in the two right-most digits of the Status display. Hexadecimal coding permits up to 256 possible error codes per category.

Figure B-1 illustrates the error code format and how it is presented within the Status display.

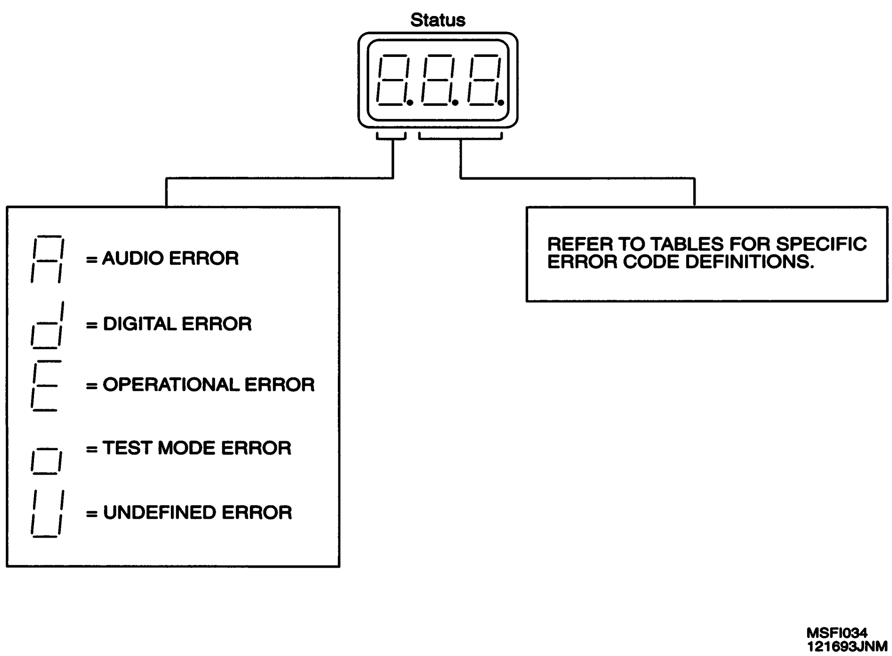

Figure B-1 ***Error Code Example***

Operational Error Code Definition

Operational error codes represent failures of a specific function of the station. Table B-2 lists all possible operational error codes of the *MSF 5000*.

Table B-1 ***Operational Error Codes***

Error	Description	Probable Cause	Corrective Action
E00	Push-To-Talk Type HSR image mismatch	• An HSR data packet was corrupted (i.e. via electrostatic discharge). • The High Speed Ring data in/data out continuity is severed	• If this error occurs only once, an HSR data packet is probably corrupted. This usually self-corrects within 125 µS. • If this error continuously occurs during key-ups, the HSR data I/O ring is no longer continuous. Reset the station. A digital error code (d.9.A.) should show up. Follow the Corrective Action for d.9.A.
E10	No RX1 band designated	The RF Band definition field in the codeplug(s) is undefined.	Reprogram the station codeplug(s). Refer to the RSS manual.
E11	No RX2 band designated	The RF Band definition field in the codeplug(s) is undefined.	Reprogram the station codeplug(s). Refer to the RSS manual.
E20	EEPOT 0 lower limit out-of-bounds (coded RX level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 0. Refer to Chapter 4, Alignment.
E21	EEPOT 1 lower limit out-of-bounds (flutter fighter level) - *900 MHz only*	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 1. Refer to Chapter 4, Alignment.
E22	EEPOT 2 lower limit out-of-bounds (repeater squelch level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 2. Refer to Chapter 4, Alignment.
E23	EEPOT 3 lower limit out-of-bounds (receiver squelch level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 3. Refer to Chapter 4, Alignment.
E24	EEPOT 4 lower limit out-of-bounds (maximum deviation level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 4. Refer to Chapter 4, Alignment.
E25	EEPOT 5 lower limit out-of-bounds (RX level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 5. Refer to Chapter 4, Alignment.
E26	EEPOT 6 lower limit out-of-bounds (coded deviation level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 6. Refer to Chapter 4, Alignment.
E28	EEPOT 0 upper limit out-of-bounds (coded RX level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 0. Refer to Chapter 4, Alignment.
E29	EEPOT 1 upper limit out-of-bounds (flutter fighter level) - *900 MHz only*	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 1. Refer to Chapter 4, Alignment.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
E2A	EEPOT 2 upper limit out-of-bounds (repeater squelch level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 2. Refer to Chapter 4, Alignment.
E2b	EEPOT 3 upper limit out-of-bounds (receiver squelch level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 3. Refer to Chapter 4, Alignment.
E2C	EEPOT 4 upper limit out-of-bounds (maximum deviation level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 4. Refer to Chapter 4, Alignment.
E2d	EEPOT 5 upper limit out-of-bounds (RX level)	Alignment procedure attempted to adjust SSCB EEPOT beyond maximum setting.	Adjust EEPOT 5. Refer to Chapter 4, Alignment.
E2E	EEPOT 6 upper limit out-of-bounds (coded deviation level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 6. Refer to Chapter 4, Alignment.
E30	EEPOT 7 lower limit out-of-bounds (transmit audio level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 7. Refer to Chapter 4, Alignment.
E31	EEPOT 8 lower limit out-of-bounds (status tone level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 8. Refer to Chapter 4, Alignment.
E32	EEPOT 9 lower limit out-of-bounds (high end equalization level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT 9. Refer to Chapter 4, Alignment.
E33	EEPOT A lower limit out-of-bounds (low end equalization level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT A. Refer to Chapter 4, Alignment.
E34	EEPOT b lower limit out-of-bounds (trunking data level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT b. Refer to Chapter 4, Alignment.
E35	EEPOT C lower limit out-of-bounds (line 2 output level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT C. Refer to Chapter 4, Alignment.
E36	EEPOT d lower limit out-of-bounds (line 4 output level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT d. Refer to Chapter 4, Alignment.
E37	EEPOT F lower limit out-of-bounds (SAM encode level)	Alignment procedure attempted to adjust EEPOT below minimum setting.	Adjust EEPOT F. Refer to Chapter 4, Alignment.
E38	EEPOT 7 upper limit out-of-bounds (transmit audio level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 7. Refer to Chapter 4, Alignment.
E39	EEPOT 8 upper limit out-of-bounds (status tone level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 8. Refer to Chapter 4, Alignment.

Operational Error Code Definition

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
E3A	EEPOT 9 upper limit out-of-bounds (high end equalization level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT 9. Refer to Chapter 4, Alignment.
E3b	EEPOT A upper limit out-of-bounds (low end equalization level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT A. Refer to Chapter 4, Alignment.
E3C	EEPOT b upper limit out-of-bounds (trunking data level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT b. Refer to Chapter 4, Alignment.
E3d	EEPOT C upper limit out-of-bounds (line 2 output level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT C. Refer to Chapter 4, Alignment.
E3E	EEPOT d upper limit out-of-bounds (line 4 output level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT d. Refer to Chapter 4, Alignment.
E3F	EEPOT F upper limit out-of-bounds (SAM encode level)	Alignment procedure attempted to adjust EEPOT beyond maximum setting.	Adjust EEPOT F. Refer to Chapter 4, Alignment.
E40	RX_Loop_Ctrl line not changing states	The RX1 Loop signal is not toggling as expected, indicating a bad receiver synthesizer.	Replace Uniboard.
E41	TX_Loop_Ctrl line not changing states	The TX Loop signal is not toggling as expected, indicating a bad transmitter synthesizer.	Replace Uniboard.
E42	Muti-Coded Squelch (MCS) update time in CP < 1 hour	MCS air-time accumulator update time in the codeplug is less than one hour. A value of one hour is assumed by the firmware.	Reprogram the SSCB codeplug to set the update time value to at least one hour. Refer to the RSS manual.
E43	Error while copying user table to MCS board	MCS board is not accepting the user table serial data transfer due to one of the following conditions: • No power to MCS board • JU1 configured incorrectly • Defective EEPROM on MCS board	• Verify power to MCS board • Verify JU1 is configured to enable EEPROM writes • Replace defective EEPROM • Replace MCS board
E44	Error in update_MCS while converting ascii to hex	The IPCB signal was temporarily corrupted while transferring user table data between the SSCB and MCS modules, resulting in non-ASCII data being received by the SSCB.	No action required, this error should self-correct.
E45	Cannot adjust receiver to saved level	Corrupted SSCB.	Reprogram. Refer to the RSS manual
E46	Transmit synthesizer failed to unlock after "Change_Freq" pulse	Faulty SSCB. Faulty VCO.	Replace SSCB. Replace VCO.
E47	Transmit synthesizer failed to lock after three program attempts	Recent frequency change or bad VCO.	Reprogram SSCB or retune Tx VCO.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
E48	RX synthesizer failed to unlock after "Change_Freq" pulse	Station was misprogrammed. Faulty SSCB.	Reprogram. Replace SSCB.
E49	RX synthesizer failed to lock after three program attempts	Recent frequency change or bad VCO.	Reprogram SSCB or retune Tx VCO.
E4A	RX2 synthesizer failed to unlock after "Change_Freq" pulse	Station was misprogrammed. Faulty SSCB.	Reprogram. Replace SSCB/Uniboard.
E4b	RX2 synthesizer failed to lock after three program attempts	Faulty SSCB.	Replace SSCB/Uniboard.
E4C	Invalid number of scan channels	There is either less than one, or more than 15, channels programmed into the station.	The station should have between 1 and 15 channels programmed. At least two channels must be scan enabled for proper scan operation.
E4d	RX1 tuning channel is programmed to 0	Station was not set back to a normal operating channel after maintenance or alignment.	Set channel to a programmed channel. Refer to Chapter 2, Operation.
E4E	RX2 tuning channel is programmed to 0	Station was not set back to a normal operating channel after maintenance or alignment.	Set channel to a programmed channel. Refer to Chapter 2, Operation.
E4F	Transmit tuning channel is programmed to 0	Station was not set back to a normal operating channel after maintenance or alignment.	Set channel to a programmed channel. Refer to Chapter 2, Operation.
E50	ALC Xmit EEPOT codeplug value invalid	EEPOT 7 invalid value. Faulty TTRC logic board. Faulty TTRC audio board.	Reset station. Realign EEPOT 7 Replace TTRC board. Replace TTRC audio board.
E51	Un-ALC Xmit EEPOT codeplug value invalid	EEPOT 7 invalid value. Faulty TTRC logic board. Faulty TTRC audio board.	Reset station. Realign EEPOT 7 Replace TTRC board. Replace TTRC audio board.
E52	HSR address specified in Ext_PTT_Ctrl_Tbl invalid	Misprogrammed. Faulty TTRC logic board.	Reprogram. Replace TTRC logic board.
E53	HSR bit specified in Ext_PTT_Ctrl_Tbl invalid	Misprogrammed. Faulty TTRC logic board.	Reprogram. Replace TTRC logic board.
E54	Encode_echo request already active (TTRC)	Faulty TTRC board.	Reset station. Replace TTRC logic board.
E55	TRC_Encode request active too long	Faulty TTRC board.	Reset station. Replace TTRC logic board. Replace TTRC audio board.
E56	Bad echo non_fatal_error_code (TTRC)	Faulty tone request.	Reset station and retry.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
E57	Invalid DC current present	Invalid DC. Faulty TTRC audio board. Faulty TTRC logic board.	Faulty external equipment. Replace TTRC audio board. Replace TTRC logic board.
E58	HSR address specified in Spare_Ctrl_Tbl invalid	Faulty TTRC logic board.	Replace TTRC logic board.
E60	Callsign (station ID) is too long	Long callsign specified.	Use Shorter callsign; reprogram via RSS
E70	RAC/SAM invalid audio source selected for tone decoder	Invalid audio source selected for tone decoder.	Reselect source and reprogram. Refer to RSS manual.
E71	RAC/SAM invalid audio source selected for binary decoder	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E72	RAC/SAM invalid audio source selected for DTMF decoder	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E73	RAC/SAM invalid data requested by EEPOT routine	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E74	RAC/SAM input specified with no associated line number	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E75	RAC/SAM IO_Assignments not input/alarm/logic conditions	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E76	RAC/SAM input number exceeds largest allowed value	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E77	RAC/SAM AND function with no addresses specified	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E78	RAC/SAM OR function with no addresses specified	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E80	Invalid common timer number (SSCB)	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E81	Invalid EEPOT update requested	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E82	Current PTT_Type is undefined	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E83	Invalid PTT Arbitration State	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E84	Bad State in transmitter manager	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E85	MCS board not present when required	• MCS IPCB interface circuitry defective. • MCS module has catastrophic failure (processor won't run, firmware missing, etc.).	• Verify that MCS module is properly installed. • Check MCS TEST LED for flashing fatal error indication.
E86	Bad State in EEPOT adjustment module	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
E87	Bad State in ring display module	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E88	PTT_Priority_List pointer is null	Improper SSCB codeplug programming.	Reprogram SSCB codeplug. Refer to RSS manual.
E89	Too many channels and modes defined	The total number of Primary Receiver Channels, Second Receiver Channels, and Modes exceeds 255.	Reduce the number of channels and/ or modes by reprogramming the SSCB codeplug.
E8A	Bad State in SSCB I/O service module	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E8b	Bad Command_State in IPCB Command_y (SSCB)	Device connected to IPCB used incorrect command format Random RAM error or software programming error.	Contact Motorola System Support Center if error recurs.
E8C	Bad State in wattmeter trip-point set module	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E8d	SSCB SP address table missing address needed for SP function	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
E8E	Bad State in Channel Scan Master	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E90	Invalid common timer number (TTRC)	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E91	Invalid EEPOT update requested	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E92	Invalid tone #, bad case call	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E93	Invalid command #, bad case call	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E94	Invalid ALC state #, bad case call	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E95	Invalid DC current number error	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
E9b	Bad Command_State in IPCB Command_y (TTRC)	Device connected to IPCB used incorrect command format Random RAM error or software programming error.	Contact Motorola System Support Center if error recurs.
E9d	TTRC sp address table missing address needed for SP function	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EA0	Invalid common timer number (Secure)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
EA1	Bad State in coded takeover module	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
EA2	RAC/SAM output response number out of range	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
EAA	RAC/SAM output line number out of range	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
EAb	Bad Command_State in IPCB Command_y (Secure)	Device connected to IPCB used incorrect command format Random RAM error or software programming error.	Contact Motorola System Support Center if error recurs.
EAC	Invalid RAC/SAM EEPOT update requested	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
EAd	Secure sp address missing address needed for SP function	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
EAE	Bad Command_State in IPCB Command_y (Secure)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
EAF	Too many IO_Assignments programmed into codeplug	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
Eb0	Undefined SSCB Reserved Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb1	Undefined SSCB SPI Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb2	Undefined SSCB Pulse Accumulator Edge Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb3	Undefined SSCB Pulse Accumulator Overflow Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb4	Undefined SSCB Timer Overflow Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb5	Undefined SSCB Timer Output Compare 5 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb6	Undefined SSCB Timer Output Compare 3 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb7	Undefined SSCB Timer output Compare 1 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb8	Undefined SSCB Timer Input Capture 3 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Eb9	Undefined SSCB Timer Input Capture 2 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EbC	Undefined SSCB Xinterrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ebd	Undefined SSCB Software Interrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
EbE	Undefined SSCB Opcode Trap Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EbF	Undefined SSCB Clock Monitor Failure Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC0	Undefined TTRC Reserved Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC1	Undefined TTRC SPI Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC2	Undefined TTRC Pulse Accumulator Edge Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC3	Undefined TTRC Pulse Accumulator Overflow Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC4	Undefined TTRC Timer Overflow Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC5	Undefined TTRC Timer Output Compare 4 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC6	Undefined TTRC Timer Output Compare 1 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC7	Undefined TTRC Timer Input Capture 3 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC8	Undefined TTRC Real-Time Interrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EC9	Undefined TTRC XInterrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
ECA	Undefined TTRC Software Interrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
ECb	Undefined TTRC Opcode Trap Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
ECC	Undefined TTRC Clock Monitor Failure Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
ECd	Undefined TTRC Computer Operating Properly (COP) Watchdog Failure Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
ECE	Undefined TTRC Timer Output Compare 5 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
ECF	Undefined TTRC Timer Output Compare 4 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed0	Undefined Secure Reserved Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed1	Undefined Secure Serial Comm Intfc Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.

Table B-1 ***Operational Error Codes (Continued)***

Error	Description	Probable Cause	Corrective Action
Ed2	Undefined Secure SPI Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed3	Undefined Secure Pulse Accumulator Edge Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed4	Undefined Secure Pulse Accumulator Overflow Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed5	Undefined Secure Timer Overflow Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed6	Undefined Secure Timer Output Compare 5 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed7	Undefined Secure Timer Output Compare 4 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed8	Undefined Secure Timer Output Compare 3 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Ed9	Undefined Secure Timer Output Compare 2 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EdA	Undefined Secure Timer Output Compare 1 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Edb	Undefined Secure Timer Interrupt Capture 3 Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EdC	Undefined Secure Real-Time Interrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
Edd	Undefined Secure Interrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EdE	Undefined Secure XInterrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EdF	Undefined Secure Software Interrupt Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EE0	Undefined Secure Opcode Trap Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EE1	Undefined Secure Clock Monitor Failure Interrupt	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
EFF	Computer Operating Properly (COP) failure	One of the MC68HC11-based modules COP timer is defective.	Reset the station. If the COP Failure error recurs, replace the defective microprocessor.

Audio Error Codes

Table B-2 **Audio Error Codes**

Error	Description	Probable Cause	Corrective Action
A00	Private Line (PL) encoder failure	The following circuits on the SSCB may be faulty: • PL 1R-2R DAC/low pass filter. • PL audio sample signal. • SSCB processor A/D converter.	Replace SSCB.
A01	Alert tone encoder failure	The following circuits on the SSCB may be faulty: • alert tone 1R-2R DAC/low pass filter. • alert tone sample signal. • SSCB processor A/D converter.	Replace SSCB.
A02	PL encoder-to-TP4 path failure	The following circuits on the SSCB may be faulty: • PL encoder-to-TP4 path. • mod audio sample. • EEPOT 4 (maximum deviation adjust) adjusted incorrectly.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace SSCB.
A03	Alert tone encoder-thru-splatter filter or maximum deviation adjust EEPOT failure	The following circuits on the SSCB may be faulty: • defective transmit alert tone gate. • limiter/splatter filter. • EEPOT 4 adjusted incorrectly (maximum deviation adjust).	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace SSCB.
A04	Alert tone encoder-to-RX1 audio path or RX level EEPOT failure	A problem between the quad audio buffer and the RX1 audio signal, indicating the following circuits of the SSCB may be faulty: • alert tone loopback gates. • flutter fighter bypass gate. • RX PL high pass filter. • EEPOT 5 (RX level) adjusted incorrectly. • de-emphasis circuitry. • expandor bypass gate. • RX1 audio sample.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace SSCB.
A05	Alert tone encoder-to-RX1 squelch detector failure	The receiver was not fully quieted during power-up diagnostics, indicating the following circuits of the SSCB may be faulty: • defective EEPOT 3 (receiver squelch level). • defective squelch noise amp. • defective receiver squelch detector.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace SSCB.

Audio Error Codes

Table B-2 **Audio Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
A06	Alert tone encoder-to-repeater squelch detector failure	The receiver was not fully quieted during power-up diagnostics, indicating the following circuits of the SSCB may be faulty: • EEPOT 2 (repeater squelch level) adjusted incorrectly. • defective squelch noise amp. • defective repeater squelch detector.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace SSCB.
A07	Alert tone encoder-to-TP1 failure	The following circuits on the SSCB may be faulty: • select audio summer defective. • system audio sample circuitry defective.	Replace SSCB.
A08	Alert tone encoder-to-line audio failure	The following circuits on the SSCB may be faulty: • defective line audio summer. • line audio alert tone gate. • line audio sample circuitry.	Replace SSCB.
A09	RX audio gate-thru-repeater audio gate-to-transmit limiter	The following circuits on the SSCB may be faulty: • defective repeat audio gate. • transmit summer. • compandor gate.	Replace SSCB.
A0A	A/D converter failure on SSCB processor	The A/D converter system on the SSCB processor is defective.	Replace processor on the SSCB. If failure still occurs, replace SSCB.
A0b	Bad alert tone TX gate (no mute)	Alert tone transmit gate/driver circuitry.	Replace SSCB.
A0C	RX1 Audio Gate failure	Receiver audio gate/driver circuitry.	Replace SSCB.
A0d	Faulty PL filter/limiter circuitry	The following circuits on the SSCB may be faulty: • PL/DPL filter/limiter circuits. • input capture system on SSCB microprocessor.	Replace processor on the SSCB. If failure still occurs, replace SSCB.
A20	A/D converter failure on TTRC processor	The A/D converter system on the TTRC processor is defective.	Replace processor on the TTRC. If failure still occurs, replace TTRC.
A21	TRC encoder failure	TRC encoder.	Replace TTRC.
A22	TRC encoder-to-line 2 path failure or Line 2 EEPOT failure	The following circuits on the TTRC may be faulty: • EEPOT C (line 2 output level) adjusted incorrectly. • Bad TRC encoder to line 2 path.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace TTRC.

Table B-2 **Audio Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
A23	TRC encoder-to-line 4 path failure	The following circuits on the TTRC may be faulty: • TRC encoder-to-line 4 path. • TRC encoder.	Replace TTRC.
A24	TRC encoder-to-line 2 path failure (STAC filter path)	The following circuits on the TTRC may be faulty: • TRC encoder-to-line 2 path. • TRC encoder. • STAC filter.	Replace TTRC.
A25	Bad line 2 gate (no mute)	Line 2 gate (no mute) on the TTRC.	Replace TTRC.
A26	TRC encoder-to-line 4 path failure or line 4 EEPOT failure	The following circuits on the TTRC may be faulty: • EEPOT d (line 4 output level) adjusted incorrectly. • TRC encoder-to-line 4 path.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace TTRC.
A27	Bad line 4 gate (no mute)	Line 4 gate (no mute).	Replace TTRC.
A28	STAC encoder failure or STAC EEPOT failure	The following circuits on the TTRC may be faulty: • EEPOT 8, 9, A adjusted incorrectly. • STAC encoder failure.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace TTRC.
A29	STAC encoder-to-line 2 path failure or line 2 EEPOT failure	The following circuits on the TTRC may be faulty: • EEPOT C (line 2 output level) adjusted incorrectly. • STAC encoder-to-line 2 path failure.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace TTRC. TTRC hardware/firmware slightly incompatible.
A2A	ALC audio circuitry failure	ALC audio circuit.	Replace TTRC.
A2b	Function tone decode circuitry failure		Replace TTRC.
A2C	Guard tone decode circuitry failure		Replace TTRC.
A2d	Wireline activity circuitry failure		Replace TTRC.
A2E	ALC audio-to-transmit audio line 4 path failure or transmit audio level EEPOT failure	The following circuits on the TTRC may be faulty: • EEPOT 7 (transmit audio level) adjusted incorrectly. • ALC audio to transmit audio line 4 path.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace TTRC.
A2F	ALC audio-to-transmit audio line 2 path failure or transmit audio level EEPOT failure	The following circuits on the TTRC may be faulty: • EEPOT 7 (transmit audio level) adjusted incorrectly. • ALC audio to transmit audio line 2 path.	Perform the alignment procedure, refer to Chapter 4 - Alignment. If failure still occurs, replace TTRC.

Audio Error Codes

Table B-2 **Audio Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
A30	non-ALC audio-to-transmit audio path failure	The following circuits on the TTRC may be faulty: • EEPOT 7 (transmit audio level) adjusted incorrectly. • ALC audio to transmit audio line 2 path. • non-ALC audio to transmit path.	Replace TTRC board. TTRC hardware/firmware slightly incompatible.
A40	processor A/D converter failure on Secure board	The A/D converter system on the Secure processor is defective.	Replace processor on the Secure board. If failure still occurs, replace Secure board.
A41	Secure alert tone encoder/filter error	The following circuits on the Secure board may be faulty: • secure alert tone low pass filter circuit. • alert tone sample circuit. • Secure processor A/D converter.	Replace Secure board.
A42	Coded Mod Splatter Filter error	The following circuits on the Secure board may be faulty: • the secure modulation filter. • modulation audio gate is defective. • SCF_CLK signal inoperable.	Replace Secure board.
A43	Coded Mod Gate failure	The coded modulation audio gate on the Secure board is not muting the 1 kHz test tone.	Replace Secure board.
A44	Coded RX Audio Line Filter error	• Secure ASIC Coded RX output driver. • Line filter/gate inoperable. • RX audio sampling circuit.	Replace Secure board.
A45	RX Coded Gate failure	Line coded gate/driver is defective.	Replace Secure board.

Digital Error Codes

Table B-3 **Digital Error Codes**

Error	Description	Probable Cause	Corrective Action
d01	Primary user area has bad check byte (SSCB)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d02	Secondary user area has bad check byte (SSCB)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d03	PTT priority table is programmed incorrectly	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d04	Skip SSCB audio diagnostics (Invalid EEPOT value in user area)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d10	TTRC did not receive wakeup command	The TTRC board was reset while SSCB remained operational (i.e. IPCB reset command or ESD reset).	The problem should self-correct. However, this error code should not occur during a power-up or test switch reset sequence.
d11	Primary user area has bad check byte (TTRC)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d12	Secondary user area has bad check byte (TTRC)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d13	Invalid guard tone frequency codeplug value	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d14	Incompatible DC threshold table & analog board version	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d15	Invalid DC threshold table	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d16	Skip TTRC audio diagnostics (Invalid EEPOT value in user area)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d20	Secure did not receive wake-up command	The Secure board was reset while the SSCB remained operational (i.e. IPCB reset command or ESD reset).	The problem should self-correct. However, this error code should not occur during a power-up or test switch reset sequence.
d21	Primary user area has bad check byte (Secure)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d22	Secondary user area has bad check byte (Secure)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d30	RAC/SAM did not receive wakeup command	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d31	RAC/SAM primary user area has bad check byte	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d32	RAC/SAM Secondary user area has bad check byte	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
d40	MCS did not receive wakeup command	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d80	Non-zero user area check byte of SSCB	Station reset during user area EEPROM update.	Reprogram the SSCB codeplug. Refer to the RSS manual.
d81	Non-zero EEPROM_check byte of SSCB	Station reset during codeplug EEPROM update.	Reprogram the SSCB Codeplug. Refer to the RSS manual.
d82	Serial EEPROM_Check byte of SSCB	• Missing or defective SSCB serial EEPROM device • codeplug programmed to expect serial EEPROM when it is not required or present.	Install & program serial EEPROM, if required. If not, reprogram SSCB codeplug to ignore serial EEPROM. Refer to the RSS manual.
d83	Codeplug on SSCB not SSCB type	The SSCB processor/codeplug device recently replaced.	Reprogram the SSCB codeplug. Refer to the RSS manual.
d84	Bad codeplug version number on SSCB	SSCB codeplug version number incompatible with SSCB firmware version.	Upgrade SSCB firmware to latest version or reprogram SSCB codeplug.
d85	Bad codeplug checksum on SSCB	SSCB codeplug is corrupt.	Reprogram SSCB codeplug.
d86	Incorrect firmware checksum on SSCB	SSCB Firmware EPROM incorrect or defective.	Replace SSCB firmware EPROM.
d87	EEPOTs failed to synchronize on SSCB	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d88	EEPROM failed to program on SSCB	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d89	Multi-Coded Squelch (MCS) board did not respond to power-up enable	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d8A	MCS DPL external RAM faulty	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d8b	MCS MUXbus bad	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d8C	MCS board enabled but did not return version number	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d8d	Incorrect firmware checksum	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d8E	EEPROM failed to program in expected time period	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d8F	MCS table pointer is out of range	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
d90	SSCB HC11 Internal RAM faulty	The SSCB internal processor RAM is defective.	Replace processor on the SSCB.
d91	SSCB MUXbus data strobe bad (internal loopback)	The SSCB standard mode ASIC is defective.	Replace the Standard Mode ASIC on the SSCB.

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
d92	SSCB MUXbus data strobe bad (normal operating mode)	• Data strobe signal (DS, U801-47) shorted • One of the following MUXbus address lines (BA0-BA3, U801-42 thru U801-45) shorted to ground • DS or BA0-BA3 pin drivers on standard mode ASIC (U801) defective.	Replace the standard mode ASIC on the SSCB. If failure still occurs, replace SSCB.
d93	SSCB MUXbus bad (internal loopback)	The SSCB standard mode ASIC is defective.	Replace the standard mode ASIC on the SSCB. If failure still occurs, replace SSCB.
d94	SSCB MUXbus bad (normal operating mode)	• One of the following MUXbus address lines (BA0-BA3, U801-42 thru U801-45) shorted high. • One of the following MUXbus data lines (BD0-BD3, U801-38 thru U801-41) shorted to ground. • BA0-BA3 or BD0-BD3 pin drivers on standard mode ASIC defective.	Replace the standard mode ASIC on the SSCB. If failure still occurs, replace SSCB.
d95	SSCB standard mode ASIC latch/buffer bad (loopback)	• Delayed reset circuitry is defective. • SSCB standard mode ASIC IOA signal is shorted. • the SSCB standard mode ASIC is defective.	Replace the standard mode ASIC on the SSCB. If failure still occurs, replace SSCB.
d96	SSCB I/O mode ASIC latch/buffer bad (loopback)	The SSCB I/O mode ASIC is defective.	Replace the I/O mode ASIC on the SSCB.
d97	SSCB HSR Clk/Sync bad (internal loopback)	The SSCB standard mode ASIC is defective.	Replace the standard mode ASIC on the SSCB.
d98	SSCB HSR Clk/Sync bad (normal operating mode)	The HSR Clock or the HSR Sync is not operating properly.	Replace the standard mode ASIC on the SSCB. If failure still occurs, replace SSCB.
d99	SSCB HSR data I/O bad (internal loopback)	The SSCB Standard Mode ASIC is defective.	Replace the standard mode ASIC on the SSCB. If failure still occurs, replace SSCB.
d9A	SSCB HSR data I/O bad (normal operating mode)	• The HSR out-to-HSR in signal path is open (not continuous) -- this condition is often caused by improper positions of SSCB jumpers JU1 and JU2. • The HSR Out or HSR In pin drivers are defective.	Verify proper positions of SSCB jumpers JU1 and JU2. JU1 and JU2 positions are determined as follows: JU1 JU2 Configuration --------- normal TTRC board present, Secure board absent normal alternate Both TTRC and Secure boards present alternate normal Both TTRC and Secure boards absent alternate TTRC board absent, Secure board present. Remove TTRC board and Secure board while moving JU1 and JU2 to the alternate and normal positions, respectively (to isolate open HSR data paths to the SSCB). If problem still exists, replace the standard mode ASIC on the SSCB. Otherwise, problem resides on either the TTRC or Secure board(s).

Digital Error Codes

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
d9b	SSCB IPCB faulty	• IPCB signal (J800-11) grounded. • SSCB IPCB interface circuitry. • SSCB microprocessor.	Replace SSCB processor. If failure still occurs, replace SSCB.
d9E	Config register reprogrammed	A new un-initialized processor was installed on the SSCB.	No actions required except to program/verify SSCB codeplug data. Refer to the RSS manual.
d9F	SSCB Config register reprogrammed and codeplug erased	An un-initialized SSCB processor was installed.	Reprogram SSCB codeplug. Refer to the RSS manual.
dA0	Non-zero user area check byte of TTRC	Station Reset occurred during user area EEPROM update.	Reprogram the TTRC codeplug. Refer to the RSS manual.
dA1	Non-zero EEPROM_Check byte of TTRC	Station reset during codeplug EEPROM update.	Reprogram the TTRC codeplug. Refer to the RSS manual.
dA2	Serial EEPROM has not responded on TTRC	• Missing or defective TTRC serial EEPROM device. • codeplug programmed to expect serial EEPROM when it is not required or present.	Install & program serial EEPROM, if required. If not, reprogram TTRC codeplug to ignore serial EEPROM. Refer to the RSS manual.
dA3	Codeplug on TTRC not TTRC type	The TTRC processor/codeplug device recently replaced.	Reprogram the TTRC codeplug. Refer to the RSS manual.
dA4	Bad codeplug version number on TTRC	TTRC codeplug version number incompatible with TTRC firmware version.	Upgrade TTRC firmware to latest version or reprogram TTRC codeplug. Refer to the RSS manual if necessary.
dA5	Bad codeplug checksum on TTRC	TTRC codeplug is corrupt.	Reprogram TTRC codeplug.
dA6	Incorrect firmware checksum on TTRC	TTRC firmware EPROM incorrect or defective.	Replace TTRC firmware EPROM.
dA7	TTRC board not responding to power-up enable	• TTRC board not present when it should be. • TTRC IPCB interface circuitry. • TTRC board has catastrophic failure (processor won't run, firmware missing, etc.).	• Verify TTRC board is properly installed. • Check TTRC FAIL LED for flashing fatal error indication. • Replace TTRC board, if necessary.
dA8	TTRC board enabled but did not return version number	TTRC board failed IPCB tests, indicating a failure in one of the following circuits: • TTRC IPCB interface circuitry defective. • TTRC processor. • Open IPCB runner from TTRC IPCB interface to SSCB IPCB interface.	Check TTRC FAIL LED for flashing fatal error indication If no error indication, replace TTRC board.
dA9	TTRC board station type does not match SSCBs	TTRC codeplug recently replaced/programmed incorrectly.	Reprogram the TTRC codeplug. Refer to the RSS manual.

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
dAA	TTRC board system version number is incompatible with SSCBs	The TTRC firmware or the SSCB firmware was replaced with an incompatible firmware version.	Change either TTRC or SSCB firmware to a compatible version, or replace both TTRC and SSCB firmware with the latest version.
dAb	EEPOTs failed to synchronize on TTRC	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dAC	EEPROM failed to program on TTRC	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
db0	TTRC HC11 Internal RAM faulty	The TTRC internal processor RAM is defective.	Replace processor on the TTRC.
db1	TTRC MUXbus data strobe bad (internal loopback)	The TTRC standard mode ASIC.	Replace standard mode ASIC on the TTRC.
db2	TTRC MUXbus data strobe bad (normal operating mode)	• Data strobe signal (DS, U4233-47) shorted. • One of the following MUXbus address lines (BA0-BA3, U4233-42 thru U4233-45) shorted to ground. • DS or BA0-BA3 pin drivers on standard mode ASIC (U4233) defective.	Replace the standard mode ASIC on the TTRC.
db3	TTRC MUXbus bad (internal loopback)	The TTRC standard mode ASIC is defective.	Replace the standard mode ASIC on the TTRC.
db4	TTRC MUXbus bad (normal operating mode)	• One of the following MUXbus address lines (BA0-BA3, U4233-42 thru U4233-45) shorted high. • One of the following MUXbus data lines (BD0-BD3, U4233-38 thru U4233-41) shorted to ground. • BA0-BA3 or BD0-BD3 pin drivers on standard mode ASIC defective.	Replace the standard mode ASIC on the TTRC.
db5	TTRC standard mode ASIC latch/ buffer bad (loopback)	The TTRC standard mode ASIC is defective.	Replace the standard mode ASIC on the TTRC.
db6	TTRC I/O mode ASIC latch/buffer bad (loopback)	The TTRC I/O mode ASIC is defective.	Replace the I/O mode ASIC on the TTRC.
db7	TTRC HSR Clk/Sync bad (internal loopback)	The TTRC standard mode ASIC is defective.	Replace the standard mode ASIC on the TTRC.
db8	TTRC HSR Clk/Sync bad (normal operating mode)	The HSR Clock or the HSR Sync is not operating properly.	Check for shorts on HSR Clk and HSR Sync. If no shorts are found and the proper signals are not observed, replace the standard mode ASIC on the TTRC.
db9	TTRC HSR data I/O bad (internal loopback)	The TTRC standard mode ASIC is defective.	Replace the standard mode ASIC on the TTRC.

Digital Error Codes

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
dbA	TTRC HSR data I/O bad (normal operating mode)	• The HSR out-to-HSR in signal path is open (not continuous). • TTRC Standard Mode ASIC defective.	Verify that the HSR Out signal (U4233-55) is identical to the HSR In signal (U4233-48). Also both of these signals should occasionally toggle. If these conditions are observed, then replace U4233 (Standard Mode ASIC) on the TTRC.
dC0	Non-zero user area check byte of Secure board	Station reset during user area EEPROM update.	Reprogram the Secure codeplug. Refer to the RSS manual.
dC1	Non-zero EEPROM_Check byte of Secure board	Station reset during codeplug EEPROM update.	Reprogram the Secure codeplug. Refer to the RSS manual.
dC3	Codeplug on Secure board not Secure type	The Secure processor/codeplug device recently replaced.	Reprogram the Secure codeplug. Refer to the RSS manual.
dC4	Bad codeplug version number on Secure board	Secure codeplug version number incompatible with Secure firmware version.	Upgrade Secure firmware to latest version or reprogram Secure codeplug. Refer to the RSS manual.
dC5	Bad codeplug checksum on Secure board	Secure codeplug is corrupt.	Reprogram Secure codeplug. Refer to the RSS manual.
dC6	Incorrect firmware checksum on Secure board	Secure firmware EPROM incorrect or defective.	Replace Secure firmware EPROM.
dC7	Secure board not responding to power-up enable	Secure board not present, indicating one of the following failures: • Secure IPCB interface circuitry. • Secure board has catastrophic failure (processor won't run, firmware missing, etc.).	• Verify that Secure board is properly installed. • Check Secure FAIL LED for flashing fatal error indication.
dC8	Secure board enabled but did not return version number	Secure board failed IPCB tests -- Secure IPCB interface circuitry faulty. Secure processor U4013 faulty. Open IPCB runner from Secure IPCB interface to SSCB IPCB interface.	Check Secure FAIL LED for flashing fatal error indication. If no error indication, check continuity of IPCB signal from SSCB Q805-Collector to Secure Q4009-Collector.
dC9	Secure board station type does not match SSCBs	Secure codeplug recently replaced/ incorrectly programmed.	Reprogram the Secure codeplug. Refer to the RSS manual.
dCA	Secure board System version number is incompatible with SSCBs	The Secure firmware or the SSCB firmware was replaced with an incompatible firmware version.	Change either Secure or SSCB firmware to a compatible version, or replace both Secure and SSCB firmware with the latest version.
dCb	EEPROM failed to program in expected time period	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dd0	Secure HC11 Internal RAM faulty	The Secure internal processor RAM is defective.	Replace processor on the Secure board.
dd1	Secure MUXbus data strobe bad (internal loopback)	The Secure standard mode ASIC is defective.	Replace standard mode ASIC on the Secure board.

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
dd2	Secure MUXbus data strobe bad (normal operating mode)	• Data strobe signal (DS, U4014-47) shorted. • One of the following MUXbus Address lines (BA0-BA3, U4014-42 thru U4014-45) shorted to ground. • DS or BA0-BA3 pin drivers on standard mode ASIC (U4014) defective.	Replace the standard mode ASIC on the Secure board.
dd3	Secure MUXbus bad (internal loopback)	The Secure standard mode ASIC is defective.	Replace standard mode ASIC on the Secure board.
dd4	Secure MUXbus bad (normal operating mode)	• One of the following MUXbus address lines (BA0-BA3, U4014-42 thru U4014-45) shorted high. • One of the following MUXbus data lines (BD0-BD3, U4014-38 thru U4014-41) shorted to ground. • BA0-BA3 or BD0-BD3 pin drivers on Standard Mode ASIC defective.	Replace standard mode ASIC on the Secure board.
dd5	Secure standard mode ASIC latch/ buffer bad (loopback)	The Secure standard mode ASIC is defective.	Replace standard mode ASIC on the Secure board.
dd7	Secure HSR Clk/Sync bad (internal loopback)	The Secure standard mode ASIC is defective.	Replace standard mode ASIC on the Secure board.
dd8	Secure HSR Clk/Sync bad (normal operating mode)	The HSR Clock or the HSR Sync is not operating properly.	Check for shorts on HSR Clk and HSR Sync. If no shorts are found, replace standard mode ASIC on the Secure board.
dd9	Secure HSR data I/O bad (internal loopback)	The Secure standard mode ASIC is defective.	Replace standard mode ASIC on the Secure board.
ddA	Secure HSR data I/O bad (normal operating mode)	The HSR out-to-HSR in signal path is open (not continuous). Secure standard mode ASIC defective.	Replace the standard mode ASIC on the Secure board.
ddb	Bad transmit phase lock detector in ASIC	The Secure ASIC is defective.	Replace the Secure ASIC on the Secure board.
ddC	Bad RX phase lock detector in Secure ASIC	The Secure ASIC is defective.	Replace the Secure ASIC on the Secure board.
ddE	Bad transmit P-S or S-P converter in Secure ASIC	The Secure ASIC is defective.	Replace the Secure ASIC on the Secure board.
ddF	Bad RX P-S or S-P converter in Secure ASIC	The Secure ASIC is defective.	Replace the Secure ASIC on the Secure board.
dE0	Non-zero user area check byte on RAC/SAM	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE1	Non-zero EEPROM check byte on RAC/SAM	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE2	Codeplug on RAC/SAM nor RAC/ SAM	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.

Table B-3 **Digital Error Codes (Continued)**

Error	Description	Probable Cause	Corrective Action
dE3	Bad RAC/SAM codeplug version number	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE4	Bad RAC/SAM internal codeplug checksum	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE5	Bad RAC/SAM external codeplug checksum	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE6	Incorrect RAC/SAM firmware checksum	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE7	RAC/SAM board not responding to power-up 'enable' com	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE8	RAC/SAM board 'enabled' but did not return version number	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dE9	RAC/SAM board Station Type doesn't match SSCBs	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dEA	RAC/SAM board System version number is incompatible with SSCB	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dEb	RAC/SAM EEPOT failed to synchronize	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dEC	RAC/SAM EEPROM failed to program in expected time	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF0	RAC/SAM HC11 Internal RAM faulty	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF1	RAC/SAM MUXbus data strobe bad (internal loopback)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF2	RAC/SAM MUXbus data strobe bad (normal operating)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF3	RAC/SAM MUXbus bad (internal loopback)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF4	RAC/SAM MUXbus bad (normal operation)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF5	RAC/SAM standard mode ASIC latch/buffer bad (loopback)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.
dF6	RAC/SAM IO mode ASIC latch/buffer bad (loopback)	Contact Motorola System Support Center if the error recurs.	Contact Motorola System Support Center if the error recurs.

Special Test Mode Error Codes

Special Test Mode error codes are displayed when a problem occurs during the station power-up/reset diagnostics.

Table B-4 **Digital Error Codes**

Error	Description	Probable Cause	Corrective Action
o80 - o89, o8 - o8F	Undefined SSCB Interrupt vector fetched	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
oA0 - ob2	Undefined TTRC Interrupt vector fetched	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
obE	TTRC processor configuration register altered	A new un-initialized processor was installed on the TTRC.	No actions required except to program/verify TTRC codeplug data.
obF	TTRC EEPROM codeplug erased	An un-initialized processor was installed on the TTRC.	Reprogram TTRC codeplug.
oC0 - od1	Undefined secure interrupt vector fetched	Random RAM error or software programming error.	Contact Motorola System Support Center if the error recurs.
odE	Secure processor configuration register altered	A new un-initialized processor was installed on the Secure board.	No actions required except to program/verify Secure codeplug data.
odF	Secure EEPROM codeplug erased	An un-initialized processor was installed on the Secure board.	Reprogram Secure codeplug.

Undefined Error Codes

Whenever an undefined error code is displayed within the Status display, contact Motorola System Support Center for help. Undefined error codes usually represent software programming errors and are always displayed in the format of U.x.x.

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MUXbus Descriptions

MUXbus Overview

This appendix provides definitions for each of the 64 MUXbus data bits. This data is normally displayed via the Diagnostic Metering Panel (DMP) or through the MUXbus display screen of the RSS.

The DMP is optional test equipment which contains a speaker, an analog meter, and a MUXbus display. The data bits are presented in a matrix on the MUXbus display in a format similar to Table C-1.

The DMP allows the service technician to read or modify MUXbus data. It is connected to the station via the expansion connector (J800) on the SSCB. This connector is located on the top of the Control Tray. Disconnect the DMP from the station during normal station operation to minimize the effects of Radio Frequency Interference (RFI) into the station.

Table C-1 ***MUXbus Bit Map***

ADDRESS	D3	D2	D1	D0
0	DAT PTT	SCAN	T ALM DS	S ALM DS
1	RPT PTT	LIN PTT	LOC PTT	INTCOM
2	TX PL DS	TX ACT	RX2 ACT	RX1 ACT
3	RX PL DS	R1 PL DT	RX CD DT	R1 UN SQ
4	R2 MUTE	R2 PL DT	R2 CD DT	R2 UN SQ
5	GD TN DT	AUX DET	RPT KD	RPT UNSQ
6	ACC DIS	EX DA DT	TX CD DT	ENCRYPT
7	SP 3	SP 2	SP 1	BAUD
8	TX RX C8	TX RX C4	TX RX C2	TX RX C1
9	AUX C8	AUX C4	AUX C2	AUX C1
10	RX2 C8	RX2 C4	RX2 C2	RX2 C1
11	TX INHB	RX INHB	R2 AUX DT	DOS
12	RW4 OVG	RW3 SYN	RW2 PA	RW1 BAT
13	RW 8	RW 7 FWD	RW 6 REF	RW 5 TSTAT
14	FW 4	FW 3	FW 2	FW 1
15	MODE 8	MODE 4	MODE 2	MODE 1

The MUXbus is a time multiplexed address and data bus with 16 addresses, each containing four data bits. The SSCB serves as the MUXbus master and drives the address and Data Strobe ($\overline{DS}$) lines. The address lines are periodically incremented, and the $\overline{DS}$ is used to synchronize the read/write cycles.

Since the MUXbus is available to all control modules in the main and expansion trays, all modules may read and write data to the MUXbus. Using the MUXbus, wildcards and special application boards in the expansion tray may easily be used to create special functions that are not a standard offering with the station.

The following descriptions define each of the 64 MUXbus bits. Each definition includes the mnemonic (abbreviation), a spelled-out description, and the associated row/column address on the MUXbus.

DAT PTT

Data Push-To-Talk (A0/D3)

Indicates if a Data PTT request is active. When active, the request is arbitrated against all other active PTT requests. The PTT priorities may be changed via the field Programmer or with option C672.

SCAN

Scan Enable (A0/D2)

In stations equipped with scan option C42, this bit activates receiver scanning. When active, the station scrolls through programmed channels, stopping when receiver activity is detected.

T ALM DS

Total Alarm Disable (A0/D1)

Unconditionally mutes all alarm tones generated in response to active reverse wildcards bits on addresses 12 and 13. See also S ALM DS.

S ALM DS

Selective Alarm Disable (A0/D0)

Mutes repetitive alarm tones generated in response to active reverse wildcard bits on addresses 12 and 13. For example, when a reverse wildcard bit is active, a corresponding number of alarm tones are generated every ten seconds. When S ALM DS is active, the alarm tones are only sent once; they are not repeated every ten seconds.

There are two modes of operation when using the Selective Alarm Disable feature. Mode A is to set this bit on the MUXbus and continue driving it active. In this mode, the SSCB will generate alarm tones only once; however, it will generate the tones whenever the state of the reverse wildcard bits changes. The user will hear one full set of alarm tones whenever the alarm status changes (unless the change is to all alarms cleared).

Mode B is to set the MUXbus bit for at lease 20 msec, and then stop driving it active. The SSCB then latches the bit active, even though the original driver has released the bit. When the state of the reverse wildcard bits change, the SSCB stops holding the S ALM DS bit active. This has the effect of stopping alarm tone generation completely until the alarm status changes, then normal alarm tone generation is resumed; alarm tones are generated every ten seconds. The SSCB also stops holding this bit active when the T ALM DS bit is activated.

RPT PTT

Repeater Push-To-Talk (A1/D3)

Indicates that a Repeater PTT or Trunking PTT is active. If this is the highest priority active PTT, then the audio gating will be set for in-cabinet repeat. If the repeater PTT time-out timer (TOT) times out, the RPT PTT bit will stay active until the request goes away; however, the active PTT type will change to the next active lowest priority, if any. PTT priorities are set on a per mode basis by the Field Programmer or with option C672.

If repeater knock down (RPT KD) goes active while RPT PTT is active, PL reverse burst or DPL turn off code (RB/TOC) will be encoded if appropriate, and the transmitter will de-key. RPT PTT is active during repeater drop-out delay and is inactive when RB/TOC is encoded.

The SSCB activates RPT PTT if qualified repeater audio activity exists on Receiver 1. Qualified repeater audio activity can be set for each mode by the Field Programmer or with option C673. Qualified repeater audio activity is determined by any combination of MUXbus bits RX PL DS, R1 PL DT, RPT USQ, and AUX DET.

The RPT PTT bit is a STATUS-ONLY bit. This means that the bit is used for indication purposes only. Activating this bit via the DMP or wildcard module will not cause the station to key or gate repeater audio. Only the SSCB may determine that the repeater squelch qualifiers have been met and allow the station to repeat.

LIN PTT

Line Push-To-Talk (A1/D2)

Keys the transmitter, modulating with TX Audio if no higher priority PTT is active. PTT priorities are set on a per mode basis by the Field Programmer or with option C672. LIN PTT is inactive when RB/TOC is encoded, unless the RB/TOC is caused by the Line PTT timing out. This bit is usually written to the MUXbus by the TTRC module in response to a console request to key the station.

LOC PTT

Local Push-To-Talk (A1/D1)

Keys the transmitter, modulating with local audio if no higher priority PTT is active. PTT priorities are set on a per mode basis by the Field Programmer or with option C672. LOC PTT is inactive when RB/TOC is encoded, unless the RB/TOC is caused by the Local PTT timing out. This bit is usually written to by the SSCB, in response to a PTT switch actuation on a local microphone plugged into the station control module front panel Control connector J812.

INTCOM

Intercom (A1/D0)

Allows LOC PTT without keying the station, which enables a service technician at the station to communicate with the console site via the wirelines. This bit is usually written to the MUXbus by the TTRC module, in response to the front panel Intercom switch.

TX PL DS

Transmit PL/DPL Disable (A2/D3)

Disables PL, DPL, or Trunking Data from being added onto the transmitted signal. The Transmit PL Strip wireline option (C63) utilizes this bit. If PL or DPL is being encoded when TX PL DS goes active, then RB/TOC will be generated before muting PL or DPL. This bit will also be set active by the front panel Xmit switch on the station control module.

TX ACT

Transmitter Activity (A2/D2)

Indicates that the transmitter is actually on. This bit is a reflection of the front panel PA ON LED.

The TX ACT bit is a STATUS-ONLY bit. This means that the bit is used for indication purposes only. Activating this bit via the DMP or wildcard module will not cause the station to key or activate the transmitter. Only the SSCB may key the station, in response to its inputs.

RX2 ACT

Receiver 2 Activity (A2/D1)

Indicates that the second receiver audio has met the qualifiers set for it on the current mode. The second receiver option is not yet supported, so this bit has no effect when active.

RX1 ACT

Receiver 1 Activity (A2/D0)

Indicates that the primary receiver has met the qualifiers set for it on the current mode. Qualified receiver audio activity can be set for each mode by the Field Programmer or with option C674. Qualified receiver audio activity is determined by any combination of MUXbus bits RX PL DS, R1 UN SQ, R1 PL DT, and AUX DET. The SSCB responds to an active RX1 ACT by opening the RX1 audio gate. This gates RX1 audio to both the line audio and select audio (local speaker) lines. RX1 audio is also gated to the SSCB repeater audio gate. An RX1 ACT must occur before a RPT PTT will be issued to open the repeater audio gate.

RX PL DS

Receiver PL/DPL Disable (A3/D3)

Indicates that the station has reverted to carrier squelch only receiver operation. The monitor and receivers Squelch on/off wireline functions utilize RX PL DS. Also, the station control module front panel PL Dis switch activates RX PL DS. This bit is usually set by the TTRC in response to a monitor command from a console.

R1 PL DT

Receiver 1 PL/DPL Detect (A3/D2)

Active when Private Line (PL), Digital Private Line (DPL), or Connect Tone (CT) coded squelch is being detected on Receiver 1.

RX CD DT

Receiver 1 Code Detect (A3/D1)

Indicates a Receiver Code Detect due to a receipt of Secure (12 Kbit) data on Receiver 1.

R1 UN SQ

Receiver 1 Unsquelch (A3/D0)

Active when the Receiver 1 audio carrier squelch circuit on the SSCB detects on-channel RF activity. R1 UN SQ is used for audio gating (refer to RX1 ACT), not for repeater keying (refer to RPT PTT).

R2 MUTE

Receiver 2 Mute (A4/D3)

Causes the second receiver audio to be muted or attenuated. The second receiver option is not yet supported, so this bit has no effect when active.

R2 PL DT

Receiver 2 PL/DPL Detect (A4/D2)

Active when PL, DPL, or CT coded squelch is being detected on Receiver 2. The second receiver option is not yet supported, so this bit has no effect when active.

R2 CD DT

Receiver 2 Code Detect (A4/D1)

Indicates a Receiver Code Detect due to receipt of Secure (12 Kbit) data on Receiver 2. The second receiver option is not yet supported, so this bit has no effect when active.

R2 UN SQ

Receiver 2 Unsquelch (A4/D0)

Active when the Receiver 2 audio carrier squelch circuit detects on-channel RF activity. R2 UN SQ is used for audio gating (refer to RX2 ACT). The second receiver option is not yet supported, so this bit has no effect when active.

GD TN DT

Guard Tone Detect (A5/D3)

Indicated that High Level Guard Tone is being detected from the Tx Audio signal. This bit is also active during the function tone detect window. The TX Audio signal is muted while GD TN DT is active, in order to prevent remote control tones from being transmitted over the air.

AUX DET

Auxiliary Detect (A5/D2)

Indicates that an optional decoder is detecting on Receiver 1. AUX DET can be used to activate RX1 ACT, RX2 ACT, and RPT PTT in a manner similar to the R1 PL DT and R1 UN SQ qualifiers.

RPT KD

Repeater Knock-down (A5/D1)

Disallows a repeater PTT when active. Inhibits in cabinet repeat, but allows receive audio to be gated to the local speaker and wireline.

RPT USQ

Repeater Unsquelch (A5/D0)

Indicates when the Receiver 1 carrier squelch circuit, located on the SSCB, detects activity. Used as a prerequisite to keying the station, if the station is a repeater, and to gating audio to the transmitter and/or wireline.

ACC DIS

Access Disable (A6/D3)

Indicates that the station is in the Access Disable mode. See the operation section for a description of the Acc Dis function.

EX DA DT

External Data Detect (A6/D2)

When active, the SSCB mutes Tx, Local, RX1 (Repeater), and MRTI audio from the transmitter unless specially enabled for the current mode. These audio paths may be enabled or disabled via the Field Programmer of with option C678. The Tx Data Audio path is always routed to the transmitter, even when this bit is active.

TX CD DT

Transmit Code Detect (A6/D1)

Indicates that a Wireline Code Detect is active due to receipt of Secure (12 Kbit) data on the transmit wireline.

ENCRYPT

Digital Voice Encryption (A6/D0)

When active, enables the encryption function of the optional Encrypt/Decrypt Secure module (voice is transmitted coded). When inactive, disables the encryption function (voice is transmitted clear). The decrypting function is not affected by this bit (decryption is always active when the proper key is loaded).

SP3, SP2, SP1

Special Purpose 3-1 (A7,/D3 thru A7,/D1)

These bits are reserved for future applications, or special customer needs.

BAUD

IPCB Baud Rate (A7/D0)

Indicates that the IPCB serial baud rate is not the default speed (1200 baud). When active, the alternate speed is 300 baud.

TX RX C8, TX RX C4, TX RX C2, and TX RX C1

Transmitter/receiver 1 Channel (A8/D3 thru A8/D0)

These four bits are used to control the channel of the transmitter and Receiver 1. The channel parameters are defined by the SSCB module code plug. These bits represent the channel number in binary format, so channels 0 through 15 may be represented with these bits. For channels higher than 15, the Auxiliary Channel bits are used (AUX C8 - AUX C1).

These MUXbus bits actually represent the requested operating channel; the actual operating channel is always indicated by the front panel Status display. A discrepancy may arise between the two indicators if an undefined channel is requested; in this case, the SSCB utilizes channel number 1.

AUX C8, AUX C4, AUX C2, and AUX C1

Auxiliary Channel (A9/D3 thru A9/D0)

These four bits are overflow bits which may be used for indicating channel, mode, or Receiver 2 channel, depending on the application.

RX2 C8, RX2 C4, RX2 C2, and RX2 C1

Second Receiver Channel (A10/D3 thru A10/D0)

These four bits are used to control the channel of Receiver 2. The channel parameters are defined by the SSCB module code plug. These bits represent the channel number in binary format, so channels 0 through 15 may be represented with these bits. For channels higher than 15, the Auxiliary Channel bits are used (AUX C8 - AUX C1). In MCS stations, these bits are used to indicate the four least significant bits of the active MCS user number. The second receiver option is not yet supported, so this bit has no effect when active.

TX INHB

Transmit Inhibit (A11/D3)

Indicates that the transmitter is inhibited. When active, no station transmitter activity is allowed. All PTT requests will be ignored.

RX INHB

Receiver 1 Inhibit (A11/D2)

Indicates that the receiver audio is inhibited from reaching the wireline. When active, no audio (including status tone) is gated to Line 2 or Line 4.

R2 AUX DT

Second Receiver Auxiliary Detect (A11/D1)

Indicates that an optional decoder is detecting on Receiver 2. In MCS stations, this bit is used to indicate the most significant bit of the active MCS user number. The second receiver option is not yet supported, so this bit has no effect when active.

DOS

Data Operated Squelch (A11/D0)

In MCS stations, this bit is used to indicate the second most significant bit of the active MCS user number. In data stations, this bit indicates a data detect has been achieved. The repeat audio pathway is muted to prevent repeating data while this bit is active.

RW4 OVG

Reverse Wildcard 4 - Battery Overvoltage (A12/D3)

Indicates that the battery overvoltage internal station alarm is active. When active, the SSCB generates four alarm beeps which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

RW3 SYN

Reverse Wildcard 3 - Synthesizer Unlock (A12/D2)

Indicates that the transmit or receiver synthesizer is out of lock. When active, the SSCB generates three alarm beeps which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

RW2 PA

Reverse Wildcard 2 - PA Fail (A12/D1)

This bit is the RF power amplifier failure alarm parameter, activated by the SSCB. RW2 PA is active when the RF power amplifier has failed. A successful keyup or a SSCB reset is required to clear the alarm. The alarm may be active when the transmitter is de-keyed, due to a prior failure. PA Fail means that one or both of the SSCB PA status lines (PA On or PA Full Power) is inactive 30-45 msec after the start of a keyup, or for 30-45 msec continuously during keyup, thereafter.

RW1 BAT

Reverse Wildcard 1 - Battery Revert (A12/D0)

Indicates that the AC main power to the station has been lost and that the station is operating on battery power. When active, the SSCB generates one alarm tone which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

RW8

Reverse Wildcard 8 - Redundant Station (A13/D3)

Indicates that a problem exists with the redundant station system. When active, the SSCB generates eight alarm tones which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

RW7 FWD

Reverse Wildcard 7 (A13/D2)

Indicates that a reverse wildcard 7 is active. This bit is set by a low forward power condition. When active, the SSCB generates seven alarm tones which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

RW6 REF

Reverse Wildcard 6 (A13/D1)

Indicates that a reverse wildcard 6 is active. This bit is set by a high reflected power condition. When active the SSCB generates six alarm tones which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

RW5 TSTAT

Reverse Wildcard 5 (A13/D0)

Indicates that a reverse wildcard 5 is active. This bit is set as an indication of a TSTAT failure. This failure is prompted by high reflected power, low forward power, or receiver synthesizer being out of lock. When active, the SSCB generates five alarm tones which can be routed to the local speaker, the wireline, and/or over the air depending on how the station is programmed.

FW4, FW3, FW2, and FW1

Forward Wildcard 4 thru 1 (A14/D3 thru A14/D0)

Indicates that a forward wildcard is active. These bits are usually driven by the TTRC module in response to a TRC command from a console. Used in conjunction with a wildcard in the expansion tray, these bits can be used to activate or signal equipment external to the station.

MODE 8, MODE 4, MODE 2, and MODE 1

Station Mode (A15/D3 thru A15/D0)

These four bits are used to control the mode of the station. The mode parameters are defined by the SSCB module code plug. These bits represent the mode number in binary format, so modes 0 through 15 may be represented with these bits. For modes higher than 15, the Auxiliary Channels bits are used (AUX C8-AUX C1).

These MUXbus bits actually represent the requested operating mode; the actual operating mode is always indicated by the front pane Status display. A discrepancy may arise between the two indicators of an undefined mode is requested; in this case, the SSCB utilizes mode number 1.

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Appendix D

Performance Specifications

About the Performance Specs

This appendix contains performance specifications for all bands of the *MSF 5000* station. Each band contains General specifications, Transmit specifications, and Receive specifications. The contents of this appendix is as follows:

- VHF (132 - 174 MHz)
- UHF (403 - 475 MHz)
- 800 MHz (806 - 869 MHz)
- 900 MHz (896 - 941 MHz)

VHF (132 - 174 MHz)

VHF General

Description	Value or Range	
Number of Channels	4 standard up to 15 frequencies optional on conventional stations. 1 standard on trunked stations.	
Input Voltage (AC)	96 - 132 Vac @ 60 Hz Optional 50 Hz, 110/220 Vac	
Operating Temperature	-30° C to +60° C	
Dimensions (H x W x D): 6 Watts 25 Watts 75 Watts 125 Watts 350 Watts †	 26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm) 26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm) 26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm) 26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm) 46″ x 22″ x 10″ (117.0 x 56.0 x 25.4 cm)	
Weight: 6 Watts 25 Watts 75 Watts 125 Watts 350 Watts †	 130 lbs. (59 kg) 140 lbs. (64 kg) 140 lbs. (64 kg) 160 lbs. (73 kg) 300 lbs. (136 kg)	
Input Power: (varies w/options) ‡ 6 Watts 25 Watts 75 Watts 125 Watts 350 Watts	Standby 60 Watts 60 Watts 80 Watts 80 Watts 150 Watts	Transmit 80 Watts 80 Watts 300 Watts 425 Watts 1150 Watts
Metering	Optional interactive DMP provides 5 Watts audio, analog metering and status display of control signals. Optional interactive RMP provides 5 Watts audio and analog metering.	

† Measurement does not include tip feet.

‡ The 75, 125, and 350 Watt VHF stations utilize dual voltage (14 and 28 Vdc) power supplies.

VHF Transmit

Description	Value or Range
Frequency	132 - 158 MHz, 146 - 174 MHz
RF Power Output Range: 6 Watts 25 Watts 75 Watts 125 Watts 350 Watts	 3 - 6 Watts 10 - 25 Watts 35 - 75 Watts 50 - 125 Watts 150 - 350 Watts
Transmit Bandwidth: 132 - 158 MHz 146 - 174 MHz	 26 MHz † 28 MHz †
Output Impedance	50 Ω
Frequency Stability	± 0.0002% from -30°C to +60°C
Isolation: 6 - 125 Watt stations 350 Watt stations	 -30 dB @ ±25 kHz -20 dB @ ±25 kHz
Deviation: Clear Coded	 ± 5 kHz for 100% @ 1 kHz ± 4 kHz for 100% @ 1 kHz
Audio Sensitivity	-35 dBm to +11 dBm variable
Conducted Spurious & Harmonic Emissions: 132 - 136 MHz 136 - 174 MHz	 -85 dBc 132 - 136 MHz (for 125, 350 Watt models only) -90 dBc 136 - 174 MHz
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth (referenced to 1 kHz tone @ 3 kHz deviation)
Audio Response	+1, -3 dB from 6 dB per octave pre-emphasis 300 - 3 kHz referenced to 1 kHz at line input
Audio Distortion	Less than 2% @ 1 kHz (@ 3 kHz deviation)
FCC Designation: 6 Watts 25 Watts 75 Watts 125 Watts 350 Watts	 ABZ89FC3769 ABZ89FC3765 ABZ89FC3767 ABZ89FC3764 ABZ89FC3766
† Bandwidth is reduced with use of duplexer or circulator option	

VHF Receive

Description	Value or Range
Frequency	132 - 158 MHz, 146 - 174 MHz
Channel Spacing	30/25 kHz
Selectivity EIA SINAD	-90 dB @ ±30 kHz
Receiver Bandwidth	2.0 MHz
Receiver Sensitivity	0.25 µV 12 dB SINAD
Off Channel Acceptance	±3 kHz minimum
Frequency Stability	±0.0002% from -30°C to +60°C
Intermodulation EIA SINAD	-85 dB
Spurious & Image Rejection	-100 dB
Audio Response	+1, -3 dB from 6 dB per octave de-emphasis from 400 Hz to 3 kHz reference to 1 kHz
Audio Distortion	Less than 3% distortion at 1 kHz
FM Hum and Noise	-45 dB nominal for 1 kHz tone @ 3 kHz deviation
RF Input Impedance	50 Ω
FCC Designation	ABZ89FR3763

UHF (403 - 475 MHz)

UHF General

Description	Value or Range	
Number of Channels	4 standard up to 15 frequencies optional on conventional stations. 1 standard on trunked stations	
Input Voltage (AC)	96 - 132 Vac @ 60 Hz (for 6 - 110 Watt stations) 103 - 132 Vac @ 60 Hz (for 225 Watt stations) Optional 50 Hz, 110/220 Vac †	
Operating Temperature	-30° C to +60° C	
Dimensions (H x W x D):		
6 Watts	26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm)	
15 Watts	26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm)	
30 Watts	26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm)	
75 Watts	26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm)	
110 Watts	26.75″ x 22″ x 10″ (68.0 x 56.0 x 25.4 cm)	
225 Watts ††	46″ x 22″ x 10″ (117.0 x 56.0 x 25.4 cm)	
Weight:		
6 Watts	140 lbs. (64 kg)	
15 Watts	140 lbs. (64 kg)	
30 Watts	140 lbs. (64 kg)	
75 Watts	160 lbs. (73 kg)	
110 Watts	160 lbs. (73 kg)	
225 Watts	300 lbs. (136 kg)	
Input Power: (varies w/options)	Standby	Transmit
6 Watts	60 Watts	80 Watts
15 Watts	60 Watts	100 Watts
30 Watts	60 Watts	245 Watts
75 Watts	80 Watts	375 Watts
110 Watts	80 Watts	475 Watts
225 Watts	150 Watts	1100 Watts
Metering	Optional interactive DMP provides 5 Watts audio, analog metering and status display of control signals Optional interactive RMP provides 5 Watts audio and analog metering	

† Reduces power output on 225 Watt stations to 200 Watts

†† Measurement does not include tip feet

UHF Transmit

Description	Value or Range
Frequency	403 - 435 MHz, 435 - 475 MHz
RF Power Output Range: 6 Watts 15 Watts 30 Watts 75 Watts 110 Watts 225 Watts	 1 - 6 Watts 7 - 15 Watts 20 - 40 Watts 35 - 75 Watts 50 - 110 Watts 110 - 225 Watts
Transmit Bandwidth	Standard 8 MHz
Output Impedance	50 Ω
Frequency Stability	± 0.0002% from -30°C to +60°C
Isolation: 6 - 110 Watt stations 225 Watt stations	 -30 dBc @ ±25 kHz -20 dBc @ ±25 kHz
Deviation: Clear Coded	 ± 5 kHz for 100% @ 1 kHz ± 4 kHz data deviation
Audio Sensitivity: Conventional Trunked	 -35 dBm to +11 dBm variable -20 dBm to +11 dBm variable
Conducted Spurious & Harmonic Emissions	-90 dBc
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth (referenced to 1 kHz tone @ 3 kHz deviation)
Audio Response (clear mode)	+1, -3 dB from 6 dB per octave pre-emphasis 300 - 3 kHz referenced to 1 kHz at line input
Audio Distortion (clear mode)	Less than 2% @ 1 kHz (@ 60% of full voice deviation)
FCC Designation: 6 Watts 15 Watts 30 Watts 75 Watts 110 Watts 225 Watts	 ABZ89FC4750 ABZ89FC4749 ABZ89FC4748 ABZ89FC4747 ABZ89FC4744 ABZ89FC4746

UHF Receive

Description	Value or Range
Frequency	403 - 435 MHz, 435 - 475 MHz
Channel Spacing	25 kHz
Selectivity EIA SINAD	-100 dB @ ±25 kHz
Receiver Bandwidth	2.0 MHz
Receiver Sensitivity	0.35 µV 12 dB SINAD, 0.5 µV 20 dBQ
Off Channel Acceptance	±2 kHz minimum
Frequency Stability	±0.0002% from -30°C to +60°C
Intermodulation EIA SINAD	-90 dB
Spurious & Image Rejection	-110 dB
Audio Response (clear mode)	+1, -3 dB from 6 dB per octave de-emphasis from 400 Hz to 3 kHz reference to 1 kHz
Audio Distortion (clear mode)	Less than 3% distortion at 1 kHz
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth referenced 1 kHz tone @ 60% full system deviation
RF Input Impedance	50 Ω
FCC Designation: 403 - 435 MHz 435 - 475 MHz	 ABZ89FR4729 ABZ89FR4632

800 MHz (806 - 869 MHz)

800 MHz General

Description	Value or Range	
Number of Channels	4 standard up to 15 frequencies optional on conventional stations. 1 standard on trunked stations	
Input Voltage (AC)	96 - 132 Vac @ 60 Hz Optional 50 Hz, 110/220 Vac	
Operating Temperature	-30° C to +60° C	
Dimensions (H x W x D): 35 Watts 75 Watts 150 Watts	 26.5″ x 21.75″ x 10″ (67.3 x 55.2 x 25.4 cm) 37″ x 21.75″ x 10″ (94.0 x 55.2 x 25.4 cm) 46″ x 21.75″ x 10″ (116.8 x 55.2 x 25.4 cm)	
Weight: 35 Watts 75 Watts 150 Watts	 130 lbs. (58.9 kg) 175 lbs. (79.4 kg) 350 lbs. (158.8 kg)	
Input Power: (varies w/options) 35 Watts 75 Watts 150 Watts	Standby 100 Watts 100 Watts 200 Watts	Transmit 275 Watts 500 Watts 1100 Watts
Metering	Optional interactive DMP provides 5 Watts audio, analog metering and status display of control signals Optional interactive RMP provides 5 Watts audio and analog metering	

800 MHz Transmit

Description	Value or Range	
Frequency	851 - 869 MHz	
RF Power Output Range: 35 Watts 75 Watts 150 Watts	 15 - 35 Watts 35 - 75 Watts 75 - 150 Watts	
Output Impedance	50 Ω	
Frequency Stability	± 0.0001% from -30°C to +60°C	
Isolation	-20 dBc @ ±25 kHz	
Deviation: Clear Coded	<u>851 - 866 MHz</u> ± 5 kHz for 100% @ 1 kHz ± 4 kHz for 100% @ 1 kHz	<u>866 - 869 MHz</u> ± 4 kHz for 100% @ 1 kHz ± 2.4 kHz for 100% @ 1 kHz
Audio Sensitivity: Conventional Trunked	 -35 dBm to +11 dBm variable -20 dBm to +11 dBm variable	
Conducted Spurious & Harmonic Emissions	-90 dBc @ 110 Watts	
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth (with 750 µ sec. pre-emphasis referenced to 1 kHz tone @ 3 kHz deviation)	
Audio Response (clear mode)	+1, -3 dB from 6 dB per octave pre-emphasis 300 - 3 kHz referenced to 1 kHz at line input	
Audio Distortion (clear mode)	Less than 2% @ 1 kHz (@ 3 kHz deviation)	
FCC Designation: 35 Watts (Digital Capable) 75 Watts (Digital Capable) 150 Watts (Digital Capable)	<u>Internal Reference</u> ABZ89FT5708 ABZ89FT5693 ABZ89FT5695	<u>External Reference</u> ABZ89FT5707 ABZ89FT5694 ABZ89FT5696

800 MHz Receive

Description	Value or Range
Frequency	806 - 824 MHz
Channel Spacing	25 kHz
Selectivity EIA SINAD	-90 dB @ ±25 kHz
Receiver Bandwidth	4.0 MHz
Receiver Sensitivity	0.25 µV 12 dB SINAD, 0.5 µV 20 dBQ
Off Channel Acceptance	±2 kHz minimum
Frequency Stability	±0.0001% from -30°C to +60°C
Intermodulation EIA SINAD	-85 dB
Spurious & Image Rejection	-100 dB
Audio Response	+1, -3 dB from 6 dB per octave de-emphasis from 400 Hz to 3 kHz bandwidth at line output
Audio Distortion	Less than 3% distortion at 1 kHz
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth (with 750 µ sec. pre-emphasis referenced to 1 kHz tone @ 3 kHz deviation)
RF Input Impedance	50 Ω
FCC Designation: Internal Reference External Reference	 ABZ89FR5697 ABZ89FR5689

900 MHz (896 - 941 MHz)

900 MHz General

Description	Value or Range	
Number of Channels	4 standard up to 15 frequencies optional on conventional stations. 1 standard on trunked stations	
Input Voltage (AC)	96 - 132 Vac @ 60 Hz Optional 50 Hz, 110/220 Vac †	
Operating Temperature	-30° C to +60° C	
Dimensions (H x W x D): 75 Watts 150 Watts ††	 37.25″ x 22″ x 10″ (95.0 x 56.0 x 25.4 cm) 46″ x 21.75″ x 10″ (117 x 56 x 25.4 cm)	
Weight: 75 Watts 150 Watts	 175 lbs. (80 kg) 340 lbs. (155 kg)	
Input Power: (varies w/options) 75 Watts 150 Watts	Standby 95 Watts 115 Watts	Transmit 440 Watts 765 Watts
Metering	Optional interactive DMP provides 5 Watts audio, analog metering and status display of control signals Optional interactive RMP provides 5 Watts audio and analog metering	

† Reduces power output on 150 Watt stations to 125 Watts

†† Measurement does not include tip feet

900 MHz Transmit

Description	Value or Range
Frequency	935 - 941 MHz
Transmit Bandwidth	6 MHz
RF Power Output Range: 75 Watts 150 Watts	 35 - 75 Watts 75 - 150 Watts
Output Impedance	50 Ω
Frequency Stability	±2 ppb from -30°C to +60°C
Isolation	-20 dBc @ ±25 kHz
Deviation Clear	 ±2.5 MHz for 100% @ 1 kHz
Audio Sensitivity: Conventional Trunked	 -35 dBm to +11 dBm variable -20 dBm to +11 dBm variable
Conducted Spurious & Harmonic Emissions	 -90 dBc
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth (with 750 μ sec. pre-emphasis referenced to 1 kHz tone @ 1.5 kHz deviation)
Audio Response	+1, -3 dB from 6 dB per octave pre-emphasis 300 - 3 kHz referenced to 1 kHz at line input
Audio Distortion	Less than 2% @ 1 kHz (@ 3 kHz deviation)
FCC Designation: 75 Watts 150 Watts	Internal Reference / External Reference ABZ89FZ5655 / ABZ89FZ5656 ABZ89FZ5658 / ABZ89FZ5659

900 MHz Receive

Description	Value or Range
Frequency	896 - 902 MHz
Channel Spacing	12.5 kHz
Selectivity EIA SINAD	-80 dB
Receiver Bandwidth	5.0 MHz
Receiver Sensitivity	0.25 µV 12 dB SINAD
Off Channel Acceptance	±2 kHz minimum
Frequency Stability	±2 ppb from -30°C to +60°C
Intermodulation EIA SINAD	-80 dB
Spurious & Image Rejection	-100 dB
Audio Response	+1, -3 dB from 6 dB per octave de-emphasis from 400 Hz to 3 kHz bandwidth at line output
Audio Distortion	Less than 3% distortion at 1 kHz
FM Hum and Noise	-45 dB nominal for 300 to 3 kHz bandwidth (with 750 µ sec. pre-emphasis referenced to 1 kHz tone @ 1.5 kHz deviation)
RF Input Impedance	50 Ω
FCC Designation: Internal Reference External Reference	 ABZ89FR5655 ABZ89FR5656

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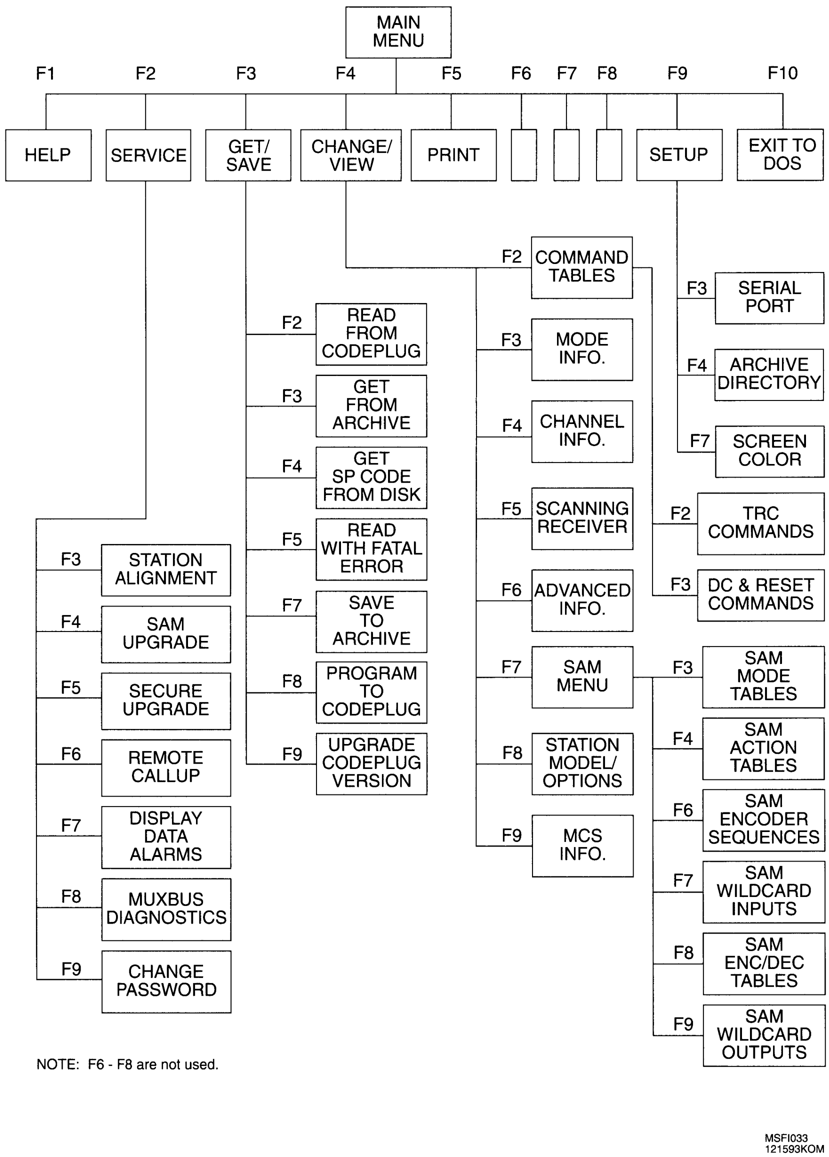
Appendix E

RSS Menu Structure

This appendix contains the menu structure of the Radio Service Software (RSS). RSS may be used to aid in configuring, aligning, or troubleshooting the *MSF 5000* station. Although it is not required, RSS may prove useful for routine maintenance of the station.



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Appendix F

MSF 5000 Options

The *MSF 5000* Digital Station Options

The following table identifies the options available for the *MSF 5000* station. The options are listed by option number and contain a description of each. Also identified are the bands which the option is available. Refer to the *MSF 5000* Options manual for detailed descriptions and related information for each option.

NOTE

Combinations of options may make one or more options incompatible.

Option	Description	VHF	UHF	800 MHz	900 MHz
C14	Receiver PL on/off	✔	✔	✔	✔
C17	Redundant RF switching	✔	✔	✔	✔
C27	Micor outdoor cabinet (46″ universal)	✔	✔	✔	✔
C28	Battery reverting power supply	✔	✔	✔	✔
C32	Omit power supply (12 Vdc operation only)	✔	✔	✔	✔
C36	Micor outdoor cabinet (75″ universal)	✔	✔	✔	✔
C40	MSF cabinet (46″ universal)	✔	✔	✔	✔
C42	Scanning receiver	✔	✔	✔	✔
C52	MSF cabinet (37″ universal)	✔	✔	✔	✔
C63	Transmit PL on/off	✔	✔	✔	✔
C84	Omit remote control	✔	✔	✔	✔
C92	MSF cabinet (26″ universal)	✔	✔	✔	–
C101	DC remote control	✔	✔	✔	✔
C115	Console priority Trunking Station	✔	✔	✔	✔
C143	Remote repeater control	✔	✔	✔	✔

The MSF 5000 Digital Station Options

Option	Description	VHF	UHF	800 MHz	900 MHz
C144	Half duplex 4-wire audio	✔	✔	✔	✔
C149	Radio Metering Panel (RMP)	✔	✔	✔	✔
C150	RA base interface	✔	✔	–	–
C153	Trunking cable (50′)	✔	✔	✔	✔
C154	Trunking cable (100′)	✔	✔	✔	✔
C160	RA repeater interface	✔	✔	✔	✔
C163	Additional channel capability (5 - 15 channels)	✔	✔	✔	✔
C164	Rack mounting	✔	✔	✔	✔
C170	Guard tone keying	✔	✔	✔	✔
C180	Micor style cabinet (60″ universal)	✔	✔	✔	✔
C182	Duplexer	✔	✔	–	–
C195	Micor style indoor cabinet, deep (46″ universal)	✔	✔	✔	✔
C197	Range expansion	✔	✔	✔	✔
C233	Wildcard (MUXbus interface)	✔	✔	✔	✔
C257	50 Hz multi-voltage power supply	✔	✔	✔	✔
C265	Single circulator	✔	–	–	–
C269	Spectra-TAC/DigiTac encoder	✔	✔	✔	✔
C291	Install MRTI phone patch	✔	✔	✔	✔
C303	Dual code select (DVP only)	✔	✔	✔	–
C304	Proper code select	✔	✔	✔	–
C307	70″ Indoor cabinet	✔	✔	✔	✔
C308	Micor indoor cabinet (46″ universal)	✔	✔	✔	✔
C331	Encode/decode capability	✔	✔	✔	–
C332	Full duplex 4-wire audio	✔	✔	✔	✔
C338	Trunking cable (75′)	✔	✔	✔	✔
C345	Auto station ID	✔	✔	✔	✔
C362	Packing kit	✔	✔	✔	✔
C367	VHF range 1	✔	–	–	–
C369	Multi Coded Squelch (MCS)	✔	✔	✔	✔
C382	Local channel control	✔	✔	✔	✔
C388	DES encryption	✔	✔	✔	–
C395	Variable TOT	✔	✔	✔	✔
C415	Omit status tone with transparent repeater	✔	✔	✔	–

Option	Description	VHF	UHF	800 MHz	900 MHz
C428	Factory installed duplexer	✔	✔	✔	✔
C432	Service manual	✔	✔	✔	✔
C462	Privacy plus slow failsoft	✔	✔	✔	✔
C514	Transparent operation	✔	✔	✔	–
C550	Reduced deviation (800 MHz only)	–	–	✔	–
C553	Smartnet fast failsoft	✔	✔	✔	✔
C557	Physical security	✔	✔	✔	–
C565	RS232 Interface	✔	✔	✔	✔
C568	Widespace receiver	✔	✔	✔	✔
C569	Shipping rack (52")	✔	✔	✔	✔
C571	Omit over-the-air alarm reporting	✔	✔	✔	✔
C573	Internal high stability reference	✔	✔	✔	✔
C574	External reference capability	✔	✔	✔	✔
C587	Repeater audio delay (MDC 600/1200)	✔	✔	✔	✔
C597	Duplex filtering for UHF range 1 & narrow band	–	✔	–	–
C599	Tone or DC control patch disable	✔	✔	✔	✔
C658	Xmit above receive (UHF only)	–	✔	–	–
C664	CSQ monitor receiver	✔	✔	✔	✔
C668	Diagnostic Metering Panel (DMP)	✔	✔	✔	✔
C669	Omit wireline alarm reporting	✔	✔	✔	✔
C670	Phone line integrity test	✔	✔	✔	✔
C671	Variable repeater dropout delay	✔	✔	✔	✔
C672	Variable PTT priority	✔	✔	✔	✔
C673	Variable repeater control	✔	✔	✔	✔
C674	Variable receiver control	✔	✔	✔	✔
C675	Duplex filtering (UHF only)	–	✔	–	–
C676	Triple circulator/isolator	–	✔	✔	✔
C677	Duplex filter with triple circulator	–	✔	–	–
C681	60 Hz Multi-voltage power supply	✔	✔	✔	✔
C682	Omit antenna relay	✔	✔	–	–
C695	Expansion tray	✔	✔	✔	✔
C696	12.5 kHz operation	✔	✔	–	–
C719	Phone patch interface	✔	✔	✔	✔
C765	Future trunking capability	–	✔	✔	✔

The MSF 5000 Digital Station Options

Option	Description	VHF	UHF	800 MHz	900 MHz
C769	Redundant operation	✔	✔	✔	✔
C777	Simulcast operation	✔	✔	✔	✔
C784	RA/RT repeater	✔	✔	✔	✔
C794	DVP encryption	✔	✔	✔	–
C795	DES-XL encryption	✔	✔	✔	–
C797	DVP-XL encryption	✔	✔	✔	–
C810	Rack (8′)	✔	✔	✔	✔
C813	Widespace receiver (2 tray)	✔	✔	✔	✔
C816	Automatic access	✔	✔	✔	✔
C832	Rack (7′)	✔	✔	✔	✔
C882	Rack (7.5′)	✔	✔	✔	✔
C974	Wildcard channel control	✔	✔	✔	✔
C975	Relay interface for smart wildcard	✔	✔	✔	✔
X34	Full diagnostics	✔	✔	✔	✔
X101	Duplexer	–	–	✔	✔
X233	Smart wildcard	✔	✔	✔	✔
X676	Dual isolator	✔	✔	✔	✔
X741	Modular rack - 16 rack unit (requires C164)	✔	✔	✔	✔
X742	Modular rack - 24 rack unit (requires C164)	✔	✔	✔	✔
X743	Modular rack - 27 rack unit (requires C164)	✔	✔	✔	✔
X962	MRTI package	✔	✔	✔	✔
X963	MRTI 1000 package	✔	✔	✔	✔
X964	MRTI package w/selective signaling	✔	✔	✔	✔
X965	MRTI 1000 package w/selective signaling	✔	✔	✔	✔

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Appendix G

Jumper Settings

SSCB Jumper Settings

Table G-1 identifies the jumper settings for the Secure Station Control Board (SSCB). Figure G-1 shows the location of the jumpers on the SSCB.

Table G-1 ***SSCB 3-pin Jumper Settings***

Jumper	Description	Normal Position	Alternate Position
JU1	TTRC HSR	TTRC present	TTRC not present
JU2	Secure HSR	Secure not present	Secure present
JU3	Coded modulation audio	Secure not present	Secure present
JU4	Post-IDC TX data	data present	data not present
JU5	Trunking modulation audio	TTRC present	TTRC not present
JU6	Transmit data path	No data	TX data around splatter filter
JU7	RX2 wireline	no RX2 to wireline	RX2 to wireline
JU8	RX2 audio	RX2 not present	RX2 present
JU9	Secure alert tones	Secure not present	Secure enc/dec present
JU10	Secure RX audio	Secure not present	Secure present
JU11	RX diversity audio	no diversity	diversity
JU12	+5 Vdc	+5 Vdc on SSCB	+5 Vdc supplied on RF Tray †
JU13	RF tray +5 Vdc	no +5 V to RF tray	+5 V to RF tray
JU14	SAM TX audio	No audio out	SAM TX audio via splatter filter
JU15	Pre-IDC TX data	data not present	data present
JU16	Exp TX audio select	processed transmit audio to J800	raw transmit audio to J800
JU17	SAM line audio	SAM audio not routed to line	SAM audio routed to line
JU18	RX1 gate control	via logic section	via squelch section
JU19	MPT squelch to exp conn	fast key from J800	MPT squelch from J800
JU20 ‡	Secure coded modulation gain	high gain	low gain ††

SSCB Jumper Settings

Table G-1 ***SSCB 3-pin Jumper Settings (Continued)***

Jumper	Description	Normal Position	Alternate Position
JU21 ‡	Wattmeter A-D resolution	low power stations	high power stations ‡‡
JU22 ‡	Wattmeter A-D resolution	low power stations	high power stations ‡‡

† For upgrading stations from analog to digital.
†† Use for TLN3045B and earlier.
‡ Present on data SSCB only.
‡‡ High power refers to 75 Watt PAs and above (TLN3318A, TLN3319A, TLN3320A, and TLN 3342A.

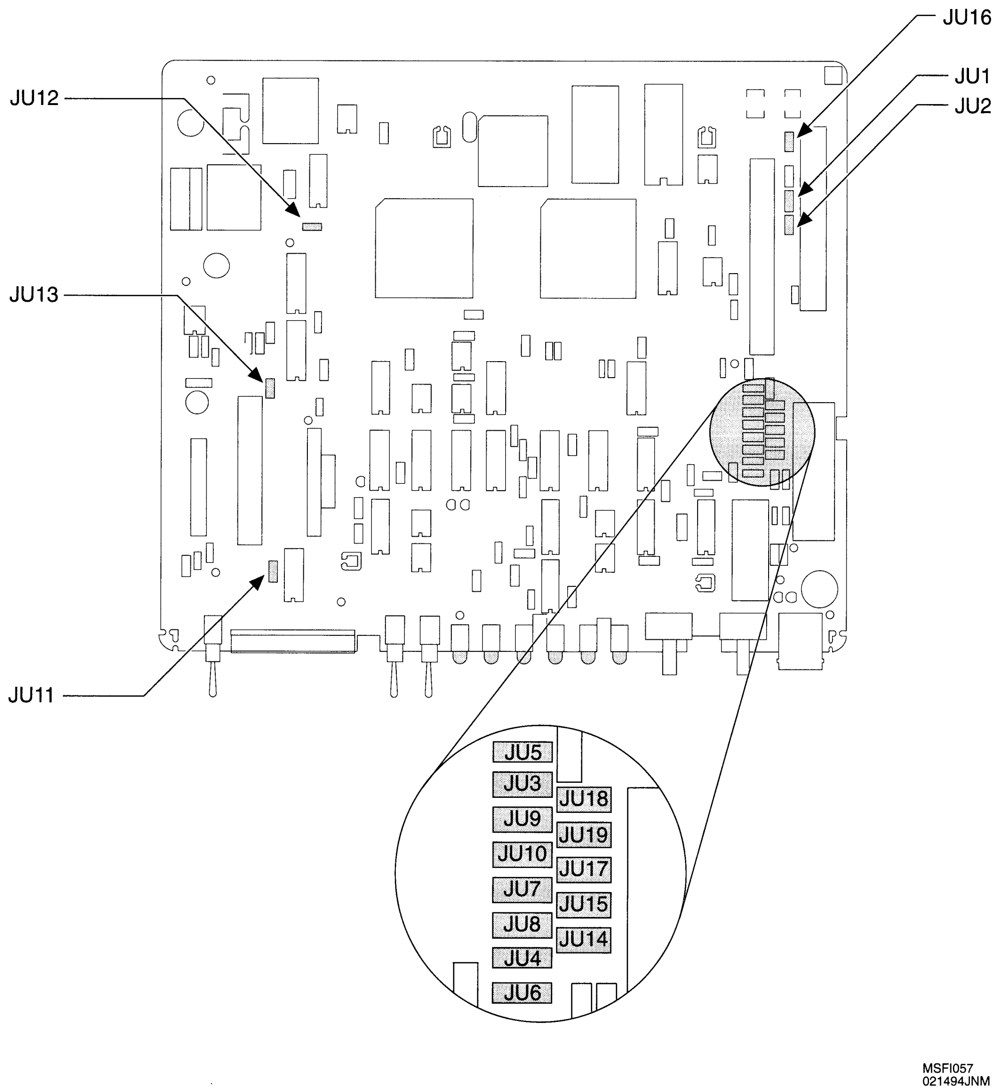

Figure G-1 ***SSCB Jumper Locations***

TTRC Jumper Settings

The TTRC jumper settings are configured on the TTRC Audio board. All jumper settings are described in Table G-2. Figure G-2 shows the jumper locations for TTRC Audio board.

Table G-2 ***TTRC Jumper Settings***

Jumper	Description	Normal Position	Alternate Position
JU4200	Line 3 termination	600 Ω	900 Ω
JU4201	Line 1 termination	600 Ω	900 Ω
JU4203	TX audio notch filter	enabled	disabled
JU4204	Wireline TX audio notch filter	enabled	disabled
JU4205	Line 2 TX cancellation circuit	2-wire audio	4-wire audio
JU4208	Trunked modulation audio	TX data	Gen TX audio
JU4209	RDM/WBM simulcast	RDM	WBM
JU4211	Line 1 DC blocking cap	DC control	Secure present
JU4212	Line 2 DC blocking cap	DC control	Secure present
JU4213	Line 3 DC blocking cap	DC control	Secure present
JU4214	Line 4 DC blocking cap	DC control	Secure present
JU4217	Line 2 termination	600 Ω	900 Ω
JU4218	Line 4 termination	600 Ω	900 Ω
JU4222	Line 2 interrupt circuit	2-wire audio	4-wire audio
JU4226	DC control (+) input	2-wire audio	4-wire audio
JU4227	DC control (–) input	2-wire audio	4-wire audio
JU4228	Line 2 output level	0 dBm	-10 dBm
JU4229	Line 4 output level	0 dBm	-10 dBm
JU4230	ALC bypass circuit	ALC active	fixed gain †
JU4231	2175 Hz status tone noise filter	2175 Hz status tone	Not 2175 Hz status tone
JU4370	Gen TX data input	non-simulcast	simulcast
JU4371	Gen TX data input	non-simulcast	simulcast
R4381	For SP simulcast (0 Ω)	not present	present for simulcast (SP)

† Using this jumper position requires a fixed level of HLGT (12.5, ±2.5 dBm) for proper operation.

TTRC Jumper Settings

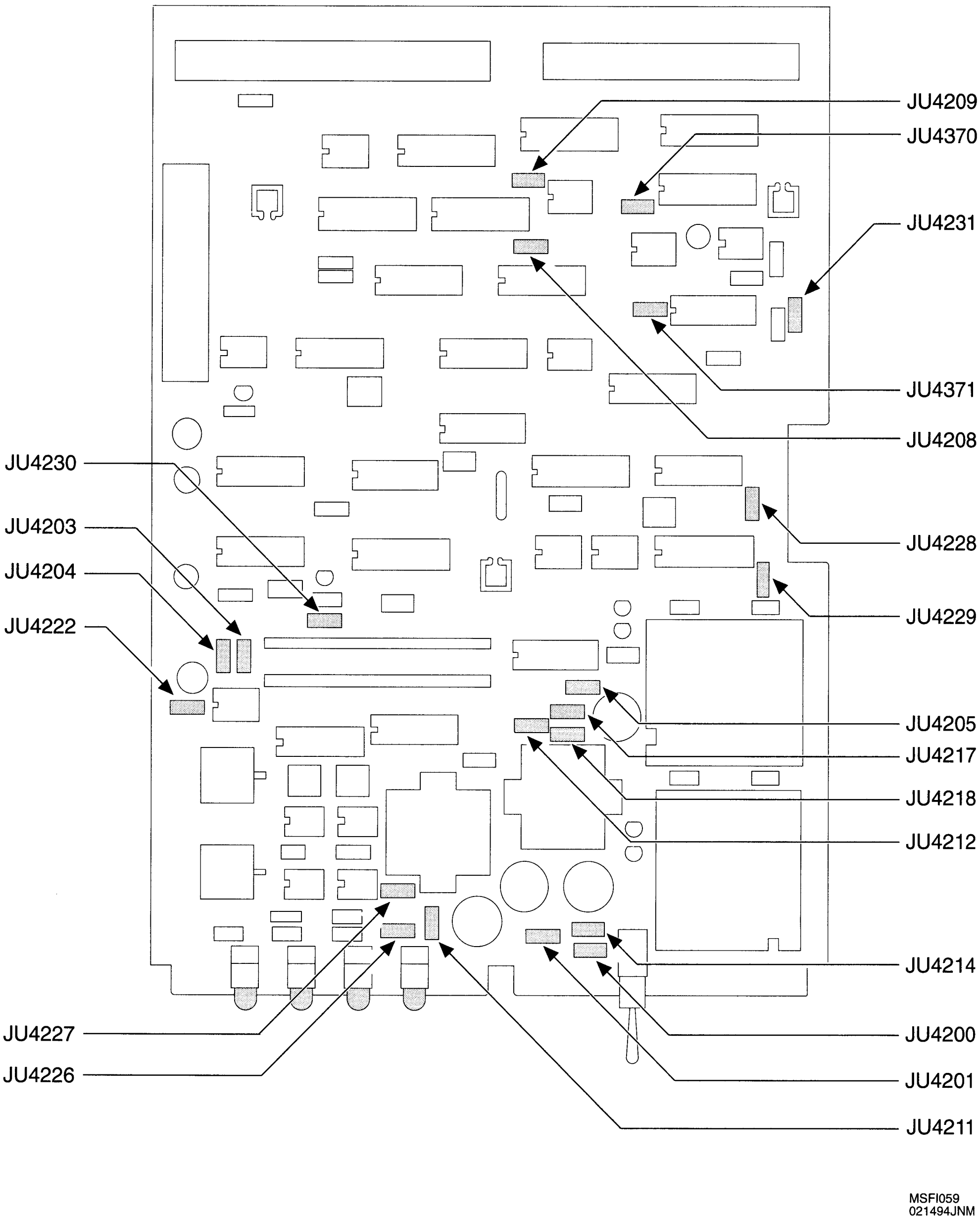

Figure G-2 ***TTRC Audio Board Jumper Locations***

Secure Board Jumper Settings

Table G-3 identifies the 3-pin jumper settings for configuring the encryption capability of the Secure board. Figure G-3 shows the jumper locations for the Secure board.

Table G-3 ***Secure Board 3-pin Jumper Settings***

Jumper	Description	Normal Position	Alternate Position
JU4002	Remote key reset	disabled	enabled
JU4003	MRTI audio encryption input	no MRTI audio	MRTI audio
JU4004	Receive audio equalizer, filter, and limiter	filter present	filter not present

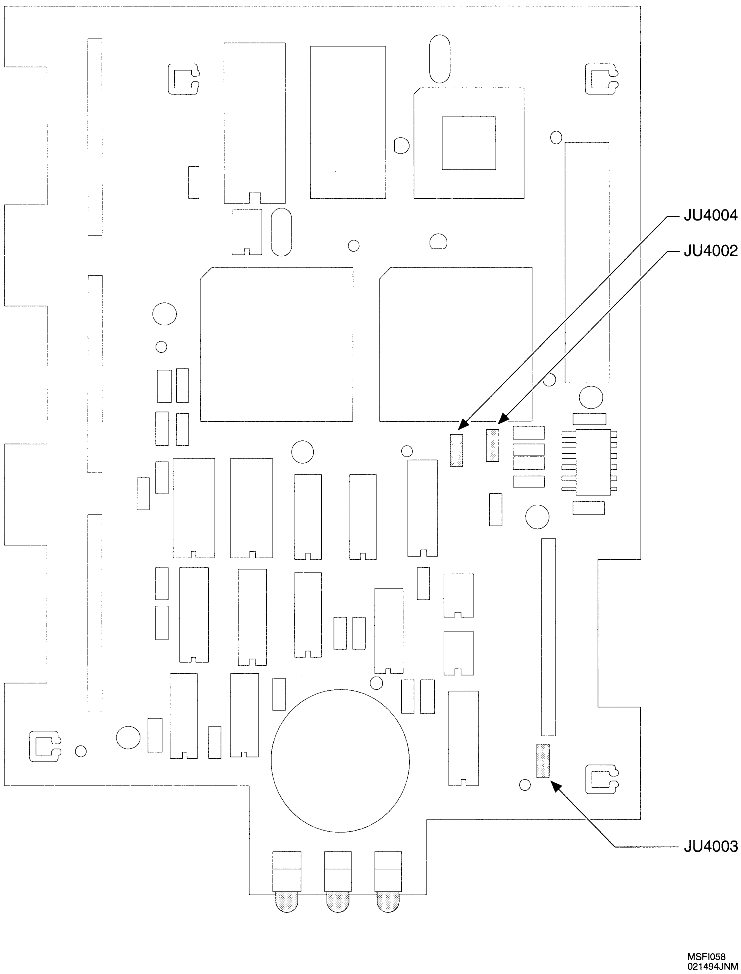

Figure G-3 ***Secure Board Jumper Locations***

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Simulcast Alignment

Receiver Adjustment

1. Adjust EEPOTs 6, 8, 9, A, and C to 00.

> **NOTE**
>
> Step 2 through step 8 require the audio generator to remain at a constant output level of 100 mV from 400 to 3000 Hz.

2. Use an audio generator and inject a 1 kHz tone at 100 mV, measured with and AC voltmeter, into the MIC AUDIO (J812-4) input on the front panel control jack; or via TP8 on the SSCB.
3. Set the front panel **Intercom** switch to **On** and activate the LOC PTT MUXbus bit.
4. Adjust EEPOT C to -10 dBm at Line 2 +/- on the Junction Box.
   This is a 600 Ω balanced output.
5. Set the generator frequency to 3 kHz and adjust EEPOT 9 to -10 dBm.
6. Repeat step 2 through step 5 until the difference is within +/- 1 dB.
   The 1 kHz level reference must remain at -10 dBm.
7. Set the generator frequency to 400 Hz.
8. Adjust EEPOT A to -10 dBm.
   Do not readjust EEPOT 9 or EEPOT C.
9. Deactivate the MUXbus bits.
10. Set the **Intercom** switch to **Off**.
11. Disconnect the audio generator from the MIC AUDIO input.
12. Set the **PL Dis/Xmit** switch to **PL Dis**.
13. Inject an on-channel 1 mV RF signal modulated with a 1 kHz tone at 100% full system deviation into the receiver port.

14. Adjust EEPOT 5 for -6 dBm at Line 2 +/-.

> **NOTE**
>
> Perform step 15 and step 16 if the station is equipped with the Secure Option C514, otherwise proceed to step 17.

15. Without changing the RF input level, inject a coded eye pattern (using the proper encryption algorithm) and adjust EEPOT C for -6 dBm at Line 2 +/-.

16. Repeat step 13 and step 14.

17. Set the **PL Dis/Xmit** switch to the center (off) position.

    Remove the RF signal from the receiver

18. Adjust EEPOT 8 for a status tone (2175 Hz) level of -19 dBm at line 2 +/-.

19. Adjust EEPOTs 2 and 3 to 00.

20. Set the **PL Dis/Xmit** switch to **PL Dis**.

    Measure and record the rms noise voltage level at Line 2.

21. Inject an on-channel 0.1 uV signal without modulation at the receive antenna port.

22. Increase the RF level until the Line 2 output level decreases by 20 dB from the level recorded in step 20 (20 dbq).

    This correlates to 17 dB SINAD.

23. Adjust EEPOT 3 until the R1 UN SQ MUXbus bit turns off.

> **NOTE**
>
> Perform step 24 if the station is equipped with Secure Option C514 and codeplug option X20AZ_SP, otherwise proceed to step 25.

24. Without changing the RF input level, inject a coded eye pattern and adjust EEPOT 2 until the RPT UN SQ MUXbus bit turns off.

25. Disconnect all test equipment.

    Alignment is complete.

Simulcast Deviation Adjustment

1. Set EEPOTs 4 and 7 to 00.
   EEPOTs 4 and 7 have no effect in simulcast.
2. Inject a 1 kHz signal at -10 dBm into the Gen TX Data input to the station.
3. Key the station by activating the Loc PTT MUXbus bit.
4. Measure the transmit deviation level and use EEPOT B to set for 60% full system deviation.
5. Dekey the station and remove the test tone.
   The transmit alignment is complete.

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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!***

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- ❑ Are accurate and easy to follow
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