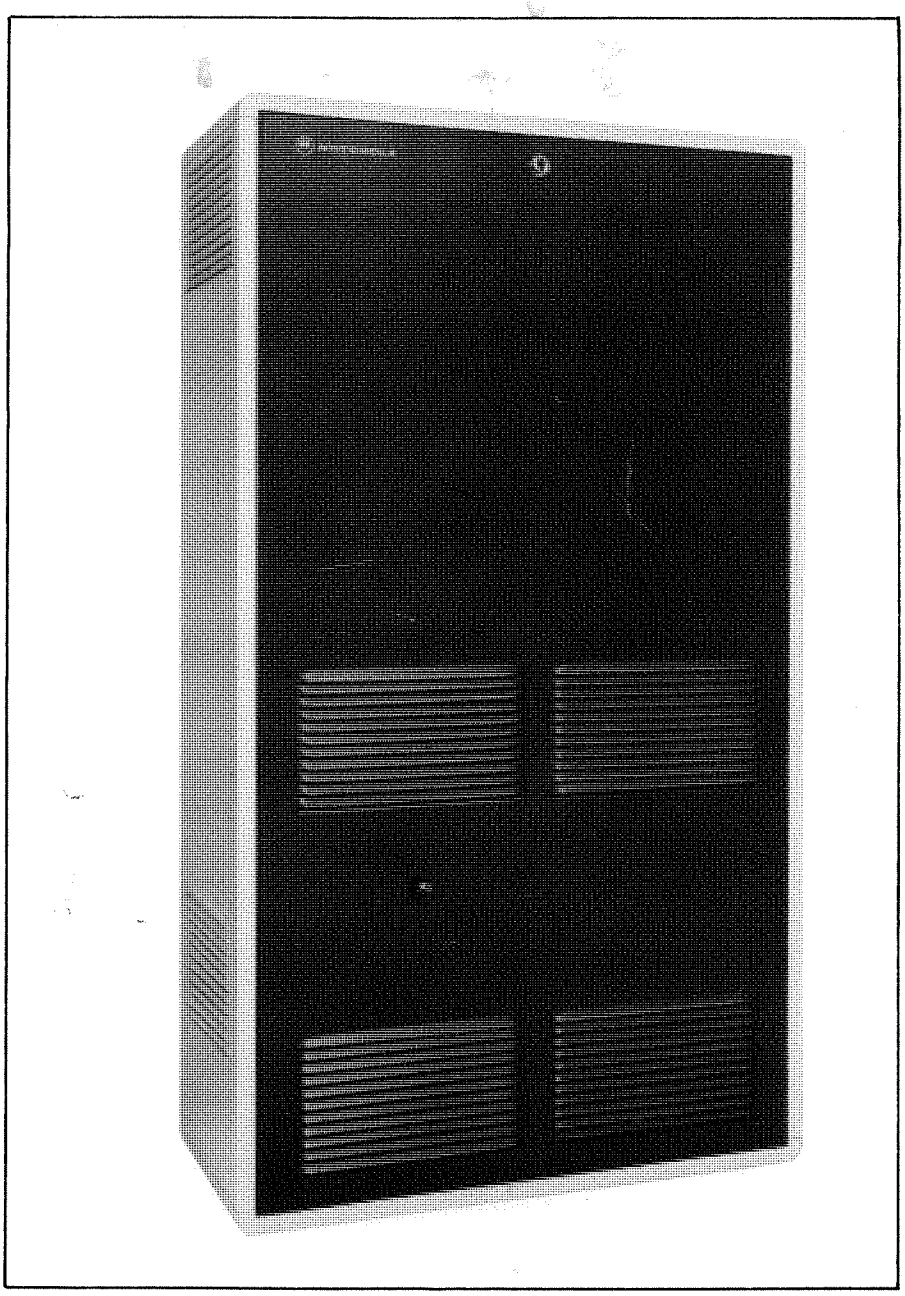
MOTOROLA INC.
Communications
Sector

MSF 5000™
DIGITAL CAPABLE AND ANALOG PLUS STATIONS



User Manual

68P81082E05-A

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EPS-34440-B

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a. the product is used in other than its normal and customary manner;
b. the product has been subject to misuse, accident, neglect or damage;
c. unauthorized alterations or repairs have been made, or unapproved parts used in the equipment.

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

This warranty applies only within the United States.

EPS-30831-O

FCC INTERFERENCE WARNING

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

WARNING

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

EPS-37978-O

MOTOROLA INC.
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MSF 5000™
DIGITAL CAPABLE AND ANALOG PLUS STATIONS

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FOREWORD

1. SCOPE OF MANUAL

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revisions (SMR). These SMR's are added to the manuals as the engineering changes are incorporated into the equipment.

2. MODEL AND KIT IDENTIFICATION

Motorola equipments are specifically identified by an overall model number on the nameplate. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them. When a production or engineering change is incorporated, the applicable schematic diagrams are updated.

3. SERVICE

Motorola's National Service Organization offers one of the finest nation-wide installation and maintenance programs available to communication equipment users. This organization includes approximately 900 authorized Motorola Service Stations (MSS) located throughout the United States, each manned by one or more trained, FCC licensed technicians.

These MSS's are independently owned and operated and were selected by Motorola to service its customers. Motorola maintenance is available on either a time and material basis or on a periodic fixed-fee type arrangement.

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

Should you wish to purchase a service contract for your 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 ORDERING

ORDERING INFORMATION

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the model number in which the part is used.

Orders for active filters, Vibrasender and Vibraspon-der resonant reeds should specify type number and frequency, should identify the owner/operator of the communications system in which these items are to be used; and should include any serial numbers stamped on the components being replaced.

MAIL ORDERS

Send written orders to the following addresses:

Replacement Parts/Test Equipment/
Crystal Service Items:
Motorola, Inc.
Communications Parts Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Federal Government Orders:

Motorola Inc.
Communications Parts Division
Attention: Order Processing
1701 McCormick Drive
Landover, MD 20785

International Orders:

Motorola Inc.
Communications Parts Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

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Replacement Parts/Test Equipment/Crystal Service Items:

Call: 1-800-422-4210
1-800-826-1913 (For Federal Government Orders)

TELEX/FAX ORDERS

Replacement Parts/Test Equipment/
Crystal Service Items:

Telex: 280127 (Domestic)
403305 MOTOPARTS SHBU UD (International)
FAX: 708-576-6285

Federal Government Orders:

FAX: 301-925-2473 or 301-925-2474

CUSTOMER SERVICE

Replacement Parts/Test Equipment:

Call: 1-800-537-7007

Crystals:

Call: 1-800-323-0234 (Except Illinois Residents)
1-800-537-7007 (For Illinois Residents)

Parts Identification:

Call: 708-576-7418

NATIONAL DATA SERVICES

1711 West 17th Street, Tempe, AZ 85281

Call: 602-994-6472, FAX: 602-994-6762

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GENERAL SAFETY INFORMATION

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

DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave and rural telephone rf equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

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

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CAUTION

Station contains CMOS devices. Good troubleshooting/installation techniques require proper grounding of personnel prior to handling equipment. Refer to the Safe Handling Of CMOS Integrated Circuit Devices instruction section of this manual.

IMPORTANT

When a Link Receiver Option is installed in a *PURC 5000* station, be sure it's SQUELCH control is **NOT** left in an unsquelched position after installation, or alignment, or maintenance. This will assure proper operation of the station.

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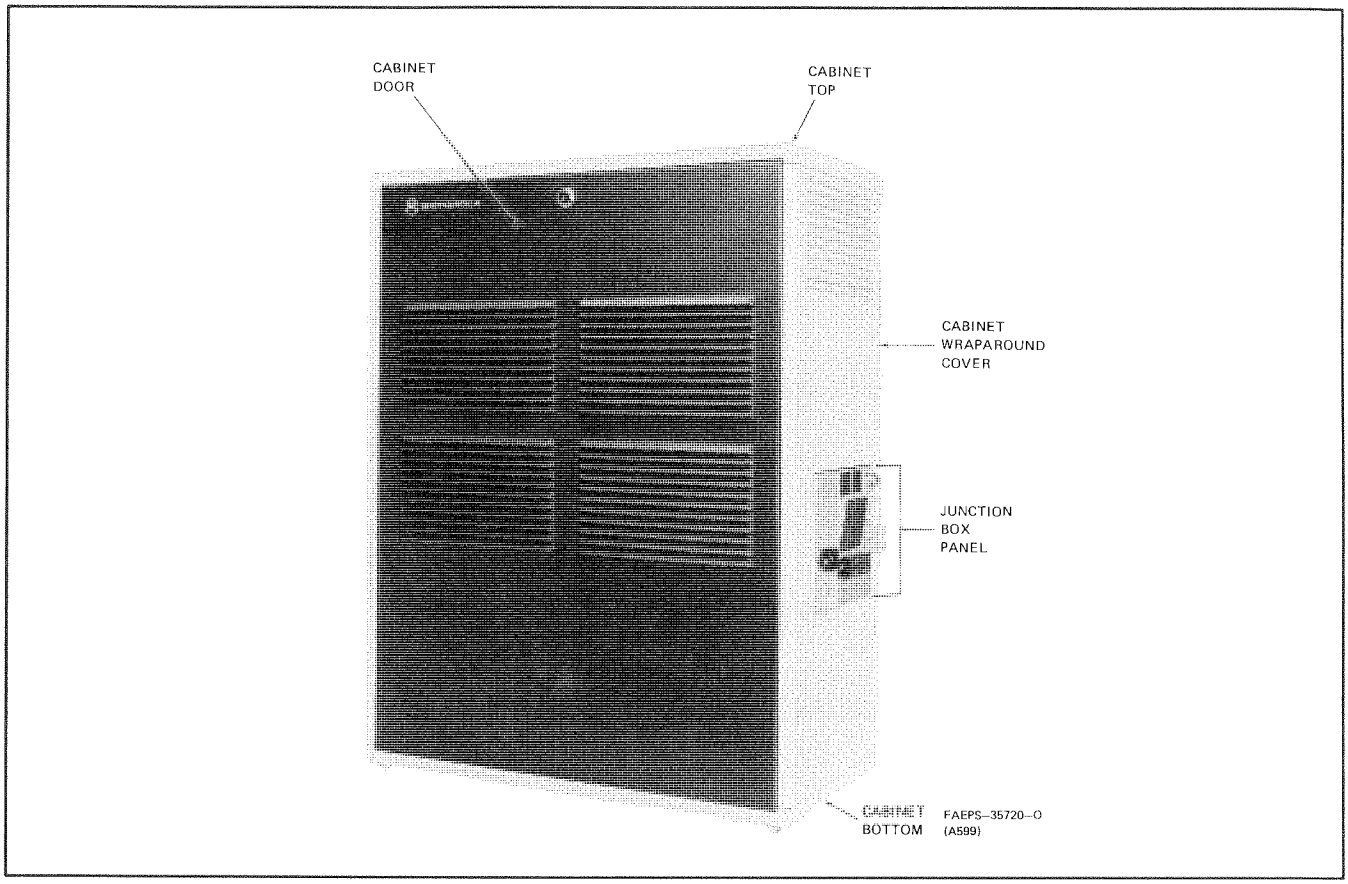

Figure 1. Typical Low Power MSF 5000 Station (Door On)

1. DESCRIPTION

1.1 INTRODUCTION

Motorola's line of *MSF 5000* base stations and repeaters are versatile enough to allow for a variety of communications applications, and flexible enough to accommodate future requirements. The standard stations are available in a full range of rf bands and power levels. A host of options may be added to the station to further expand its capabilities. For the most part, these options are accomplished in software, so as to minimize hardware changes.

The *MSF 5000* stations are completely solid state, microprocessor controlled stations. Transmit and receive frequencies are generated and controlled by frequency synthesizers. RF output power levels are available in high power (two PA decks) and low power (one PA deck) models. Table 1 lists the frequency ranges versus power levels for standard *MSF 5000* stations.

Table 1. MSF 5000 Frequencies and Power Levels				
Band	Tx (MHz)	RX (MHZ)	High Power Models (Watts)	Low Power Models (Watts)
VHF	132–174	132–174	350	125
UHF	403–475	403–475	225	110, 75, 40, 15, 6
800	851–870	806–825	150	75, 35
900	935–941	896–902	150	75
JT*	850–860	905–915	---	75
*Japan Trunking Analog Plus model				

Transmit and receive frequencies, as well as many other station parameters, are controlled by data stored in code plugs in the station's control circuits. A code plug is a non–volatile memory area, usually EEPROM. Since it contains the unique information for each station, the actual program PROM, or firmware, can be identical in every station, regardless of its options or system use. The code plug's data can be altered through the use of the *MSF 5000* Radio Service Software and Accessories (field programmer) when it is necessary to change station operating parameters or functions.

1.2 *MSF 5000* STANDARD FEATURES

All Digital and Analog Plus *MSF 5000* stations provide the following standard features:

- Microprocessor station control
- Transmit/Receive Frequency synthesis
- Wide operating temperature range: from -30° to +60° C (-22° to +140° F)
- Solid–state, easily serviceable, modular design
- Extensive self diagnostics
- Full MRTI compatibility
- Variable communication channel parameters (on a per Channel/Mode basis)
- Easily upgradable with Secure module to support *SECURENET*, Secure *SMARTNET* trunking, and Secure Digital Voice Encryption/Decryption operation (with option C514; C514 is not available for Analog Plus models).
- No hardware changes for the station to operate in any of the following system types:
  - Conventional
  - Simulcast
  - Trunking (with Console Priority)
  - Tone Remote Control
  - DC Remote Control
  - *Spectra–TAC* or *DIGITAC*
  - RA/RT Applications
- High Performance Continuous Duty Transmitter
- Capable of 1200 Baud and 4800 Baud Data transmission
- Flush mounted junction box on the side of the station to make all system interconnections. This junction box includes the System Connector
- Rf shielding and filtering to meet domestic FCC Industrial Class A specifications
- Ferro–resonant power supplies which offer enhanced immunity to power line transients
- All assemblies may be serviced, removed, and/or replaced through the front door of the station cabinet
- Field programmability with the *MSF 5000* field programmer software running on an IBM PC (or compatible)

In addition, many software and hardware options are available to configure the station to operate in a variety of systems. See paragraph 1.6 for a listing of the available options.

1.3 RELATED SERVICE MANUALS

This section describes the operation for all bands of the Digital and Analog Plus *MSF 5000* stations. For more information on circuit details, troubleshooting, and band–specific issues, see the appropriate Service Manual section. For more information on options and system planning, see the Options Manual. Table 2 lists all related *MSF 5000* manuals and their part numbers.

Table 2. List of MSF 5000 Manuals	
6881082E10	UHF Digital *MSF 5000* Service Manual
6881082E20	VHF Digital *MSF 5000* Service Manual
6881080E90	800 MHz Digital *MSF 5000* Service Manual
6881084E25	900 MHz Analog Plus *MSF 5000* Service Manual
6881082E90	J–Trunking Analog Plus *MSF 5000* Manual
6881080E30	*MSF 5000* Options Manual
6881125E68	*MSF 5000* Field Programmer Manual

1.4 ANALOG vs. DIGITAL / ANALOG PLUS

The Digital Capable *MSF 5000* was developed to provide the *MSF 5000* product line with the capability of supporting *SECURENET* and Secure *SMARTNET* trunking systems. The newly designed Digital and Analog Plus models maximize the software control of the station to obtain the same functionality that required separate hardware options in the Analog models.

The Station Control Board was re-designed for Digital and Analog Plus models, and is now referred to as the Secure Station Control Board (SSCB). The functions of the Tone Remote Control, *Spectra-TAC*, Trunk Control, and DC Remote Control Analog boards were designed into the new Trunked Tone Remote Control module (TTRC). A third module, the Secure board, was developed as an option, to be added to the Digital control tray when the station is operating in *SECURENET* or Secure *SMARTNET* trunking systems. Although the new control boards fit in the same spaces in the control tray as the Analog control boards, they are not compatible with the Analog boards, and cannot be added to an Analog station in any combination.

The terms Analog Plus, Digital, Digital Capable, and Secure Capable all refer to a station with the newly designed control hardware described above. The Digital stations are capable of receiving and transmitting digitally encrypted voice signals (Transparent stations), as well as performing the actual encryption and decryption of voice signals (Encryption/Decryption stations), with the addition of the Secure module. The term Analog Plus refers to the newly designed control hardware that is not secure capable. The term Analog refers to previously existing control hardware that does not support Secure operation.

In a major departure from the Analog control boards, all of the level setting potentiometers in the newly designed control tray, except the front panel Volume and Squelch controls, have been replaced with EEPOTs. An EEPOT is an integrated circuit (IC) that allows attenuation of an audio signal in 100 discrete steps. The EEPOT is controlled by a microprocessor, which in turn gets its commands to change the audio level via the field programmer or front panel switches. There are seven EEPOTs on both the SSCB and TTRC boards. Some other distinguishing features of the Digital control tray include a front panel with a three digit Status display. This display is capable of displaying Channel, Mode, and Secure Key information as well as error codes, EEPOT settings, forward and reflected power trip point settings (trunking models only), and station High Speed Ring (HSR) data. Also, the front panel SQUELCH pot controls receiver squelch only while the ACC DIS switch is active. When the station is not Access Disabled, the front panel SQUELCH pot is inactive and receiver squelch is controlled by EEPOT No. 3 (see paragraph 2.3.3, EEPOT Adjust Mode).

In an effort to increase manufacturability and decrease costs, many existing discrete logic circuits were designed into an Application Specific Integrated Circuit (ASIC). This 84-pin IC allows a higher level of integration in the control sections of the station. This lowers both parts count and current draw, while increasing the functionality of the station.

The rf sections of the Digital and Analog Plus stations remain basically unchanged from those of the Analog station. However, the present station takes advantage of some newer technologies and manufacturing processes in this area, too. To avoid confusion, use the Digital or Analog Plus Service Manuals for all servicing information related to the Digital or Analog Plus stations; do not use the Analog manuals.

1.5 STATION ELEMENTS

1.5.1 CABINET

The station cabinet (optional) consists of a standard 19-inch wide, rack-mount internal frame, a vinyl-covered steel wraparound skin, top and bottom plastic covers, and a door, as shown in Figure 1. The cabinet is designed for indoor installation, and may be stacked at site installations using an optional station stacking hardware kit.

When the front door is removed, all major internal assemblies are accessible from the front of the cabinet (see Figure 2) and either tilt outward, or are slide mounted to facilitate maintenance. No rear access is necessary while servicing the station.

1.5.2 JUNCTION BOX

The junction box, flush-mounted in the right side of the cabinet, provides facilities for all external connections to the station. These include ac and dc power connections, rf connections, and wireline audio connections. Slots for three 25-pin D-type connectors are provided on the junction box. Slot J1 is used for special applications and options. The system connector, located at slot J2, comes standard with the station. The trunking controller connector, located at slot J3, is standard on all trunking stations. No additional holes need be drilled or cut in the exterior surface of the cabinet for installation. Line transient protection is provided at the wireline input connectors to the junction box.

Two different styles of the station junction box are used, one for low power stations and another for high power models, as shown in Figure 3 and Figure 4.

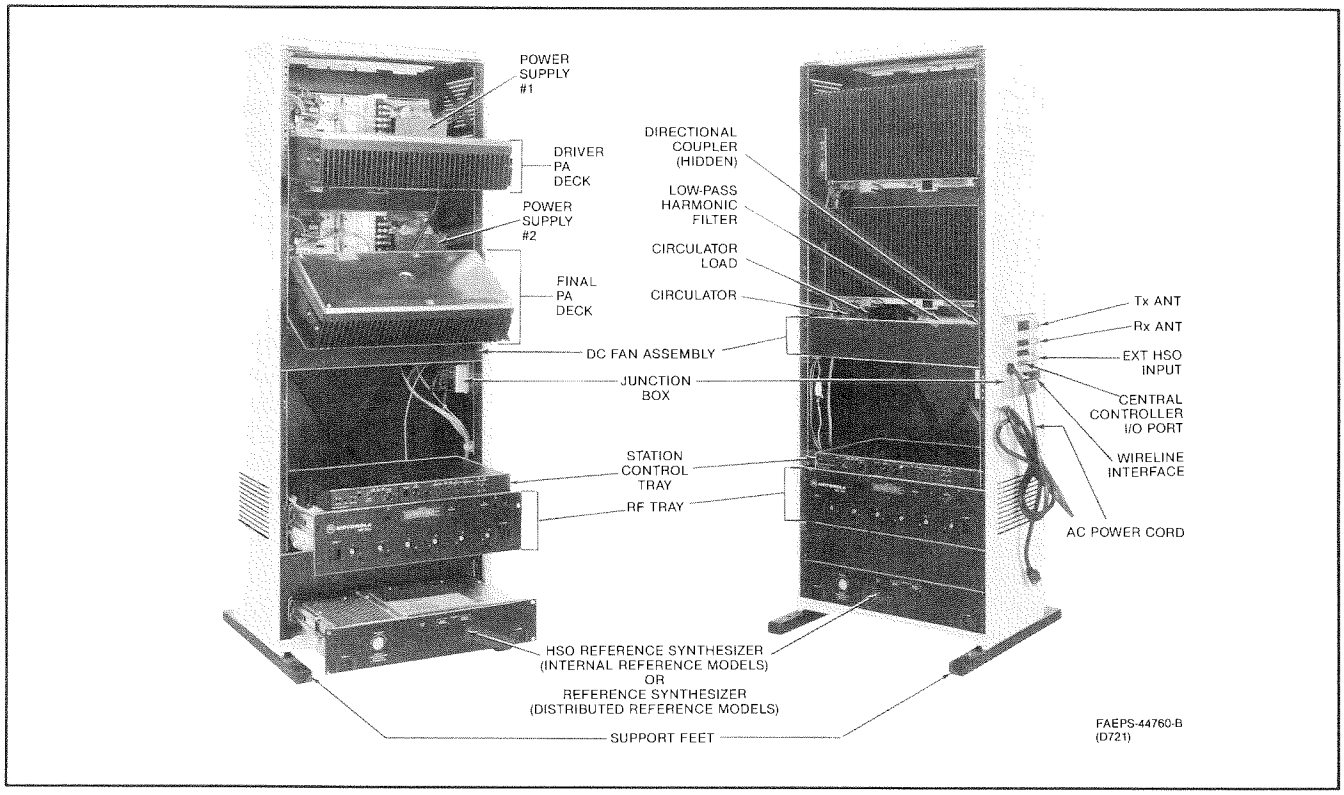

*Figure 2. Typical High Power **MSF 5000** Station (Door Off)*

1.5.3 POWER SUPPLY

The station power supplies are mounted in the upper half of the cabinet behind the power amplifier decks (see Figure 2 and Figure 5) and are accessible when the power amplifier decks are tilted forward. The standard power supplies are ferro-resonant types designed to operate from a nominal 110 volt, single-phase, 60 Hz ac power source. They also provide transient protection against line surges and lightning. Options are available for other primary voltages and 50 Hz operation on selected models. On all models, one supply is used for low power stations, and two supplies are used for high power stations. For VHF stations, the power supplies are each capable of delivering up to 675 watts. They operate with line voltages of 96 to 132 volts ac and provide both a 14 volts dc and a 28 volts dc output. For UHF, 800 MHz and 900 MHz stations, the power supplies are each capable of delivering up to 500 watts, with a single 13.8 volts dc output. They operate with line voltages of 96 to 132 volts ac on all 800 MHz and 900 MHz models and low power UHF models, and 103 to 127 volts ac on the high power UHF model.

1.5.4 RF TRAY

The rf tray is mounted on slides in the bottom half of the cabinet (refer to Figure 2, Figure 5, and Figure 7). Latches on the ends of the front panel secure the tray to the cabinet frame. The rf tray is a compartmentalized casting that contains and provides shielding for the station receiver, low-level transmitter, and power control circuitry.

The interconnect board, vertically mounted in a slot beneath the rf tray, provides connections between the rf tray and the power amplifier deck, power supply, and control tray. The interconnect board also contains a portion of the power control circuitry as well as a linear voltage regulator which supplies the rf tray with 5 volts dc. Feedthrough plate assemblies mounted in the rf tray provide rf isolation between the interconnect board and circuits contained in the rf tray casting. Additional shielding and isolation is provided by covers and plates over critical circuit board areas and compartments, by metal braid between compartments, and by the rf tray cover.

The uniboard is the large board mounted solder side up inside the rf tray. It contains circuits for the receiver, transmitter, and power control. The reference element used for frequency generation by the receive and transmit synthesizers is also located on the uniboard for Digital models. This element provides a 14.4 MHz output, and is adjustable through the front panel or top cover of the rf tray. Its stability is 2 ppm for VHF and UHF models, and 1 ppm for 800 MHz models. This frequency element is removed if the internal UHSO (C573) or external reference (C574) option is added to the station. The reference element is not included on Analog Plus models. Conventional Analog Plus stations are equipped with the UHSO standard. Trunking Analog Plus stations are equipped with the external reference standard.

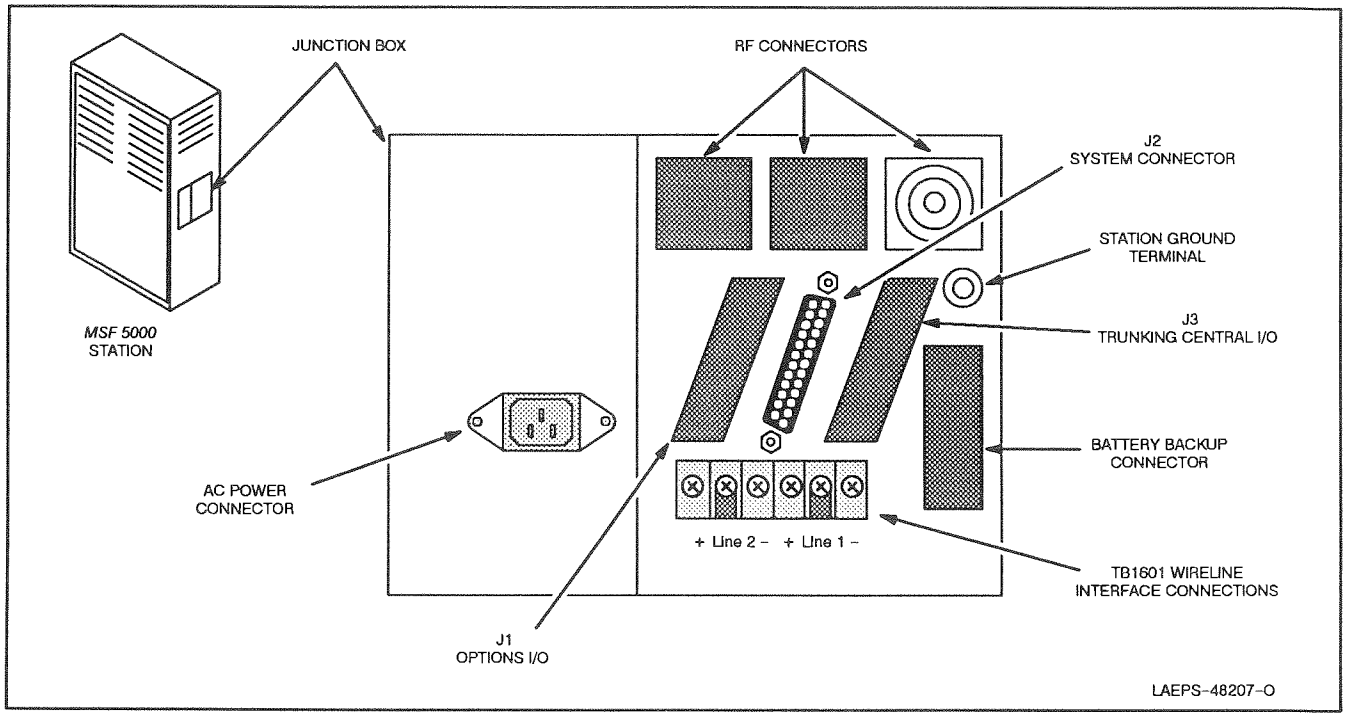

Figure 3. Low Power MSF 5000 Junction Box

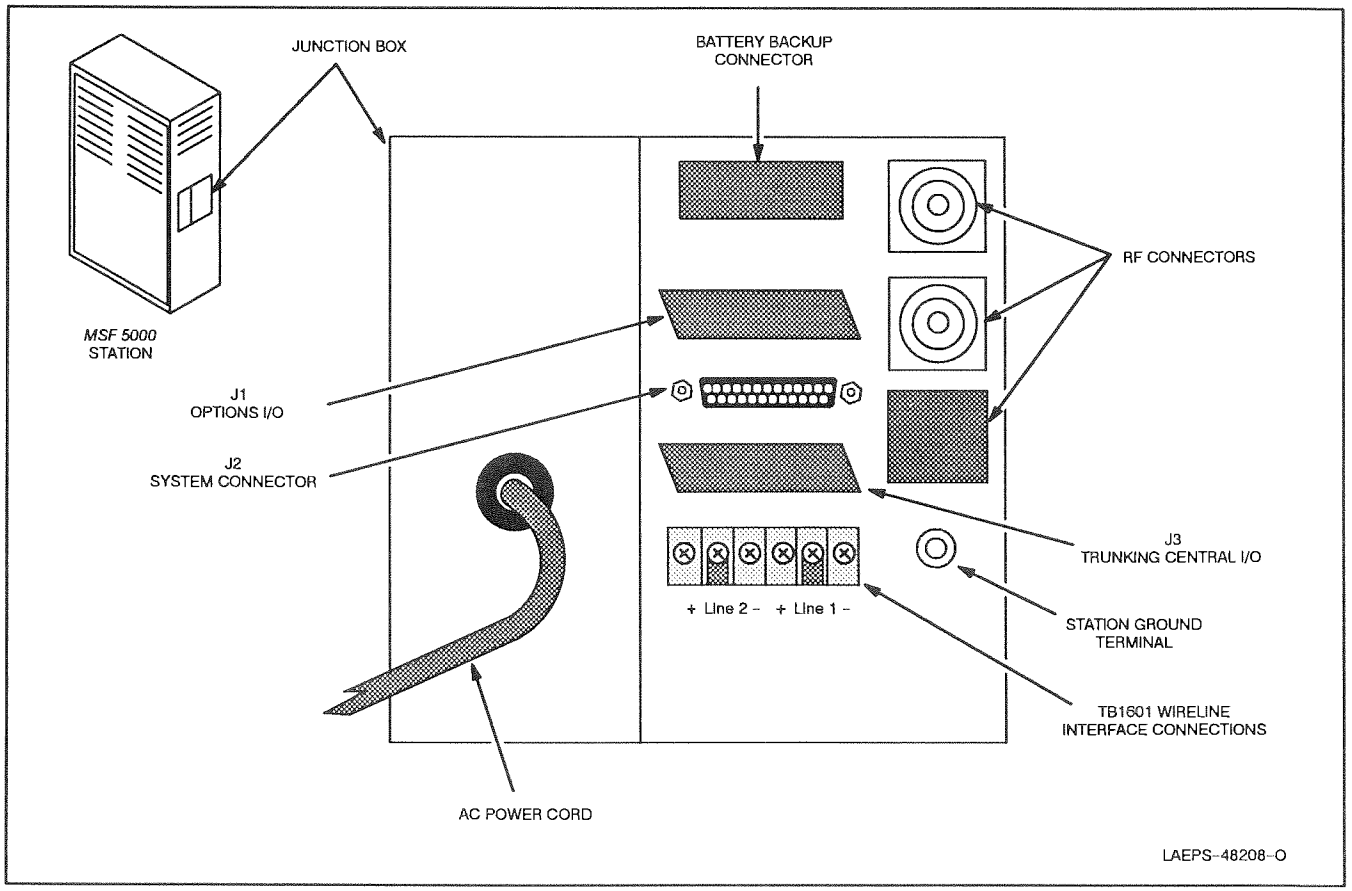

Figure 4. High Power MSF 5000 Junction Box

The station receiver is comprised of several modules located in the rf tray. The rf preselector filter is a mechanical filter located along the bottom of the rf tray. The image and injection filters are located in the front left hand corner of the rf tray and have tuning screws which extend through the rf tray casting. The rf preamplifier and mixer board is located between the preselector casing and the rf tray casting next to the image and injection filters. The receive VCO is located in the back left hand corner of the rf tray. The injection amplifier is located on the left hand side of the rf tray between the receive VCO and the injection filters. The receiver synthesizer, local oscillator, high-gain selective i-f stages, quadrature detector, and audio buffer amplifier are all located on the receive portion (left hand side) of the uniboard. The receiver develops a low noise audio signal from a frequency modulated on-channel rf carrier. Several points in the receiver circuitry may be metered through a front panel jack on the rf tray.

The low level transmitter consists of the synthesizer and modulation compensation circuits on the uniboard, the transmit VCO in the back right hand side of the rf tray, and the Intermediate Power Amplifier (IPA) located in the center rear of the rf tray. The low-level transmitter develops several watts of output power on the transmit frequency for amplification by the power amplifier. Several points in the transmitter circuitry may be metered through a front panel jack on the rf tray.

The power control circuitry is located on the uniboard, and on some models, on the interconnect board also. This circuitry receives inputs from the power amplifier decks and SSCB to control the keying and power output level of the station. It signals the SSCB when the output power cannot be leveled to the desired power setting, and protects the power amplifier by reducing the output power. The rf output power level is set via a potentiometer accessed through the front panel of the rf tray, depending upon the model.

1.5.5 DRIVER POWER AMPLIFIER (DPA) AND FINAL POWER AMPLIFIER (FPA) DECKS

The transmitter power amplifier decks are mounted in the upper half of the cabinet and are accessible when the cabinet door is removed. The decks can be tilted outward (see Figure 2 and Figure 6) when screws securing it to the cabinet frame are removed. All PA deck connections (rf, power, and control) are made at the right or left end of the PA deck heat sink, beneath a cover plate.

In high power models, the driver power amplifier (DPA) is mounted directly above the FPA and consists of single- or multiple-connected transistor stages (amplifier modules). Low power models do not contain a DPA. Instead, one or more series connected amplifier modules contained within the FPA act as pre-drivers to the final amplifier stages. The final power amplifier (FPA) in both high and low models consists of several identical parallel connected amplifier modules. The FPA deck is designed such that should any one of the parallel connected final amplifier stages fail, the transmitter will continue to safely operate at a reduced power output. Both the DPA and FPA feature metering jacks which permit measurement of amplifier module current to facilitate servicing of the PA deck. The forward power output of the FPA deck is monitored via a directional coupler to provide power control error signaling.

1.5.6 TRANSMITTER PERIPHERALS

Several peripheral devices are used to improve transmitter performance and protection. A single circulator (standard on all models except VHF), mounted beneath or internal to the FPA deck, provides protection for the FPA modules against transmitter intermodulation and antenna mismatch (see Figure 2, Figure 5, and Figure 6). A triple circulator is available for some models to provide better isolation and protection against intermodulation. An optional duplexer is available on all models except high power VHF to combine 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. An rf low-pass filter is provided with all stations without the duplexer option to attenuate transmitter harmonics. On VHF low power models, the low pass filter housing (sometimes refered to as the Peripheral Box) also contains an antenna relay when required. Other models use a separate antenna relay mounted between the low-pass filter and the junction box. Instead of an antenna relay, trunking stations contain a wattmeter element mounted between the low-pass filter and junction box.

1.5.7 UHSO REFERENCE SYNTHESIZER

NOTE

UHSO is standard on conventional Analog Plus models. External Reference Capability is standard on trunking Analog Plus models.

The optional internal ultra-high stability reference synthesizer (C573) is mounted on slides at the bottom of the station cabinet (see Figure 2). Latches at the sides of its front panel secure this tray to the cabinet frame. The left side of the synthesizer chassis contains the 2 ppb oscillator and its power supply. The right side of the chassis contains the circuitry to provide a 14.4 MHz reference signal to the uniboard in the rf tray.

External frequency reference is a related option (C574) that can be used to provide an even higher stability signal. This option is usually used in simulcast systems. The same hardware is used as in C573, but the 2 ppb oscillator is deleted and an external frequency source of high accuracy (normally 5 MHz) is applied to the station via a junction box connector. This signal is then transformed into a 14.4 MHz reference for the rf tray by the UHSO synthesizer.

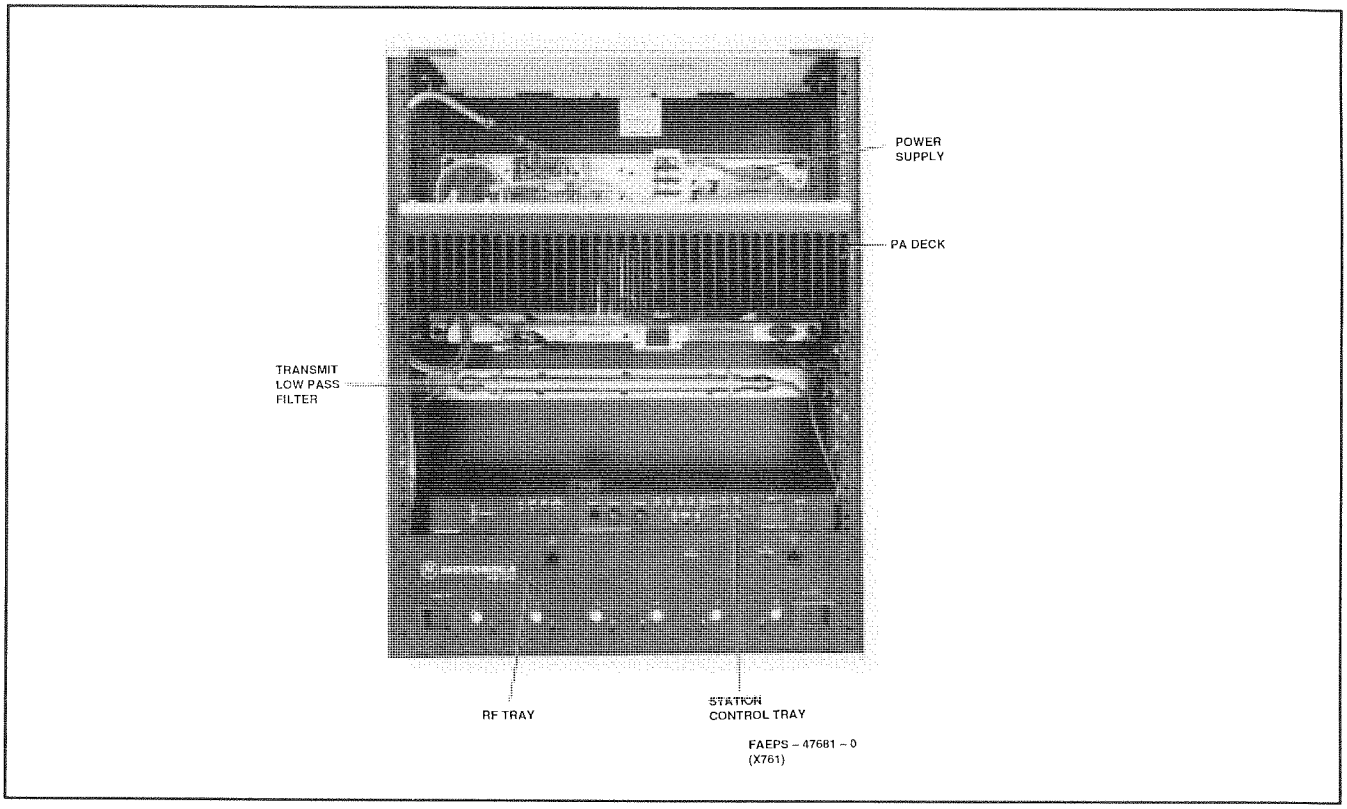

*Figure 5. Typical Low Power **MSF 5000** Station (Door Off)*

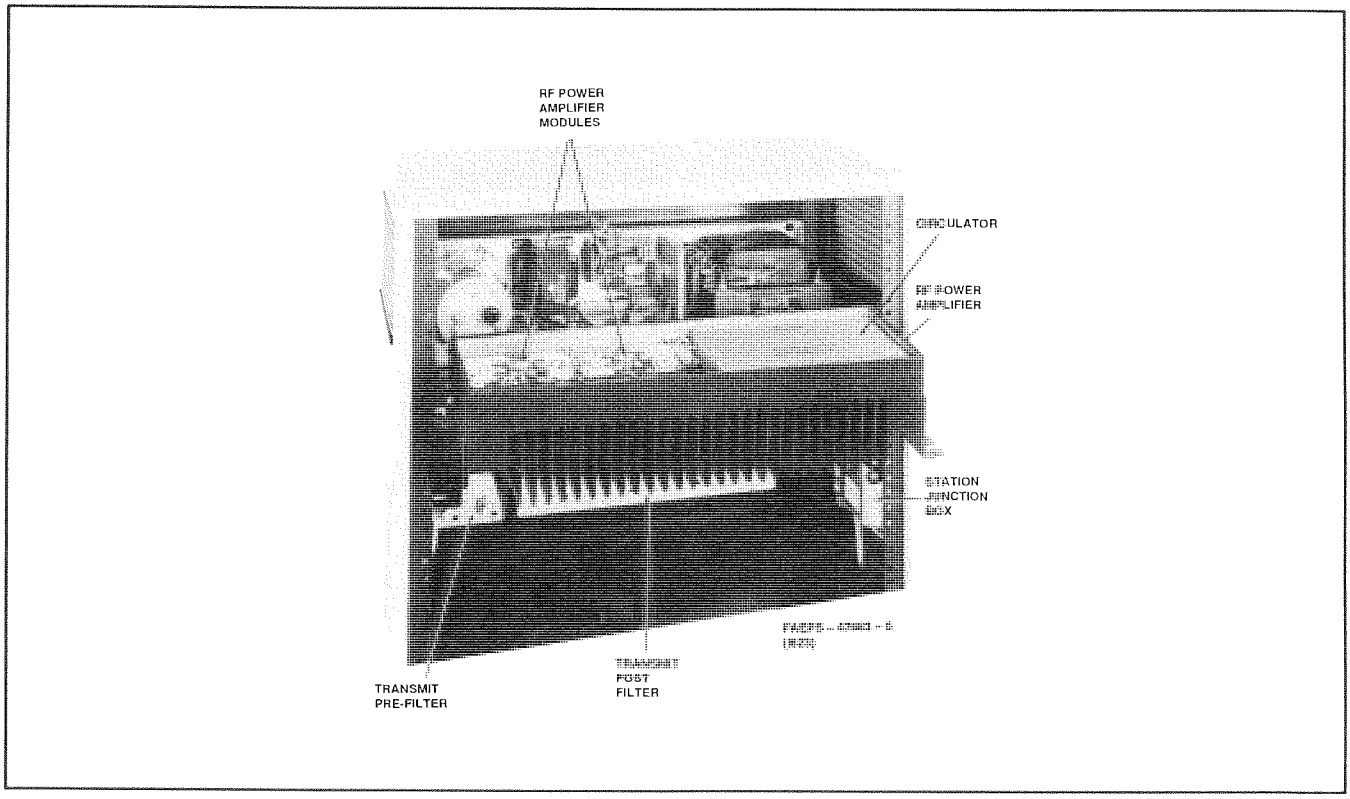

Figure 6. Typical MSF 5000 PA Deck (Internal View)

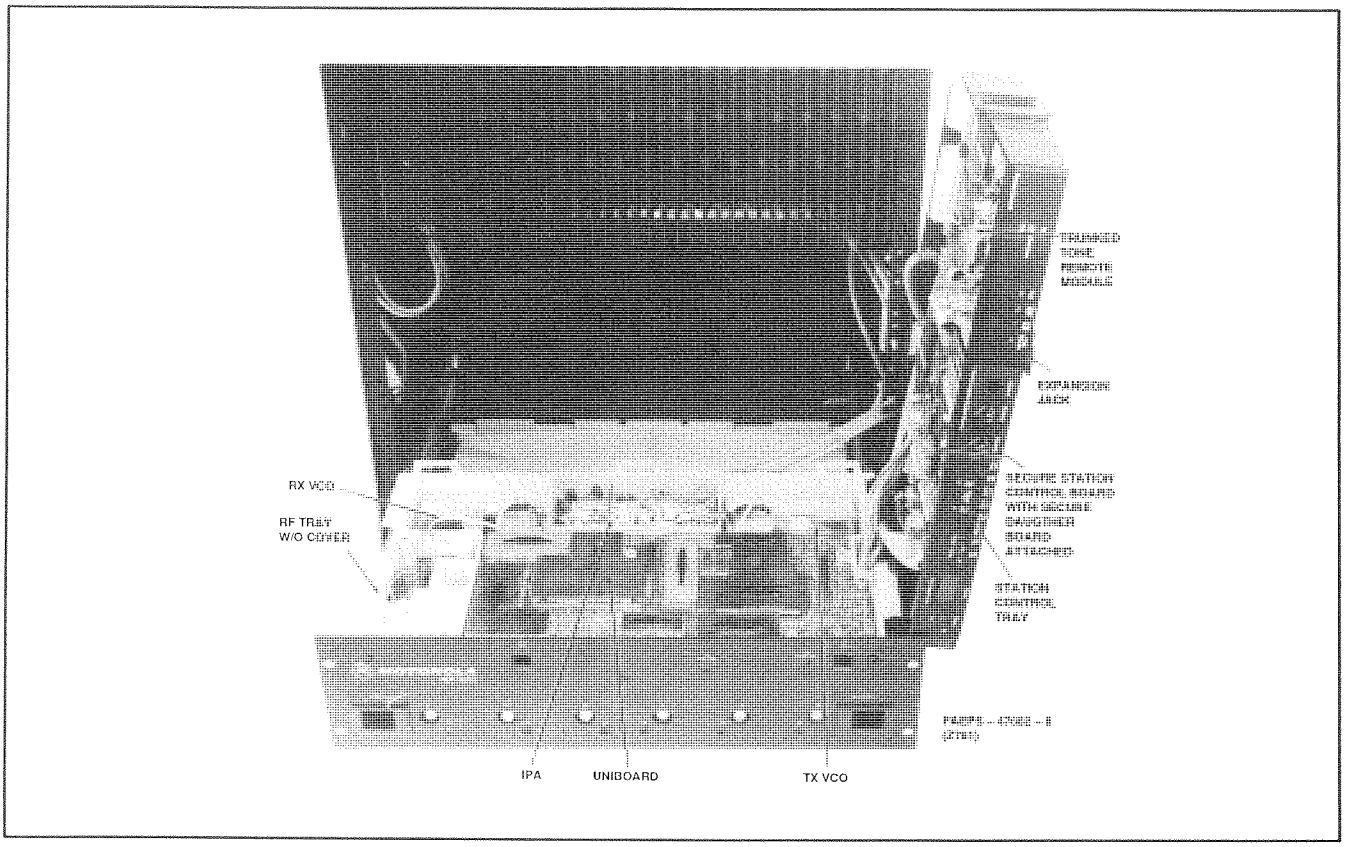

Figure 7. Rf and Main Control Trays

1.5.8 CONTROL TRAYS

1.5.8.1 INTRODUCTION

The main control tray is mounted on top of the rf tray and provides mounting space for the Secure Station Control Board (SSCB), the Trunked Tone Remote Control module (TTRC), and the optional Secure board. The control tray is secured to the top of the rf tray on the left end and hinged on the right end. After sliding the rf tray from the cabinet, the snaplock securing the station control tray to the rf tray can be released and the station control tray tilted up to the right (refer to Figure 7). This exposes the station control and remote control boards for servicing Controls and indicators for the control boards are accessible from the front of the control trays and are described in paragraph 2.1 of this manual.

The optional expansion tray mounts directly on top of the main control tray. The expansion tray's top cover is hinged at the rear providing access to the expansion tray modules. The 40-conductor expansion bus connector (J800), consisting of power, ground, the IPCB, the MUXbus, and various other control and audio signals, protrudes through the top of the main control tray to provide electrical access to the expansion tray. This connector also provides an interface for the *MSF 5000* field programmer and the Diagnostic Metering Panel (DMP).

The main control modules are MC68HC11 microprocessor based and can communicate with each other (or the external environment) via either the Interprocessor Communications Bus (IPCB) or the Multiplexed Logic Lines (MUXbus). The three modules also communicate with each other via the High Speed Ring (HSR). The HSR is a dedicated high speed serial data link that passes status and control information between the three modules. The IPCB is a "party line" that allows serial communication between devices internal or external to the station. The *MSF 5000* field programmer utilizes the IPCB (via the expansion tray connector) to read and program the station code plugs. The MUXbus consists of 4 address lines and 4 data lines which define 16 words of 4 bits each, or 64 total bits. These 64 bits form a multi-directional digital communication path as defined in the MUXbus Bit Map of Table 3. Refer to paragraph 2.5 for MUXbus bit definitions.

Table 3. 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	RW 6	RW 5
14	FW 4	FW 3	FW 2	FW 1
15	MODE 8	MODE 4	MODE 2	MODE 1

1.5.8.2 SECURE STATION CONTROL BOARD

The SSCB is the largest PC board in the main control tray. There are four SSCB kits, the VHF (TLN3059), UHF (TLN3043), the 800 MHz (TLN3090), and the 900 MHz (TLN3137). The only difference between the four kits is the component values in the squelch circuitry. The SSCB controls station operation based on station status information. The SSCB also routes and processes all station transmit and receive audio. The 5 volt dc supply for all of the main control tray circuits is generated by a switching supply located on the SSCB. The functions performed by this board include the following:

- PL/DPL Encode & Decode
- Connect Tone Encode & Decode
- Automatic Station Identification
- Station Alarm Tone Generation
- Receive and Transmit Synthesizer Programming
- Transmit Audio Pre-emphasis and processing
- Receive Audio De-emphasis and processing
- Receiver and Repeater Squelch Indication
- Station Transmitter Control
- MRTI Phone Patch Interface
- Forward and Reflected Power Monitoring

1.5.8.3 TRUNKED TONE REMOTE CONTROL MODULE

The TTRC module is made up of two separate PC boards, which operate as a single unit, located in the smaller section of the main control tray. The TTRC audio board (TLN3112) is the larger of the two and mounts directly to the main control tray housing. The smaller TTRC logic board (TLN3114) mounts as a stand-off daughter board to the TTRC audio board and contains the TTRC logic kernel. The main function of the TTRC module is to route and process all wireline audio, as well as the audio and control signals present on Trunking and System connectors. The functions supported by this module include the following:

- Tone Remote Control
- DC Remote Control
- Trunking Central Interface
- Trunking Failsoft Operation
- Console Priority Operation
- *Spectra-TAC / DIGITAC* Operation
- Simulcast Operation
- Console/CIU Interface
- Trunking Phone Patch Interface (CIT)
- RA / RT Applications

1.5.8.4 SECURE BOARD

NOTE

The secure board cannot be added to Analog Plus models.

The optional Secure Board (option C514) equips the station to operate in *SECURENET* and Secure *SMARTNET* systems. The Secure board (TLN3045A) mounts as a stand-off daughter board to the SSCB module. A Secure voice signal is a digitally encrypted 12 kbaud data stream that must be processed by the station. In the transparent mode of operation, the Secure board detects the presence of 12 kbaud data, at either the station receiver or the transmit wireline, and re-routes the signal through the Secure board circuitry for re-clocking, buffering, and filtering before being transmitted and/or sent down the wireline. If the station is equipped with a Secure Encryption option (C388, C794, C795, or C797), audio can be encrypted or decrypted at the station under the control of TTRC wireline commands. The functions supported by this module include the following:

- Receive and Transmit Secure Code Detection
- Re-clocking, buffering, and filtering of Secure Data
- Encryption of Transmit Audio signals
- Decryption of Secure Receive Signals
- Encode/Decode Alert Tone Generation

1.5.8.5 *MSF 5000* CODE PLUGS

Most station operating parameters are controlled by programmed data contained in the station code plugs (EEPROMs) internal to each of the MC68HC11 microprocessors. External serial EEPROMs are utilized on the SSCB and TTRC modules to provide additional code plug storage capacity when necessary. The code plugs are programmed at the factory, but can be re-programmed if necessary in the field to accommodate station expansion and/or changes in function. The *MSF 5000* Field Programmer software provides the ability to re-program code plugs in the field. An IBM PC (or compatible) connected to the station expansion tray connector through a Radio Interface Box (RIB) along with the appropriate cabling, is required. See the field programmer manual for more information on changing station parameters.

1.5.8.6 STATION PARAMETER BOOKLET

The Station Parameter Booklet is a document printed by the factory computer as it generates the programming information for the station code plugs. The programmed code plugs contain the customer's specific requirements. The Station Parameter Booklet provides a listing of those specific customer requirements. After the booklet is printed, it is placed in the tuning tool pouch included with the station. The booklet should be used to determine the specific station parameters describing the customer's equipment, e.g., Time-Out-Timer (TOT) times, PTT priorities, receive and transmit frequencies, PL codes, etc. Any field changes to code plug programming should be recorded in the booklet, or a new booklet should be printed by the field programmer.

1.5.8.7 SYSTEM CONNECTOR

The system connector is a DB-25 (25 pin) connector located on the station's junction box. This connector allows easy access to the station's miscellaneous I/O and audio phone lines. Figure 3 shows the location of the Junction Box on the low power *MSF 5000* cabinet. Figure 4 shows the location of the Junction Box on the high power *MSF 5000* cabinet. The system connector is J2 on both forms of the Junction Box. Figure 8 shows the pin-out of the DB-25 system connector, and a description of the I/O related to this option.

- **Line 1:** This is a 600 ohm balanced audio input to the station. The station can be adjusted for rated deviation with input levels of -35 dBm to +11 dBm on this input.
- **Line 2:** This is a 600 ohm balanced audio output from the station. The level can be adjusted from -35 dBm to +11 dBm with 60% full system deviation on the receiver.
- **Line 3:** This is a 600 ohm balanced audio input to the station. The station can be adjusted for rated deviation with input levels of -35 dBm to +11 dBm on this input.
- **Line 4:** This is a 600 ohm balanced audio output from the station. The level can be adjusted from -35 dBm to +11 dBm with 60% full system deviation on the receiver.
- **Tx Inhibit:** This is an active low input to the station. It inhibits all transmitter activity, regardless of the key request.
- **Rx Inhibit:** This is an active low input to the station. It prevents the station from driving both outbound phone lines (Line 2 and Line 4) with receiver audio or status tone (in stations so equipped).
- **Ext Tx Code Detect:** This is an active low input to the station. It is pulled up to +5V via a 10K ohm resistor in the station. It is used to indicate to the station that another secure device (usually a modem or CIU) has detected the presence of secure code. The station then switches to the coded mode, thereby speeding up the system access time.

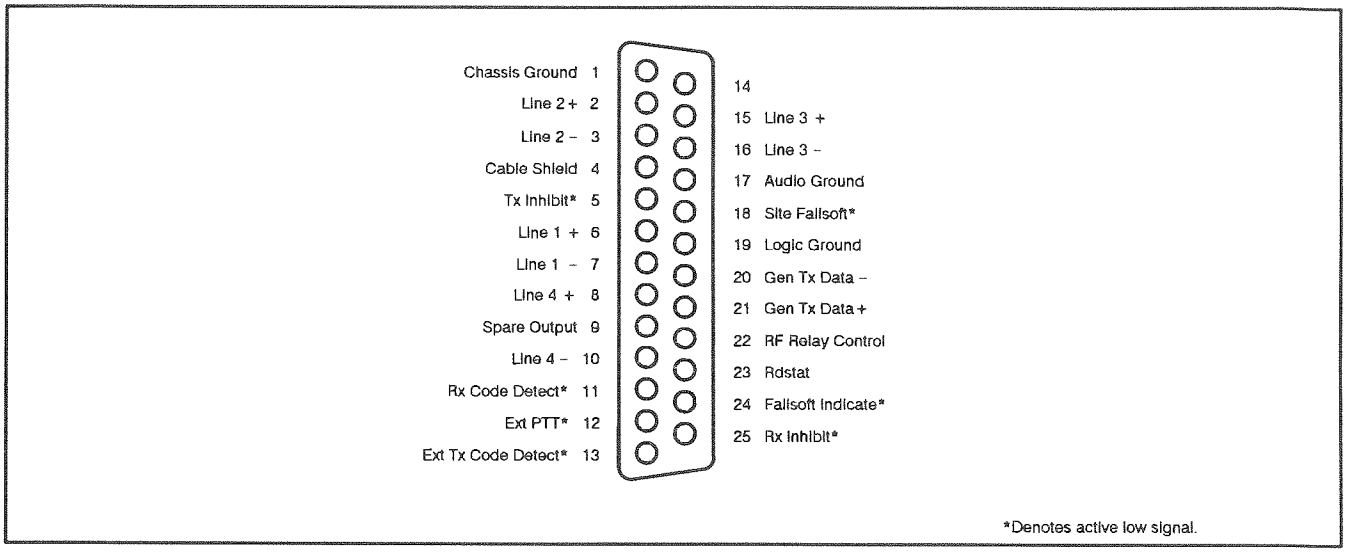

Figure 8. System Connector (DB-25 Female Connector, J2 on Junction Box)

- **Site Failsoft**: This is an active low input to the station. In trunking stations, activating this input changes the failsoft mode. It does not cause a failsoft condition, but when the station goes into failsoft (in the normal manner) it causes a "Site Failsoft". In this mode, the station keys, mutes all outbound and inbound line audio (including STAC tone), and transmits in-cabinet repeat audio along with the failsoft code word and double alert tone. This failsoft mode is only used on voice channels in AMSS systems.

- **Ext PTT**: This is an active low input to the station. It is pulled up to +5V via a 10K ohm resistor in the station. By default, this input causes a Line PTT by writing the LIN_PTT bit on the MUXbus (a Trunking PTT is generated in trunking stations). However, the PTT type may be changed via the field programmer. In secure systems, this input may be used as the "Line Assert" input, as it causes the same reaction in the station.

- **Failsoft Indicate**: This is an active low output from the station. There is no pull-up on the station side. This output is pulled low whenever the station is in local or site failsoft. This output can sink 15 mA at Vo = 0.5V.

- **Rx Code Detect**: This is an active low output from the station. There is a 10K ohm pull-up resistor on the station side to pull this line to +5V (this resistor may be removed if desired). This output is pulled low whenever the station detects the presence of secure data on receiver 1. This output can sink 15 mA at Vo = 0.5V.

- **Rdstat**: This is an active high output from the station. There is a 10K ohm pull-up resistor on the station side to pull this line to +5V (this resistor may be removed if desired). This output is simply a reflection of the RX1_ACT MUXbus bit OR'ed with the RX_CD_DT MUXbus bit, and therefore indicates the receiver 1 qualified squelch detect OR receiver Code Detect.

- **RF Relay Control**: This is an active high output from the station. The output is switched to the station's A+ line in two situations: 1) in a trunking station when the station is selected as the control channel, or 2) in a conventional station with option C753 (Standby Operation), when the station is activated. This output is capable of supplying up to 300 mA of A+ current, and is designed to be used with the drop ship rf relay (DQB717350). This item does not mount in the station. The return for this output should be made through the Audio Ground output (pin 10 on the 50 pin connector; pin 17 on the DB25).

- **Spare Output**: This is an output from the station. There is no pull-up on the station side. This output may be switched to reflect any of the MUXbus bits via the field programmer. It may also be chosen to be active high or low. This output can sink 15 mA at Vo = 0.5V.

- **Gen Tx Data + & -**: This is a balanced, 600 ohm, non-transformer audio input to the station for use in simulcast systems. The input is activated when option C777 is included.

1.6 DIGITAL AND ANALOG PLUS STATION OPTIONS

Table 4 identifies the options available for the *MSF 5000* Stations. See the *MSF 5000* Options Manual for detailed option descriptions and information.

Table 4. MSF 5000 Options

OPTION	DESCRIPTION	OPTION	DESCRIPTION	OPTION	DESCRIPTION
C14	Receiver PL On/Off	C280	Wide Space Revr With 1 rf Tray	C668	DMP
C27	46" Micor Outdoor Cabinet	C291	Install MRTI Phone Patch	C669	Omit Wireline Alarm Reporting
C28	Battery Reverting Pwr Suply	C303	Dual Code Select	C670	Phone Line Integrity Test
C29	Battery Protection	C304	Proper Code Select	C671(1)	Variable Repeater Dropout Delay
C32	Omit Power Supply	C307	70" Micor Indoor Cabinet	C672(1)	Variable PTT Priority
C36	70" Micor Outdoor Cabinet	C308	46" Micor Indoor Cabinet	C673(1)	Variable Repeater Control
C40	46" MSF Cabinet	C331(2)	Secure Encryption	C674(1)	Variable Receiver Audio Control
C42	Scanning Receiver	C332	Full Duplex 4-Wire Audio	C675	Duplex Filtering
C52	37" Indoor Cabinet	C338	75' Trunking Cable	C676	Triple Circulator
C63	Transmit PL Off for Paging	C345(1)	Auto Station ID	C677	Duplex Filter w/Triple Circulator
C84	Omit Remote Control	C362	Packing Kit for High Power	C678(1)	Transmit Audio Mixing Control
C92	26" MSF Cabinet	C367	VHF Range 1	C681	60 Hz Multi-Voltage Power Suply
C101	DC Remote Control	C369	MCS	C682	Omit Antenna Relay
C115	Console Priority in Station	C382	Local Channel Control	C695	Expansion Tray
C143	Remote Repeater Control	C388	DES Encryption	C719	Phone Patch Interface
C144	Half Duplex 4-Wire Audio	C395(1)	Variable TOT	C746	2100 Hz Guard Tone
C149	RMP	C415	Omit Status Tone with Trans Rptr	C747	2325 Hz Guard Tone
C150	RA Base	C432	Service Manual	C753	Standby Operation
C153	50' Trunking Cable	C436	Positive Mode Control	C765	Trunking Capability
C154	100' Trunking Cable	C462	Privacy Plus Slow Failsoft	C777	Simulcast Operation
C160	RA Repeater	C514	Transparent Operation	C784	RA/RT Repeater
C162	2nd Receiver	C550	Reduced Deviation	C794	DVP Encryption
C163	Additional Channel Capability	C553	Smartnet Fast Failsoft	C795	DES-XL Encryption
C164	Rack Mounting	C557	Physical Security	C797	DVP-XL Encryption
C170	Guard Tone Keying	C565	RS232 Interface	C810	8' Rack
C180	60" Micor Cabinet	C568	Wide Space Revr With 2 rf Trays	C816	Automatic Access
C182	Duplexer	C569	52" Shipping Rack	C832	7' Rack
C195	46" Micor Indoor Cab, Deep	C571	Omit Over-the-Air Alarms	C882	7.5' Rack
C199	Hot Main/Standby Operation	C573	Internal High Stability	C932	Repeater Access Controller
C233	Wildcard	C574	External Reference Capability	C949	Commander's Net
C257	50 Hz Multi-Voltage Power Supply	C587(1)	Repeater Audio Delay	C974	Wildcard Channel Control
C265	Single Circulator	C597	Duplex Filtering - Range 1 UHF		
C269	*Spectra-TAC/ DIGITAC* Encoder	C658(2)	Xmit above Rev		

The following notes apply to Table 4:
(1) indicates that STIC 374 must be supplied
(2) indicates an internal option that may not be ordered by the customer, but is automatically supplied by the factory if required

2. STATION OPERATION

This section describes the controls and indicators located on the main control tray front panel. In addition, a description of the extensive station diagnostics is included, as is a description of the station MUXbus.

2.1 CONTROLS AND INDICATORS

The controls and indicators associated with the Station Control and Secure Modules are shown in Figure 9. Figure 10 shows the controls and indicators associated with the Trunked Tone Remote Control Module. Refer to these diagrams when performing the adjustments required during installation or when servicing the station. The following paragraphs describe the operation of the front panel switches. The functions of the indicators are described in Figure 9 and Figure 10.

2.1.1 PL DIS/XMIT Switch

When this switch is held in the XMIT position, the station transmitter will key without audio, PL/DPL codes, or TDATA present in the transmitted signal. If this switch is actuated simultaneously with another push-to-talk (PTT) function, any PL tone, DPL code, or TDATA will be stripped from the transmitted signal.

In the PL DIS position, receiver audio gating qualifiers are set to carrier squelch operation, although repeater squelch qualifiers are not affected. Receiver audio signals will be gated to the wireline and local speaker when an on-channel carrier is detected. The front panel Disable LED is lit to provide a warning while the PL DIS switch is activated.

2.1.2 ACC DIS/RESET Switch

When this switch is placed in the RESET position, all of the control circuits in the main and expansion trays are held in reset. This inhibits all station operation, and is indicated by all STATUS display segments being lit along with all of the TTRC LEDs and the Secure Fail LED. Releasing the RESET switch initiates the power-up / reset diagnostic routines. The station will not be operable until after it passes these diagnostic routines without encountering fatal errors; these are described in the paragraph 2.4.

The ACC DIS switch position enables manual selection of the station operating channel, mode, and encryption key via the front panel SELECT/SET switch. The front panel SQUELCH pot will control station receiver squelch only while ACC DIS is active. The following operations are disabled while in Access Disable: PTT Time-out-timers, channel and mode changes from the wireline, encryption key changes from the wireline, transmitter key requests from the wireline, automatic station identification, and repeater activity. When the ACC DIS switch is returned to its center (Off) position, the previously disabled functions are re-enabled and the station will resume operation on the channel last selected by wireline command (even if the wireline command occurred while the station was in Access Disable).

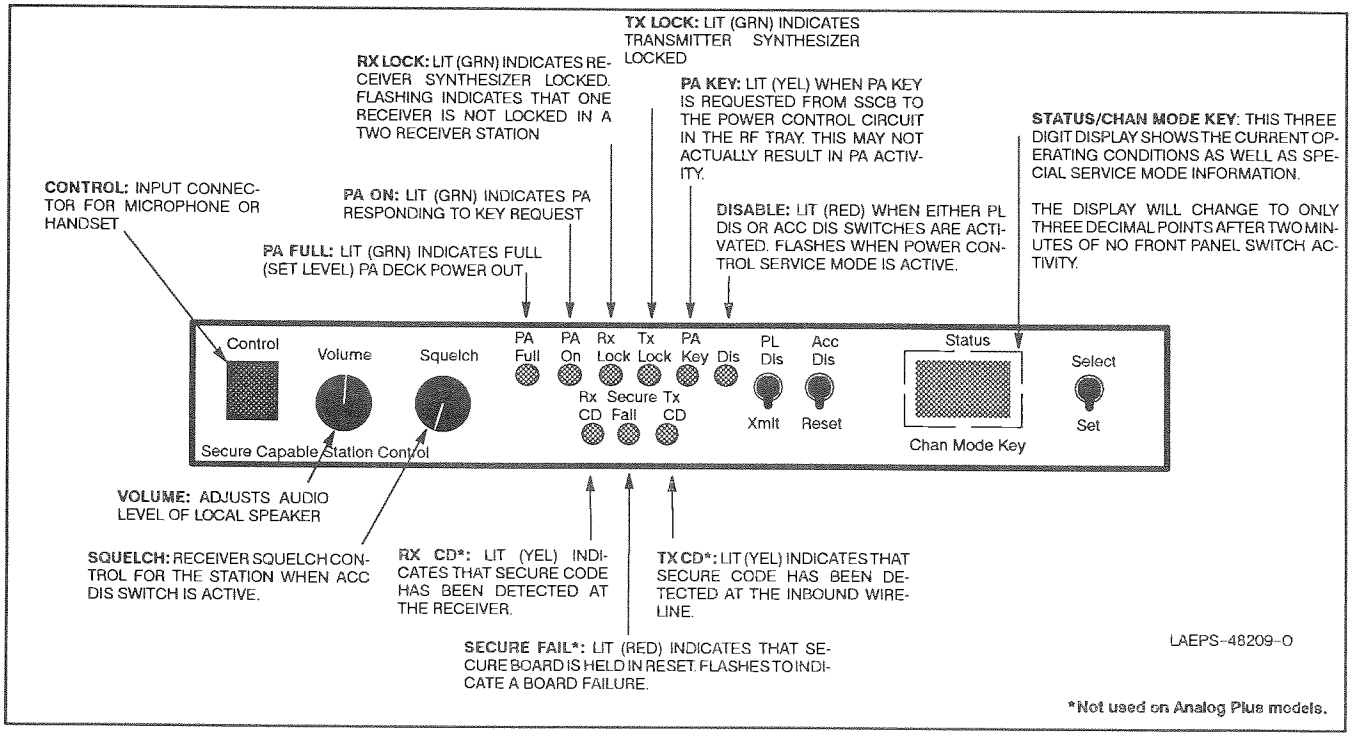

Figure 9. Secure Station Control Module: Controls and Indicators

CAUTION

When the station is Access Disabled, most key requests are ignored to protect the local serviceman. The station may only be keyed using a local microphone, with the LOC PTT bit on the MUXbus, or from the front panel Xmit switch. Line, Repeater, and Trunking PTTs are disabled, as are PTTs due to alarms and auto IDs. However, wireline functions that are defined to write directly to the MUXbus cannot be disabled, **so the station may still be remotely keyed** in this manner. To completely insure that the station cannot be keyed remotely, the wireline must be disconnected at the station junction box.

2.1.3 SELECT/SET Switch

When this switch is toggled in the SELECT position, one of the three digits in the Status display may be selected for changing. Selection is indicated with a decimal point display cursor immediately to the right of the desired digit.

In the SET position, a selected digit may be incremented by one. The display cursor will automatically deactivate after several seconds if neither the SELECT or the SET switches are toggled. To exit any of the special Status display modes, toggle the switch in the SET position after the display cursor has timed out. Refer to paragraphs 2.2 and 2.3 when using the SELECT/SET switch to change Channels, Modes, Keys, and EEPOT settings.

2.1.4 INTERCOM Switch

The INTERCOM switch on the Trunked Tone Remote Control Module allows a serviceman at the station to communicate with the remote control operator without keying the station. When this switch is in the ON position, the transmit wireline audio is gated to the local speaker without requiring a Line PTT signal. The transmitter cannot be keyed with a Local or Mic PTT while the INTERCOM switch is ON. When the microphone PTT switch is actuated, the transmit wireline audio gate is turned off and the local audio gate is turned on sending mic audio to the wireline.

If the receiver unsquelches while the INTERCOM switch is on, received audio is gated to the local speaker and to the wireline. This audio will be mixed with any other audio signals which are gated at the same time.

The INTERCOM switch can also be used to disable the trunking failsoft condition. Refer to paragraph 2.3.1, Failsoft Disable Mode, for details.

2.2 CHANGING CHANNELS/MODES

The *MSF 5000* Control tray provides local channel and mode selection through manipulation of the digits on the Status display. To change the channel, repeatedly depress (or continuously hold) the front panel SELECT switch until the Channel (Chan) digit is selected with the decimal point display cursor. If no digits are selected or Channel will not select, then the station is programmed to be remotely controlled, so the ACC DIS switch must first be activated. With Channel still selected, repeatedly depress (or continuously hold) the SET switch until the desired channel number appears in the Status display. If the Channel digit de-selects (display cursor disappears) and more channel changes are desired, momentarily depress the SELECT switch and Channel will be re-selected.

Channel 0 is the station tuning channel. The station should never be keyed over the air while channel 0 is selected, since the transmit frequency may not be on an authorized channel specified by the FCC license. The tuning channel is programmed with the optimum frequency for tuning the rf sections and conducting audio tests in the station. The channel 0 transmit signal will consist of audio encoded with DPL code 031.

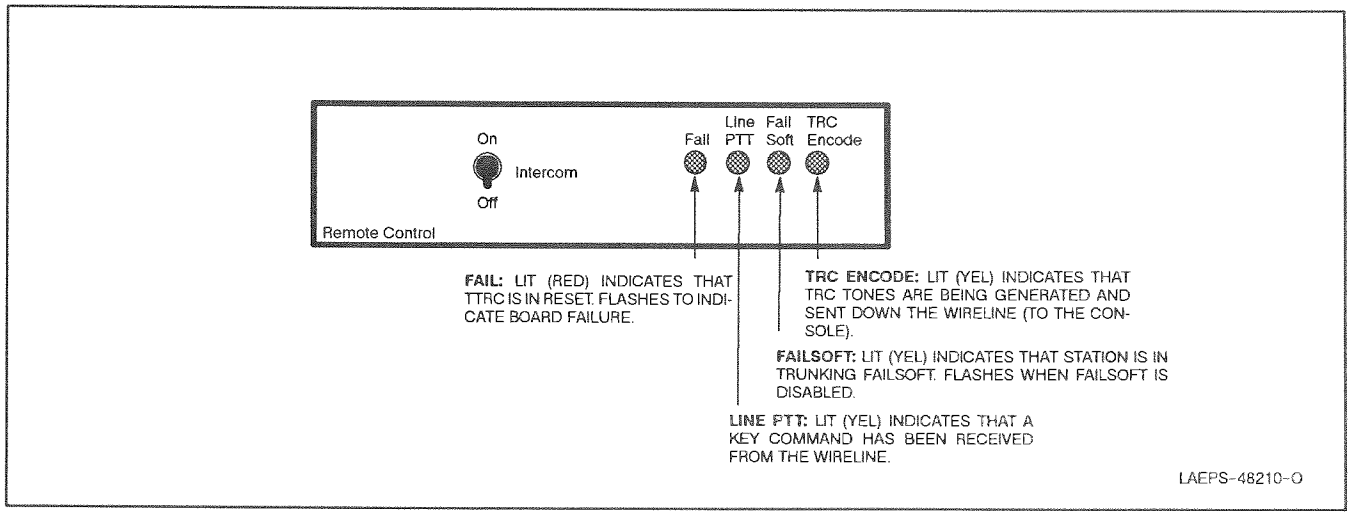

Figure 10. Trunked Tone Remote Control Module: Controls and Indicators

Selecting and changing Modes is accomplished in the same manner as channels. Depending on how the SSCB code plug is programmed, there may be several Modes available 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 parameters associated with a given channel. These include:

- Receive and Transmit PL/DPL Codes
- PTT Priority
- Time Out Timers
- Receiver Qualifiers
- Repeater 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

The only properties unique to the channel number are:

- 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. However, 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, so that the mode parameters are correct for the selected channel. This slaving property can be disabled for special applications by using the field programmer.

When a station is programmed, identical modes are automatically deleted. For example, if a station is programmed for four channels, each channel with a different Tx and Rx frequency but all other information the same, there will be only one mode, since four identical modes would be redundant and waste code plug space. Note, however, that channels are never automatically deleted, even if the channel information is identical.

2.2.1 SELECTING/LOADING ENCRYPTION KEYS

NOTE

The Secure Encryption options are only available for Digital models.

A station equipped with one of the Secure Encryption options (C388, C794, C795, or C797) will allow the front panel Key digit to be selected on the Status display to facilitate the Encryption Key loading process. The Key digit is only illuminated in stations equipped with a Secure Encryption option.

The Secure Encryption option requires the Secure hybrids to be loaded with an encryption key variable. A Key Variable Loader (KVL) is a device used to transfer encryption keys from its memory into other Securenet equipment containing secure hybrids. A KVL will only load a hybrid of the same type as that specified on the back of the KVL unit. When a KVL is connected to the station, the station is automatically placed in Access Disable. The front panel SELECT/SET switch can then be used to select the desired hybrid for key loading. To select the Key, repeatedly depress (or continuously hold) the front panel SELECT switch until the Key digit is selected with the decimal point display cursor. With Key still selected, repeatedly depress (or continuously hold) the SET switch until the desired Key number appears in the Status display. If the Key digit de-selects (display cursor disappears) and more Key loading is necessary, momentarily depress the SELECT switch and Key will be re-selected. The Key selection process will allow any of the eight possible hybrids to be selected, even if less than eight hybrids are installed. In a Full Duplex wireline station, hybrids are grouped in encrypt/decrypt pairs and are loaded with the same encryption key (see Table 5). For example, to keyload a Full Duplex wireline station with two hybrids, follow these steps:

Step 1. Plug in the KVL cable (TKN8531B) into the station and verify that station is in Access Disable (The SSCB Disable LED should be lit).

Step 2. Select KEY 1 with the SELECT/SET toggle switch on the station front panel.

Step 3. Depress program switch on KVL. Verify successful key transfer on KVL display (PASS).

NOTE

Omit Steps 4 – 6 if the station is configured for a Half Duplex wireline.

Step 4. Select KEY 5 with the SELECT/SET toggle switch on the station front panel.

Step 5. Depress program switch on KVL. Verify successful key transfer on KVL display.

Step 6. Disconnect KVL cable. The SSCB Disable LED should turn off.

Table 5. Full Duplex Hybrid Pairs

Encrypt	Decrypt
1	5
2	6
3	7
4	8

The Key digit can be selected and changed during normal station operation to select another Secure hybrid. If no digits are selected or Key will not select, then the station is programmed to be remotely controlled, so the ACC DIS switch must first be activated. When selecting hybrid pairs in a full duplex wireline station, select only keys 1 through 4 from the front panel to designate the encrypt/decrypt pair. Selecting Keys 5 through 8 will have the same effect as selecting Keys 1 through 4, respectively.

2.3 SPECIAL SERVICE MODES

The following special service modes may be entered from the front panel through a special key activation sequence. These service modes are useful in troubleshooting, testing, and aligning the station.

Each mode is entered in a unique way, and some modes may be exited by unique methods. Note that all active special service modes are terminated upon a station reset (toggling the front panel Reset switch).

2.3.1 Failsoft Disable Mode

While aligning Trunking Stations, it may be necessary to disconnect the trunking cable from the TTRC board at J2901 or at the junction box to prevent the TDATA signal from mixing in with transmit audio signals. When the TDATA or MUTE signal is removed, the station will key with failsoft data. To disable the failsoft function, toggle the INTERCOM front panel switch On and back Off again quickly. The Fail Soft LED will blink signaling that failsoft function has been temporarily disabled. Toggle the INTERCOM switch again to enable failsoft. Always return the Intercom switch to the Off position after toggling it unless intercom operation is desired.

2.3.2 Power Control Service Mode

In normal operation, the power control circuits continuously monitor the PA output power, and reduce it or turn it completely off in case of potentially damaging problems. Therefore, while servicing the station, it may be necessary to override the power control circuits to key the station. While the Power Control Service mode is enabled, SSCB requests to key the transmitter will disregard any power control failure indications. To enable this mode, depress and hold the SELECT/SET switch in the SET position (display cursor should not be active at this time). While holding the SET switch, press and hold the PL DIS/XMIT switch in the Xmit position. When tSt appears in the Status display, release the SET switch first, and then the Xmit switch (station will key after the SET switch is released and until Xmit is released). While this mode is active, the Disable LED will flash. Toggle the RESET switch to take the station out of the Power Control Service Mode. The Disable LED should stop flashing.

CAUTION

Activation of the Power Control Service Mode allows the transmitter to continue 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.

2.3.3 EEPOT Adjustment Mode

Most of the level setting potentiometers in the digital control tray are digitally-controlled solid-state nonvolatile potentiometers, referred to as EEPOTs. These EEPOTs can only be manipulated by using the *MSF 5000* field programmer or through a front panel switch toggling sequence. To enter the front panel EEPOT Adjustment Mode, depress and hold the SELECT/SET switch in the SET position (display cursor should not be active at this time). While holding the SET switch, press and hold the PL DIS/XMIT switch in the PL DIS position. When EEP appears in the Status display, release the SET switch first, and then the PL DIS switch may be returned to its normal position. After a few seconds, the leftmost digit of the STATUS display will show a 0 which represents the EEPOT number (from 0 to hex F). The other two digits will show a decimal value from 00 to 99 which represents the current wiper position of the EEPOT.

Table 6. EEPOT Functions

EEPOT Number	EEPOT Function	EEPOT Number	EEPOT Function
0*	Decrypted Rx Level	8	Status Tone Level
1	Flutter Fighter Level	9	High End Equalization Level
2	Repeater Squelch Level	A	Low End Equalization Level
3	Receiver Squelch Level	b	Trunking Data Level
4	Max Deviation Level	C	Line 2 Output Level
5	Rx Level	d	Line 4 Output Level
6*	Coded Deviation Level	E	Coarse Tx Level
7	Tx Level		

* Not used on Analog Plus models.

Toggle the SELECT/SET switch to the SELECT position. A decimal point on the display will light. Toggle the switch again to move the decimal point from one digit to another. Set the decimal point to the leftmost digit. Now toggle the switch to the SET position. Toggling to the SET position scans the current settings of the EEPOTs. A delay between toggles of more than 5 seconds times out the decimal point. To bring it back, toggle to the SELECT position. However, if the SET position is toggled after the decimal point times out, the display will exit the EEPOT setting mode and revert to normal operation. To re-enter the EEPOT mode, simply begin the sequence again.

To set station levels, select the desired EEPOT (see Table 6 or the alignment procedure), and move the decimal point to the next (tens) digit. Toggle to the SET position while monitoring the output you are trying to adjust. When the output gets close to the required level, move the decimal to the third (ones) digit, and fine tune to the required level. If you overshoot the required level, scroll the wiper through position 99, and repeat the procedure. From the front panel, the EEPOTs can be adjusted only in one direction. When using the field programmer's alignment screens, the EEPOTs may be adjusted in either direction.

2.3.4 High Speed Ring Display Mode

To aid in troubleshooting of the control tray, the front panel Status display can be used to read the five High Speed Ring data bytes that circulate between the control tray modules. To enable this mode, depress and hold the SELECT/SET switch in the SET position (display cursor should not be active at this time). While holding the SET switch, press and hold the ACC DIS/Reset switch in the ACC DIS position. When HSr appears in the Status display, release the SET switch first, and then the ACC DIS switch. A 1 will appear in the leftmost position of the Status display, and a two digit hexadecimal value will occupy the remaining two positions; this represents the eight-bit data of the first ring byte. The HSR data must be decoded from their hex byte format to binary representation to determine which data signals are active. See Table 7 for a listing of the data definitions.To see the values of the other ring bytes, press and release the SELECT switch to activate the display cursor on the byte number, then repeatedly depress (or continuously hold) the SET switch to scroll through the other ring bytes. The HSR bytes are read only; that is, the displayed data may not be changed. Toggle the SET switch after the display cursor disappears to take the station out of the High Speed Ring display mode.

2.3.5 Wattmeter Alarm Adjust Mode

Trunking stations are equipped with a wattmeter which is used to monitor the power output (Forward Power) of the station, as well as the power reflected back into the station (Reflected Power). TSTAT is deactivated when either the Forward power drops below its pre-determined trip point, or the Reflected power exceeds its pre-determined trip point setting. This indicates a station malfunction to the trunking central controller. A special front panel Status display mode is used to read and adjust the Forward and Reflected trip point settings.

To access this mode, depress and hold the Select/Set switch in the Set position (the display cursor should not be active at this time). While holding the Set switch, press and hold both the PL Dis/Xmit and ACC Dis/Reset switches in the PL Dis and Acc Dis positions until trP appears in the Status Display. Release the Set, PL Dis, and the Acc Dis switches (in that order). The Status Display should flash F and r for Forward and Reflected power.

The numbers displayed after the F and r are relative levels only. They represent a hexadecimal number, not the power level in watts. During the adjustment procedure, the output power of the station is set to the trip point values to allow the wattmeter to record them. The current output power of the station is saved as the forward trip point by pressing the set switch while F is in the display. Likewise, the current output power of the station is saved as the reflected trip point by pressing the set switch while the r is displayed. To exit this mode, toggle the SET/SELECT switch to the SELECT position.

Table 7. HSR Byte Definitions

HSR Byte	Definition	Bit Positions	HSR Byte	Definition	Bit Positions
1	RSTAT	10000000	2	*	00001111
1	RdSTAT	01000000	3	Tx Inhibit	10000000
1	TSTAT	00100000	3	TPTT	01000000
1	MRTI DVP Mode	00010000	3	Duplex Enable	00100000
1	GCC Seize	00001000	3	CCI	00010000
1	Keyword Number (0–7 hex)	00000111	3	Failsoft	00001000
2	Coded Takeover	10000000	3	WL Key Number (0–7 hex)	00000111
2	Ring PL Detect	01000000	4	WL Key Erase	10000000
2	Gen Simulcast RB	00100000	4	MUTE	01000000
2	*	00010000	4	Ext Code Detect	00100000
2	Line PTT	00000001	4	Site Failsoft	00010000
2	Local PTT	00000010	4	DVP 0 = Code 1, 1 = Code 2	00001000
2	Repeater PTT	00000011	4	*	00000100
2	*	00000100	4	*	00000010
2	ID PTT	00000101	4	*	00000001
2	Rx Coded PTT	00000110	5	EOM Audio Mute	10000000
2	Tx Coded PTT	00000111	5	*	01000000
2	Data PTT	00001000	5	*	00100000
2	Alarm PTT	00001001	5	Rx EOM Detect	00010000
2	Xmit PTT	00001010	5	Int TX CD DT	00001000
2	MRTI PTT	00001011	5	Int RX CD DT	00000100
2	Clr_RPT_DOD	00001100	5	Int ACC DIS	00000010
2	Coded_RPT_DOD	00001101	5	*	00000001
2	*	00001110			

* = currently unassigned

2.4 STATION DIAGNOSTICS

The following sections detail the extensive diagnostic capabilities of the *MSF 5000* Stations. These diagnostics fall into two basic categories: Power-up/Reset Diagnostics and Continuous Diagnostics. Both are described in the following sections.

2.4.1 POWER-UP / RESET DIAGNOSTICS DESCRIPTION

Upon station power-up or reset, a variety of diagnostic tests are performed to verify both that the hardware is functional and that the firmware and code plug devices are correctly programmed. The hardware diagnostic tests encompass both digital and audio tests, and are designed to 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 SSCB and the FAIL LEDs on the TTRC and Secure Module.

2.4.1.1 POWER-UP / RESET DIAGNOSTIC ERROR DISPLAYS

Three forms of power-up / reset diagnostic failure indications are possible:

1. Flashing SSCB Status Display. The entire Status Display may flash 8.8.8. two or four times in a sequence to indicate a specific error (see Table 8 for further definition). This method of failure indication is only used when it is determined that the Status Display may not be capable of displaying normal error codes.

2. Flashing TTRC or Secure FAIL LEDs. These LEDs may flash two, four, or six times in a sequence to indicate a specific error (see the List of Error Codes for further definition). This type of failure display indicates that the TTRC or Secure module 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 that SSCB can display the appropriate error codes on the Status Display.

3. Displaying the Error Code on the SSCB Status Display. A detected failure is indicated by displaying y.x.x. on the Status Display. y defines the error code class (i.e. 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.), while xx defines the specific error code within the error code class. The error code is displayed in hexadecimal format, permitting up to 256 error codes per class. All non-fatal error codes are displayed for two seconds. All fatal error codes are displayed for five seconds. If the error code is greater than or equal to hexadecimal $80, then the error is fatal and the station will reset after the error code is displayed. When the station resets, the Status Display will momentarily show 8.8.8.. This single flash should not be confused with flashing Status Display error code indication. In such a case, the Status Display will blink 2 or 4 times, then once, then 2 or 4 times again, etc. Non-fatal errors will allow the station to continue with diagnostics and eventually operate normally after all of the error codes and software version numbers have been displayed.

NOTE

Error Codes are differentiated from other potential display modes because all three Status Display decimal points are lit while error codes are being displayed.

2.4.1.2 POWER-UP / RESET SEQUENCE

The following list describes the sequence of events upon a station power-up / reset. See the Service Manual for specific information.

1. The SSCB activates the Expansion Reset while SSCB self-tests are being performed. While Expansion Reset is active, TTRC, Secure, and any Expansion tray modules are held in reset.

2. Test SSCB Status display-driving circuitry, by turning on all of the digits (8.8.8.) as a lamp test to determine if error codes can be displayed. If this test fails, the entire Status display flashes 2 times.

3. Test SSCB external and internal RAM. The display completely blanks for about 1.5 seconds while digital and software diagnostic tests are performed. If this test fails, the entire Status display flashes 4 times.

4. Test SSCB firmware checksum, test SSCB Standard Mode and I/O Mode ASICs. This includes output latch and input buffer loopback, MUXbus circuitry, and HSR circuitry. Test SSCB code plug for proper module ID, version number, and checksum. Test SSCB IPCB ports. If any of these tests fail, the corresponding error code is displayed on the Status display.

5. Perform audio diagnostics. As SSCB audio tests are invoked, --- is displayed as an indication of Test in Progress. See the next sub-section for more details on the Audio Diagnostics. If any of these tests fail, the corresponding error code is displayed on the Status display.

6. Disable Expansion Reset.

7. Display the SSCB Firmware Version number.

8. Enable TTRC diagnostic routines (if TTRC module present) with an IPCB wake-up command. A --- is displayed while the TTRC performs its digital and audio diagnostic tests. All TTRC failures are reported at this time. When the TTRC board completes its diagnostic sequences, the TTRC Software Version number is then displayed.

9. Enable Secure board diagnostic routines (if Secure module present) with an IPCB wake-up command. A --- is displayed while the Secure board performs its digital and audio diagnostic tests. All Secure failures are reported at this time. When the Secure board completes its diagnostic sequences, the Secure board Software Version number is then displayed.

10. At this time, the normal station operating mode is entered, and the display reverts to its Channel Mode Key indication. If several non-fatal errors were detected during diagnostics, they may have been queued up. If so, they will be displayed in order until the error queue is emptied.

NOTE

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

2.4.1.3 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 of potential problems BEFORE they experience them, reducing station down time and service costs.

Typically, the audio tests are performed as part of the station's 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.

All audio errors are non-fatal. A faulty audio circuit will 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 front-panel Status Display in the format of A.x.x. , where xx is a hexadecimal error code. The A in the first digit of the Status Display indicates that the error is an Audio-class error code.

To further aid the diagnosis and analysis of an audio error, the serviceman may freeze the audio tests in the current configuration if an audio error is detected. This configuration maintains the source signal generation, proper audio gating and EEPOT level adjustments used during the failed test. While the failed test is frozen, the serviceman can probe the circuits with an oscilloscope to further define the faulty component or circuit. Freezing the audio diagnostic routine after an error is necessary in order to set up the proper gating required to find the problem circuit, which may be difficult to do under normal operating conditions.

Once an audio test fails, the audio error code is displayed for two seconds. While the error code is displayed, the serviceman may freeze the test configuration by activating the front panel Access Disable switch. The tests are kept frozen until two seconds after Access Disable is deactivated. While Access Disable is active, the Status Display changes from the audio error code (A.x.x.) to L.yy. This special display mode indicates the average hexadecimal analog level measured by the MC68HC11 analog-to-digital converter system. The measurement algorithm averages 1024 conversion samples over a 16.5 msec period. This displayed level can be compared to the actual signal observed at the A/D input to the MC68HC11 to aid in the debug process. The yy hexadecimal value can be converted to a mean voltage level as follows: Mean Voltage Level = Ψ * [decimal(yy)/256]. Where Ψ is V_E for the Secure Station Control Board (typically 5.1 V dc), V_B for the Secure board (typically 4.8 V dc but it should be measured at SSCB U819 pin 8), + 5V dc for the Trunked Tone Remote Control board. In all cases, the level of Ψ should be verified before proceeding with audio circuit analysis. The calculated mean voltage level can also be converted to a zero-to-peak voltage level by multiplying the mean voltage level by $\sqrt{2}$. During repeater and receiver squelch tests, the A/D is not utilized, so the average value is not displayed.

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), then the EEPOTs will not be returned to their true original positions, and station realignment may be necessary.

2.4.1.4 STATUS DISPLAY ERROR CODE DEFINITIONS

The following list provides a brief description of the Digital *MSF 5000* error codes that may be encountered when the station is performing self diagnostics. See the Service Manual for a more detailed description of the error codes and the necessary corrective action.

Table 8. Flashing Error Indications

Front Panel LED Indication	Description
Entire Status Display Flashes Twice	Faulty SSCB Display Driver or No IRQ Interrupt
Entire Status Display Flashes Four Times	Faulty SSCB External RAM
TTRC FAIL LED Flashes Two Times	No IRQ interrupt to the TTRC microprocessor (322 uS pulses)
TTRC FAIL LED Flashes Four Times	Faulty TTRC External RAM
TTRC FAIL LED Flashes Six Times	Faulty IPCB operation on the TTRC module
Secure FAIL LED Flashes Two Times	No RX_IRQ or TX_IRQ signal (667 uS pulses)
Secure FAIL LED Flashes Four Times	Faulty Secure Module External RAM
Secure FAIL LED Flashes Six Times	Faulty IPCB operation on the Secure module

Table 9. Operational Error Codes

Error	Description	Error	Description
E10	No station band designated	E8b	Bad Command_State in IPCB handler
E20	SSCB EEPOT #0 lower limit out-of-bounds	E8C	Bad *State* in wattmeter trip-point set module
E21	SSCB EEPOT #1 lower limit out-of-bounds	E90	Invalid common timer number
E22	SSCB EEPOT #2 lower limit out-of-bounds	E91	Invalid TTRC EEPOT update requested
E23	SSCB EEPOT #3 lower limit out-of-bounds	E92	Invalid tone #, bad *case* call
E24	SSCB EEPOT #4 lower limit out-of-bounds	E93	Invalid command #, bad *case* call
E25	SSCB EEPOT #5 lower limit out-of-bounds	E94	Invalid ALC state #, bad *case* call
E26	SSCB EEPOT #6 lower limit out-of-bounds	E95	Invalid DC current number error
E28	SSCB EEPOT #0 upper limit out-of-bounds	E9b	Bad Command_State in IPCB Command_y
E29	SSCB EEPOT #1 upper limit out-of-bounds	EA0	Invalid common timer number
E2A	SSCB EEPOT #2 upper limit out-of-bounds	EA1	Bad *State* in coded takeover module
E2b	SSCB EEPOT #3 upper limit out-of-bounds	EAb	Bad Command_State in IPCB handler
E2C	SSCB EEPOT #4 upper limit out-of-bounds	Eb0	Undefined SSCB Reserved IRQ
E2d	SSCB EEPOT #5 upper limit out-of-bounds	Eb1	Undefined SSCB SPI IRQ
E2E	SSCB EEPOT #6 upper limit out-of-bounds	Eb2	Undefined SSCB Pulse Accumulator Edge IRQ
E30	TTRC EEPOT #0(7) lower limit out-of-bounds	Eb3	Undefined SSCB Pulse Accum Overflow IRQ
E31	TTRC EEPOT #1(8) lower limit out-of-bounds	Eb4	Undefined SSCB Timer Overflow IRQ
E32	TTRC EEPOT #2(9) lower limit out-of-bounds	Eb5	Undefined SSCB Timer Output Compare 5 IRQ
E33	TTRC EEPOT #3(A) lower limit out-of-bounds	Eb6	Undefined SSCB Timer Output Compare 3 IRQ
E34	TTRC EEPOT #4(b) lower limit out-of-bounds	Eb7	Undefined SSCB Timer Output Compare 1 IRQ
E35	TTRC EEPOT #5(C) lower limit out-of-bounds	Eb8	Undefined SSCB Timer Input Capture 3 IRQ
E36	TTRC EEPOT #6(d) lower limit out-of-bounds	Eb9	Undefined SSCB Timer Input Capture 2 IRQ
E38	TTRC EEPOT #0(7) upper limit out-of-bounds	EbC	Undefined SSCB XIRQ IRQ
E39	TTRC EEPOT #1(8) upper limit out-of-bounds	Ebd	Undefined SSCB Software Interrupt IRQ
E3A	TTRC EEPOT #2(9) upper limit out-of-bounds	EbE	Undefined SSCB Opcode Trap IRQ
E3b	TTRC EEPOT #3(A) upper limit out-of-bounds	EbF	Undefined SSCB Clock Monitor Failure IRQ
E3C	TTRC EEPOT #4(b) upper limit out-of-bounds	EC0	Undefined TTRC Reserved IRQ
E3d	TTRC EEPOT #5(C) upper limit out-of-bounds	EC1	Undefined TTRC SPI IRQ
E3E	TTRC EEPOT #6(d) upper limit out-of-bounds	EC2	Undefined TTRC Pulse Accumulator Edge IRQ
E40	Rx_Loop_Ctrl line not changing states	EC3	Undefined TTRC Pulse Accum Overflow IRQ
E41	Tx_Loop_Ctrl line not changing states	EC4	Undefined TTRC Timer Overflow IRQ
E42	MCS Update Time in CP < 1 hour	EC5	Undefined TTRC Timer Output Compare 4 IRQ
E43	Error while copying user table to MCS bd	EC6	Undefined TTRC Timer Output Compare 1 IRQ
E44	Error in update_MCS while converting ascii to hex	EC7	Undefined TTRC Timer Input Capture 3 IRQ
E45	Cannot adjust receiver to saved level	EC8	Undefined TTRC Real-Time Interrupt IRQ
E46	Tx synthesizer failed to unlock after "Change_Freq" pulse	EC9	Undefined TTRC XIRQ IRQ
E47	Tx synthesizer failed to lock after three program attempts	ECA	Undefined TTRC Software Interrupt IRQ
E48	Rx synthesizer failed to unlock after "Change_Freq" pulse	ECb	Undefined TTRC Opcode Trap IRQ
E49	Rx synthesizer failed to lock after three program attempts	ECC	Undefined TTRC Clock Monitor Failure IRQ
E4a	Rx2 syn. failed to unlock after "Change_Freq" pulse	ECd	Undefined TTRC COP Watchdog Failure IRQ
E4b	Rx2 syn. failed to lock after three program attempts	Ed0	Undefined Secure Reserved IRQ
E50	ALC Xmit EEPOT code plug value invalid	Ed1	Undefined Secure Serial Comm Intfc IRQ
E51	Un-ALC Xmit EEPOT code plug value invalid	Ed2	Undefined Secure SPI IRQ
E52	HSR addr specified in Ext_PTT_Ctrl_Tbl invalid	Ed3	Undefined Secure Pulse Accumulator Edge IRQ

E53	HSR bit specified in Ext_PTT_Ctrl_Tbl invalid	Ed4	Undefined Secure Pulse Accum Overflow IRQ
E54	Encode_echo request already active	Ed5	Undefined Secure Timer Overflow IRQ
E55	TRC_Encode request active too long	Ed6	Undefined Secure Timer Output Compare 5 IRQ
E56	Bad echo non_fatal_error_code	Ed7	Undefined Secure Timer Output Compare 4 IRQ
E57	Invalid DC current present	Ed8	Undefined Secure Timer Output Compare 3 IRQ
E80	Invalid common timer number	Ed9	Undefined Secure Timer Output Compare 2 IRQ
E81	Invalid SSCB EEPOT update requested	EdA	Undefined Secure Timer Output Compare 1 IRQ
E82	Current PTT_Type is undefined	Edb	Undefined Secure Timer Input Capture 3 IRQ
E83	Arbitrate PTTs, bad *State*	EdC	Undefined Secure Real-Time Interrupt IRQ
E84	Bad *State* in transmitter manager	Edd	Undefined Secure IRQ IRQ
E85	MCS board not present when required	EdE	Undefined Secure XIRQ IRQ
E86	Bad *State* in EEPOT adjustment module	EdF	Undefined Secure Software Interrupt IRQ
E87	Bad *State* in ring display module	EE0	Undefined Secure Opcode Trap IRQ
E88	PTT_Priority_List pointer is null	EE1	Undefined Secure Clock Monitor Failure IRQ
E89	Too many channels and modes defined	EFF	COP failure
E8A	Bad *State* in SSCB I/O service module		

Table 10. Audio Error Codes

Error	Description	Error	Description
A00	PL Encoder failure	A26	TRC Encoder to Line 4 path failure
A01	Alert Tone Encoder failure	A27	Bad Line 4 gate (no mute)
A02	PL Encdr-to-TP4 path failure	A28	STAC Encoder failure or STAC EEpot failure
A03	Alrt Tone Encdr-thru-Splatter Filter	A29	STAC Encoder to Line 2 path failure
A04	Alrt Tone Encdr-to-Rx1 Audio or	A2A	ALC Audio circuitry failure
A05	Alrt Tone Encdr-to-Rx1 Squelch Det. failure	A2b	Function Tone Decode circuitry failure
A06	Alrt Tone Encdr-to-Rptr Squelch Det. failure	A2C	Guard Tone Decode circuitry failure
A07	Alrt Tone Encdr-to-TP1 failure	A2d	Wireline Activity circuitry failure
A08	Alrt Tone Encdr-to-Line Audio failure	A2E	ALC audio to Tx audio 4 path failure
A09	Rx Audio Gate-thru-Rpt Audio Gate	A2F	ALC audio to Tx audio 2 path failure
A0A	MC68HC11 A-to-D Converter failure on SSCB	A30	Un-ALC audio to Tx audio path failure
A0b	Bad Alert Tone Tx Gate (no mute)	A31	Failsoft codeword Trunking Mod Audio path failure
A0C	Rx1 Audio Gate failure	A32	Failsoft tone Trunking Mod Audio path failure
A0d	Faulty PL Filter/Limiter Circuitry	A33	Bad Data/Failsoft gate
A20	MC68HC11 A-to-D Converter failure on TTRC	A40	MC68HC11 A-to-D Converter failure on Secure Bd
A21	TRC Encoder failure	A41	Secure Alert Tone Encoder/Filter error
A22	TRC Encoder to Line 2 path failure	A42	Coded Mod Splatter Filter error
A23	TRC Encoder to Line 4 path failure	A43	Coded Mod Gate failure
A24	TRC Encoder to Line 2 path failure	A44	Coded Rx Audio Line Filter error
A25	Bad Line 2 gate (no mute)	A45	Rx Coded Gate failure

Table 11. Digital Error Codes

Error	Description	Error	Description
d01	Primary User Area has bad check byte	dA9	TTRC board Station Type does not match SSCBs
d02	Secondary User Area has bad check byte	dAA	TTRC board System Ver # is incompatible with SSCBs
d03	PTT priority table is programmed incorrectly	dAb	EEPOTs failed to synchronize on TTRC
d10	TTRC did not receive wakeup command	dAC	EEPROM failed to program on TTRC
d11	Primary User Area has bad check byte	db0	TTRC HC11 Internal RAM faulty
d12	Secondary User Area has bad check byte	db1	TTRC Muxbus DS bad (internal loopback)
d13	Invalid Guard Tone frequency code plug value	db2	TTRC Muxbus DS bad (normal operating mode)
d14	Incompatible DC threshold table & analog bd version	db3	TTRC Muxbus bad (internal loopback)
d15	Invalid DC threshold table	db4	TTRC Muxbus bad (normal operating mode)
d20	Secure did not receive wakeup command	db5	TTRC Std Mode ASIC latch/buffer bad (loopback)
d21	Primary User Area has bad check byte	db6	TTRC I/O Mode ASIC latch/buffer bad (loopback)
d22	Secondary User Area has bad check byte	db7	TTRC HSR Clk/Sync bad (internal loopback)
d80	Non-zero User-Area Check byte of SSCB	db8	TTRC HSR Clk/Sync bad (normal operating mode)
d81	Non-zero EEPROM_Check byte of SSCB	db9	TTRC HSR Data In/Out bad (internal loopback)
d82	Serial EEPROM has not responded on SSCB	dbA	TTRC HSR Data In/Out bad (normal operating mode)
d83	Code plug on SSCB not SSCB type.	dC0	Non-zero User-Area Check byte of Secure Board
d84	Bad code plug version number on SSCB	dC1	Non-zero EEPROM_Check byte of Secure Board
d85	Bad code plug checksum on SSCB	dC3	Code plug on Secure Bd not *Secure* type.
d86	Incorrect firmware checksum on SSCB	dC4	Bad code plug version number on Secure Board
d87	EEPOTs failed to synchronize on SSCB	dC5	Bad code plug checksum on Secure Board
d88	EEPROM failed to program on SSCB	dC6	Incorrect firmware checksum on Secure Board
d90	SSCB HC11 Internal RAM faulty	dC7	Secure bd not responding to power-up enable
d91	SSCB Muxbus DS bad (internal loopback)	dC8	Secure bd enabled but did not return version #
d92	SSCB Muxbus DS bad (normal operating mode)	dC9	Secure bd Station_Type bytes do not match SSCBs
d93	SSCB Muxbus bad (internal loopback)	dCA	Secure bd System Ver # is incompatible with SSCBs
d94	SSCB Muxbus bad (normal operating mode)	dCb	EEPROM failed to program in expected time period
d95	SSCB Std Mode ASIC latch/buffer bad (loopback)	dd0	Secure HC11 Internal RAM faulty
d96	SSCB I/O Mode ASIC latch/buffer bad (loopback)	dd1	Secure Muxbus DS bad (internal loopback)
d97	SSCB HSR Clk/Sync bad (internal loopback)	dd2	Secure Muxbus DS bad (normal operating mode)
d98	SSCB HSR Clk/Sync bad (normal operating mode)	dd3	Secure Muxbus bad (internal loopback)
d99	SSCB HSR Data In/Out bad (internal loopback)	dd4	Secure Muxbus bad (normal operating mode)
d9A	SSCB HSR Data In/Out bad (normal operating mode)	dd5	Secure Std Mode ASIC latch/buffer bad (loopback)
d9b	SSCB IPCB faulty	dd7	Secure HSR Clk/Sync bad (internal loopback)
d9E	SSCB Config register reprogrammed	dd8	Secure HSR Clk/Sync bad (normal operating mode)
d9F	SSCB Config register & CP erased & re-programmed	dd9	Secure HSR Data In/Out bad (internal loopback)
dA0	Non-zero User-Area Check byte of TTRC	ddA	Secure HSR Data In/Out bad (normal operating mode)
dA1	Non-zero EEPROM_Check byte of TTRC	ddb	Bad Tx Phase Lock Detector in Secure ASIC
dA2	Serial EEPROM has not responded on TTRC	ddC	Bad Rx Phase Lock Detector in Secure ASIC
dA3	Code plug on TTRC not TTRC type.	ddE	Bad Tx P-S or S-P Converter in Secure ASIC
dA4	Bad code plug version number on TTRC	ddF	Bad Rx P-S or S-P Converter in Secure ASIC
dA5	Bad code plug checksum on TTRC	de7	RAC board not responding to power-up 'enable' com
dA6	Incorrect firmware checksum on TTRC	de8	RAC board 'enabled' but did not return version #
dA7	TTRC board not responding to power-up enable	de9	RAC board Station Type doesn't match SSCBs
dA8	TTRC board enabled but did not return version #	dea	RAC board System Version # is incompatible with SSCB

Table 12. Special Test Mode Error Codes			
Error	Description	Error	Description
o80	Undefined SSCB Reserved1–Reserved11 IRQ	oAE	Undefined TTRC XIRQ IRQ
o81	Undefined SSCB SPI IRQ	oAF	Undefined TTRC Software Interrupt IRQ
o82	Undefined SSCB Pulse Accumulator Edge IRQ	ob0	Undefined TTRC Opcode Trap IRQ
o83	Undefined SSCB Pulse Accumulator Overflow IRQ	ob1	Undefined TTRC Clock Monitor Failure IRQ
o84	Undefined SSCB Timer Overflow IRQ	ob2	Undefined TTRC COP Watchdog Failure IRQ
o85	Undefined SSCB Timer Output Compare 5 IRQ	obE	TTRC Config register reprogrammed
o86	Undefined SSCB Timer Output Compare 3 IRQ	obF	TTRC Config register & CP erased & re-programmed
o87	Undefined SSCB Timer Output Compare 1 IRQ	oC0	Undefined Secure Reserved1–Reserved11 IRQ
o88	Undefined SSCB Timer Input Capture 3 IRQ	oC1	Undefined Secure Serial Comm Intfc IRQ
o89	Undefined SSCB Timer Input Capture 2 IRQ	oC2	Undefined Secure SPI IRQ
o8C	Undefined SSCB XIRQ IRQ	oC3	Undefined Secure Pulse Accumulator Edge IRQ
o8d	Undefined SSCB Software Interrupt IRQ	oC4	Undefined Secure Pulse Accumulator Overflow IRQ
o8E	Undefined SSCB Opcode Trap IRQ	oC5	Undefined Secure Timer Overflow IRQ
o8F	Undefined SSCB Clock Monitor Failure IRQ	oC6	Undefined Secure Timer Output Compare 5 IRQ
oA0	Undefined TTRC Reserved1–Reserved11 IRQ	oC7	Undefined Secure Timer Output Compare 4 IRQ
oA1	Undefined TTRC SPI IRQ	oC8	Undefined Secure Timer Output Compare 3 IRQ
oA2	Undefined TTRC Pulse Accumulator Edge IRQ	oC9	Undefined Secure Timer Output Compare 2 IRQ
oA3	Undefined TTRC Pulse Accumulator Overflow IRQ	oCA	Undefined Secure Timer Output Compare 1 IRQ
oA4	Undefined TTRC Timer Overflow IRQ	oCb	Undefined Secure Timer Input Capture 3 IRQ
oA5	Undefined TTRC Timer Output Compare 5 IRQ	oCC	Undefined Secure Real-Time Interrupt IRQ
oA6	Undefined TTRC Timer Output Compare 4 IRQ	oCd	Undefined Secure IRQ IRQ
oA7	Undefined TTRC Timer Output Compare 3 IRQ	oCE	Undefined Secure XIRQ IRQ
oA8	Undefined TTRC Timer Output Compare 2 IRQ	oCF	Undefined Secure Software Interrupt IRQ
oA9	Undefined TTRC Timer Output Compare 1 IRQ	od0	Undefined Secure Opcode Trap IRQ
oAA	Undefined TTRC Timer Input Capture 3 IRQ	od1	Undefined Secure Clock Monitor Failure IRQ
oAb	Undefined TTRC Timer Input Capture 2 IRQ	odE	Config register reprogrammed on Secure Board
oAC	Undefined TTRC Timer Input Capture 1 IRQ	odF	Config register & CP erased & re-programmed
oAd	Undefined TTRC Real-Time Interrupt IRQ		

2.4.2 CONTINUOUS STATION DIAGNOSTICS

In contrast to the Powerup / Reset Diagnostics, which run only immediately after a station reset, the Continuous class of diagnostics is always monitoring 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 displayed in the Secure Station Control Board status display. These error codes are listed in Table 9, "Operational Error Codes".

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 & 13. If any of these bits are active, a corresponding number of alarm tones is generated. 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 are generated 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 four pre-defined alarms that are provided as standard in the station. These alarms are defined below. In addition, the user may add up to four more custom alarms in the RW5 - RW8 positions with a wildcard option. See paragraph 2.5 for more detailed information on the MUXbus.

- RW1 - One Beep — *Battery Revert Alarm*
  Indicates the station has lost ac line power and reverted to battery backup (if so 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 PA ON or PA FULL lines are inactive for 30–45 msec during a key-up. The alarm is cleared only by a successful key-up of the station. It will not be reset during the same key-up in which the alarm was set.

- RW3 - Three Beeps — *Synthesizer Alarm*
  Indicates that either the Tx or Rx synthesizer is out of lock. The alarm is cleared as soon as both lock lines are active.

- RW4 - Four Beeps — *Overvoltage Alarm*
  Indicates that the battery charging voltage (on stations so equipped) is too high. The alarm is cleared when the voltage assumes a normal level.

2.5 MUXBUS DESCRIPTION

This section provides definitions for each of the 64 MUXbus data bits. This data is normally displayed to the user by the Diagnostic Meter Panel (DMP), in the format shown in Table 13. The DMP is an optional piece of hardware (C669) that contains a speaker, analog meter, and the MUXbus display. In addition, the DMP has the capability to modify the MUXbus data, as well as read it. The DMP is connected to the station via the expansion connector on the SSCB (J800). It is not recommended that the DMP be left connected to the station during normal, unattended station operation.

Table 13. 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	RW 6	RW 5
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 of which contains 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 paragraphs give definitions for each of the 64 MUXbus bits. These definitions include the mnemonic (abbreviation) as shown on the DMP front panel and in Table 13, a description of the bit's function, and its row-column address on the MUXbus.

2.5.1 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.

2.5.2 SCAN (SCAN ENABLE) A0, D2

The scanning receiver option is not yet supported. Therefore, this bit has no effect when active.

2.5.3 T ALM DS (TOTAL ALARM DISABLE) A0, D1

Unconditionally mutes all alarm tones generated in response to active reverse wildcards bits on addresses 12 & 13. See also S ALM DS.

2.5.4 S ALM DS (SELECTIVE ALARM DISABLE) A0, D0

Mutes repetitive alarm tones generated in response to active reverse wildcard bits on addresses 12 & 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 this MUXbus bit for at least 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.

2.5.5 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 dekey. 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.

2.5.6 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.

2.5.7 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.

2.5.8 INTCOM (INTERCOM) A1, D0

Allows LOC PTT without keying the station, which enables a serviceman 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.

2.5.9 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 station control module.

2.5.10 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.

2.5.11 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.

2.5.12 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.

2.5.13 RX PL DS (RECEIVER PL/DPL DISABLE) A3, D3

Indicates that the station has reverted to carrier squelch only receiver operation for purposes of determining the status of RX1 ACT and RX2 ACT. The Monitor and Receiver Squelch On/Off wireline functions utilize RX PL DS. Also, the station control module front panel PL Disable switch activates RX PL DS.

2.5.14 R1 PL DT (RECEIVER 1 PL/DPL DETECT) A3, D2

Active when PL, DPL, or CT coded squelch is being detected on Receiver 1.

2.5.15 RX CD DT (RECEIVER 1 CODE DETECT) A3, D1

Indicates a Receiver Code Detect due to receipt of Secure (12 Kbit) data on Receiver 1.

2.5.16 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).

2.5.17 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.

2.5.18 R2 PL DT (RECEIVER 2 PL/DPL DETECT) A4, D2

Active when PL, DPL, or CT coded squelch is being detected on Receiver 2.

2.5.19 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.

2.5.20 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).

2.5.21 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.

2.5.22 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.

2.5.23 RPT KD (REPEATER KNOCK-DOWN) A5, D1

Disallows a repeater PTT when active.

2.5.24 RPT USQ (REPEATER UNSQUELCH) A5, D0

Indicates when the Receiver 1 repeater carrier squelch circuit, located on the SSCB, detects activity. Used as a prerequisite to keying the repeater and to gating repeater audio to the transmitter.

2.5.25 ACC DIS (ACCESS DISABLE) A6, D3

Indicates that the station is in the Access Disable mode. See section 2.1.2 for a description of the ACC DIS function.

2.5.26 EX DA DT (EXTERNAL DATA DETECT) A6, D2

When active, the SSCB mutes Tx, Local, RX1 (Repeater), and MRTI audio from the transmitter unless specifically enabled for the current mode. These audio paths may be enabled or disabled via the Field Programmer or with option C678. The Tx Data Audio path is always routed to the transmitter, even when this bit is active.

2.5.27 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 wireline.

2.5.28 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 decryption function is not affected by this bit (it is always active).

2.5.29 SP3, SP2, SP1 (SPECIAL PURPOSE 3 - 1) A7, D3 THRU A7, D1

These bits are reserved for future applications, or special customer needs.

2.5.30 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.

2.5.31 TX RX C8, TX RX C4, TX RX C2, & 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 theses 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 changes to channel number 1.

2.5.32 AUX C8, AUX C4, AUX C2, & 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.

2.5.33 RX2 C8, RX2 C4, RX2 C2, & 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 theses 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.

2.5.34 TX INHB (TRANSMIT INHIBIT) A11, D3

Indicates that the transmitter is inhibited. When active, no station transmitter activity is allowed.

2.5.35 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.

2.5.36 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.

2.5.37 DOS (DATA OPERATED SQUELCH) A11, D0

The Repeater Access Controller option is not yet supported, so this bit has no effect when active. In MCS stations, this bit is used to indicate the second most significant bit of the active MCS user number.

2.5.38 RW4 OVG (REVERSE WILD CARD 4 – BATTERY OVERVOLTAGE) A12, D3

Indicates that the battery overvoltage internal station alarm is active. When active, the SSCB generates 4 alarm tones, which are routed to the local speaker, the wireline, and over the air.

2.5.39 RW3 SYN (REVERSE WILD CARD 3 – SYNTHESIZER UNLOCK) A12, D2

Indicates that the transmit or receiver synthesizer is out of lock. When active, the SSCB generates 3 alarm tones, which are routed to the local speaker, the wireline, and over the air.

2.5.40 RW2 PA (REVERSE WILD CARD 2 – PA FAIL) A12, D1

This bit is the rf power amplifier fail internal station 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.

2.5.41 RW1 BAT (REVERSE WILD CARD 1 – BATTERY REVERT) A12, D0

Indicates that the AC main to the station has been lost and that the station is operating on battery power. When active, the SSCB generates 1 alarm tone, which is routed to the local speaker, the wireline, and over the air.

2.5.42 RW8 (REVERSE WILDCARD 8 – MAIN STANDBY) A13, D3

Indicates that the a problem exists with the main / standby system. When active, the SSCB generates 8 alarm tones, which are routed to the local speaker, the wireline, and over the air.

2.5.43 RW 7, RW 6, & RW 5 (REVERSE WILDCARD 5 THRU 7) A13, D3 THRU A13, D0

Indicates that a reverse wildcard is active. These bits are normally driven by a wildcard module in the expansion tray. When active, the SSCB generates 7, 6, and/or 5 alarm tones, which are routed to the local speaker, the wireline, and over the air.

2.5.44 FW 4, FW 3, FW 2, & FW 1 (FORWARD WILD CARD 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.

2.5.45 MODE 8, MODE 4, MODE 2, & 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 Channel 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 panel Status display. A discrepancy may arise between the two indicators if an undefined mode is requested; in this case, the SSCB changes to mode number 1.

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LIGHTNING PROTECTION RECOMMENDATIONS

1. GENERAL

The conditions that make a site desirable for two-way radio are the same as those that make a site an excellent target for lightning. Proper lightning protection can completely prevent equipment damage in all but the most severe strikes, and even then, can keep the equipment damage to a minimum. Lightning protection consists basically of preventing the strike from entering the equipment room, and then preventing damage to the equipment from induced voltages and currents on power and control lines to the equipment. The following suggestions will help protect valuable radio facilities. Some products already incorporate certain suppressors as standard equipment. In these cases, additional protection is not normally required, unless dictated by unusual site considerations. When such unique situations occur, consult the appropriate area office for further information.

1.1 RECOMMENDATIONS

- Keep the tower grounding resistance as low as possible. The lightning stroke current belongs in the tower structure and grounding system; not on the transmission line.
- Use copper clad grounding rods at least eight feet long. Multiple grounding rods are better than one, especially in areas with dry climate and/or soil that is sandy, rocky, or both.
- Bring the transmission line off the tower with the sharpest bend permitted by the manufacturer's specifications, and make a solid bond between the tower and the transmission line sheath just prior to the bend. The sharp bend acts as a high impedance to the extremely high strike current. This shunts more of the strike current into the tower ground, rather than into the equipment. Use no more and no less than the minimum bending radius wherever the transmission line changes direction, and introduce a change of direction at every reasonable opportunity; grounding the transmission line sheath solidly at the antenna side of each bend in the transmission line.

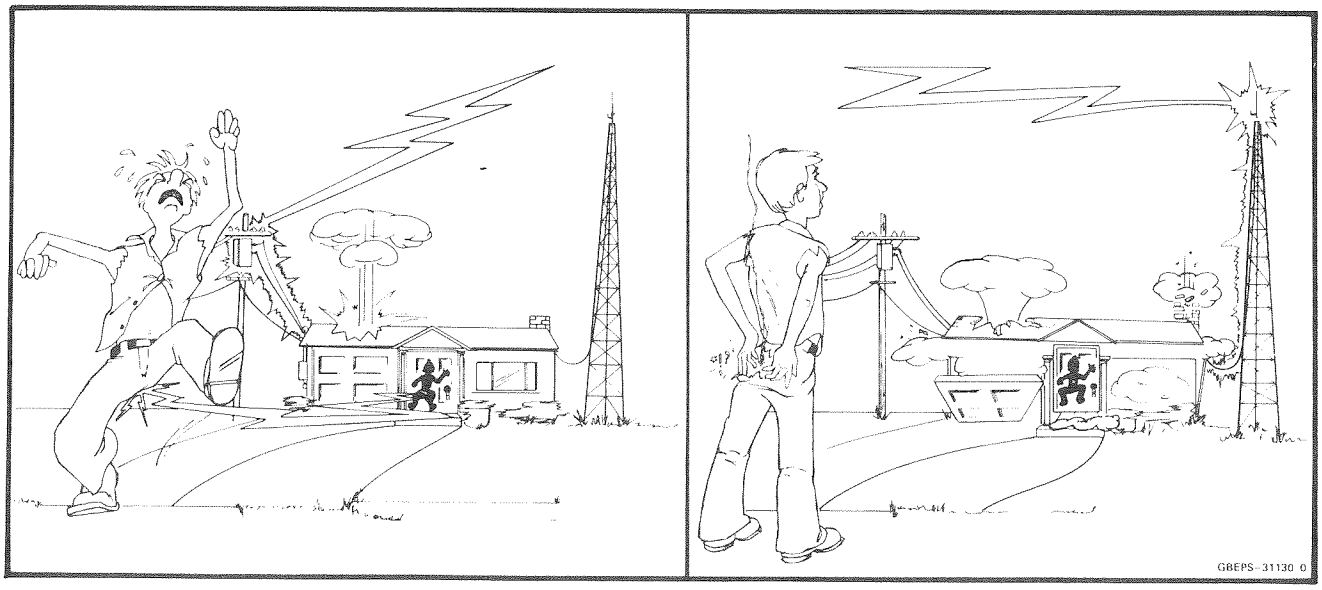

Figure 1. Unprotected power/control lines and antenna installations can be hazardous to equipment and personnel.

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- Provide additional grounding to the transmission line sheath wherever possible. Make it a point to ground the transmission line where it is supported on poles and where it enters a building.
- It is wise to take at least part of the transmission line through a length of grounded conduit.
- *Bond all equipment cabinets together at a single point.* Then ground that point to a grounding rod network, using as short, straight, and heavy a ground wire as possible. If bends in the ground wire are necessary, give them as large a radius as practical.
- Transmission lines should be brought into the equipment cabinets adjacent to the single point ground connection where a good low impedance bond can be made to the transmission line sheath.
- Install a gas tube protector between the equipment cabinet ground and AC-neutral where it enters the equipment cabinet. Install gas tube protectors where the control lines enter the building and at the point of entry into the equipment cabinet. Also install gas tube protectors wherever control lines enter a building, and install additional protectors as close as possible to the remote control console.
- Keep ground wires from gas tube protectors to ground rods or perimeter grounds as short and straight as possible. Avoid sharp bends in ground wires.
- Never bundle a ground wire with any other cabling or wiring. Also, never run as ground wire along any metal wall, along any electrical conduit, or inside a conduit.

Remember that the greatest possible protection is afforded to the equipment by making the impedance of the grounding system as low as possible in relation top the impedance of the equipment. Protection is provided by keeping the lightning strike current in the grounding network; rather then letting it find its own way to ground through the equipment.

2. RECOMMENDED PROTECTORS

The devices listed below are available from your local Motorola Parts Center. Other devices are available from different manufacturers for special applications, and may be used in place of those listed here. Installation instructions are generally included with each device. The following listing includes phone line suppressors, ac line surge protectors, coaxial cable in-line lightning arrestors, and coaxial cable ground clamp kits. Refer to the Motorola Buyer's Guide for additional information.

2.1 PHONE LINE SUPPRESSORS

- **TRN8187A** Single Line Suppressor, 3-electrode gas tube protector
- **TRN4589A** Dual Line Suppressor, 3-electrode gas tube protector
- **RRX4021B** Single Line Suppressor, 3-electrode gas tube protector

2.2 AC LINE SURGE PROTECTORS

- **TLN4399A** AC Line Surge Protector, 117 V ac line, 7/8" x 14 conduit hole mounting
- **TLN5920A** AC Line Surge Protector, 240 V ac line, 7/8" x 14 conduit hole mounting

2.3 COAXIAL CABLE IN-LINE LIGHTNING ARRESTORS

- **RRX4024** UHF type connector
- **RRX4025** N type connector
- **RRX4032** Tower Mount Kit

2.4 COAXIAL CABLE GROUND CLAMP KITS

- **ST-788** For 1/2" jacketed heliax and pipe or grounding rod
- **ST-853** For 7/8" jacketed heliax and pipe or grounding rod
- **ST-789** For 1/2" unjacketed heliax, includes bushings for better contact without collapsing line
- **ST-789** For 7/8" unjacketed heliax, includes bushings for better contact without collapsing line

INSTALLATION

1. FCC REQUIREMENTS

IMPORTANT

FCC regulations state that:

1. The Grantee of a license has the responsibility of assuring that all equipment operated under that license conforms to the specifications of the license.

2. The rf power output of a radio transmitter shall be no more than that required for satisfactory technical operation considering the area to be covered and local conditions.

3. The frequency, deviation, and power of a radio transmitter must be maintained within specified limits. It is recommended, therefore, that these three parameters be checked before the station is placed in service.

REMEMBER

The efficiency of the equipment depends upon a good installation. Motorola recommends that adjustments to this equipment be made ONLY by a certified technician.

2. INSPECTION

CAUTION

Station contains CMOS devices. Good troubleshooting and installation techniques require proper grounding of personnel prior to handling equipment. Refer to the *Safe Handling of CMOS Integrated Circuits* instruction section of this manual.

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

3. PLANNING THE INSTALLATION

Since a good installation is important to obtain the best possible performance of the communications system, carefully plan the installation before actual work is started. Location of the station in relation to power, control lines, the antenna, and convenience and access for servicing should be considered. The cabinet dimensional detail diagrams show the size of the various cabinets for planning the space requirements. Read the entire procedure and the many suggestions offered to help you plan your installation. Make sure all tools, equipment, and facilities are available when the installation is begun.

WARNING

The tip feet are provided for your protection. Any unauthorized modification or removal will result in the possibility of the station tipping over and perhaps causing injury.

4. VENTILATION

The radio equipment is operated with forced ventilation. The cabinets have been designed with vents that allow outside air to be drawn in through louvered openings in the door and expelled through an opening in the cabinet wrapper (sides). It is essential that the openings be kept free of obstructions so the air flow will not be restricted. Also, site installations require that adjacent cabinets be located a minimum of six inches from all vents.

NOTE

Sufficient clearance (12" minimum) must also be provided at the front of the cabinet to allow for servicing and component removal.

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5. INSTALLATION OF INDOOR CABINETS

5.1 REQUIRED TOOLS

- *TORX* Model T-45 Driver (Motorola Part No. 66-84071N02)
- Hoist (for stacked installations)
- 1/4" flat blade screwdriver.

5.2 GENERAL

The cabinet should be located on a solid, level surface convenient to the power source and the rf transmission line. The rf transmission line should be kept as short as possible to minimize line losses.

All antenna power and control lines are connected at the junction box located on the right side of the cabinet.

CAUTION

It is recommended that no additional holes be drilled into the cabinet.

The station can be either free standing or bolted to the floor. It is recommended that stations be bolted to the floor. Mounting holes are provided in the stability supports for 150-watt stations. The recommended mounting patterns are shown in Figure 1 for 46 and 51 inch stations or Figure 2 for 26 and 37 inch stations.

5.3 FLUSH WALL AND BACK-TO-BACK MOUNTING

NOTE

Refer to tip feet removal procedure in *Stacking Considerations* paragraph.

Flush wall mounting of the station requires that the tip feet at the bottom of the 41 or 51 inch station be removed and that the station be bolted to the floor. It is recommended that the TRN5757A Stacking Bracket Kit be used to secure the top of the station to the adjacent wall. In the case of back-to-back installations, it is necessary to stagger the units by 1.5 inches to allow for tip feet clearance (refer to Figure 3). If perfect back-to-back alignment is necessary, the tip feet must be removed and the station bolted to the floor as shown in Figure 2. Floor mounting hardware must be customer supplied and must have a minimum shank diameter of 5/16 inches.

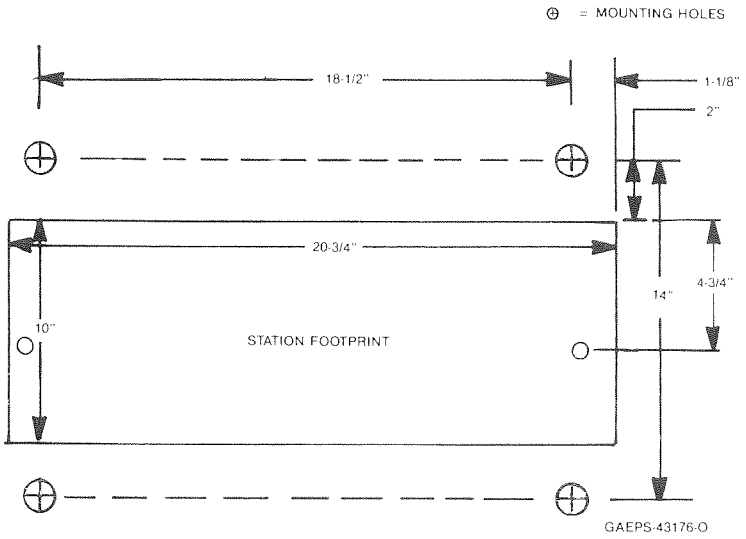
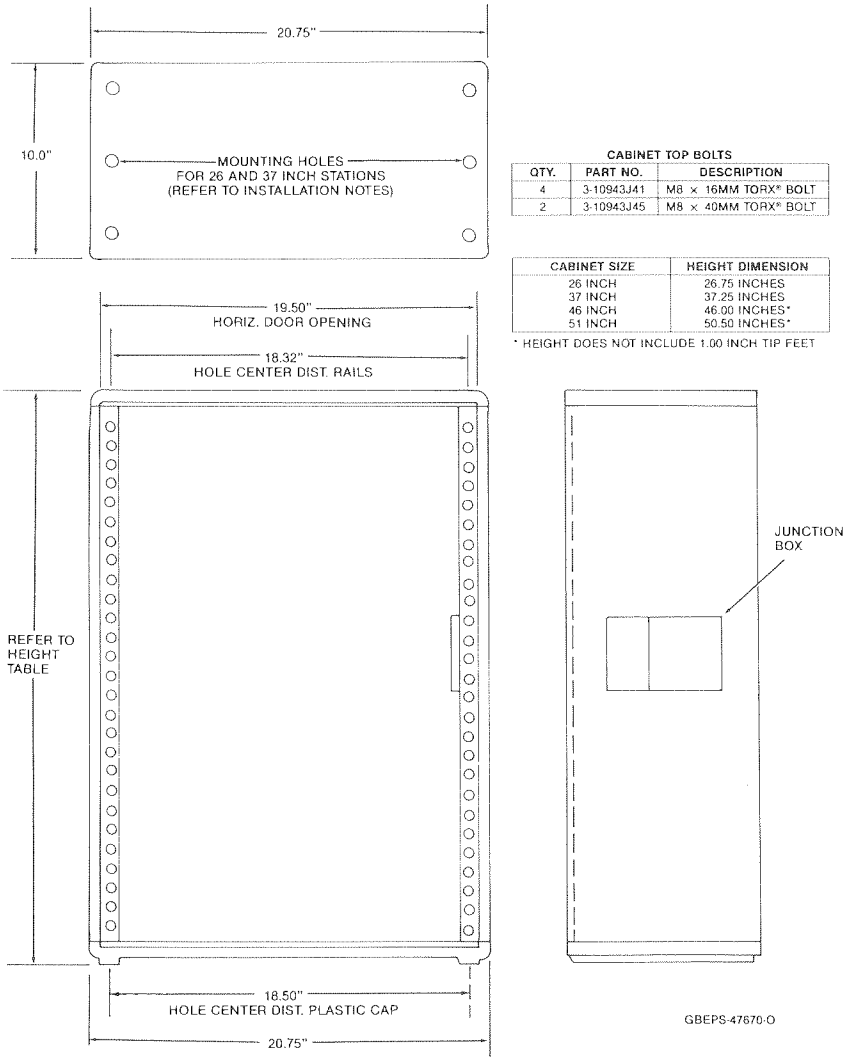


Figure 1. Recommended Mounting Pattern, 150-Watt Stations Only



CABINET TOP BOLTS

QTY.	PART NO.	DESCRIPTION
4	3-10943J41	M8 x 16MM TORX® BOLT
2	3-10943J45	M8 x 40MM TORX® BOLT

CABINET SIZE	HEIGHT DIMENSION
26 INCH	26.75 INCHES
37 INCH	37.25 INCHES
46 INCH	46.00 INCHES*
51 INCH	50.50 INCHES*

* HEIGHT DOES NOT INCLUDE 1.00 INCH TIP FEET

Figure 2. Cabinet Dimensional Details

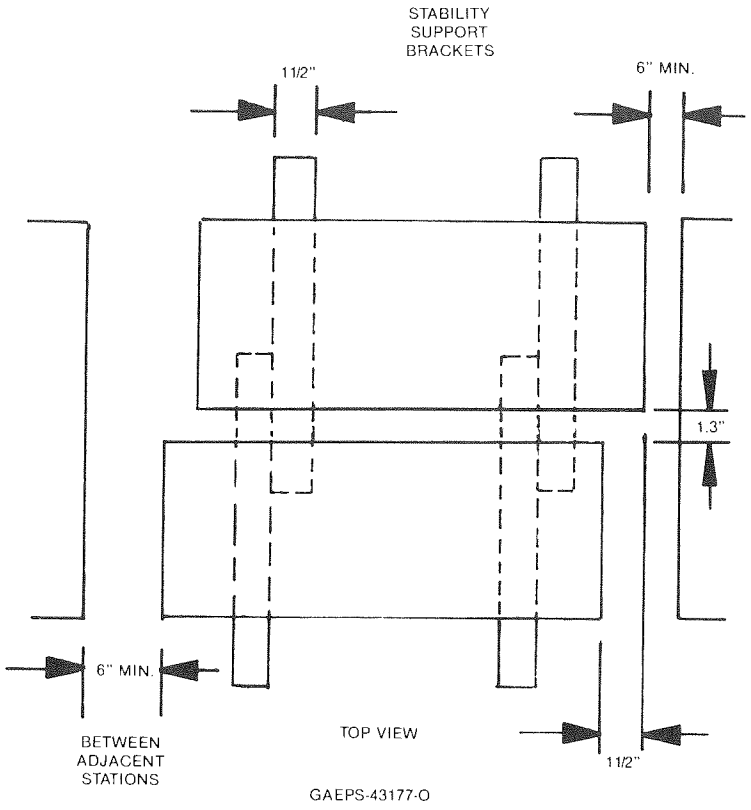


Figure 3. Staggered Back-to-Back Installation

5.4 STACKING CONSIDERATIONS

Prior to installation, all stacked stations require removal of their tip feet. This should be done by elevating the station with a hoist and placing a block under the unit. Refer to the Station Hoisting Considerations (and note 3 in the *Stacking Bracket Installation Diagram*, of section 60P81114E30) for specific warnings and hoisting details. The tip feet should be removed, one foot at a time, by removing the two outer screws from the bottom of the tip foot. The center screw should be left in to hold the cabinet bottom to the frame. After all tip feet are removed, replace the two outside mounting screws on each empty tip foot position, and then remove the center screw. The station is structurally capable of being stacked. The allowable stacking configurations are described in the *Stacking Bracket* instruction section (60P81114E30).

WARNING

Stations stacked against a wall must be secured top and bottom as shown in the *Stacking Bracket* instruction section. Stations not stacked against a wall should be stacked **only** back-to-back as shown in Figures 5 and 7 of the stacking bracket instruction section and also should be stabilized by using the brackets provided in the TRN5757A Stacking Bracket Kit.

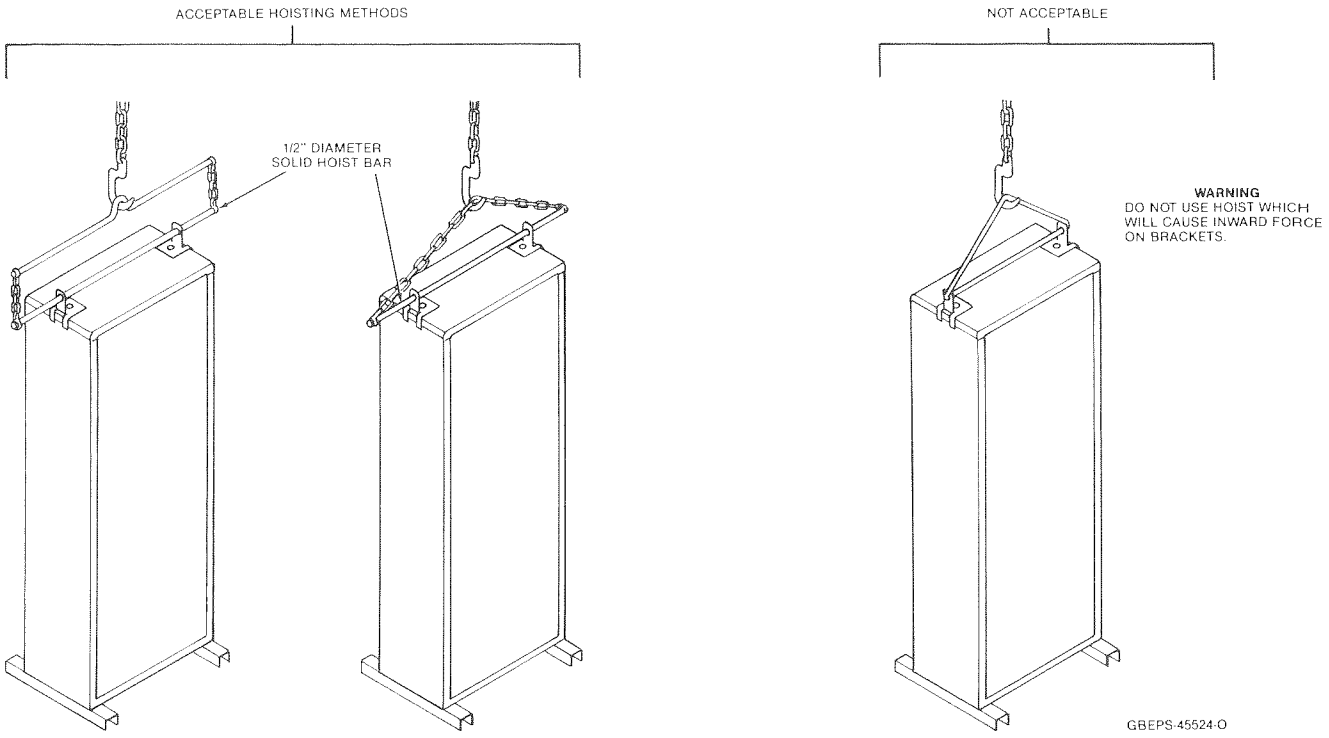


Figure 4. Recommended Hoisting Methods

5.5 STATION HOISTING CONSIDERATIONS

WARNING

Use extreme care when hoisting. The lifting brackets provided as part of the packing kit should be used with a hoist which will apply upward force **only** on the lifting brackets. The lifting brackets may bend and fail if inward force is applied. Refer to Figure 4 for recommended hoisting methods.

6. ANTENNA AND SITE FREQUENCY STANDARD CONNECTIONS

6.1 ANTENNA CONNECTIONS

The antennas and transmission lines are not part of the station. Therefore, antenna installation instructions are not included in this section. Follow the instructions shipped with the antenna for applicable information.

In its primary application, the station is used for communications with mobile units. Thus, antennas having omnidirectional characteristics are desirable. However, if the station is located at the outer perimeter of a communications area, or if it is to be used for communications with a fixed station, an antenna with specific requirements may also dictate the type of antenna to be used.

All coaxial antenna cables connect to the coaxial connectors located on the junction box. Two antennas may be required; one for the transmitter and one for the receiver. Refer to Figures 5 through 7 as applicable for antenna connection details. Type "N" connectors are used for all stations.

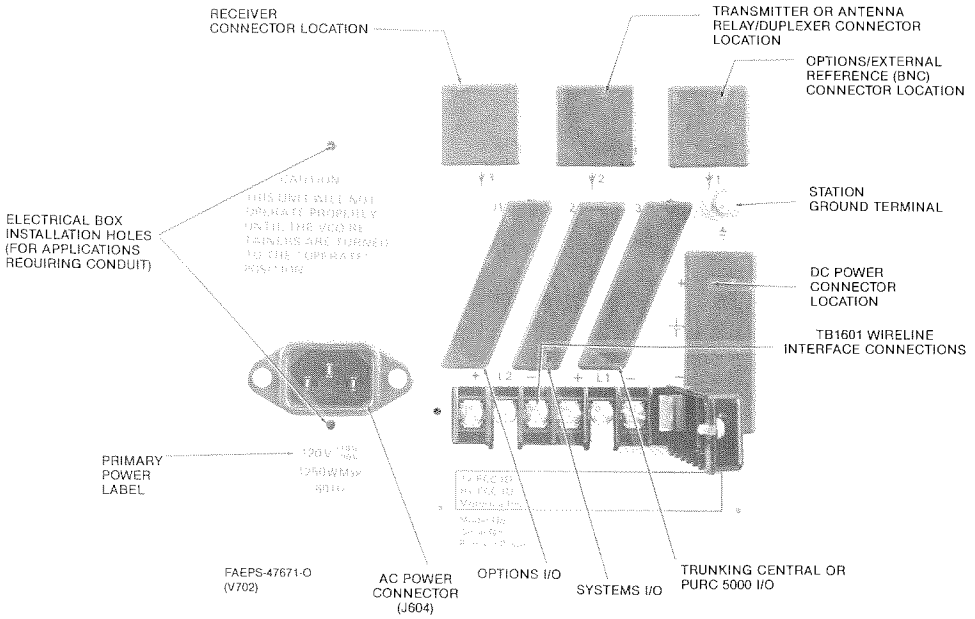


Figure 5. Connections for Low Power Junction Box

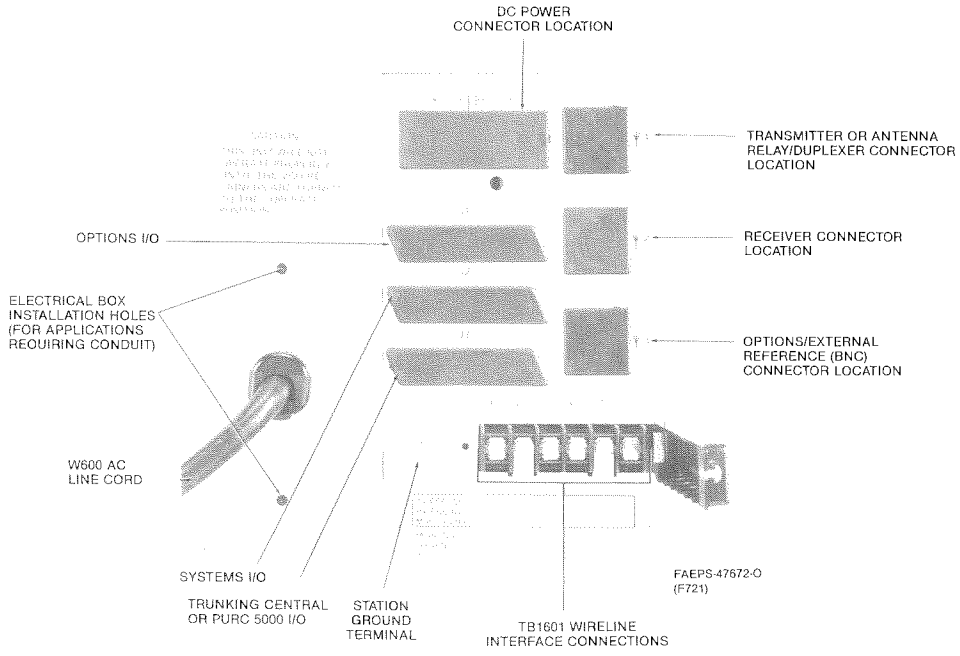


Figure 6. Connections for High Power Junction Box

6.2 EXTERNAL SITE FREQUENCY STANDARD CONNECTIONS

When the optional external site frequency standard is used, a coaxial cable fitted with a BNC type connector is required to connect the site frequency standard to station junction box. See Figures 5 and 6.

7. AC INPUT POWER AND GROUND CONNECTIONS

7.1 GENERAL
(Refer to Figures 5 through 7)

All stations should have a separate power circuit from a 120-volt ac, 60 Hz power source. Circuit current rating is determined by the number of power supplies contained in the station. Circuit must be capable of 10-ampere (minimum) per power supply. Be sure to use High Magnetic (HM) circuit breakers to avoid nuisance openings. The power lines should be installed in accordance with local electrical codes. A substantial earth ground must be provided as close to and in as straight a line as possible with the ground terminal provided on the junction box. Do NOT consider the electrical outlet box as a substantial ground. Refer to Figure 7 for grounding details. Refer to the *Lightning Protection Recommendations* sheet, 68P81111E17, elsewhere in this instruction manual for additional grounding recommendations.

The primary ac power line may be installed prior to installation of the cabinet and terminated near the location chosen for the station if the power line cord supplied with the station is to be used . If the station power is to be supplied by conduit wiring, the station must be installed first. Separate procedures are provided for each type of installation in the following.

7.2 INSTALLATION USING LINE CORD SUPPLIED WITH THE STATION

Step 1. Install the station as described in paragraph 5.

Step 2. Connect the ground terminal on the junction box to a substantial earth ground located as close as possible to the station and in as straight a line as possible with the ground terminal.

WARNING

Even if a three-wire grounded primary ac power source is available, the radio equipment **must be grounded** separately to prevent electrical shock hazards and provide lightning protection.

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

NOTE

A power ON-OFF switch is not provided on the station, therefore, the equipment is immediately operational when the power cord is plugged into a live ac outlet.

7.3 INSTALLATION USING CONDUIT FOR PRIMARY POWER CONNECTION

The junction box has provisions that allow ac power connection to the station using conduit. The following installation procedure is recommended.

Step 1. Remove the line cord supplied with the station.

Step 2. Install three wires of appropriate length and gauge to TB600 where the line cord was disconnected. See NEC and local electrical codes to determine the proper wire gauge required. Typical wire gauge for a 15-ampere system is #12 AWG.

NOTE

The primary power wire colors used conform to international standards for the low power junction box and to US standard for the high power junction box. Refer to cross reference Table 1, as required.

Table 1. Power Lead Color Code

Power Connection	International STD Wire Color	US Standard Wire Color
Live	Brown	Black
Neutral	Blue	White
Ground	Green/Yellow	Green

Step 3. Strip insulation from the wires for a sufficient length to allow connection to the incoming power leads.

Step 4. Attach a 4-1/8" X 2-3/8" X 1-1/2" electrical box (Appleton Catalogue No. 184-E, universal code 69351 or equivalent box extension ring, not supplied) to the junction box using two No. 6-32 X 5/16" self-tapping washer head screws in the holes provided. Refer to Figures 5 and 6.

Step 5. Attach the conduit to the electrical box and secure the electrical connections. It may be desirable to provide an ON-OFF switch or convenience outlet on the electrical box.

Step 6. Attach a suitable cover to the electrical box.

7.4 OPTIONAL DC INPUT POWER INSTALLATION

Connection of the optional dc input power requires assembly and connection of the TRN5155A External Battery Cable Kit. This kit includes a fuse block assembly that must be mounted to the base station along with wires and terminals that must be assembled and connected to the external battery. Install as follows:

Step 1. Determine the length of black 8-gauge wire required to run from P605 directly to the battery negative terminal. Route and cut the black wire to length. A ring tongue lug is provided to facilitate connecting the wire to the battery.

NOTE

The TRN5155A External Battery Cable kit contains 10 feet of red and black 8-gauge wire. Runs longer than 10 feet are not recommended for efficient battery operation. If runs longer than 10 feet are necessary, increase the wire gauge by 3 AWG for each increase of 10 feet in run length.

Step 2. Make sure all power is disconnected from the station

WARNING

Refer to Power Supply section for proper battery voltage setting before connecting the station to the battery.

Step 3. Connect the blue connector (P605, part of the TRN5155A External Battery Cable Kit) into the optional battery power connector (J605) located on the junction box. See Figures 5 or 6 as applicable.

Step 4. Remove the fuse from the fuse holder and mount the fuse holder (supplied with the TRN5155A kit) to the battery rack as close as possible to the battery using the two 8 X 1-1/4" tapping screws provided.

Step 5. Determine the length of red 8-gauge wire required to run from P605 to the fuse block. Route and cut the red wire to length. Attach the red wire to the fuse block.

Step 6. Use the cutoff piece of red wire to connect the fuse block to the battery. A ring tongue lug is provided to facilitate connecting the wire to the battery. After checking that all connections are secure and that polarity is proper, install the fuse removed in Step 4.

8. CODE PLUG OPTIONS

Various station features that were previously associated with wire jumpers such as time-out timer duration and repeater dropout delay are now programmed into the code plug on the station control board. Certain option boards also contain code plugs, which specify certain functions or features on that board. These features are now selected at the time of shipment according to information given on the customer order forms. These selections are listed in the code plug parameter booklet accompanying the station. Refer to the service manual for assistance in interpreting the parameter designations.

9. CONNECT TONE DECODER

Connect Tone Decoder (CTD) is available only on *MSF 5000* Trunked repeater stations. Connect tone operates in a trunking system very much like *Private Line* (PL) in a conventional system. The connect tone prevents the radio from unsquelching and repeating undesired received signals. Typically, each trunked system has its own unique connect tone which prevents systems from breaking each others squelch circuit. Connect tone is a subaudible, low deviation tone which is selected by the customer as a number from 0 through 7. Disconnect tone (163.6 Hz) which follows connect tone is non-selectable.

Table 2. Connect Tone Decoder

Connect Tone Number	Frequency (Hz)
0	105.9
1	76.6
2	83.7
3	90.0
4	97.3
5	116.1
6	128.6
7	138.5

10. CONTROL WIRELINE CONNECTIONS

10.1 TRUNKED REPEATER CONNECTIONS

Trunked repeater stations require the installation of a TKN8498B, 25-foot cable (or optional 50, 75, or 100-foot cable) between the central controller and the station. This cable connects to J3 on the station junction box. Alarm and audio interconnections are made to the LINE 1 and LINE 2 wireline terminals on the station junction box. The wireline installation and specifications are the same as described for repeater (RT) stations.

10.2 REPEATER (RT) CONNECTIONS

The station can be controlled from a remote point over wireline circuits. Simplex audio is used, meaning that the remote point can send audio to the station or receive audio from the station, but not both at the same time. Therefore, a single audio pair will suffice.

An optional 4-wire tone remote control module provides separate paths for transmit audio and for receive audio. In such operation, line 1 is the transmit pair and line 2 is the receive pair.

11. CONTROL WIRELINE DESCRIPTION

11.1 INSTALLATION

The control line may be installed prior to installation of the cabinet and terminated near the location chosen for the station. Conduit or two-wire cable can be used from this termination to the station junction box line interface terminal block.

Connect the wirelines to the screw terminals on the junction box line interface terminal block as shown in Figures 5 and 6.

11.2 SPECIFICATIONS

Before installing the equipment, verify the characteristics of leased telephone lines with the company providing the service. The audio wireline(s) 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-ohm or 900-ohm 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 ohms. 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 (for example, line loss greater than 22 dB).

12. WIRELINE CONNECTIONS

The station junction box provides wireline terminals (L1 and L2), a system connector (J2), and a trunking connector (J3), to make all system interconnections to the Digital *MSF 5000* stations. Connections to Line 3 and Line 4 are available, utilizing the System connector to provide the additional junction box wireline terminals (these connections are not spark-gap protected). Table 3 describes the various connections to be made for each system type. Figure 7 provides connector details for the system and trunking connectors.

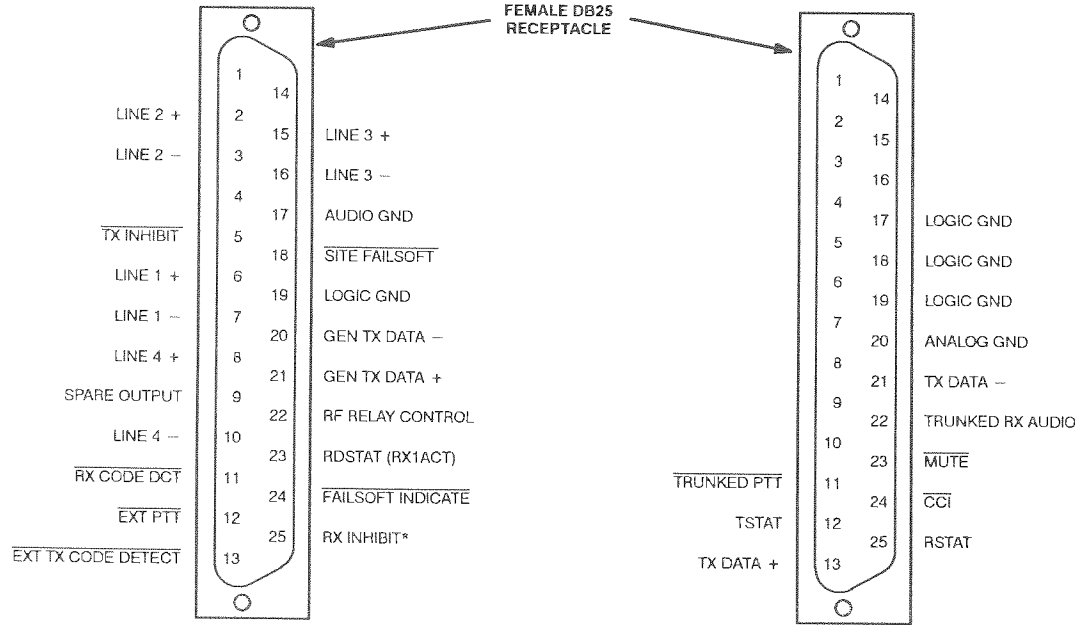


Figure 7. System Connector and Trunking Connector Pin-Out Details

Table 3. Digital MSF 5000 Wireline Matrix				
System	**Line 1**	**Line 2**	**Line 3**	**Line 4**
Conventional Local Area Clear	CONSOLE	CONSOLE	not used	not used
Conventional Wide Area Clear	COMPARATOR or CONSOLE	COMPARATOR	not used	not used
Conventional Local Area Coded	DVM or CIU	DVM or CIU	not used	not used
Conventional Wide Area Coded	DVM, *Digi–TAC*, or CIU	DVM or *Digi–TAC*	not used	not used
Conventional Simulcast Clear	MODEM	COMPARATOR via MODEM	not used	not used
Trunked Local Area Clear without CPI	CIT PP	CIT PP	not used	not used
Trunked Local Area Clear with CPI	CONSOLE	CONSOLE	CIT PP	CIT PP
Trunked Wide Area Clear without CPI	COMPARATOR	COMPARATOR	not used	not used
Trunked Wide Area Clear with CPI	CONSOLE	COMPARATOR	COMPARATOR	CONSOLE
Trunked Local Area Coded	DVM or CIU	DVM or CIU	not used	not used
Trunked Wide Area Coded	DVM or *Digi–TAC*	DVM or *Digi–TAC*	not used	not used
Trunked AMSS Clear	AUDIO DISTRIBUTOR	COMPARATOR	not used	not used
Trunked AMSS Coded	DVM or *Digi–TAC*	DVM or *Digi–TAC*	not used	not used
Trunked Simulcast Clear	not used	COMPARATOR via MODEM	not used	not used

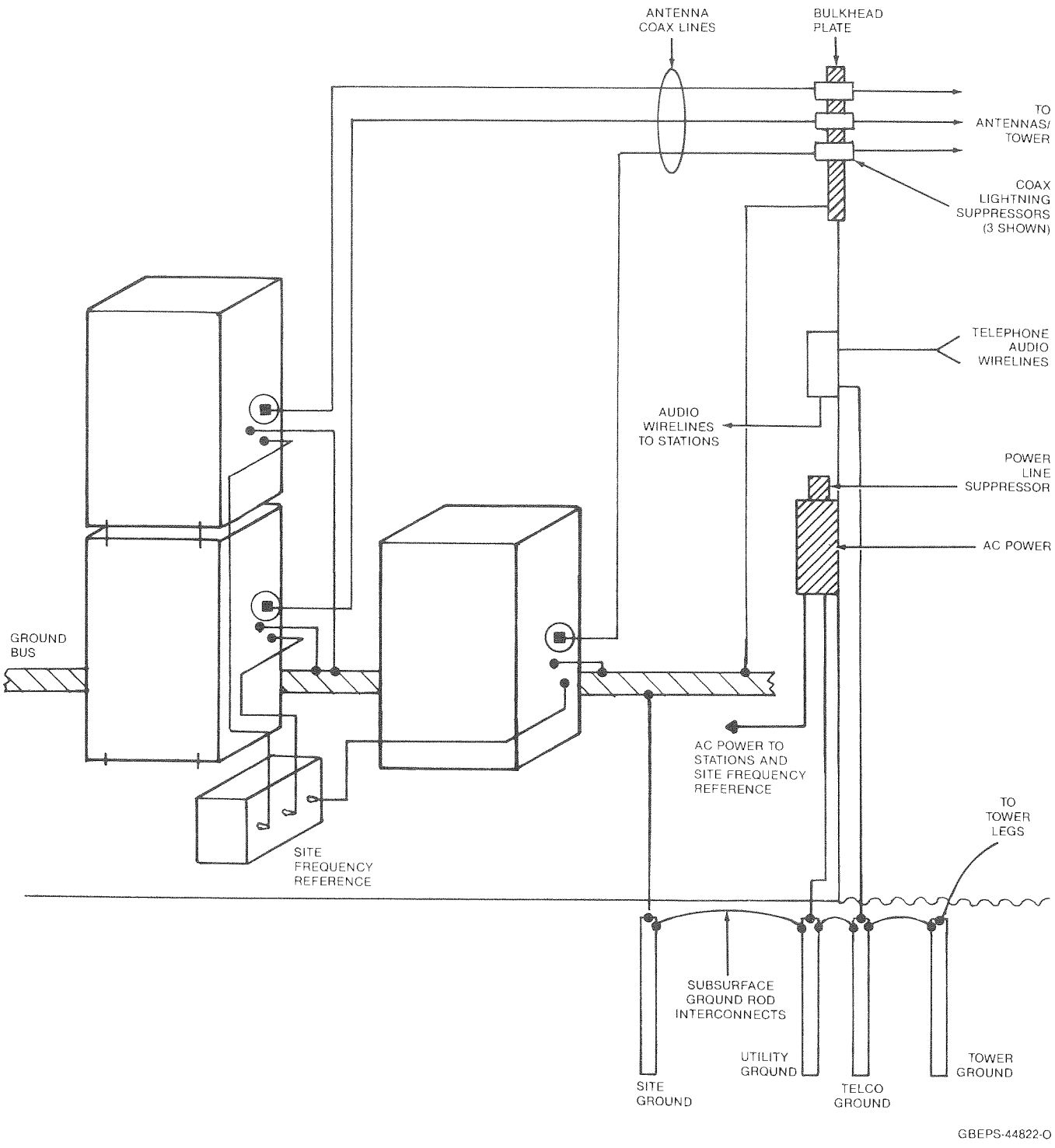


Figure 7. Recommended Station Grounding Detail

MOTOROLA INC.
Communications
Sector

STACKING BRACKET

Model TRN5757A

1. DESCRIPTION

The TRN5757A Stacking Bracket hardware provides wall or overhead anchor points for stacked *MSR 2000, MSF 5000,* and *PURC 5000* cabinets. Cabinet dimensions and the maximum number of cabinets that can be stacked are shown in Table 1 and Figure 1.

Table 1. Cabinet Height and Stacking

Size (Inches)	Height (Inches)	Maximum Stacking
26	26,75	4
37	37.25	3
46	46.00	2
51	50.50	2

2. INSTALLATION DETAILS

The following procedures describe how the Stacking Bracket hardware is to be installed. The procedures consist of anchoring the cabinet(s) to the floor, stacking the cabinet(s), and anchoring them at the top.

2.1 LOCATION

For proper ventilation, allow at least a 6-inch clearance between louvered side panels. Further, allow at least a 12-inch access space at the cabinet door.

2.2 BOTTOM ANCHORING
(Refer to Figure 2, Detail A.)

WARNING
Always secure the tallest and usually the heaviest cabinet at the bottom of the cabinet stack.

Step 1. Remove the break-away weld-nut tabs from the bottom rails of 26, 37, and 46-inch cabinets. These tabs are not used on 51" cabinets. Use a flat blade screwdriver to pry the tab loose.

Step 2. Insert two M8 (or 5/16") shank diameter screws or bolts, of suitable length, through the center holes of the bottom rails and secure the cabinet to the floor.

2.3 CABINET STACKING
(Refer to Figures 2 through 5.)

Step 1. Remove the middle two bolts (M8 x 40mm) from the top cover of the lower cabinet. Save the bolts because they will be used later.

Step 2. Remove the break-away weld-nut tabs from the bottom rails of the cabinet to be placed on top of the one anchored to the floor. The 51" cabinet does not have break-away weld-nut tabs.

Step 3. Carefully lift and position the cabinet on top of the one anchored to the floor. For back-to-back cabinet installations as shown in Figures 5 and 7, place the cross strapping between the upper and lower cabinets before the top cabinet is set in position. Refer to Table 1 for maximum limitation of the number of stacked cabinets. DO NOT exceed 111" maximum cabinet stack height.

Step 4. Insert two bolts (removed earlier) into the center holes at the bottom rails of the upper cabinet and screw them into the top rails of the lower cabinet. Go to Step 5 for 51" cabinets.

Step 5. FOR DUAL 51" CABINETS ONLY - Tilt the driver PA deck in the bottom cabinet forward to access the mounting holes from inside the top of the bottom cabinet. Bend the lifting bracket tab nut away and insert the center mounting screws from the bottom cabinet upward, engaging the center hole at the bottom of the top cabinet. Refer to Figures 6 and 7 for details.

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1301 E. Algonquin Road, Schaumburg, IL 60196

68P81114E30-D
7/1/90—UP

2.4 TOP ANCHORING

WARNING

The top cabinet of a stacked installation should be secured to the ceiling, or to the walls, using TRN5757A Stacking Bracket hardware. This will minimize the danger of topping, in the event that mechanical shock or vibration occurs.

2.4.1 Wall Support of Cabinet
(Refer to Figure 2.)

Step 1. Remove the four screws from the top cover.

Step 2. Mount the brackets as shown using the four M8 x 40mm screws supplied with the bracket hardware.

Step 3. Use customer supplied screws to fasten the brackets to the wall.

2.4.2 Overhead Support of Single Cabinet Stacks
(Refer to Figure 3.)

Step 1. Remove the four screws from the top cover.

Step 2. Mount the brackets as shown using the four M8 x 40mm screws supplied with the bracket hardware.

Step 3. Use customer supplied screws to fasten the brackets to the overhead support.

2.4.3 Overhead Support of Adjacent Cabinet Stacks
(Refer to Figure 4.)

Step 1. Remove the four screws from the top cover.

Step 2. Mount the brackets as shown using the four M8 x 40mm screws supplied with the bracket hardware.

Step 3. Use customer supplied screws to fasten the brackets to the overhead support.

2.4.4 Overhead Support of Back-to-Back Cabinets
(Refer to Figure 5.)

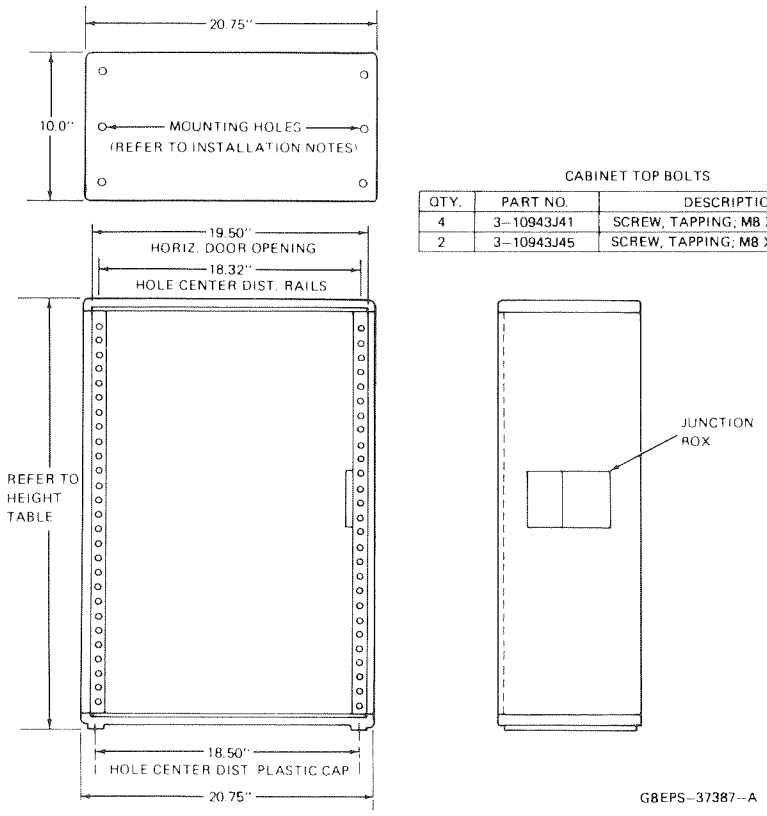
Step 1. Remove the four screws from the top cover.

Step 2. Mount the brackets as shown using the four M8 x 40mm screws supplied with the bracket hardware.

Step 3. Use customer supplied screws to fasten the brackets to the overhead support.

2.4.5 Back-to-Back and Flush Stacks for 51" Cabinets

Step 4. Refer to Figures 6 and 7 for details of stacking and anchoring 51" cabinets.



CABINET TOP BOLTS

QTY.	PART NO.	DESCRIPTION
4	3-10943J41	SCREW, TAPPING; M8 X 1.25 X 16MM
2	3-10943J45	SCREW, TAPPING; M8 X 1.25 X 40MM

Figure 1. Cabinet Dimensional Details

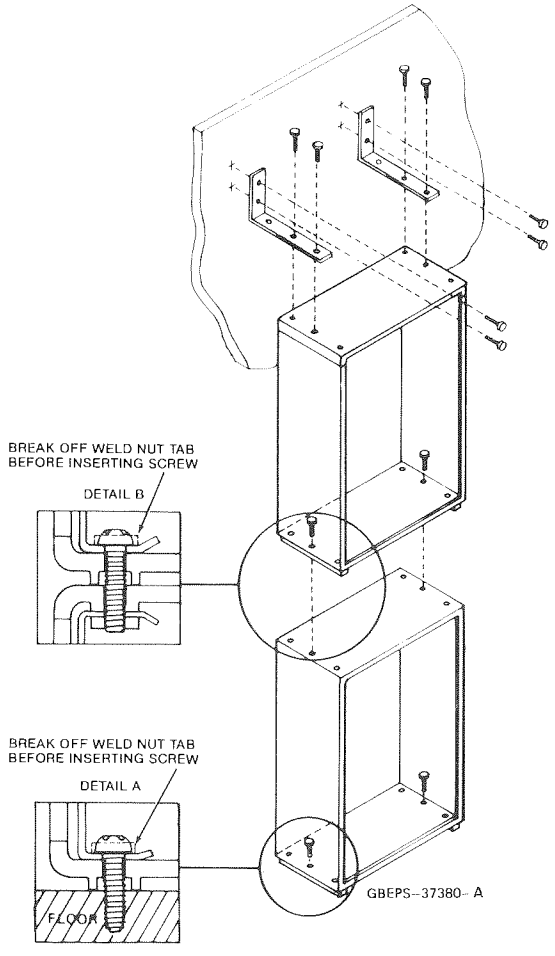


Figure 2. Bracket Installation for Wall Support

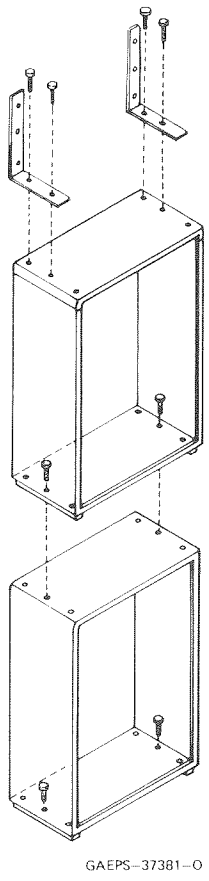


Figure 3. Bracket Installation for Overhead Support of Single Cabinet Stacks

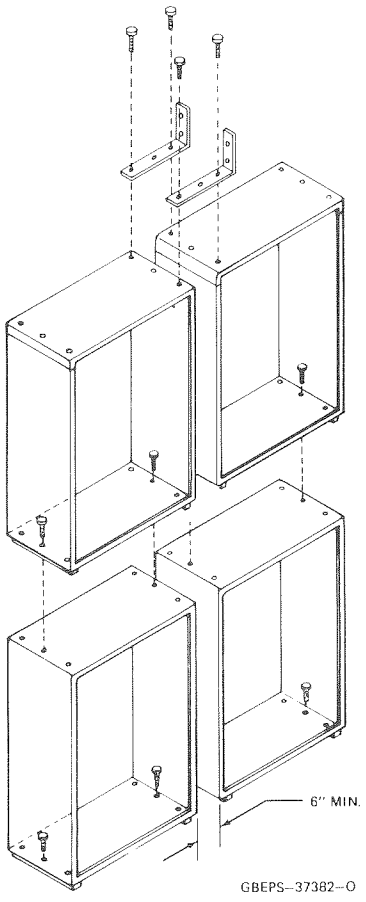


Figure 4. Bracket Installaton for Overhead Support of Adjacent Cabinet Stacks

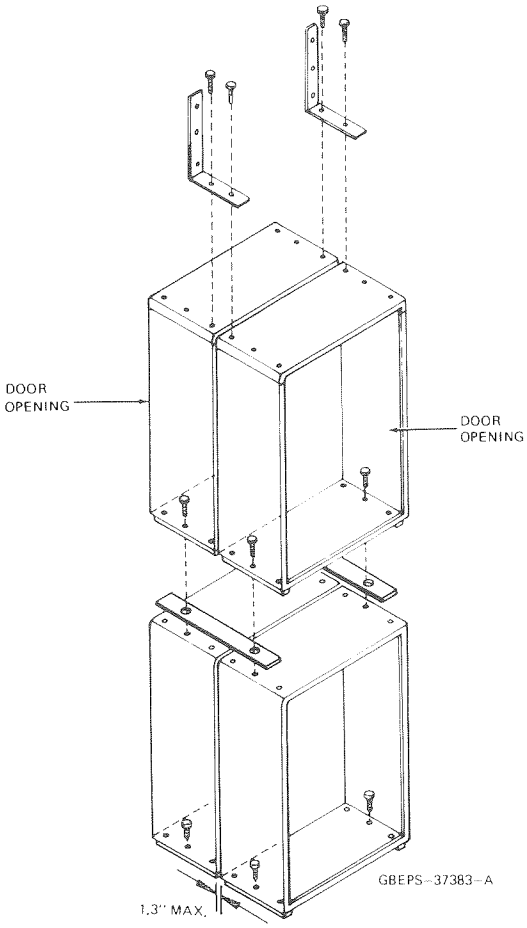


Figure 5. Bracket Installation for Overhead Support of Back–to–Back Cabinets

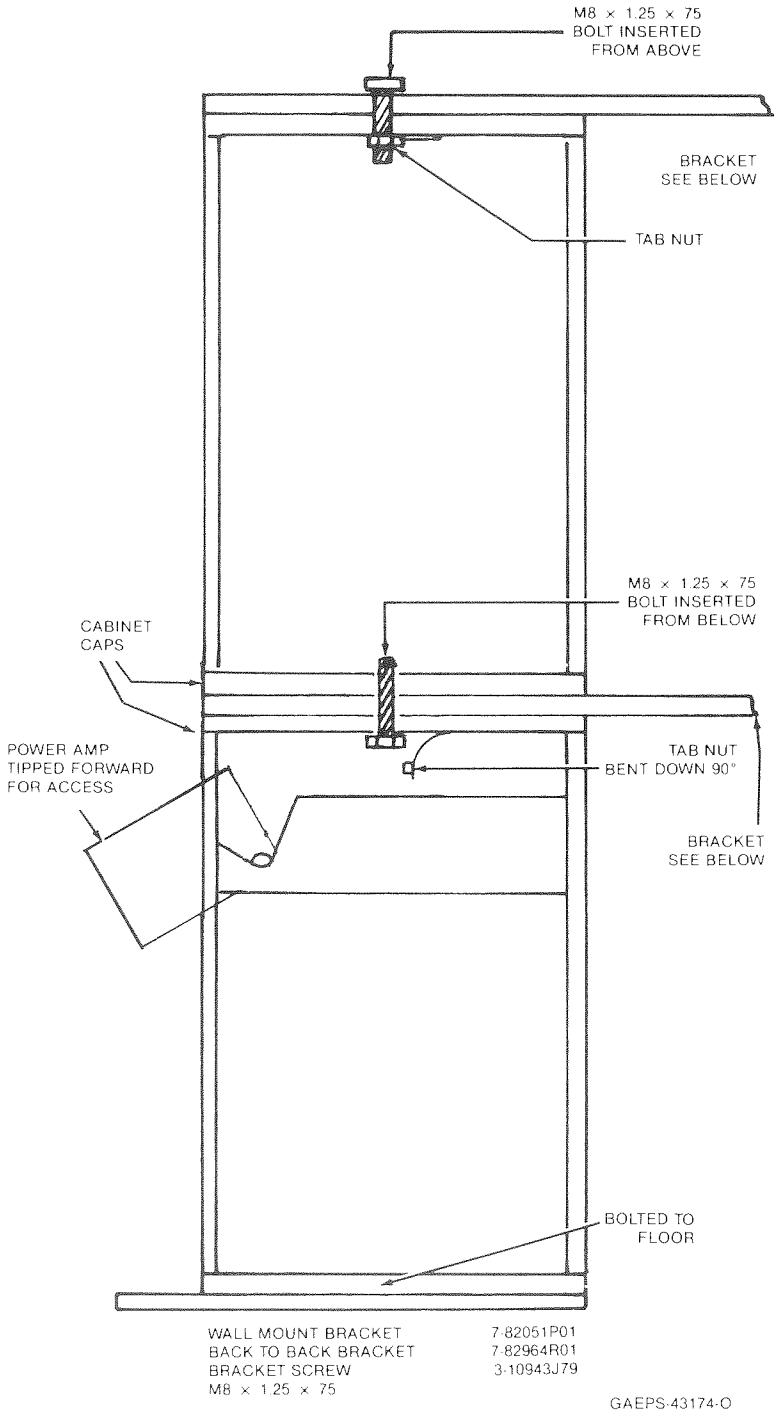


Figure 6. Stacking Installation Details, 51-inch Cabinet

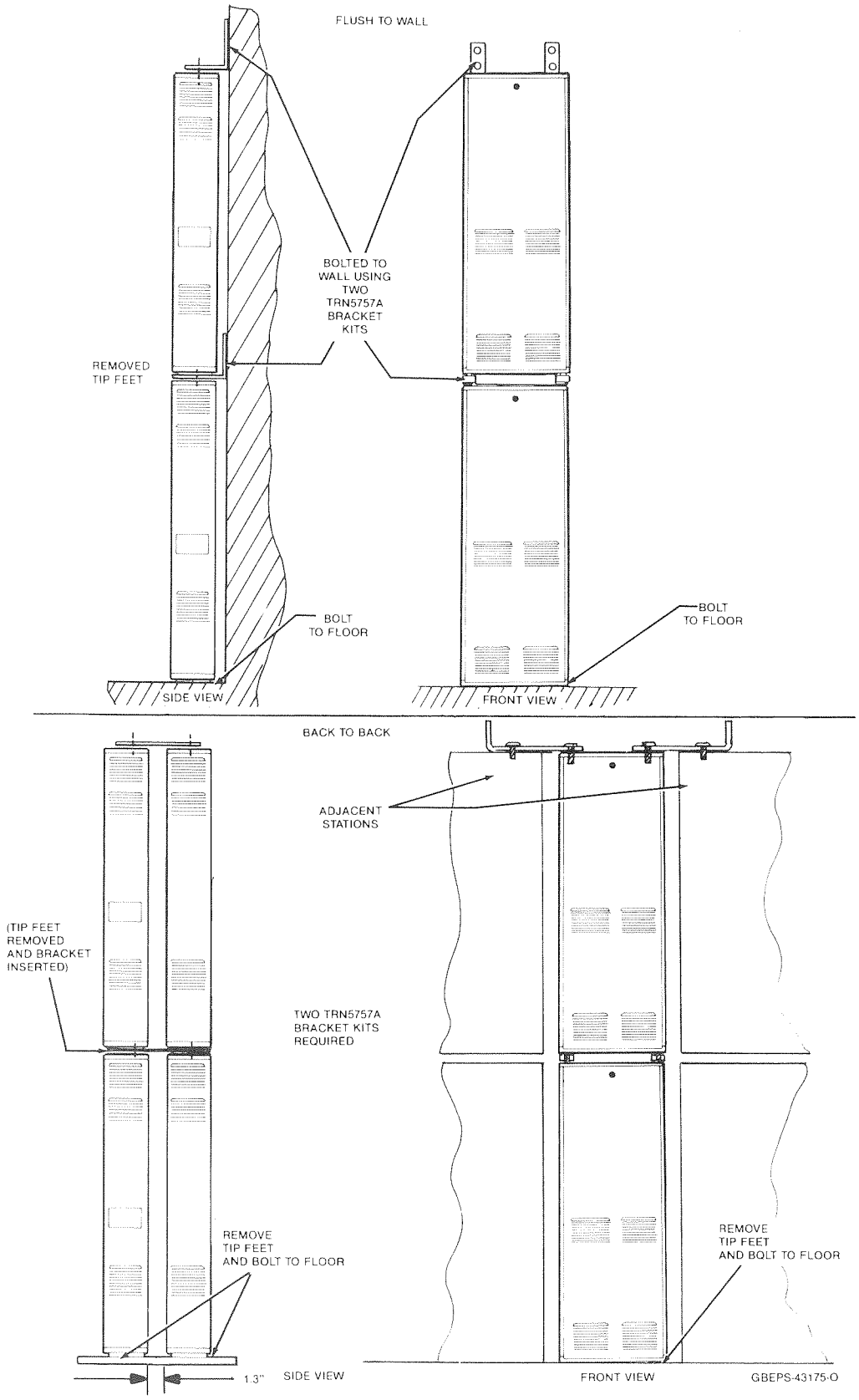
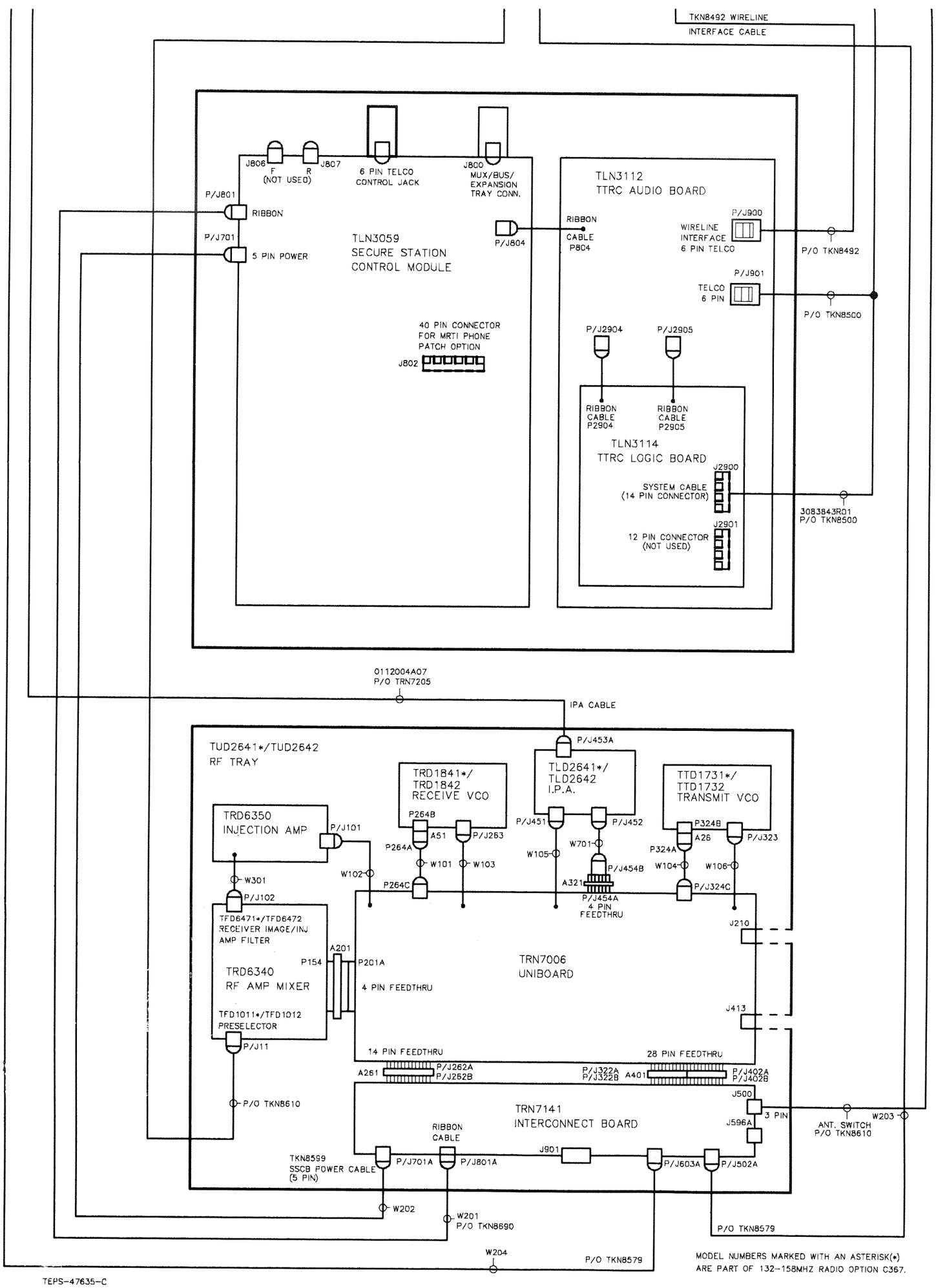
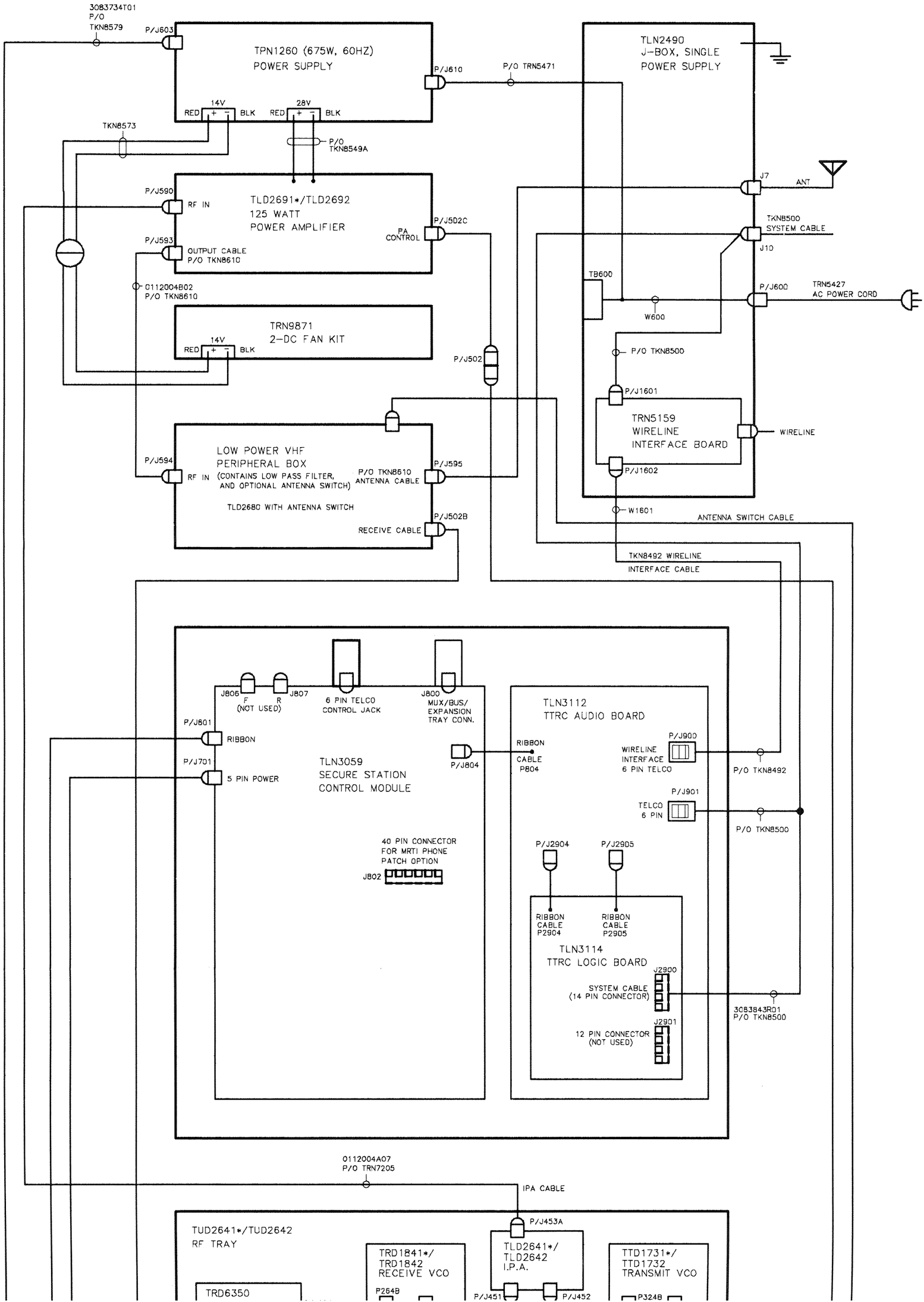
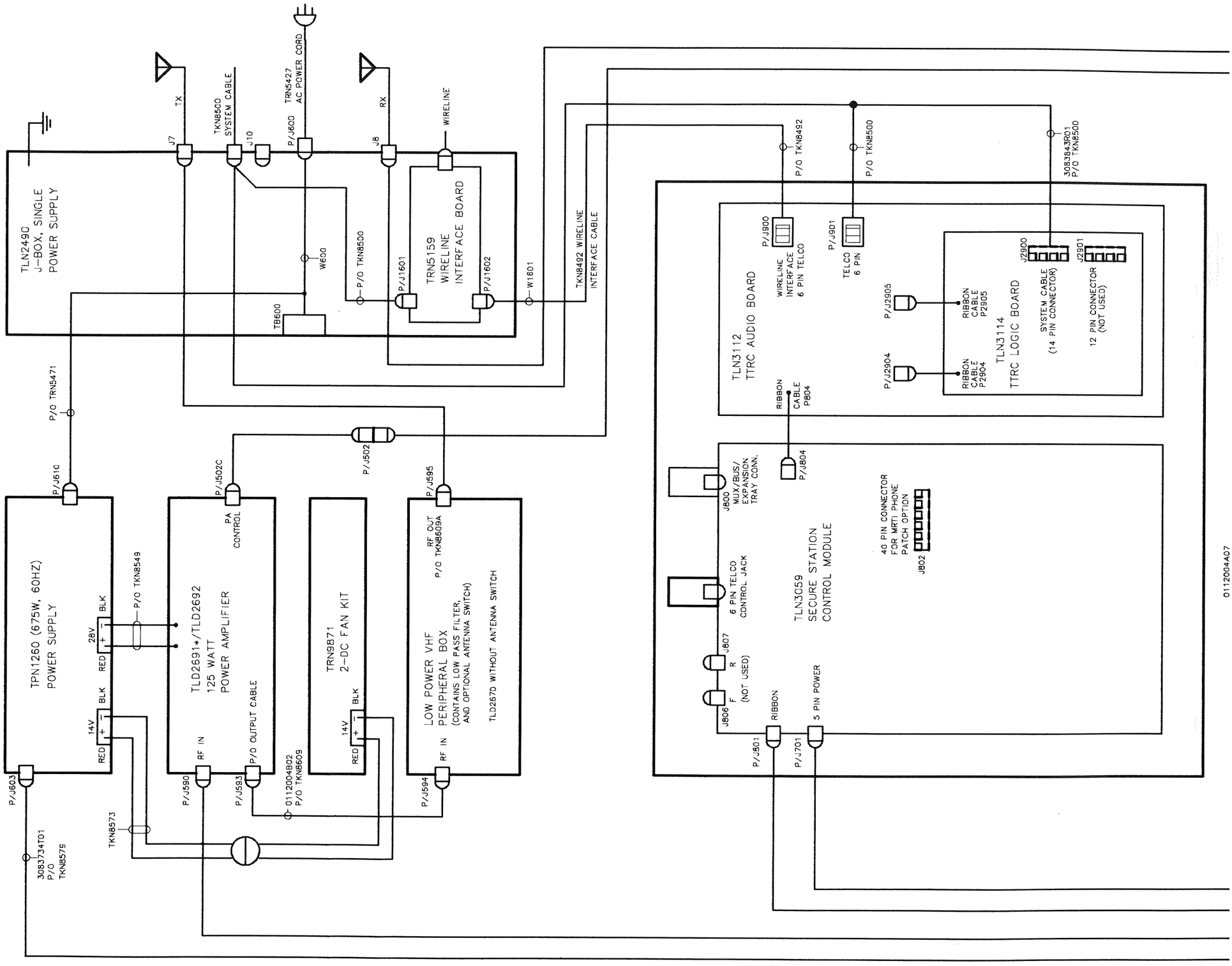


Figure 7. Flush Wall and Back–to–Back Mounting Detail, 51–inch Cabinets

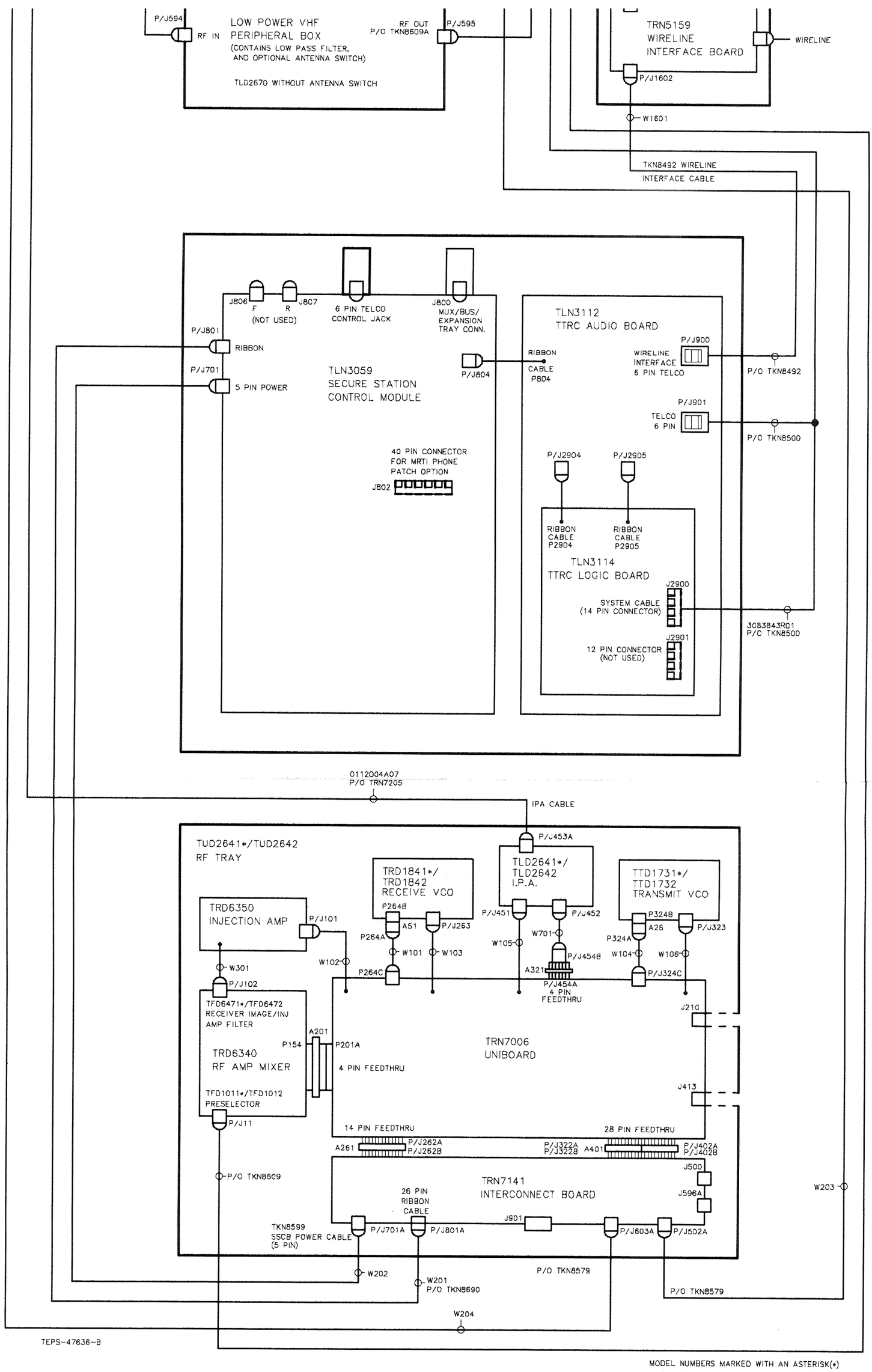

TKN8492 WIRELINE
INTERFACE CABLE
J806
F
(NOT USED)
R
J807
6 PIN TELCO
CONTROL JACK
J800
MUX/BUS/
EXPANSION
TRAY CONN.
P/J801
RIBBON
P/J701
5 PIN POWER
TLN3059
SECURE STATION
CONTROL MODULE
P/J804
RIBBON
CABLE
P804
TLN3112
TTRC AUDIO BOARD
P/J900
WIRELINE
INTERFACE
6 PIN TELCO
P/O TKN8492
P/J901
TELCO
6 PIN
P/O TKN8500
40 PIN CONNECTOR
FOR MRTI PHONE
PATCH OPTION
J802
P/J2904
P/J2905
RIBBON
CABLE
P2904
RIBBON
CABLE
P2905
TLN3114
TTRC LOGIC BOARD
J2900
SYSTEM CABLE
(14 PIN CONNECTOR)
3083843R01
P/O TKN8500
J2901
12 PIN CONNECTOR
(NOT USED)
0112004A07
P/O TRN7205
IPA CABLE
TUD2641*/TUD2642
RF TRAY
P/J453A
TRD1841*/
TRD1842
RECEIVE VCO
TLD2641*/
TLD2642
I.P.A.
TTD1731*/
TTD1732
TRANSMIT VCO
TRD6350
INJECTION AMP
P/J101
P264B
A51
P/J263
P264A
W101
W103
P/J451
P/J452
W701
W105
P/J454B
A321
P/J454A
4 PIN
FEEDTHRU
P324B
A26
P/J323
P324A
W104
W106
P/J324C
W102
P264C
W301
P/J102
TFD6471*/TFD6472
RECEIVER IMAGE/INJ
AMP FILTER
TRD6340
RF AMP MIXER
TFD1011*/TFD1012
PRESELECTOR
P/J11
A201
P154
P201A
4 PIN FEEDTHRU
TRN7006
UNIBOARD
J210
J413
14 PIN FEEDTHRU
28 PIN FEEDTHRU
A261
P/J262A
P/J262B
P/J322A
P/J322B
A401
P/J402A
P/J402B
J500
3 PIN
W203
ANT. SWITCH
P/O TKN8610
P/O TKN8610
TRN7141
INTERCONNECT BOARD
J596A
RIBBON
CABLE
J901
TKN8599
SSCB POWER CABLE
(5 PIN)
P/J701A
P/J801A
P/J603A
P/J502A
W202
W201
P/O TKN8690
P/O TKN8579
W204
P/O TKN8579
MODEL NUMBERS MARKED WITH AN ASTERISK(*)
ARE PART OF 132-158MHZ RADIO OPTION C367.
TEPS-47635-C


3083734T01
P/O
TKN8579
P/J603
TPN1260 (675W, 60HZ)
POWER SUPPLY
P/J610
P/O TRN5471
TLN2490
J-BOX, SINGLE
POWER SUPPLY
14V
RED
+
-
BLK
28V
RED
+
-
BLK
TKN8573
P/O
TKN8549A
J7
ANT
P/J590
RF IN
TLD2691*/TLD2692
125 WATT
POWER AMPLIFIER
P/J502C
PA
CONTROL
TKN8500
SYSTEM CABLE
J10
P/J593
OUTPUT CABLE
P/O TKN8610
TB600
P/J600
TRN5427
AC POWER CORD
0112004B02
P/O TKN8610
W600
TRN9871
2-DC FAN KIT
14V
RED
+
-
BLK
P/O TKN8500
P/J502
P/J1601
TRN5159
WIRELINE
INTERFACE BOARD
WIRELINE
P/J594
RF IN
LOW POWER VHF
PERIPHERAL BOX
(CONTAINS LOW PASS FILTER,
AND OPTIONAL ANTENNA SWITCH)
TLD2680 WITH ANTENNA SWITCH
P/O TKN8610
ANTENNA CABLE
P/J595
P/J502B
RECEIVE CABLE
P/J1602
W1601
ANTENNA SWITCH CABLE
TKN8492 WIRELINE
INTERFACE CABLE
J806
F
(NOT USED)
R
J807
6 PIN TELCO
CONTROL JACK
J800
MUX/BUS/
EXPANSION
TRAY CONN.
TLN3112
TTRC AUDIO BOARD
P/J801
RIBBON
P/J701
5 PIN POWER
TLN3059
SECURE STATION
CONTROL MODULE
P/J804
RIBBON
CABLE
P804
P/J900
WIRELINE
INTERFACE
6 PIN TELCO
P/O TKN8492
P/J901
TELCO
6 PIN
P/O TKN8500
40 PIN CONNECTOR
FOR MRTI PHONE
PATCH OPTION
J802
P/J2904
P/J2905
RIBBON
CABLE
P2904
RIBBON
CABLE
P2905
TLN3114
TTRC LOGIC BOARD
J2900
SYSTEM CABLE
(14 PIN CONNECTOR)
3083843R01
P/O TKN8500
J2901
12 PIN CONNECTOR
(NOT USED)
0112004A07
P/O TRN7205
IPA CABLE
TUD2641*/TUD2642
RF TRAY
P/J453A
TRD1841*/
TRD1842
RECEIVE VCO
TLD2641*/
TLD2642
I.P.A.
TTD1731*/
TTD1732
TRANSMIT VCO
TRD6350
P264B
P/J451
P/J452
P324B

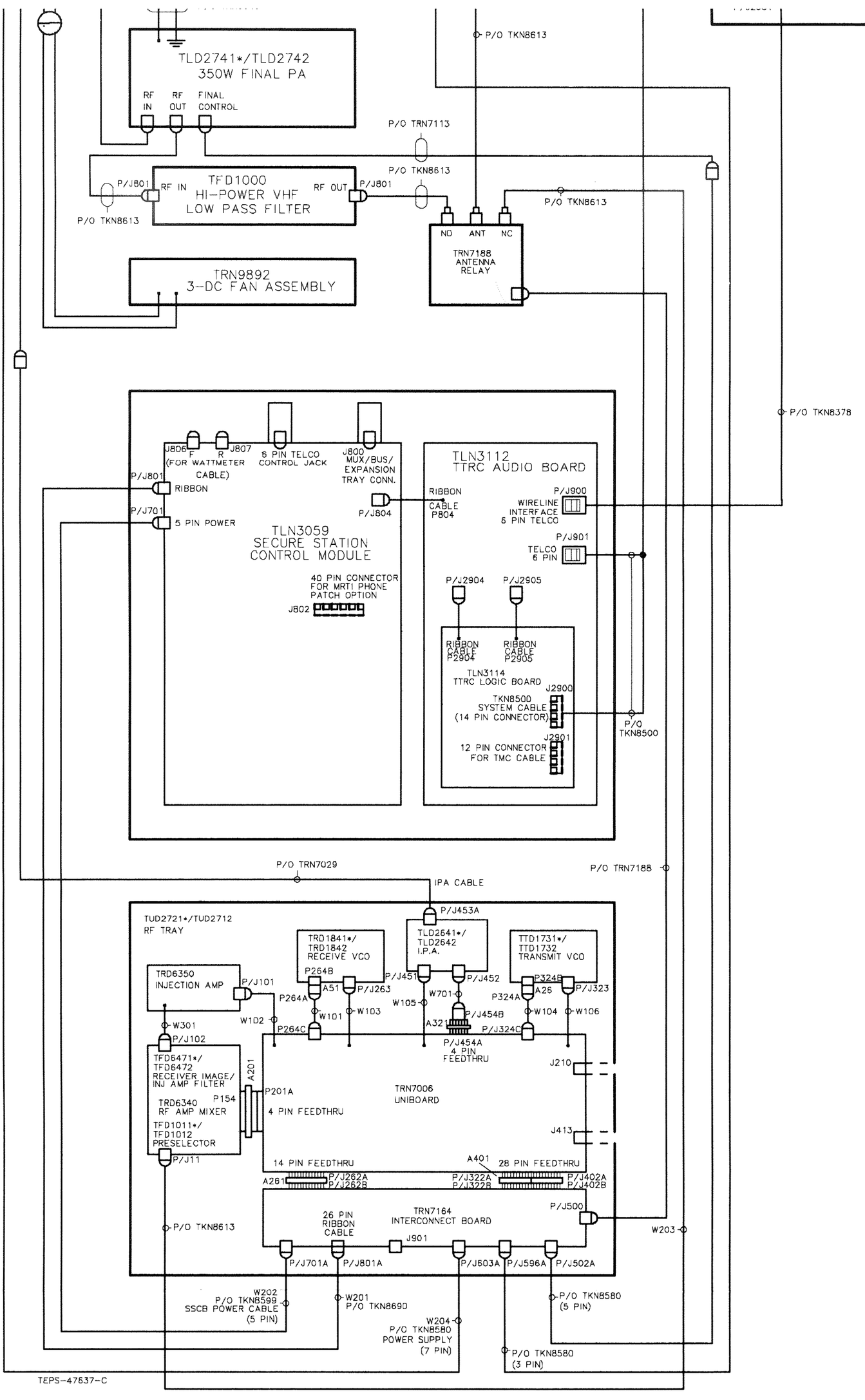
MSF 5000
STATION INTERCABLING
VHF 125 W REPEATER STATION



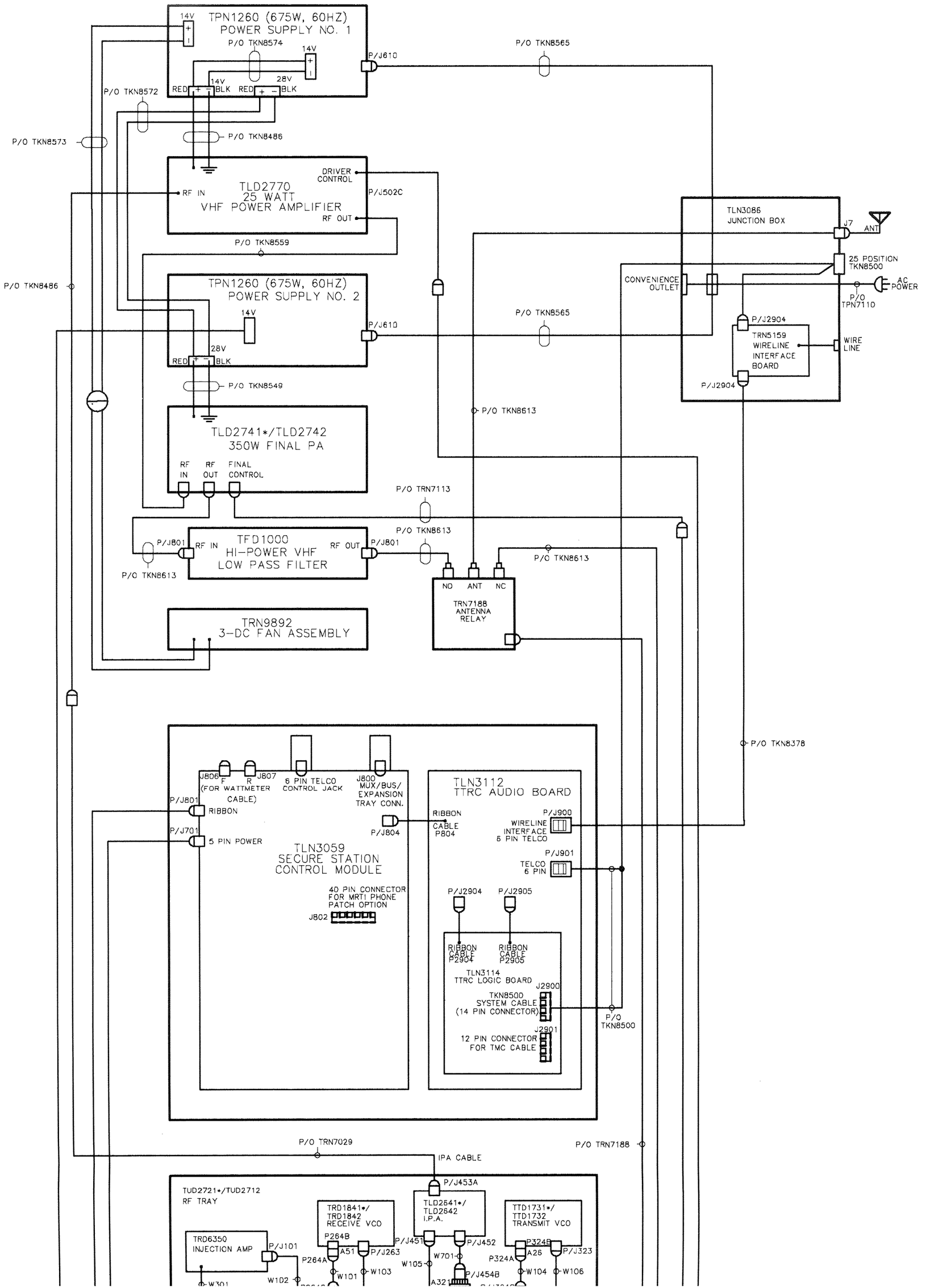
68P81084E49-O
(Sheet 2 of 14)
7/15/90 – UP

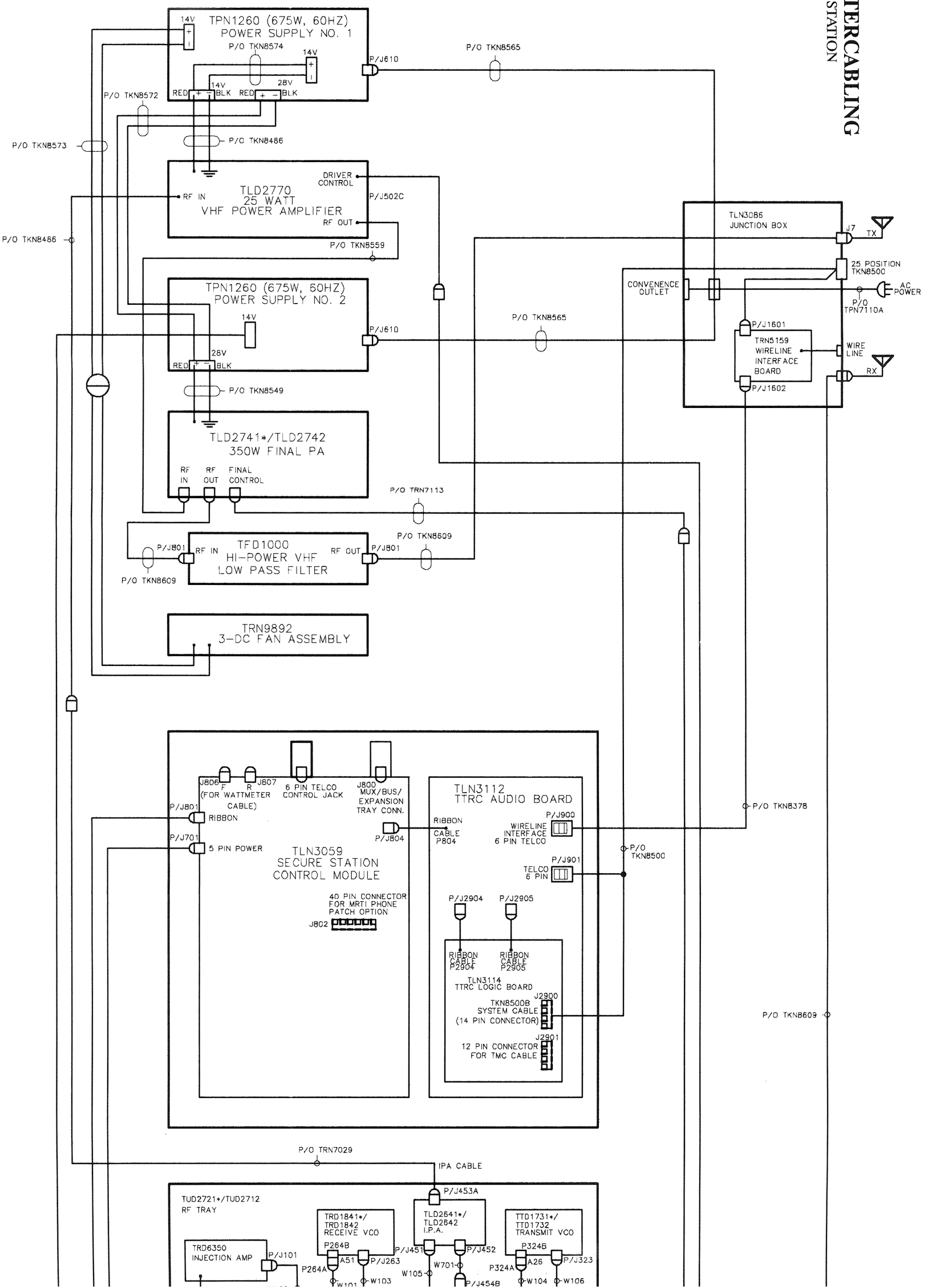


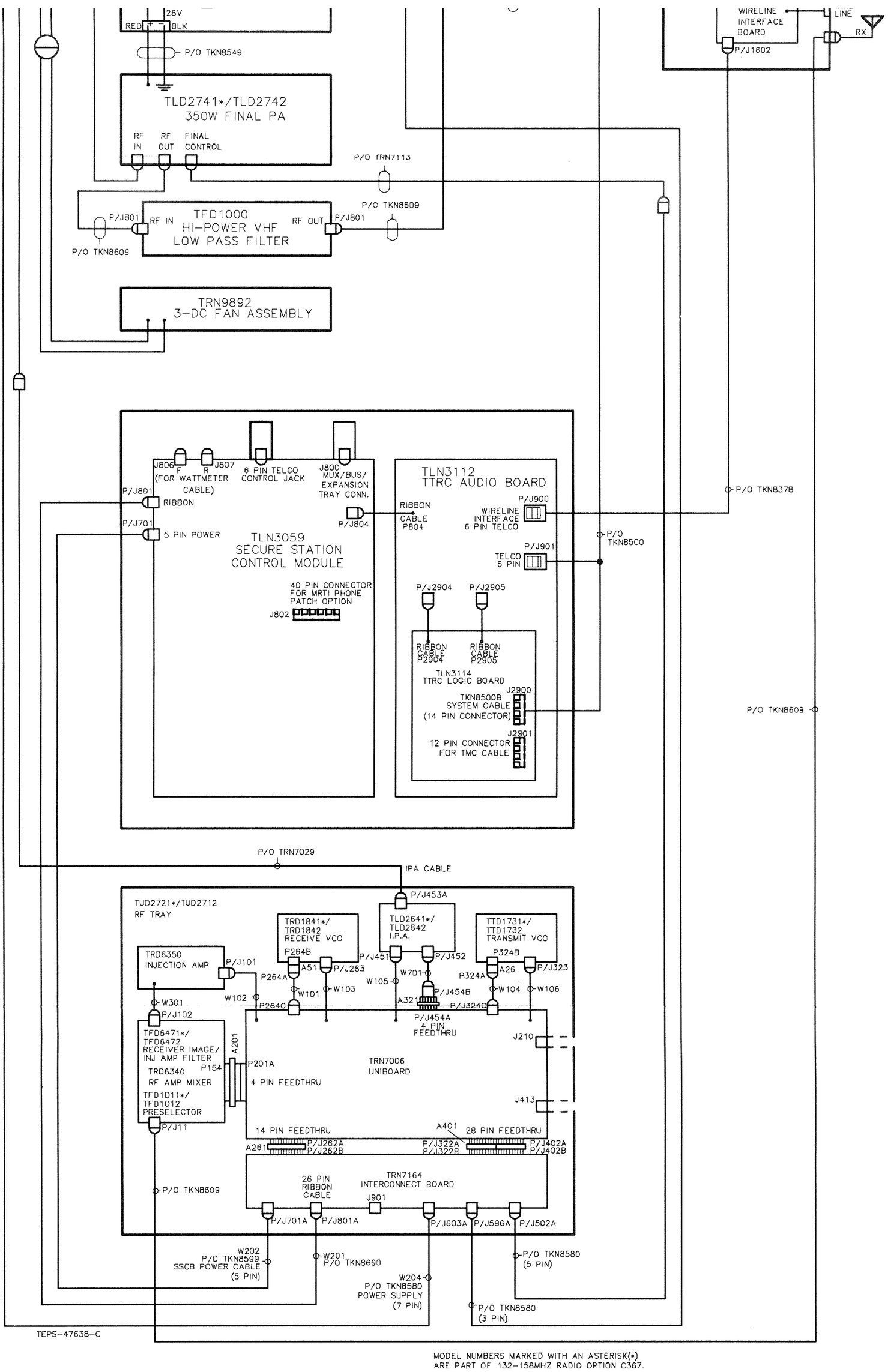
MODEL NUMBERS MARKED WITH AN ASTERISK(*)
ARE PART OF 132–158MHZ RADIO OPTION C367.



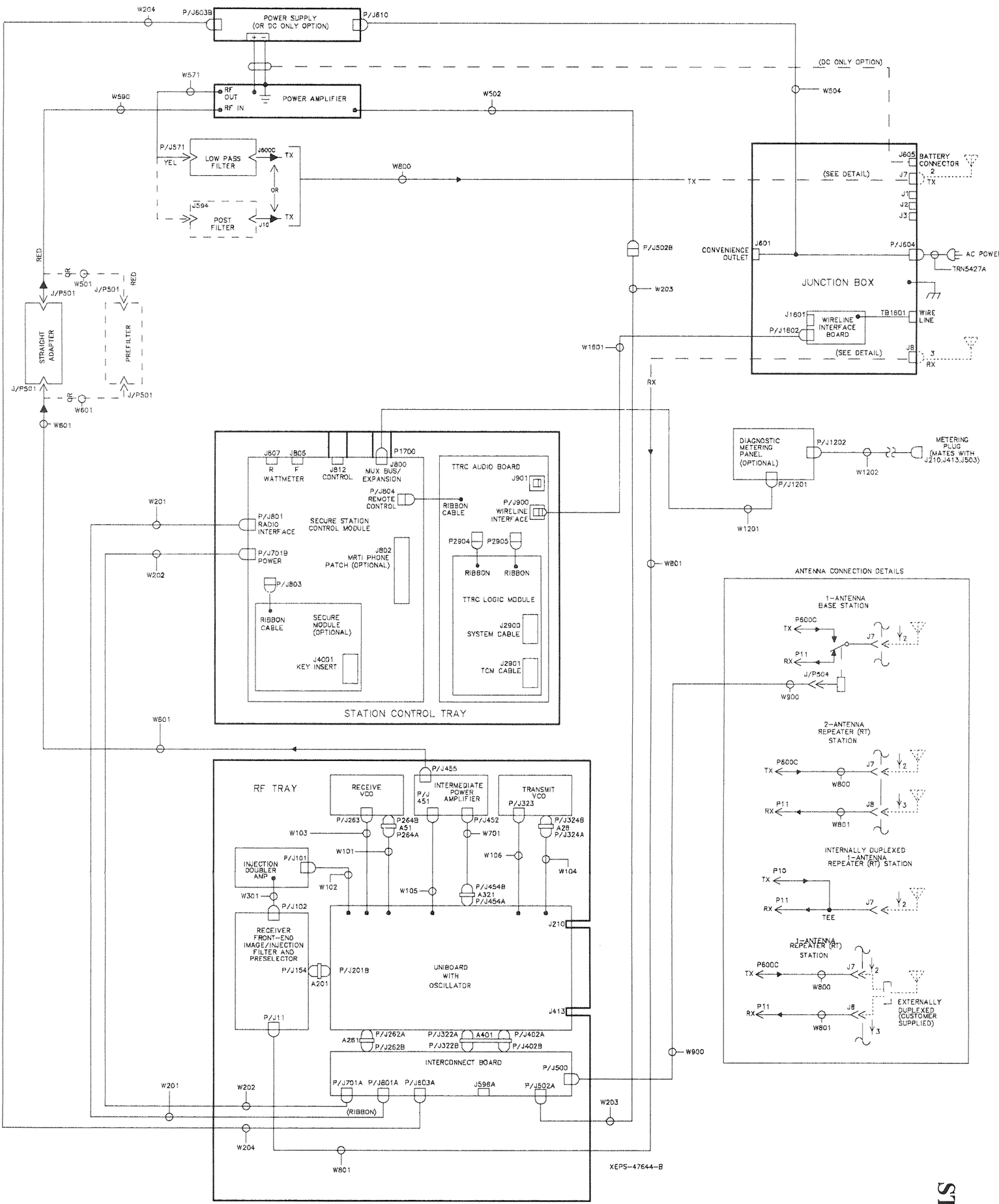
MODEL NUMBERS MARKED WITH AN ASTERISK(*)
ARE PART OF 132–158MHZ RADIO OPTION C367.


TPN1260 (675W, 60HZ)
POWER SUPPLY NO. 1
14V
P/O TKN8574
14V
28V
RED
BLK
P/J610
P/O TKN8565
P/O TKN8572
P/O TKN8573
P/O TKN8486
TLD2770
25 WATT
VHF POWER AMPLIFIER
DRIVER CONTROL
RF IN
RF OUT
P/J502C
P/O TKN8559
TPN1260 (675W, 60HZ)
POWER SUPPLY NO. 2
P/O TKN8549
TLD2741*/TLD2742
350W FINAL PA
RF IN
RF OUT
FINAL CONTROL
P/O TRN7113
P/O TKN8613
TFD1000
HI-POWER VHF
LOW PASS FILTER
P/J801
TRN9892
3-DC FAN ASSEMBLY
TLN3086
JUNCTION BOX
J7
ANT
25 POSITION
TKN8500
CONVENIENCE OUTLET
AC POWER
P/O TPN7110
P/J2904
TRN5159
WIRELINE
INTERFACE
BOARD
WIRE LINE
NO
ANT
NC
TRN7188
ANTENNA
RELAY
P/O TKN8378
J806
F
R
J807
(FOR WATTMETER CABLE)
6 PIN TELCO CONTROL JACK
J800
MUX/BUS/
EXPANSION
TRAY CONN.
RIBBON
5 PIN POWER
P/J701
P/J804
TLN3059
SECURE STATION
CONTROL MODULE
40 PIN CONNECTOR
FOR MRTI PHONE
PATCH OPTION
J802
TLN3112
TTRC AUDIO BOARD
RIBBON CABLE P804
WIRELINE INTERFACE 6 PIN TELCO
P/J900
P/J901
TELCO 6 PIN
P/J2905
RIBBON CABLE P2904
RIBBON CABLE P2905
TLN3114
TTRC LOGIC BOARD
J2900
TKN8500
SYSTEM CABLE
(14 PIN CONNECTOR)
J2901
12 PIN CONNECTOR
FOR TMC CABLE
P/O TKN8500
P/O TRN7029
IPA CABLE
P/O TRN7188
TUD2721*/TUD2712
RF TRAY
P/J453A
TRD1841*/
TRD1842
RECEIVE VCO
TLD2641*/
TLD2642
I.P.A.
TTD1731*/
TTD1732
TRANSMIT VCO
TRD6350
INJECTION AMP
P/J101
P264B
P264A
A51
P/J263
P/J451
P/J452
P324B
P324A
A25
P/J323
W701
W105
W101
W103
W104
W106
W102
W301
P/J454B
A32


TPN1260 (675W, 60HZ)
POWER SUPPLY NO. 1
14V
P/O TKN8574
14V
28V
RED
BLK
P/J610
P/O TKN8565
P/O TKN8572
P/O TKN8573
P/O TKN8486
TLD2770
25 WATT
VHF POWER AMPLIFIER
DRIVER CONTROL
RF IN
P/J502C
RF OUT
P/O TKN8559
TPN1260 (675W, 60HZ)
POWER SUPPLY NO. 2
P/O TKN8549
TLD2741*/TLD2742
350W FINAL PA
RF IN
RF OUT
FINAL CONTROL
P/O TRN7113
TFD1000
HI-POWER VHF
LOW PASS FILTER
P/J801
P/O TKN8609
TRN9892
3-DC FAN ASSEMBLY
TLN3086
JUNCTION BOX
J7
TX
RX
25 POSITION
TKN8500
CONVENENCE OUTLET
AC POWER
P/O TPN7110A
P/J1601
TRN5159
WIRELINE
INTERFACE
BOARD
P/J1602
WIRE LINE
J806
F
R
J807
(FOR WATTMETER CABLE)
6 PIN TELCO CONTROL JACK
J800
MUX/BUS/
EXPANSION
TRAY CONN.
P/J801
RIBBON
P/J701
5 PIN POWER
TLN3059
SECURE STATION
CONTROL MODULE
40 PIN CONNECTOR
FOR MRTI PHONE
PATCH OPTION
J802
TLN3112
TTRC AUDIO BOARD
P/J804
RIBBON CABLE P804
P/J900
WIRELINE INTERFACE 6 PIN TELCO
P/J901
TELCO 6 PIN
P/O TKN8500
P/O TKN8378
P/J2904
P/J2905
RIBBON CABLE P2904
RIBBON CABLE P2905
TLN3114
TTRC LOGIC BOARD
J2900
TKN8500B
SYSTEM CABLE
(14 PIN CONNECTOR)
J2901
12 PIN CONNECTOR
FOR TMC CABLE
P/O TKN8609
P/O TRN7029
IPA CABLE
P/J453A
TUD2721*/TUD2712
RF TRAY
TRD1841*/
TRD1842
RECEIVE VCO
TLD2641*/
TLD2642
I.P.A.
TTD1731*/
TTD1732
TRANSMIT VCO
TRD6350
INJECTION AMP
P/J101
P264B
P264A
A51
P/J263
W103
P/J451
W105
W701
P/J452
P/J454B
P324B
P324A
A26
P/J323
W104
W106

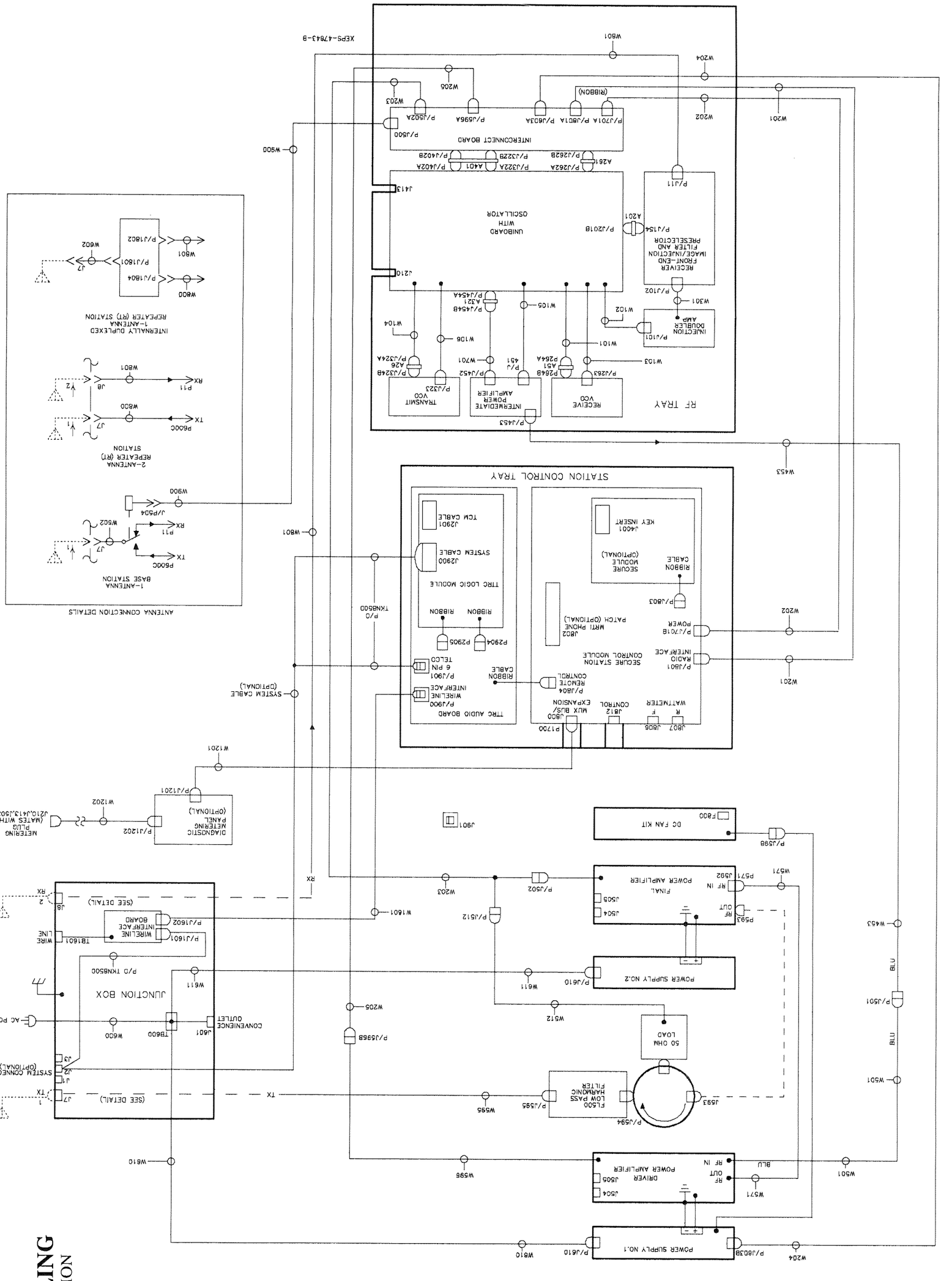


MODEL NUMBERS MARKED WITH AN ASTERISK(*)
ARE PART OF 132-158MHZ RADIO OPTION C367.

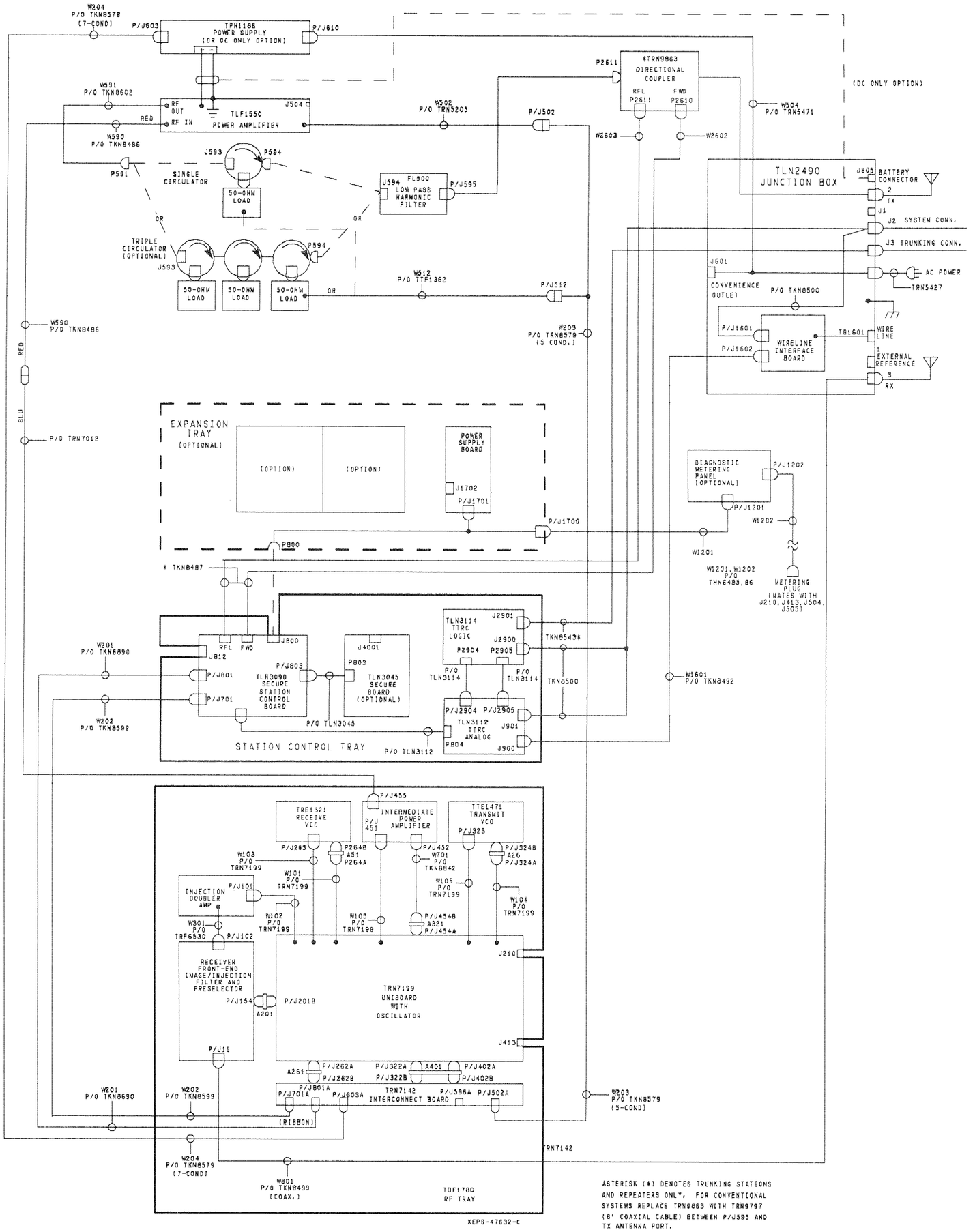


MSF 5000
STATION INTERCABLING
UHF LOW POWER BASE STATION

MSF 5000
STATION INTERCABLING
UHF HIGH POWER BASE STATION

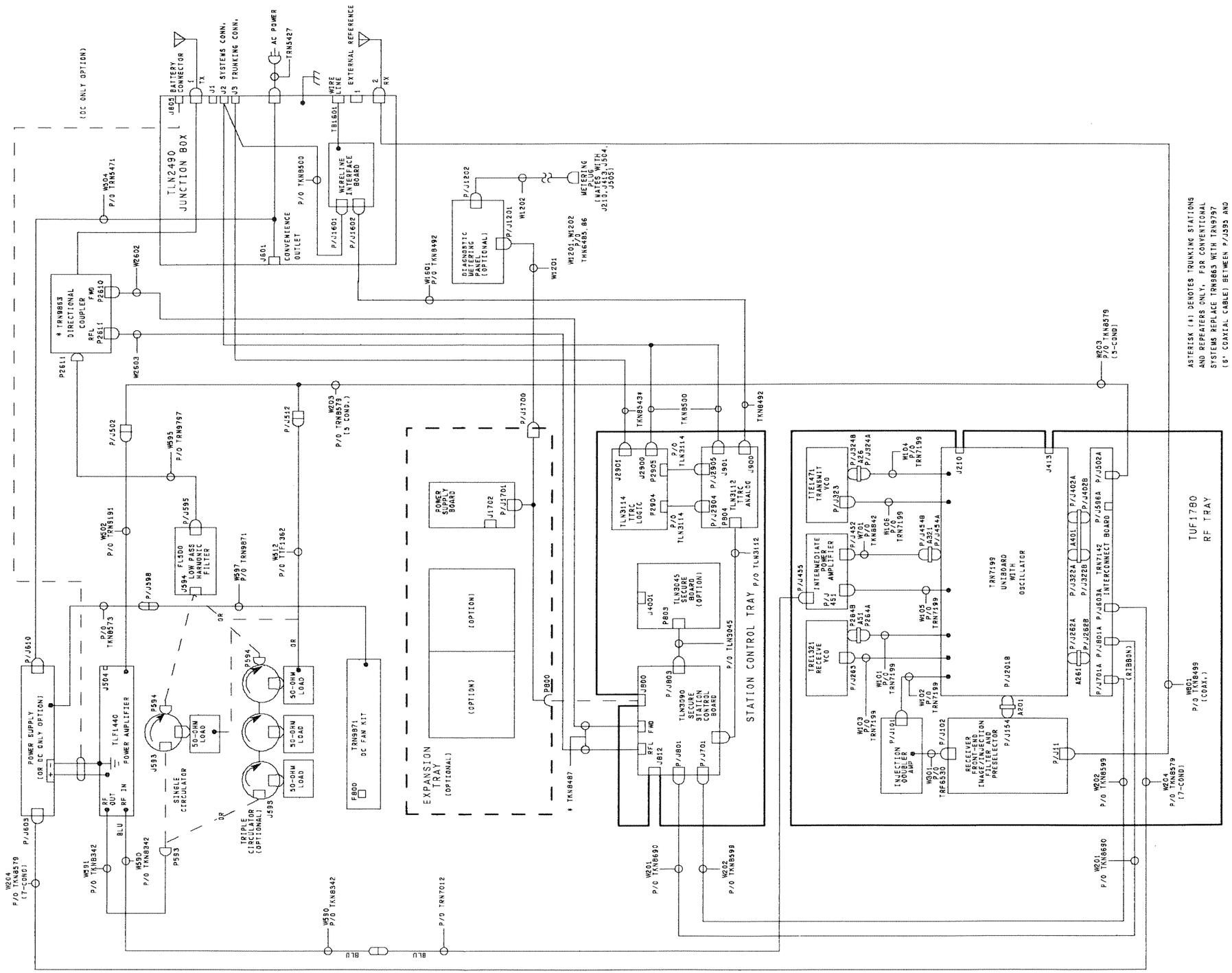


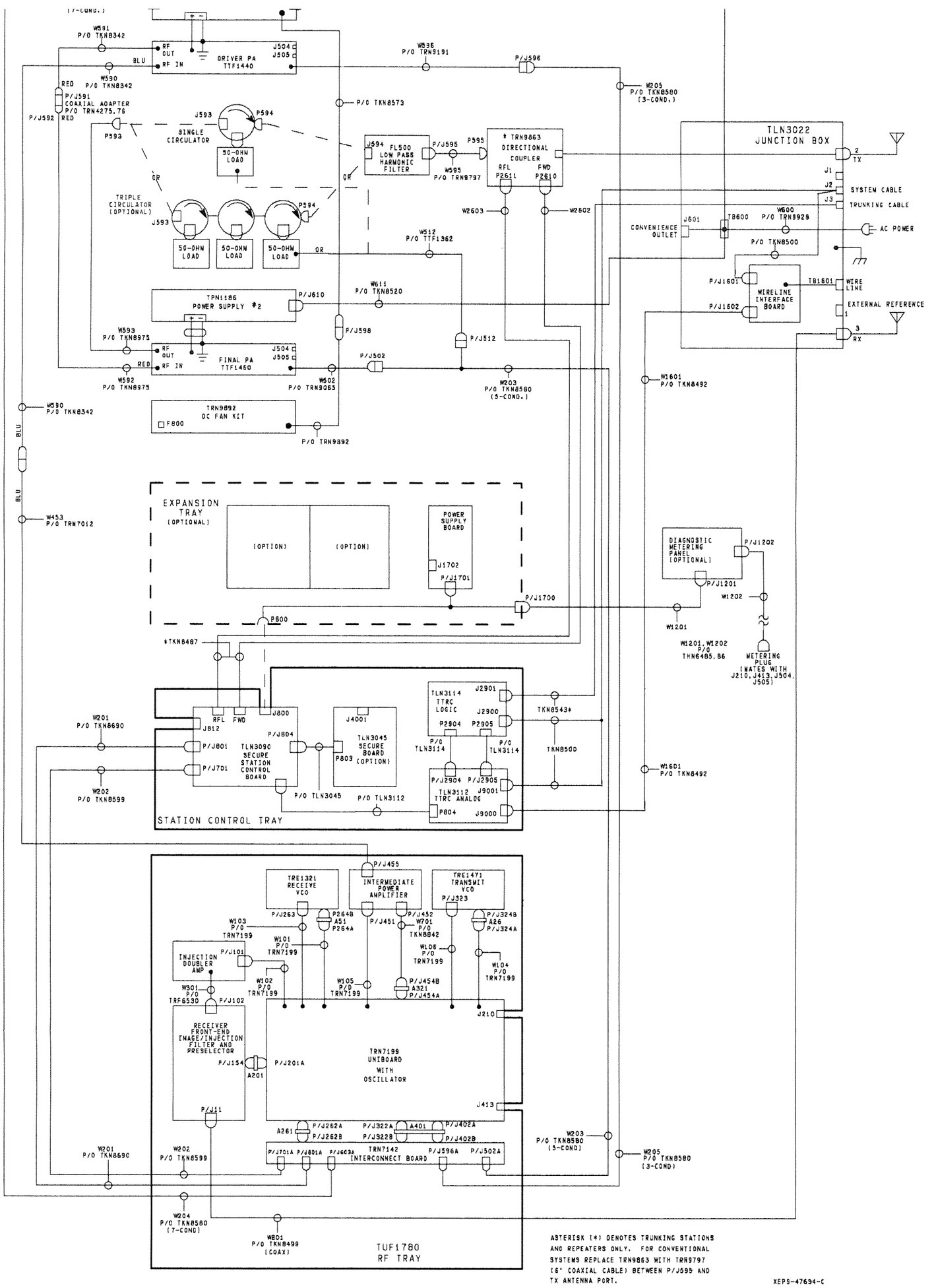
68P81084E49-O
(Sheet 6 of 14)
7/15/90–UP

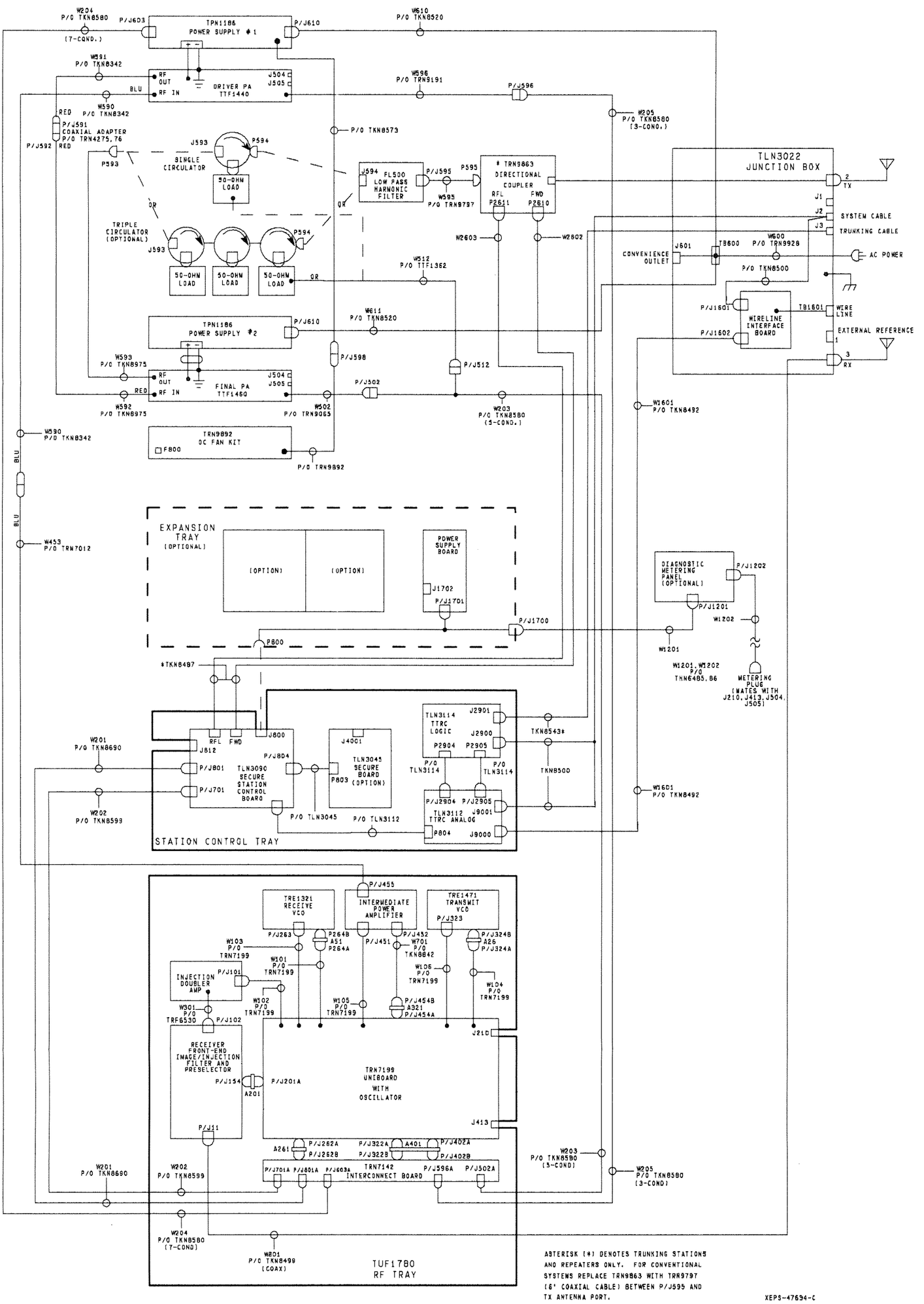


MSF 5000
STATION INTERCABLING
800 MHZ 35 W TRUNKED REPEATER

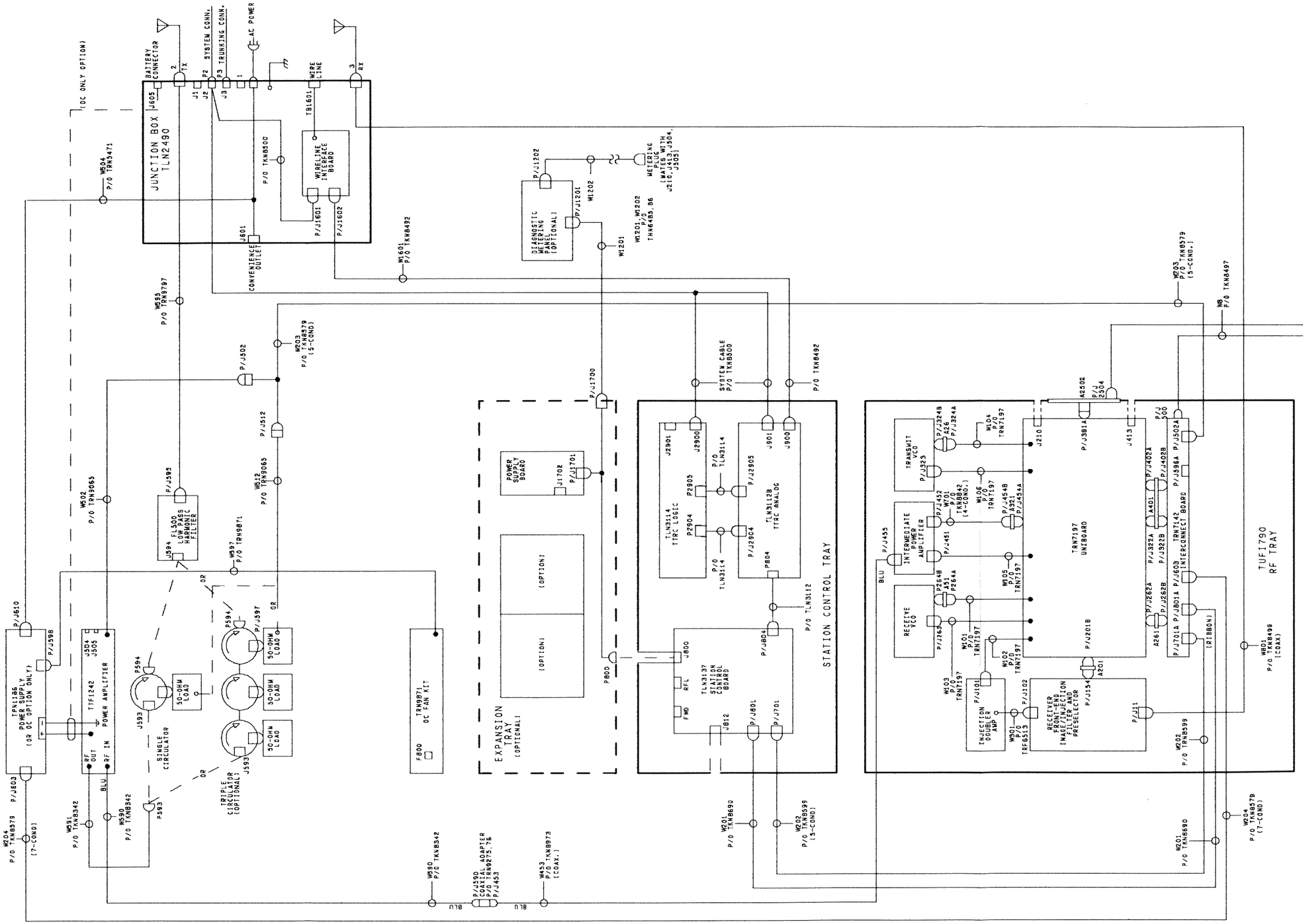
MSF 5000
STATION INTERCABLING
800 MHZ 75 W TRUNKED REPEATER

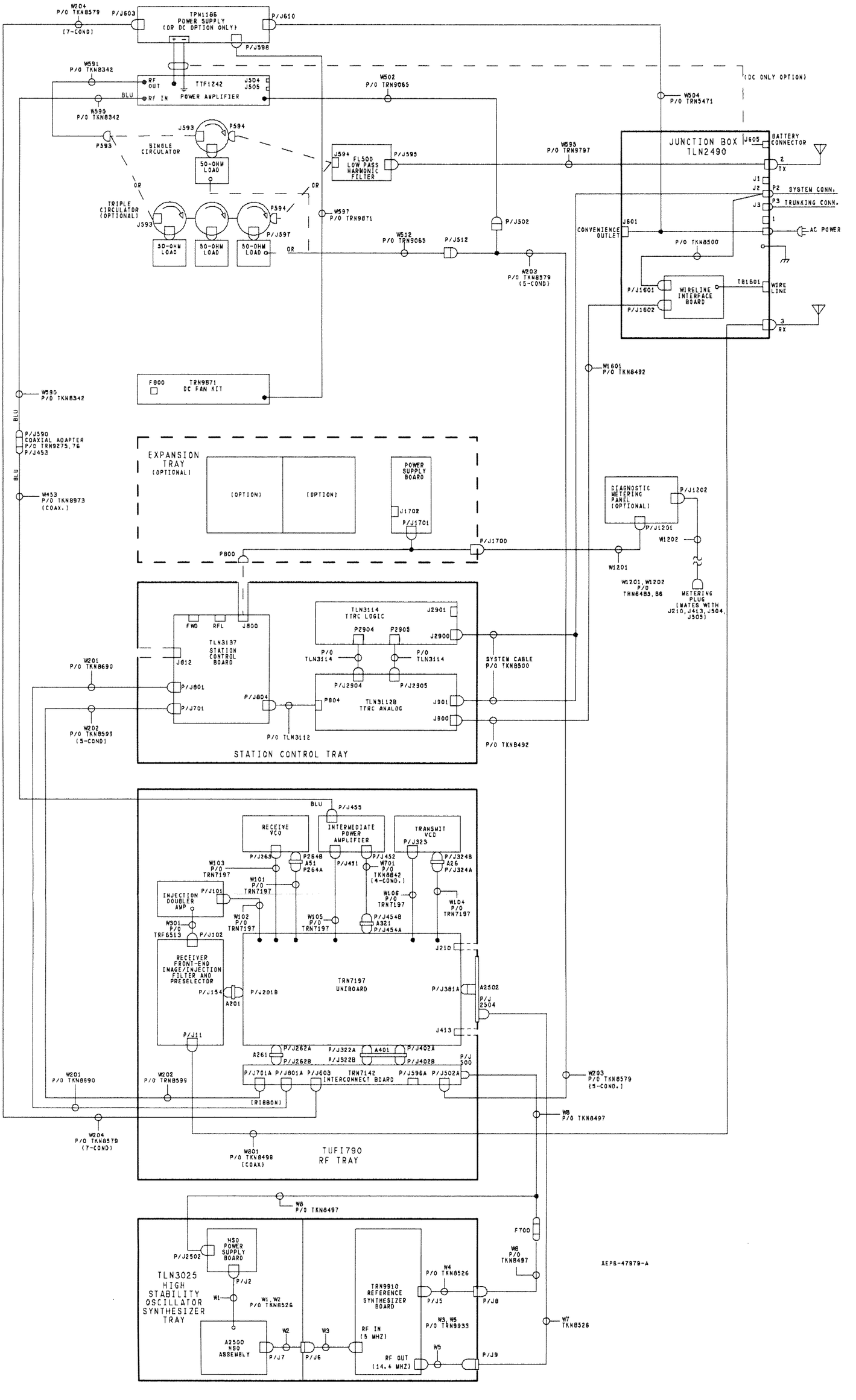


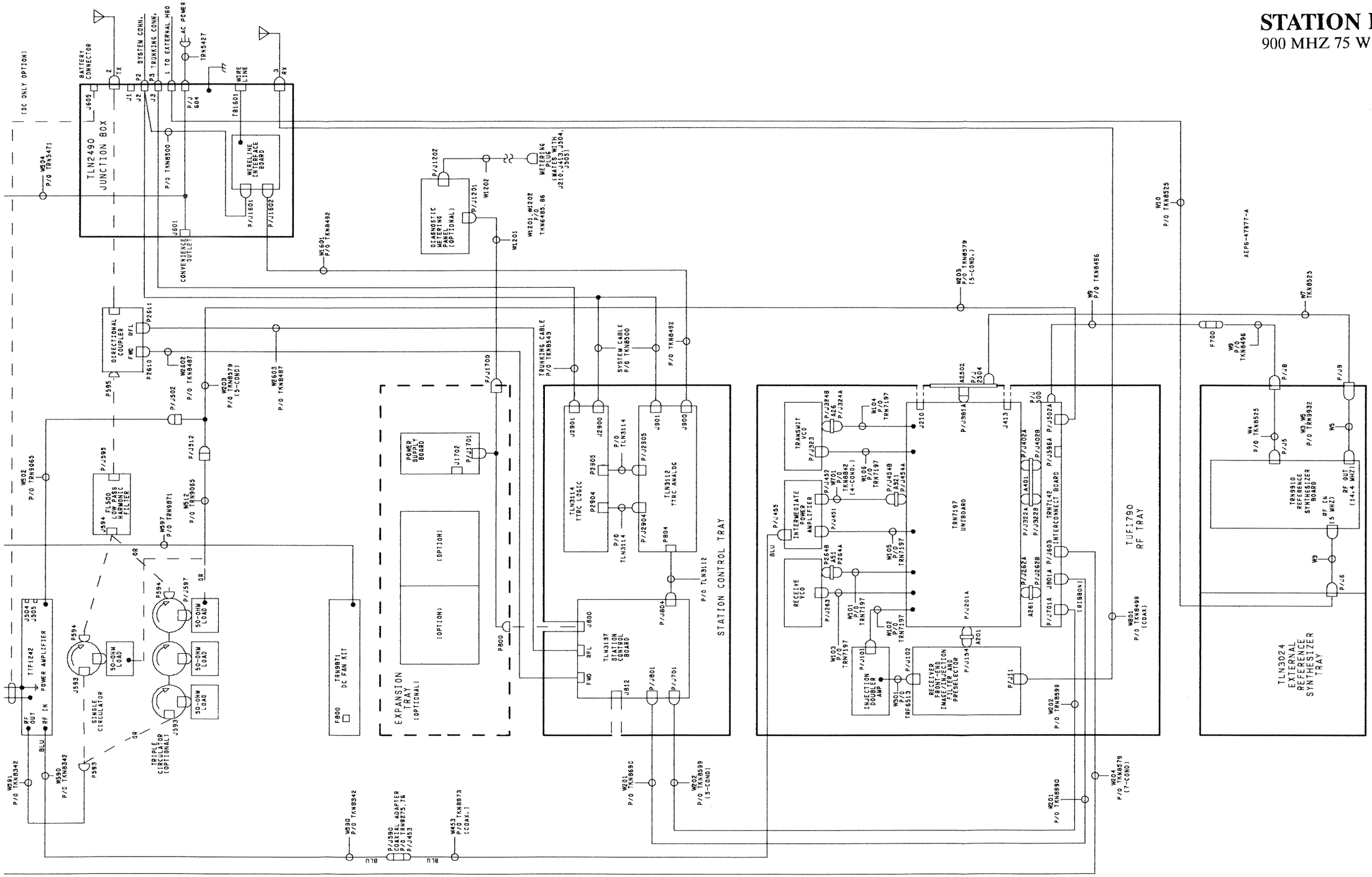

TLN3022
JUNCTION BOX
DRIVER PA
TTF1440
FINAL PA
TTF1460
TPN1186
POWER SUPPLY #2
TRN9892
DC FAN KIT
SINGLE
CIRCULATOR
TRIPLE
CIRCULATOR
(OPTIONAL)
50-OHM
LOAD
FL500
LOW PASS
HARMONIC
FILTER
DIRECTIONAL
COUPLER
COAXIAL ADAPTER
P/O TRN4275,76
CONVENIENCE
OUTLET
SYSTEM CABLE
TRUNKING CABLE
AC POWER
WIRELINE
INTERFACE
BOARD
WIRE
LINE
EXTERNAL REFERENCE
EXPANSION
TRAY
(OPTIONAL)
(OPTION)
POWER
SUPPLY
BOARD
DIAGNOSTIC
METERING
PANEL
(OPTIONAL)
METERING
PLUG
(MATES WITH
J210, J413, J504,
J505)
TLN3090
SECURE
STATION
CONTROL
BOARD
TLN3045
SECURE
BOARD
(OPTION)
TLN3114
TTRC
LOGIC
TLN3112
TTRC ANALOG
STATION CONTROL TRAY
TRE1321
RECEIVE
VCO
INTERMEDIATE
POWER
AMPLIFIER
TRE1471
TRANSMIT
VCO
INJECTION
DOUBLER
AMP
RECEIVER
FRONT-END
IMAGE/INJECTION
FILTER AND
PRESELECTOR
TRN7199
UNIBOARD
WITH
OSCILLATOR
TRN7142
INTERCONNECT BOARD
TUF1780
RF TRAY
ASTERISK (*) DENOTES TRUNKING STATIONS
AND REPEATERS ONLY. FOR CONVENTIONAL
SYSTEMS REPLACE TRN9863 WITH TRN9797
(6' COAXIAL CABLE) BETWEEN P/J595 AND
TX ANTENNA PORT.
XEPS-47694-C

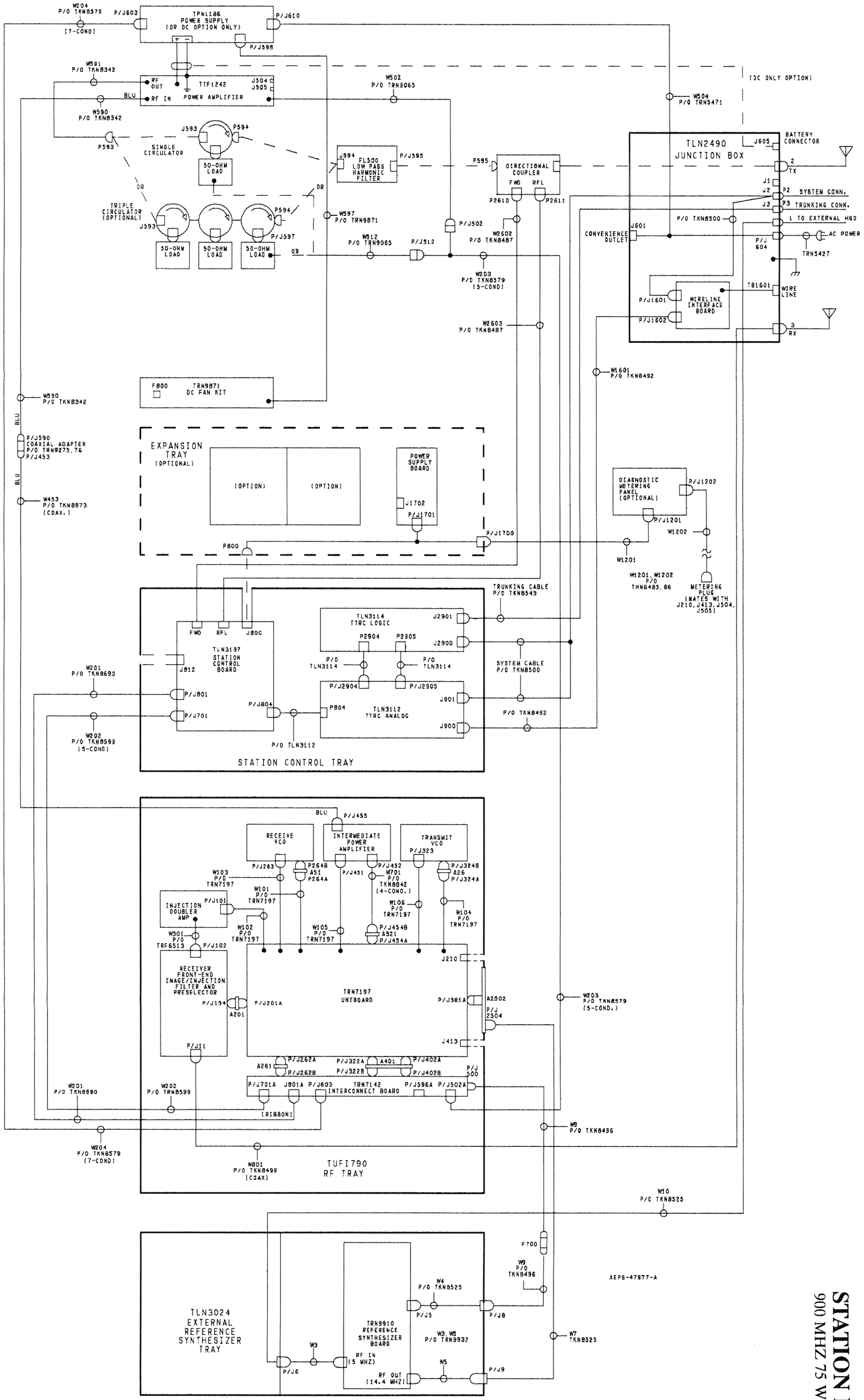

TPN1186 POWER SUPPLY #1
TPN1186 POWER SUPPLY #2
DRIVER PA TTF1440
FINAL PA TTF1460
SINGLE CIRCULATOR
TRIPLE CIRCULATOR (OPTIONAL)
50-OHM LOAD
FL500 LOW PASS HARMONIC FILTER
TRN9863 DIRECTIONAL COUPLER
TLN3022 JUNCTION BOX
TX
SYSTEM CABLE
TRUNKING CABLE
AC POWER
WIRELINE INTERFACE BOARD
WIRE LINE
EXTERNAL REFERENCE
RX
CONVENIENCE OUTLET
TRN9892 DC FAN KIT
EXPANSION TRAY (OPTIONAL)
POWER SUPPLY BOARD
DIAGNOSTIC METERING PANEL (OPTIONAL)
METERING PLUG (MATES WITH J210, J413, J504, J505)
TLN3090 SECURE STATION CONTROL BOARD
TLN3045 SECURE BOARD (OPTION)
TLN3114 TTRC LOGIC
TLN3112 TTRC ANALOG
STATION CONTROL TRAY
TRE1321 RECEIVE VCO
INTERMEDIATE POWER AMPLIFIER
TRE1471 TRANSMIT VCO
INJECTION DOUBLER AMP
RECEIVER FRONT-END IMAGE/INJECTION FILTER AND PRESELECTOR
TRN7199 UNIBOARD WITH OSCILLATOR
TRN7142 INTERCONNECT BOARD
TUF1780 RF TRAY
ASTERISK (*) DENOTES TRUNKING STATIONS AND REPEATERS ONLY. FOR CONVENTIONAL SYSTEMS REPLACE TRN9863 WITH TRN9797 (6' COAXIAL CABLE) BETWEEN P/J595 AND TX ANTENNA PORT.
XEPS-47694-C

MSF 5000
STATION INTERCABLING
900 MHZ 75 W REPEATER



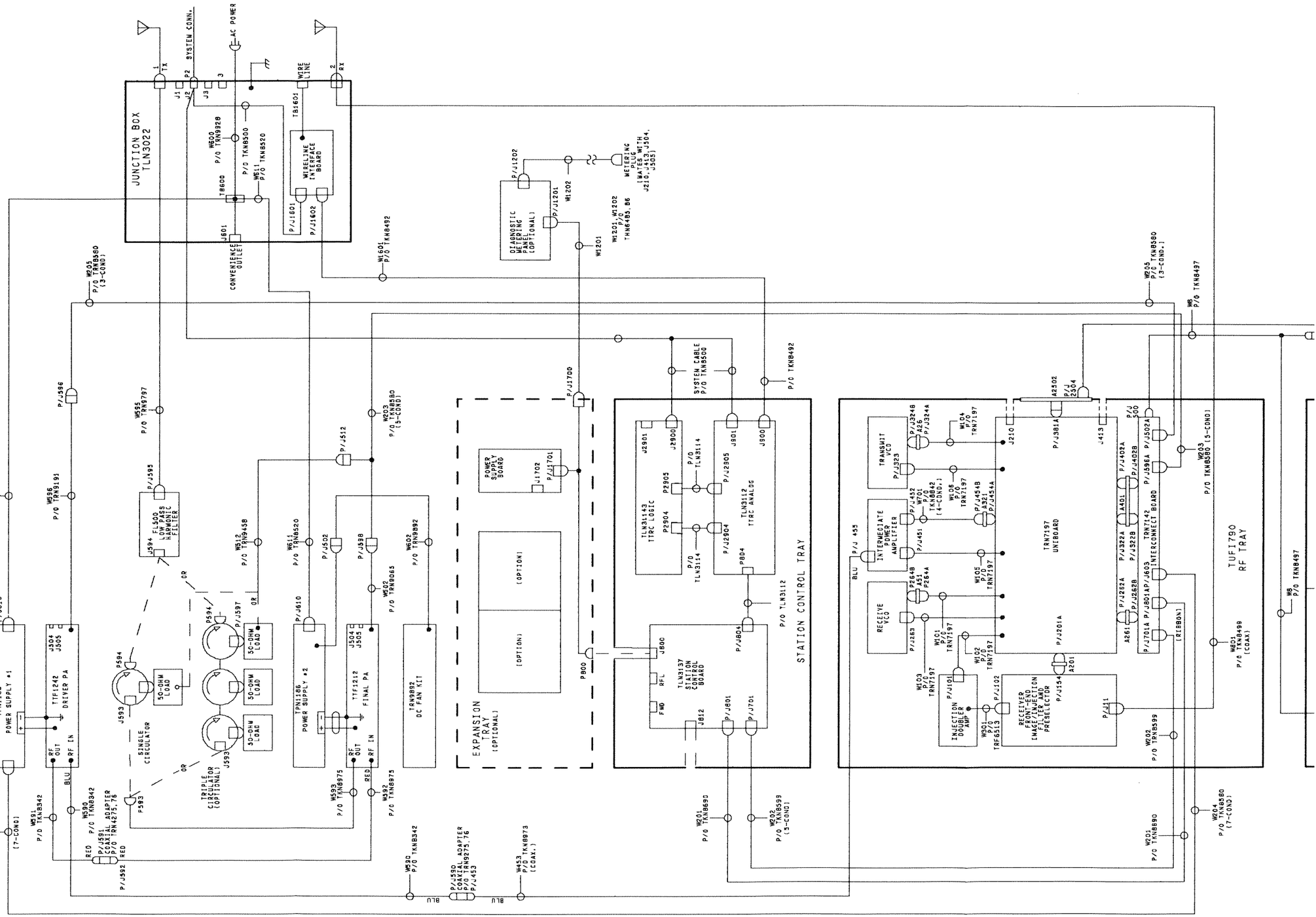

TPN1186
POWER SUPPLY
(OR DC OPTION ONLY)
TTF1242
POWER AMPLIFIER
SINGLE CIRCULATOR
50-OHM LOAD
TRIPLE CIRCULATOR (OPTIONAL)
FL500 LOW PASS HARMONIC FILTER
JUNCTION BOX TLN2490
BATTERY CONNECTOR
SYSTEM CONN.
TRUNKING CONN.
AC POWER
WIRELINE INTERFACE BOARD
WIRE LINE
TRN9871 DC FAN KIT
EXPANSION TRAY (OPTIONAL)
(OPTION)
POWER SUPPLY BOARD
DIAGNOSTIC METERING PANEL (OPTIONAL)
METERING PLUG (MATES WITH J210, J413, J504, J505)
TLN3137 STATION CONTROL BOARD
TLN3114 TTRC LOGIC
TLN3112B TTRC ANALOG
SYSTEM CABLE P/O TKN8500
STATION CONTROL TRAY
RECEIVE VCO
INTERMEDIATE POWER AMPLIFIER
TRANSMIT VCO
INJECTION DOUBLER AMP
RECEIVER FRONT-END IMAGE/INJECTION FILTER AND PRESELECTOR
TRN7197 UNIBOARD
TRN7142 INTERCONNECT BOARD
TUF1790 RF TRAY
H50 POWER SUPPLY BOARD
TLN3025 HIGH STABILITY OSCILLATOR SYNTHESIZER TRAY
A2550D H50 ASSEMBLY
TRN9810 REFERENCE SYNTHESIZER BOARD
RF IN (5 MHZ)
RF OUT (14.4 MHZ)
XEPS-47979-A

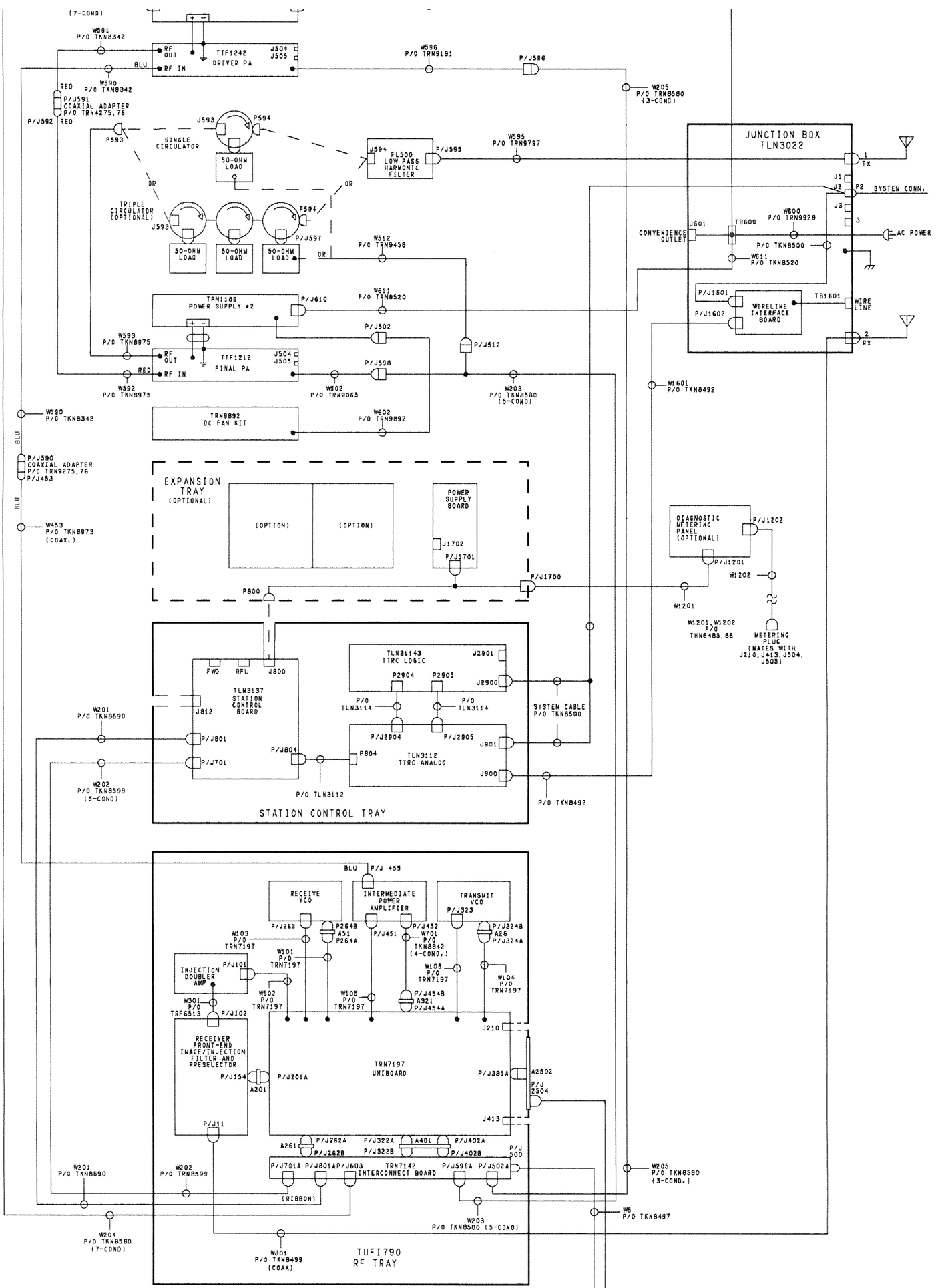

(DC ONLY OPTION)
BATTERY CONNECTOR
J605
2 TX
P1 J1
P2 J2
SYSTEM CONN.
P3 J3
TRUNKING CONN.
1 TO EXTERNAL H&O
AC POWER
TRN5427
P/J 604
WIRE LINE
TB1601
3 RX
TLN2490 JUNCTION BOX
WIRELINE INTERFACE BOARD
P/J1601
P/J1602
P/O TKN8500
J601 CONVENIENCE OUTLET
W534 P/O TRN5471
P/J1202
W1202
W1201
P/J1201
DIAGNOSTIC WIRING PANEL (OPTIONAL)
WIRING PLUG (MATES WITH J210,1304, J305)
W1201, W1202 P/O TKN6485.86
W1601 P/O TKN8492
W10 P/O TKN8525
AEPS-47877-A
W203 P/O TKN8579 (5-COND.)
W9 P/O TKN8496
W7 TKN8525
F700
W8 P/O TKN8496
P/J8
P/J9
W4 P/O TKN8525
P/J5
W3, W5 P/O TRN3932
W5
TRN8910 REFERENCE SYNTHESIZER BOARD
RF IN (15 WHZ)
RF OUT (14.4 MHZ)
W3
P/J6
TLN3024 EXTERNAL REFERENCE SYNTHESIZER TRAY
DIRECTIONAL COUPLER
P2611
FWD
RFL
P2610
P595
P/J502
W2602 P/O TKN8487
W2603 P/O TKN8487
W2603 P/O TKN8579 (5-COND)
P/J1700
TRUNKING CABLE P/O TKN8543
SYSTEM CABLE P/O TKN8500
P/O TKN8492
J2901
J2900
P/O TLN3114
P2305
P2304
P/J2305
P/J2304
J901
J900
TLN3114 TTRC L91C
TLN3112 TTRC ANALOG
P804
P/O TLN3112
STATION CONTROL TRAY
P/J1512
P/J595
W502 P/O TRN9065
J594 TLS00 LOW PASS HARMONIC FILTER
W512 P/O TRN9065
W597 P/O TRN9871
OR
P594
P/J597
50-OHM LOAD
J593
SINGLE CIRCULATOR
TRIPLE CIRCULATOR (OPTIONAL)
J504
J505
TFF1242 POWER AMPLIFIER
RF OUT
RF IN
BLU
W591 P/O TKN8342
W590 P/O TKN8342
P593
F800
TRN9871 DC FAN KIT
EXPANSION TRAY (OPTIONAL)
(OPTION)
POWER SUPPLY BOARD
J1702
P/J1701
P800
J800
RFL
FWD
TLN3197 STATION CONTROL BOARD
J812
P/J801
P/J701
P/J804
W201 P/O TKN8690
W202 P/O TKN8599 (5-COND)
W530 P/O TKN8342
P/J590 P/O TKN8272,78 P/J453
W453 P/O TKN8873 (COAX.)
BLU
TUF1790 RF TRAY
TRANSMIT VCO
P/J323
P/J324B
A26
P/J324A
W104 P/O TRN7197
J210
A2502
P/J
2304
P/J3814
J413
P/J
500
P/J502A
P/J4028
P/J596A
P/J502A
P/J4548
A321
P/J454A
P/J452
W701 P/O TKN8842 (4-COND.)
INTERMEDIATE POWER AMPLIFIER
P/J451
P/J455
W105 P/O TRN7197
TRN7197 UNTBOARD
P/J322A
A401
P/J322B
TRN7142 INTERCONNECT BOARD
P/J603
P/J601A
J601A
P/J2622A
P/J2628
A261
P/J261A
(RIBBON)
RECEIVE VCO
P2648
A51
P2644
P/J263
W101 TRN7197
W103 TRN7197
W102 P/O TRN7197
INJECTION DOUBLER AMP
P/J101
W301 P/O TRF6513
P/J102
RECEIVER FRONT-END INTERCONNECTION FILTER AND PRESELECTOR
P/J194
A201
P/J201A
P/J11
W801 P/O TKN8499 (COAX)
W202 P/O TKN8599
W201 P/O TKN8690
W204 P/O TKN8579 (7-COND)

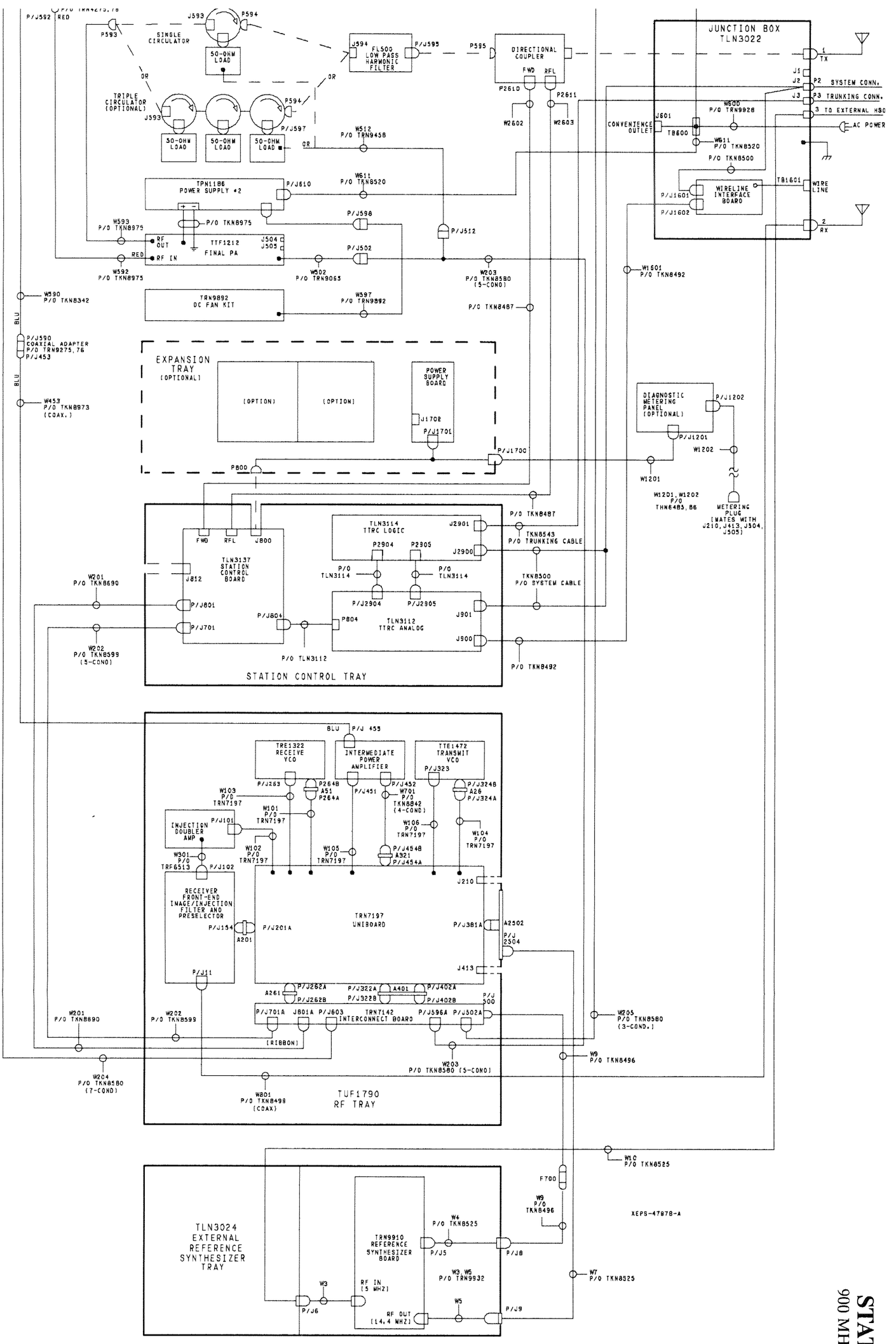


MSF 5000
STATION INTERCABLING
900 MHZ 75 W TRUNKED REPEATER

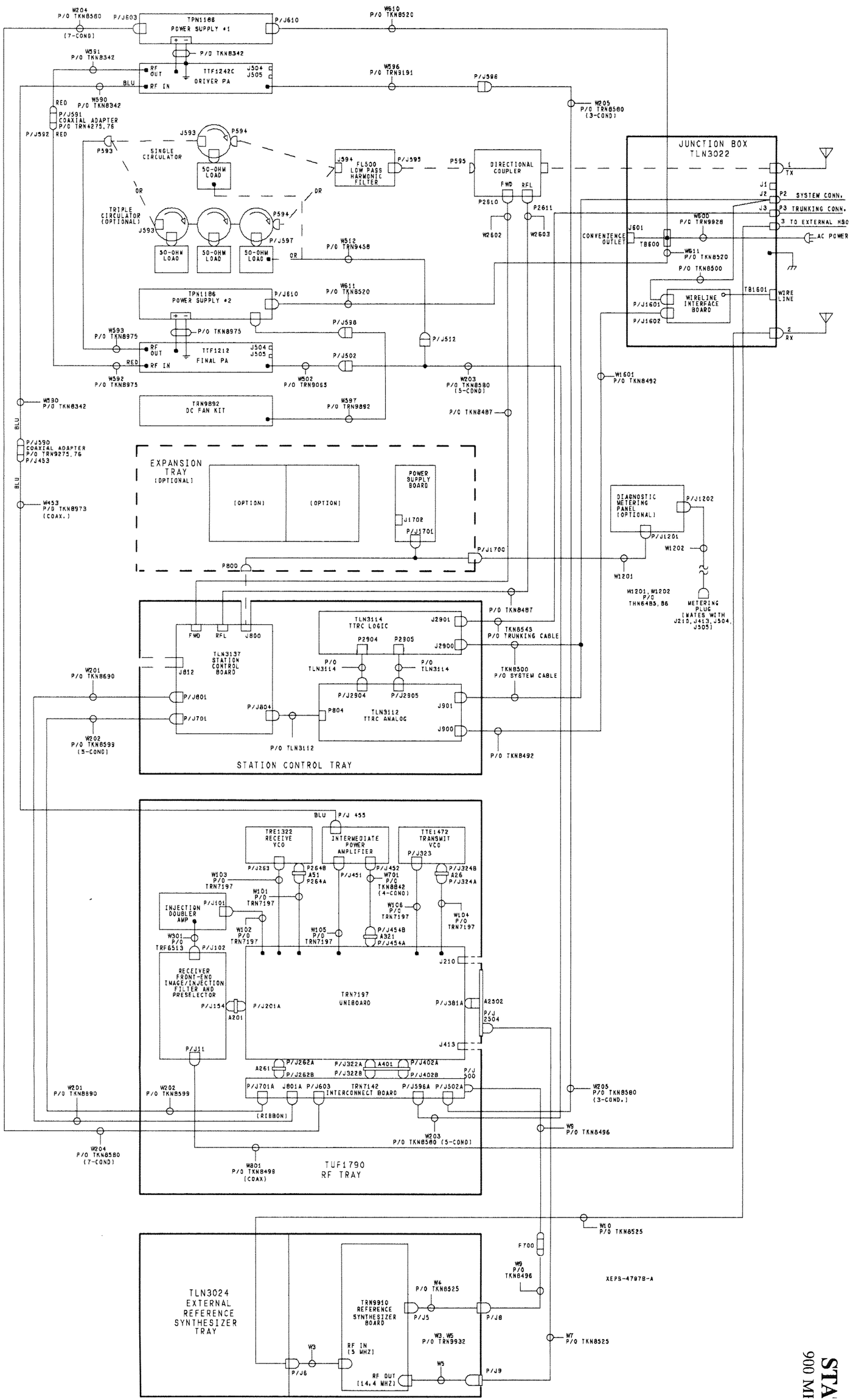
MSF 5000
STATION INTERCABLING
900 MHZ 150 W REPEATER




(7-COND)
W591
P/O TKN8342
RF OUT
RF IN
TTF1242
DRIVER PA
J304
J305
W596
P/O TRN9191
P/J596
W205
P/O TKN8580
(3-COND)
BLU
W590
P/O TKN8342
RED
P/J591
COAXIAL ADAPTER
P/O TRN4275,76
P/J592
SINGLE
CIRCULATOR
J593
P594
P593
50-OHM
LOAD
J594
FL500
LOW PASS
HARMONIC
FILTER
P/J595
W595
P/O TRN9797
OR
TRIPLE
CIRCULATOR
(OPTIONAL)
P/J597
W512
P/O TRN9458
TPN1186
POWER SUPPLY #2
P/J610
W611
P/O TRN8520
P/J502
P/J512
W593
P/O TKN8975
TTF1212
FINAL PA
J504
J505
P/J598
W592
P/O TKN8975
W502
P/O TRN9063
W203
P/O TKN8580
(5-COND)
TRN9892
DC FAN KIT
W602
P/O TRN9892
W530
P/O TKN8342
P/J590
COAXIAL ADAPTER
P/O TRN9275,76
P/J453
W453
P/O TKN8973
(COAX.)
EXPANSION
TRAY
(OPTIONAL)
(OPTION)
(OPTION)
POWER
SUPPLY
BOARD
J1702
P/J1701
P/J1700
P800
JUNCTION BOX
TLN3022
1
TX
J1
J2
P2
SYSTEM CONN.
J3
3
W600
P/O TRN9928
AC POWER
J601
CONVENIENCE
OUTLET
T8600
P/O TKN8500
W511
P/O TKN8520
P/J1601
P/J1602
WIRELINE
INTERFACE
BOARD
TB1601
WIRE
LINE
2
RX
W1601
P/O TKN8492
DIAGNOSTIC
METERING
PANEL
(OPTIONAL)
P/J1202
P/J1201
W1202
W1201
W1201,W1202
P/O
TKN6485,86
METERING
PLUG
(MATES WITH
J210,J413,J504,
J505)
FWD
RFL
J800
TLN3137
STATION
CONTROL
BOARD
J812
W201
P/O TKN8690
P/J801
P/J701
W202
P/O TKN8599
(5-COND)
P/J804
P/O TLN3112
TLN31143
TTRC LOGIC
J2901
P2904
P2905
J2900
P/O
TLN3114
P/O
TLN3114
P/J2904
P/J2905
TLN3112
TTRC ANALOG
J901
J900
SYSTEM CABLE
P/O TKN8500
P/O TKN8492
STATION CONTROL TRAY
BLU
P/J 455
RECEIVE
VCO
INTERMEDIATE
POWER
AMPLIFIER
TRANSMIT
VCO
P/J323
P/J253
P264B
A51
P264A
P/J451
P/J452
W701
P/O
TKN8842
(4-COND.)
P/J324B
A26
P/J324A
W103
P/O
TRN7197
W101
P/O
TRN7197
INJECTION
DOUBLER
AMP
P/J101
W108
P/O
TRN7197
W104
P/O
TRN7197
W102
P/O
TRN7197
W105
P/O
TRN7197
P/J454B
A921
P/J454A
W301
P/O
TRF6513
P/J102
J210
RECEIVER
FRONT-END
IMAGE/INJECTION
FILTER AND
PRESELECTOR
TRN7197
UNIBOARD
P/J154
A201
P/J201A
P/J381A
A2502
P/J
2304
J413
P/J11
A261
P/J262A
P/J262B
P/J322A
P/J322B
A401
P/J402A
P/J402B
P/J
300
P/J701A
P/J801A
P/J603
TRN7142
INTERCONNECT BOARD
P/J596A
P/J502A
(RIBBON)
W205
P/O TKN8580
(3-COND.)
W8
P/O TKN8497
W203
P/O TKN8580 (3-COND)
W204
P/O TKN8580
(7-COND)
W801
P/O TKN8499
(COAX)
TUF1790
RF TRAY
W8
P/O TKN8497
FT00
W8
P/O
TKN8497
H50
POWER
SUPPLY
BOARD
P/J2502
P/J2
TLN3025
HIGH
STABILITY
OSCILLATOR
SYNTHESIZER
TRAY
W1
W1,W2
P/O TKN8526
A2500
H50
ASSEMBLY
P/J7
W2
P/J6
W3
RF IN
(5 MHZ)
RF OUT
(14.4 MHZ)
TRN9910
REFERENCE
SYNTHESIZER
BOARD
W4
P/O TKN8526
P/J5
P/J8
W3,W5
P/O TRN9933
W5
P/J9
W7
TKN8526
XEPS-47976-A

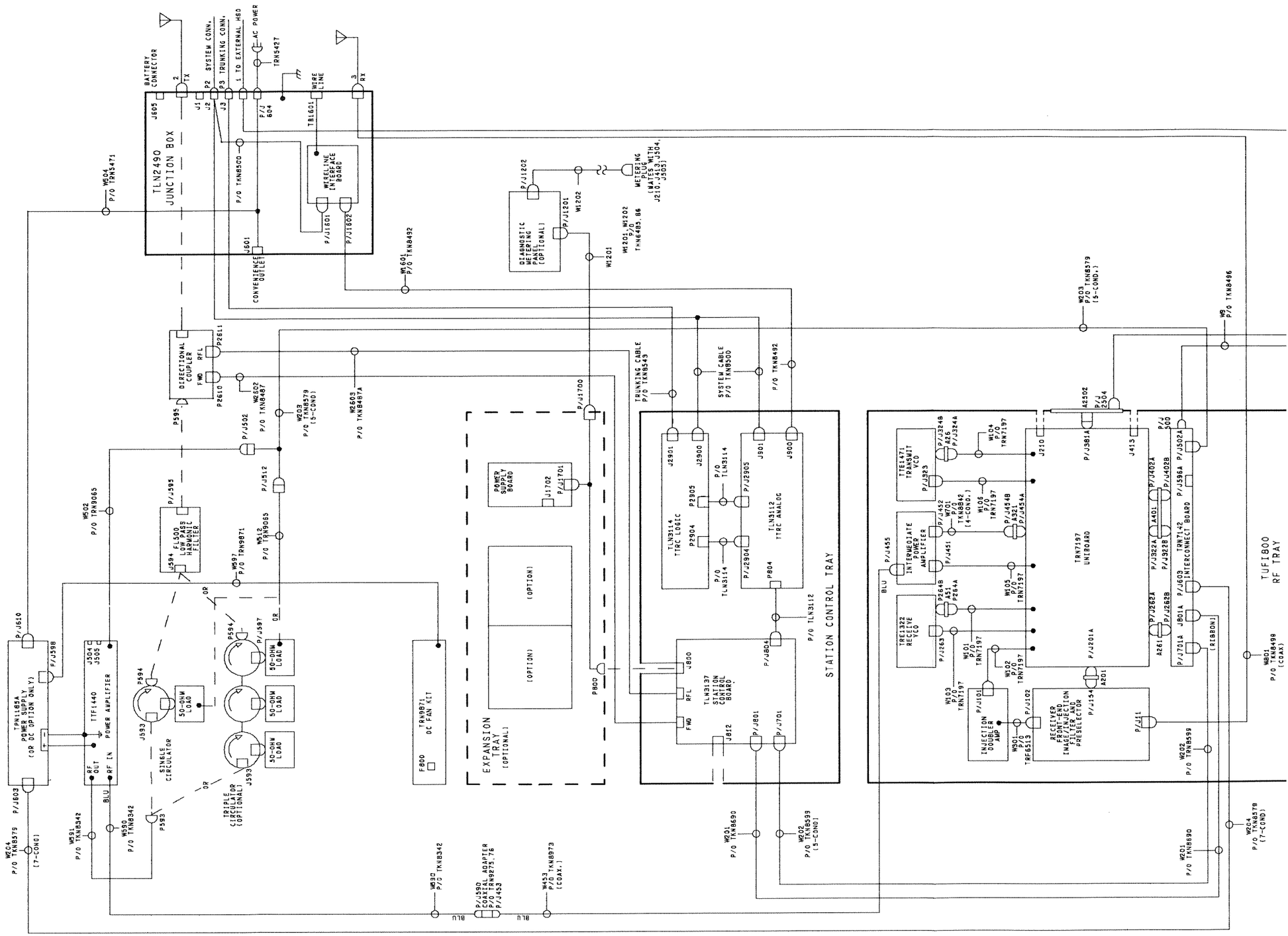


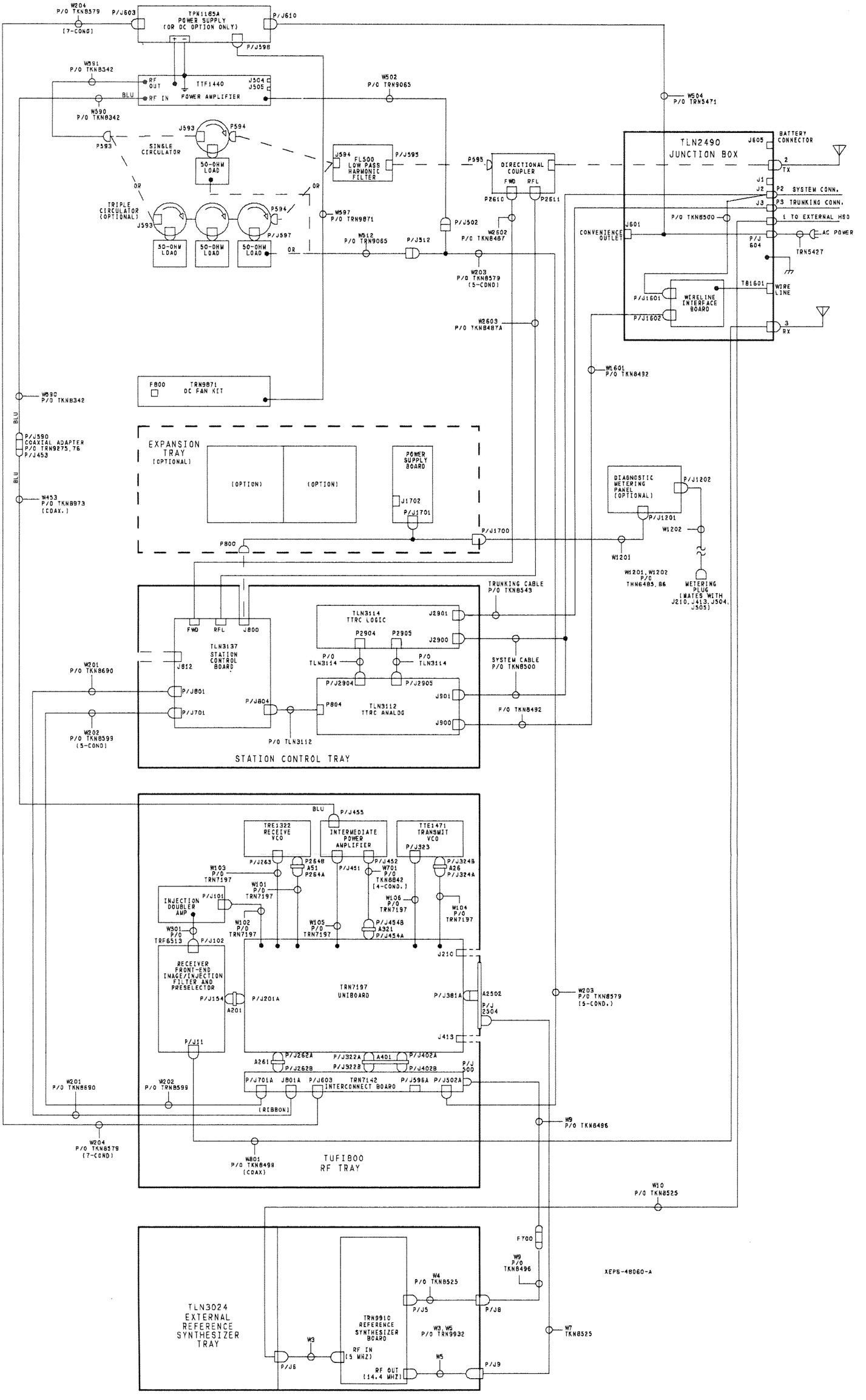
MSF 5000
STATION INTERCABLING
900 MHZ 150 W TRUNKED REPEATER


JUNCTION BOX
TLN3022
TPN1188
POWER SUPPLY #1
TPN1186
POWER SUPPLY #2
TTF1242C
DRIVER PA
TTF1212
FINAL PA
SINGLE CIRCULATOR
TRIPLE CIRCULATOR (OPTIONAL)
50-OHM LOAD
FL500
LOW PASS HARMONIC FILTER
DIRECTIONAL COUPLER
FWD
RFL
TX
RX
SYSTEM CONN.
TRUNKING CONN.
TO EXTERNAL MSO
AC POWER
CONVENIENCE OUTLET
WIRELINE INTERFACE BOARD
WIRE LINE
TRN9892
DC FAN KIT
EXPANSION TRAY
(OPTIONAL)
(OPTION)
POWER SUPPLY BOARD
DIAGNOSTIC METERING PANEL (OPTIONAL)
METERING PLUG
(MATES WITH J210, J413, J504, J505)
TLN3137
STATION CONTROL BOARD
TLN3114
TTRC LOGIC
TLN3112
TTRC ANALOG
STATION CONTROL TRAY
TRE1322
RECEIVE VCO
INTERMEDIATE POWER AMPLIFIER
TTE1472
TRANSMIT VCO
INJECTION DOUBLER AMP
RECEIVER FRONT-END IMAGE/INJECTION FILTER AND PRESELECTOR
TRN7197
UNIBOARD
TRN7142
INTERCONNECT BOARD
(RIBBON)
TUF1790
RF TRAY
TLN3024
EXTERNAL REFERENCE SYNTHESIZER TRAY
TRN9910
REFERENCE SYNTHESIZER BOARD
RF IN (5 MHZ)
RF OUT (14.4 MHZ)
XEPS-47978-A

STA
900 MI

MSF 5000
STATION INTERCABLING
900 MHZ 75 WATT J–TRUNKING REPEATER




TPN1185A
POWER SUPPLY
(OR DC OPTION ONLY)
TTF1440
POWER AMPLIFIER
SINGLE CIRCULATOR
TRIPLE CIRCULATOR (OPTIONAL)
50-OHM LOAD
FL500
LOW PASS HARMONIC FILTER
DIRECTIONAL COUPLER
TLN2490
JUNCTION BOX
BATTERY CONNECTOR
SYSTEM CONN.
TRUNKING CONN.
TO EXTERNAL HSO
CONVENIENCE OUTLET
AC POWER
WIRELINE INTERFACE BOARD
WIRE LINE
TRN9871
DC FAN KIT
EXPANSION TRAY
(OPTIONAL)
(OPTION)
POWER SUPPLY BOARD
DIAGNOSTIC METERING PANEL (OPTIONAL)
METERING PLUG
(MATES WITH J210, J413, J504, J505)
TRUNKING CABLE
SYSTEM CABLE
TLN3137
STATION CONTROL BOARD
TLN3114
TTRC LOGIC
TLN3112
TTRC ANALOG
STATION CONTROL TRAY
TRE1322
RECEIVE VCO
INTERMEDIATE POWER AMPLIFIER
TTE1471
TRANSMIT VCO
INJECTION DOUBLER AMP
RECEIVER FRONT-END IMAGE/INJECTION FILTER AND PRESELECTOR
TRN7197
UNIBOARD
TRN7142
INTERCONNECT BOARD
(RIBBON)
TUF1800
RF TRAY
TLN3024
EXTERNAL REFERENCE SYNTHESIZER TRAY
TRN9910
REFERENCE SYNTHESIZER BOARD
RF IN (5 MHZ)
RF OUT (14.4 MHZ)
XEPS-48060-A

MOTOROLA INC.
Communications Sector

SAFE HANDLING OF CMOS INTEGRATED CIRCUIT DEVICES

Many of the integrated circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open circuit impedance, CMOS ICs are vulnerable to damage from static charges. Care must be taken in handling, shipping, and servicing them and the assemblies in which they are used.

Even though protection devices are provided in CMOS IC inputs, the protection is effective only against overvoltage in the hundreds of volts range such as are encountered in an operating system. In a system, circuit elements distribute static charges and load the CMOS circuits, decreasing the chance of damage. *However, CMOS circuits can be damaged by improper handling of the modules even in a system.*

To avoid damage to circuits, observe the following handling, shipping, and servicing precautions.

1. Prior to and while servicing a circuit module, particularly after moving within the service area, momentarily touch *both* hands to a bare metal earth grounded surface. This will discharge any static charge which may have accumulated on the person doing the servicing.

NOTE
Wearing Conductive Wrist Strap (Motorola No. RSX-4015A) will minimize static buildup during servicing.

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

2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.

3. Normally, circuit modules can be inserted or removed with power applied to the unit. However, check the INSTALLATION and MAINTENANCE sections of the manual as well as the module schematic diagram to insure there are no objections to this practice.

4. When servicing a circuit module, avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) because they contribute to static buildup.

5. All electrically powered test equipment should be grounded. *Apply* the *ground lead* from the test equipment to the circuit module *before* connecting the *test probe*. Similarly, *disconnect* the *test probe prior* to removing the *ground lead.*

6. If a circuit module is removed from the system, it is desirable to lay it on a conductive surface (such as a sheet of aluminum foil) which is connected to ground through 100k of resistance.

WARNING
If the aluminum foil is connected directly to ground, be cautious of possible electrical shock from contacting the foil at the same time as other electrical circuits.

7. When soldering, be sure the soldering iron is grounded.

8. Prior to connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary in the replacement of an integrated circuit device), be sure to discharge any static buildup as described in procedure 1. Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch pins on the CMOS device and associated board wiring.

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9. When replacing a CMOS integrated circuit device, leave the device in its metal rail container or conductive foam until it is to be inserted into the printed circuit module.

10. All low impedance test equipment (such as pulse generators, etc.) should be connected to CMOS device inputs after power is applied to the CMOS circuitry. Similarly, such low impedance equipment should be disconnected before power is turned off.

11. Replacement modules shipped separately from the factory will be packaged in a conductive material. Any modules being transported from one area to another should be wrapped in a simlar material (aluminum foil may be used). NEVER USE NON-CONDUCTIVE MATERIAL for packaging these modules.

MOTOROLA INC.
Communications
Sector

SITE ALIGNMENT and ROUTINE MAINTENANCE

1. GENERAL

This section contains the site alignment checks, level sets, and maintenance information for all bands of the Digital and Analog Plus *MSF 5000* station. This information is provided for use at station installation time and for periodic maintenance thereafter. This section does not cover rf tuning or troubleshooting. See the appropriate service manual for these activities or other details not covered in this section.

2. TEST EQUIPMENT

The site alignment check and level set procedure requires the following test equipment:

- *R2000* series Service Monitor
- *MSF 5000* Diagnostic Metering Panel (DMP)
- HP3552A transmission test set (or equivalent for setting transmit and receive wireline signals with a 600 ohm terminating impedance)

3. PRELIMINARY CONSIDERATIONS and SET-UP

3.1 GENERAL

The procedures described below assume that the Technician has basic knowledge of the operation of the Digital *MSF 5000* station. If this is not the case, read the Description/Operation section of this manual first.

The following procedures do not apply to stations equipped with option C777 (Simulcast), since these systems usually require system dependent alignment procedures. Refer to the Option Manual or the appropriate system manual for more information on the setup of Simulcast systems.

All deviation levels should be checked by measuring the highest positive or negative peak deviation, whichever is greater, on a modulation analyzer or service monitor.

All 600 ohm wireline inputs and outputs must be properly terminated with 600 ohms when making measurements.

Trunking stations must be aligned while connected to an operational Trunking Central Controller. Disable the station at the Trunking Central Controller.

3.2 LEVEL SETTING

Most of the level setting potentiometers in the *MSF 5000* control tray are digitally controlled, solid state nonvolatile potentiometers referred to as EEPOTs. These EEPOTs can be manipulated by using the *MSF 5000* Field Programmer or through a front panel switch toggling sequence. Use the following procedure to utilize the EEPOT setting mode from the front panel:

Step 1. Verify that all front panel switches are in their normal positions. The station should not be in PL DISABLE or ACCESS DISABLE.

Step 2. Hold the SELECT/SET switch in the SET position, and then move the PL DIS/XMIT switch to the PL DIS position. Be sure to move and hold the SET switch before the PL DIS switch. While both switches are active, three digits on the front panel STATUS display will show EEP.

Step 3. Release the SET switch, and then return the PL DIS switch to the normal position. After a few seconds, the leftmost digit of the STATUS display will show a 0 which represents the EEPOT hex number (0 through hex No. F). The other two digits will show a decimal value from 00 to 99 which represents the current wiper position of the EEPOT.

Step 4. Toggle the SELECT/SET switch to the SELECT position. A decimal point on the display will light. Toggle the switch again to move the decimal point from one digit to another. Set the decimal point to the leftmost digit. Now toggle the switch to the SET position. Toggling to

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the SET position scans the current settings of the EEPOTs. A delay between toggles of more than 5 seconds times out the decimal point. To bring the decimal point back, toggle to the SELECT position. However, if the SET position is toggled after the decimal point times out, the display will exit the EEPOT setting mode and revert to normal operation. To re-enter the EEPOT mode, return to Step 1.

Step 5. Select the desired EEPOT (see Table 1 or the alignment procedure), and move the decimal point to the next (tens) digit. Toggle to the SET position while monitoring the output you are trying to adjust. When the output gets close to the required level, move the decimal to the third (ones) digit, and fine tune to the required level. If you overshoot the required level, scroll the wiper through position 99, and try it again. The EEPOTs can be adjusted only in one direction from the front panel. When using the field programmer's alignment screens, the EEPOTs may be adjusted in either direction.

Table 1. EEPOT Functions

EEPOT Number	EEPOT Function	EEPOT Number	EEPOT Function
0*	Coded Rx Level	8	Status Tone Level
1	Flutter Fighter Level	9	High End Equalization Level
2	Repeater Squelch Level	A	Low End Equalization Level
3	Receiver Squelch Level	b	Trunking Data Level
4	Max Deviation Level	C	Line 2 Output Level
5	Rx Level	d	Line 4 Output Level
6*	Coded Deviation Level	E	Tx Coarse Level
7	Tx Audio Level		

*Not used on Analog Plus models.

4. SITE ALIGNMENT PROCEDURE

The following station site alignment procedure contains 14 separate sub-procedures. It is recommended that the entire procedure be followed in sequence upon station installation. Some sub-procedures are option-dependent, and might be skipped. The following procedure may also be found in the alignment screens of the field programmer.

4.1 BATTERY CHARGER VOLTAGE CHECK PROCEDURE

If the station is not equipped with option C28 (Battery Charging), proceed to the Frequency Adjustment Procedure.

Step 1. Verify that the station is not transmitting. Disconnect the batteries from the station at J605 on the junction box. Set the FLOAT/EQUALIZE switch (S650) on the power supply board to the FLOAT position.

Step 2. Adjust VOLTAGE SET POT (R662) on the power supply board to set the voltage at the battery connector of the Junction Box. For optimum performance use the manufacturer's recommended battery voltage. Table 2 should only be used as a general guide for room temperature conditions. Voltages in parentheses are for VHF stations using the 24V output post on J605.

Table 2. Battery Charging Voltages

Battery Type	Voltage
Lead Acid	13.25 V (26.50 V)
Nicad	14.25 V (28.50 V)
Gel-Cell	13.50 V (27.00 V)
No Batteries	14.25 V (28.50 V)

Step 3. Reconnect the batteries to J605 on the Junction Box observing the polarity of the connector. Leave the FLOAT/EQUALIZE switch in the FLOAT position.

CAUTION

When connecting discharged batteries to the station, set the battery charger voltage as described above, then allow the batteries to charge for at least three hours before attempting to key the station.

NOTE

Although the batteries will recharge slowly with the FLOAT/EQUALIZE switch in the FLOAT position, it is recommended that the switch be placed in the EQUALIZE position for about 24 hours periodically (every 3-4 months, or after heavy use) to fully charge the batteries.

4.2 FREQUENCY ADJUSTMENT PROCEDURE

The station requires a minimum warm-up period of 60 minutes if it is equipped with option C573 (High Stability Oscillator), or if it is a conventional Analog Plus model. When the station is equipped with option C574 (External Reference), or if it is a trunking Analog Plus model, make sure that the frequency reference device is fully warmed up. When using a frequency measuring device, make certain that the accuracy is better than or equal to 10 times the stability of the station.

Step 1. If the station is equipped with option C574 (External Reference), or if it is a trunking Analog Plus model, apply the 5 MHz reference signal to the EXTERNAL REFERENCE input on the station junction box.

Step 2. If the station is equipped with option C574 (External Reference), C573 (High Stability Oscillator), or if the station is an Analog Plus model, adjust U1 on the reference synthesizer board for 1.5 ± 0.1 Volts at TP1.

Step 3. Set the front panel ACC DIS/RESET switch to the ACC DIS position.

Step 4. Attenuate the transmitted rf signal from the station and connect it to the frequency measuring device.

Step 5. Key the station by setting the LOC PTT MUXbus bit. Measure the transmitter carrier frequency.

Step 6. If the station is equipped with option C574 (External Reference) or C573 (High Stability Oscillator) and the frequency is out of alignment, or if the station is an Analog Plus model, refer to the appropriate alignment procedure. Proceed to Step 8.

Step 7. If necessary, adjust the rf tray front panel Fo FREQ ADJ warp control to set the measured transmit frequency within the rated station frequency tolerance. On some stations, this adjustment is made through the top of the rf tray cover, instead of through the front panel.

Step 8. De-key the station by clearing the LOC PTT MUXbus bit.

4.3 MODULATION COMPENSATION ADJUSTMENT PROCEDURE

Step 1. Place the front panel ACC DIS/RESET switch in the ACC DIS position.

Step 2. Set the station to the tuning channel (channel 0) by setting the SELECT/SET switch to the SELECT position to select the Chan digit and then toggling the SELECT/SET switch to the SET position until the Chan digit reads 0.

Step 3. If the station is a trunking station, disconnect the cable to the Trunking Connector (J3) of the Junction Box.

Step 4. Key the station by setting the LOC PTT MUXbus bit and monitor the transmitter waveform. The waveform should consist of the DPL code word 031.

Step 5. Examine the waveform for straightness of the long transitions. These long transitions should be as straight as possible. The transition may have a slope, but it should be a constant slope. See Figure 1.

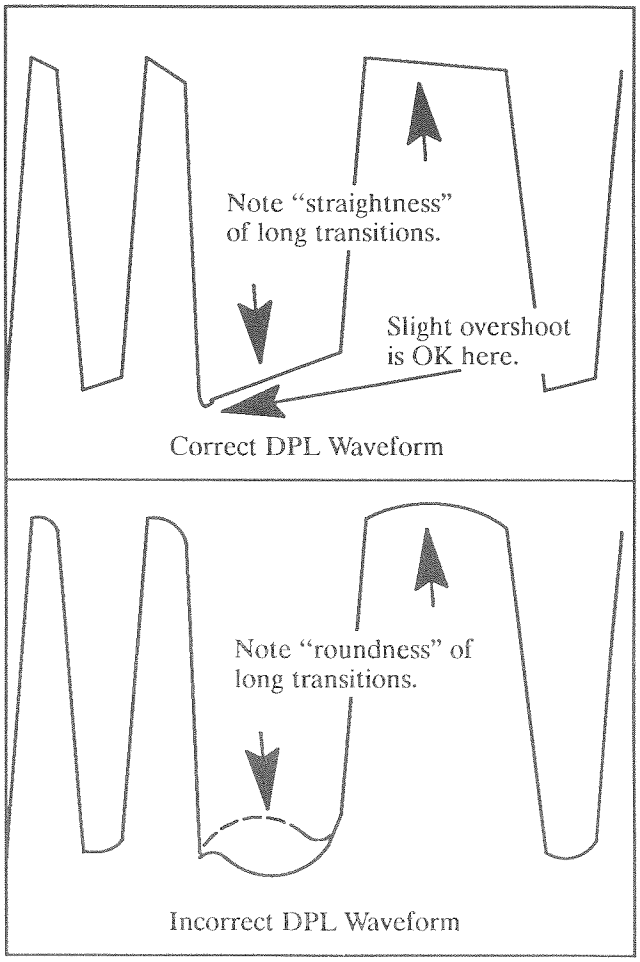

Figure 1. Modulation Compensation Waveforms

Step 6. If adjustment of the modulation compensation network is required, remove the rf tray cover and adjust R358 on the uniboard for best waveform.

Step 7. Replace the rf tray cover (if removed) and de-key the station by clearing the LOC PTT MUXbus bit. Reconnect the Trunking cable to the Trunking Connector (J3) of the Junction Box if removed in Step 3. Set the station to the desired operating channel, and return the ACC DIS switch to its center (off) position.

4.4 TRUNKING DATA DEVIATION ADJUSTMENT PROCEDURE

Perform this sub-procedure only if this is a Trunked station. Otherwise, proceed to the Transmitter Max Deviation Adjustment Procedure.

Step 1. With an operational Trunking Central connected to the station, key the station by setting the LOC PTT MUXbus bit and monitor the transmitted deviation level. The front panel FAILSOFT LED should not be lit. The station must not be the trunking control channel. If the station is an AMSS control channel, then select the alternate control channel in order to perform Step 2 using the disconnect word.

Step 2. Measure the Trunking Data Deviation level and compare it to Table 3. If this level is out of adjustment, set it using EEPOT No. b. Note that the data being transmitted is disconnect word.

Step 3. De-key the station by clearing the LOC PTT MUXbus bit.

Step 4. Disconnect the trunking cable from junction box connector J3 to remove the TDATA and MUTE signals and put the station into Failsoft. The station should key with the front panel FAILSOFT LED lit. (This may take up to 72 seconds in certain systems.)

Step 5. Measure the Failsoft Data Deviation level and compare it to Table 3. If this level is out of adjustment, set it using EEPOT No. b. (Note: Ignore deviation caused by the failsoft tone.)

Step 6. If an adjustment was made in Step 5, repeat Step 1 through Step 5. The adjustments in Step 2 and Step 5 both change the same EEPOT. If both adjustments cannot be made within the ± 100 Hz spec, see the service manual for troubleshooting information.

Step 7. Re-connect the trunking cable to J3 on the junction box. The station should de-key and the FAILSOFT LED indicator should turn off. (This may take up to 72 seconds in certain systems.)

Table 3. Deviation Settings

Deviation Adjustment	Frequency Range		
	VHF, UHF, & 800 MHz (kHz)	866–869 MHz (kHz)	J-Trunking & 900 MHz (kHz)
100% Full System Deviation	5	4	2.5
Max Station Deviation	4.6	3.7	2.3
60% Full System Deviation	3	2.4	1.5
40% Full System Deviation	2	1.6	1.0
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	None

Note: All deviation measurements and settings must be within ± 100 Hz, except where noted.

4.5 TRANSMITTER MAX DEVIATION ADJUSTMENT PROCEDURE

Each station channel must have the Max Deviation level measured and set individually since this level is channel-slaved. It is not necessary to check the tuning channel (channel 0) deviation levels.

Step 1. Inject a 1 kHz tone at a 1 Vrms closed circuit level into the MIC AUDIO (J812-3) input on the front panel Control jack or via TP8 on the SSCB. This is a 600 ohm input.

Step 2. Set the ACC DIS MUXbus bit using the Diagnostic Metering Panel (DMP).

Step 3. Select channel 1 on the Status display by toggling the SELECT switch to move the decimal point to the Chan digit. Toggle the SET switch until a 1 appears in the Chan digit.

Step 4. Locally key the station by grounding TP9 (or J812-4) on the station control board.

IMPORTANT

If the station is in a trunking system or is equipped with PL or DPL coded squelch, the transmit signal will consist of Mic Audio summed in with TDATA or the coded squelch signal. Do not use the front panel XMIT switch to key the station because it will strip off the TDATA and coded squelch signals from the transmitted signal.

Step 5. Measure the Max Station Deviation level and compare it to Table 3. If the level is out of adjustment, set it using EEPOT No. 4.

Step 6. De-key the station by clearing the LOC PTT MUXbus bit.

Step 7. If the station has multiple channels (excluding tuning channel 0), exit the EEPOT mode, increment the channel number and repeat Step 4 through Step 6 until all channels have been checked.

Step 8. Set the station to the desired operating channel and return the ACC DIS switch to its center (off) position.

4.6 TRANSMIT WIRELINE AUDIO ADJUSTMENT PROCEDURE

Step 1. Inject a 1 kHz tone from the console or remote device at the desired level (maximum allowable phone line level, typically 0 dBm to –10 dBm), through the wireline into the station transmit wireline interface. The transmit wireline interface for a four wire system is across Line 1 (+) and Line 1 (–) on the junction box screw terminal strip. The transmit wireline interface for a two wire system is across Line 2 (+) and Line 2 (–) on the junction box screw terminal strip. These are 600 ohm balanced inputs.

Step 2. Gate the wireline audio to the transmitter by setting the LIN PTT MUXbus bit.

Step 3. If this is a trunking station, key the transmitter with a trunking PTT. This is accomplished by disconnecting the trunking cable from the junction box connector J3 or by connecting a wire jumper from pin 8 of J2901 on the TTRC logic board to ground. Pins 1 and 2 are ground on J2901. A trunking PTT generated in this fashion (by disconnecting J3) may take 72 seconds for certain systems.

Step 4. Enter the EEPOT adjust mode and then hold the front panel PL DIS/XMIT switch in the XMIT position throughout this procedure.

Step 5. Adjust the Wireline TX Level (EEPOT No. 7) until the transmitted deviation level reaches 60% Full System Deviation (see Table 3). If the station is equipped with option C101 (DC remote) or is a trunking station without Option C115 (Console Priority) and without Option C514 (Secure Operation), the TX Coarse Adjust (EEPOT No. E) may be adjusted to select the appropriate range (0 through 3) of EEPOT No. 7. This is only required if the deviation level cannot be set within the current adjust range.

Step 6. If the station is equipped with Option C115 (Console Priority), EEPOT No. 7 must be adjusted a second time to set the transmit Line 3 (CIT Tx) audio level. Clear the LIN PTT MUXbus bit leaving only the trunking PTT active. Inject a 1 kHz tone from the console or remote device at the desired level (maximum allowable phone line level, typically 0 dBm to –10 dBm), through the wireline into the Line 3 input on the System connector. Scroll through the EEPOT numbers once back to EEPOT No. 7 to read and set the second level. Adjust the Wireline Tx Level (EEPOT No. 7) until the transmitted deviation level reaches 60% Full System Deviation (see Table 3). If the deviation level cannot be set within the range of EEPOT No. 7, adjust the Tx Course Level (EEPOT No. E) to select the appropriate range (0 through 3) of EEPOT No. 7.

Step 7. De-key the station. Deactivate any activated MUXbus bits and remove the wire jumper (if used) from the trunking connector. Reconnect the central controller to J3 (if previously disconnected).

4.7 RECEIVER LEVEL ADJUSTMENT PROCEDURE

Step 1. Inject a 1 mV rf receive signal modulated with a 1 kHz tone at 40% Full System Deviation (see Table 3) into the receiver antenna port on the junction box.

Step 2. Set the R1 PL DT MUXbus bit.

Step 3. If the station is equipped with an antenna relay or is a trunking station with C269 (*Spectra–TAC*), proceed to Step 7.

Step 4. If this is a trunking station, key the transmitter with a trunking PTT. This is accomplished by disconnecting the trunking cable from junction box connector J3 or by connecting a wire jumper from pin 8 of J2901 on the TTRC logic board to ground. Pins 1 and 2 are ground on J2901. A trunking PTT generated in this fashion (by disconnecting J3) may take 72 seconds for certain systems.

Step 5. Hold the front panel PL DIS/XMIT switch in the XMIT position (to strip off any transmit TDATA or PL/DPL) and verify that the transmit deviation level is at 60% Full System Deviation (see Table 3). This setting provides +3.5 dB of repeater gain. If the level is out of adjustment, set the level using EEPOT No. 5. If this is a Digital or Japan Trunking station, proceed to Step 10.

Step 6. For Analog Plus models, select EEPOT No. 1 to enable *FlutterFighter* ™. Hold the front panel PL Dis/Xmit switch in the XMIT position and verify that the transmit deviation is the same as measured in Step 5. If not, set it using EEPOT No. 1. Proceed to Step 10.

Step 7. Measure the ac voltage at TP1 on the SSCB.

Step 8. Adjust the setting of EEPOT No. 5 until the level at TP1 is 350 ± 50 mV rms. If this is a Japan Trunking station, proceed to Step 10.

Step 9. For Analog Plus models, select EEPOT No. 1 to enable *FlutterFighter* ™. Measure the voltage at TP1 and verify that it is the same as measured in Step 8. If not, set it using EEPOT No. 1.

Step 10. Deactivate all activated MUXbus bits. Set front panel PL DIS/XMIT switch to its center (OFF) position and remove the wire jumper (if used) from the trunking connector.

4.8 RECEIVE WIRELINE AUDIO ADJUSTMENT PROCEDURE

Perform this sub-procedure only if the station is NOT equipped with a C269 *Spectra-TAC / DIGITAC* Encoder Option. Otherwise, proceed to the *Spectra-TAC* System Adjustment Procedure.

Step 1. Inject a 1 mV rf receive signal modulated with a 1 kHz tone at 60% Full System Deviation (see Table 3) into the receiver antenna port on the junction box.

Step 2. Set the front panel PL DIS/XMIT switch to the PL DIS position.

Step 3. Monitor the receiver audio between Line 2 (+) and Line 2 (-) on the junction box screw terminal strip. Adjust the Line 2 Audio Level (EEPOT No. C) to yield the desired phone line level (maximum allowable phone line level, typically 0 dBm to -10 dBm). This is a 600 ohm balanced output.

Step 4. If this is a Trunked Radio System station with Option C115 (Console Priority), monitor the receiver audio at Line 4 on the System connector. Adjust the Line 4 Output Level (EEPOT No. d) to yield the desired phone line level (maximum allowable phone line level, typically 0 dBm to -10 dBm). This is a 600 ohm balanced output.

If the station is equipped with a C514 Transparent Operation (Secure Operation), and NO Secure Encryption Options (C388, C794, C795, or C797), the 2175 Hz Status Tone level must be set as described in Step 5. Otherwise, proceed to Step 6.

Step 5. Remove the rf receiver signal (make sure the receiver is squelched) in order to enable the Status Tone output from Line 2. Adjust the STAC Encoder Level (EEPOT No. 8) to a level 13 dB lower than the Line 2 Audio Level set is Step 3.

Step 6. Deactivate all activated MUXbus bits. Set front panel PL DIS/XMIT switch to its center (OFF) position.

4.9 SQUELCH ADJUSTMENT PROCEDURE

If the station is equipped with Option C269 (*Spectra-TAC/DIGITAC*™ Encoder), proceed to *Spectra-TAC* System Adjustment Procedure.

Step 1. Set the front panel PL DIS/XMIT switch to the PL DIS position.

Step 2. Set the Receiver Squelch Level (EEPOT No. 3) and the Repeater Squelch Level (EEPOT No. 2) to their minimum values (00) to open the squelch fully.

Step 3. If this is a trunking station, inject an on-channel rf signal into the receiver antenna port on the junction box and proceed to Step 6, leaving the Repeater Squelch level set at 00.

Step 4. Inject an on-channel rf signal at the desired repeater squelch threshold level into the receiver antenna port on the junction box. Repeater squelch is typically set for an rf level corresponding to 15 dB SINAD as measured at SPKR AUDIO on the front panel Control Jack (J812-5).

Step 5. Adjust the Repeater Squelch Level (EEPOT No. 2) until the RPT USQ MUXbus bit just turns off.

Step 6. Set the rf signal level to the desired receiver squelch threshold. Receiver squelch is typically set for an rf level corresponding to 12 dB SINAD (15 dB SINAD for trunking stations), as measured at SPKR AUDIO on the front panel Control Jack (J812-5).

Step 7. Adjust the Receiver Squelch Level (EEPOT No. 3) until the R1 UN SQ MUXbus bit just turns off.

Step 8. Set front panel PL DIS/XMIT switch to its center (OFF) position.

4.10 *SPECTRA–TAC* SYSTEM ADJUSTMENT PROCEDURE

Perform this procedure only if the station is equipped with a C269 *Spectra–TAC / DIGITAC* Encoder Option, Otherwise, proceed to the Coded Transmit Deviation Adjustment Procedure.

NOTE

This procedure requires a technician at both the comparator and station sites. This procedure applies to both *Spectra–TAC* and *DIGITAC* comparator systems.

Step 1. Adjust the STAC Encoder Level (EEPOT No. 8) to its minimum value (00) to yield the minimum wireline status tone output.

Step 2. Use an audio generator to inject a 1 kHz tone at 100 mV into the MIC AUDIO (J812–4) input on the front panel Control jack; or via TP8 on the SSCB. This is a 600 ohm input.

NOTE

It is important that the generator output remain at a constant output level from 400 Hz to 4000 Hz.

Step 3. Set the front panel INTERCOM switch to the ON position and activate the LOC PTT MUXbus bit.

Step 4. Adjust the Line 2 Output Level (EEPOT No. C) to yield –10 dBm as measured across Line 2 (+) and Line 2 (–) on the junction box screw terminal strip. Measure and record the level at the input to the comparator (SQM input).

Step 5. Set the generator frequency to 3000 Hz, and adjust the STAC High End Equalization Level (EEPOT No. 9) to yield the same level at the comparator input as recorded in Step 4.

Step 6. Repeat Step 2 through Step 5 until the level difference between 1 kHz and 3 kHz is within ±1 dB. The 1 kHz level reference must remain at –10 dBm.

Step 7. Set the generator frequency to 400 Hz, and adjust the STAC Low End Equalization Level (EEPOT No. A) to yield the same level (within ±3.0 dB) at the comparator input as recorded in Step 4. Do not re–adjust EEPOTs No. C or No. 9.

Step 8. Deactivate all activated MUXbus bits. Set the front panel INTERCOM switch to its OFF position. Disconnect the audio generator from the MIC AUDIO input.

Step 9. Inject a on–channel 1 mV rf signal, modulated with a 1 kHz tone at 100% Full System Deviation into the receiver antenna port on the junction box. For Trunked Radio System stations, use 60% Full System Deviation, as shown in Table 3.

Step 10. Set the front panel PL DIS/XMIT switch to the PL DIS position. Monitor the receiver audio across Line 2 (+) and Line 2 (–) on the junction box screw terminal strip. This is a 600 ohm balanced output.

Step 11. Adjust the setting of EEPOT No. 5 for 350 mV rms at TP1 on the SSCB.

Step 12. Adjust the Line 2 Audio Level (EEPOT No. C) to yield the desired phone line level (maximum allowable phone line level, typically 0 dBm to –10 dBm). Measure and record the level at the input to the comparator.

Step 13. Set front panel PL DIS/XMIT switch to its center (OFF) position. Remove the rf signal generator from the receiver (make sure the receiver is squelched).

Step 14. Adjust the STAC Encoder Level (EEPOT No. 8) to yield a 2175 Hz status tone level at the *Spectra–TAC / DIGITAC* comparator 13 dB (9 dB for trunked stations) below the level recorded in Step 12.

Step 15. Adjust the Receiver Squelch Level (EEPOT No. 3) and the Repeater Squelch Level (EEPOT No. 2) to their minimum value (00) to open the squelch fully. Activate the front panel PL DIS switch.

Step 16. Measure and record the rms noise voltage level at the Line 2 output.

Step 17. Inject an on–channel 0.1 μV rf signal without modulation at the receive antenna port on the junction box.

Step 18. Increase the rf level until the Line 2 output level decreases 20 dB from the level recorded in Step 16 (20 dBQ). This level correlates to a 17 dB SINAD measurement.

Step 19. Adjust the Receiver Squelch Level (EEPOT No. 3) until the R1 UN SQ MUXbus bit just turns off.

Step 20. Adjust the Repeater Squelch Level (EEPOT No. 2) until the RPT USQ MUXbus bit just turns off.

Step 21. Disconnect all test equipment and return the PL DIS switch to its center (off) position.

4.11 CODED TRANSMIT DEVIATION ADJUSTMENT PROCEDURE

Perform this sub–procedure only if the station is equipped with Option C514, Transparent Operation (Secure Operation). Otherwise, proceed to the Forward and Reflected Power Set procedure.

NOTE

Option C514, Transparent Operation is not available for Analog Plus models.

Step 1. Select EEPOT No. 6 on the front panel Status display. After 5 seconds, an internal 1 kHz square wave generator will be enabled in the station.

Step 2. Key the station by holding the front panel PL DIS/XMIT switch in the XMIT position.

Step 3. Measure the transmitter deviation level and compare it to the Coded Deviation level in Table 3. Adjust EEPOT No. 6 if required.

NOTE

This measurement requires that the modulation analyzer have a wide (greater than 15 kHz) receive filter to make an accurate measurement.

Step 4. Reset the station by toggling the front panel ACC DIS/RESET switch to the RESET position momentarily.

Step 5. Set front panel PL DIS/XMIT switch to its center (OFF) position. Disconnect all test equipment.

4.12 DECRYPTED RX LEVEL ADJUSTMENT PROCEDURE

Perform this sub–procedure only if the station is equipped with a Secure Encryption option (one of the following options: C388, C794, C795, or C797). Otherwise, proceed to the Forward and Reflected Power Set procedure.

NOTE

Line 2 level must be set before this adjustment is made.

Step 1. Inject an on–channel 1 mV rf signal modulated with an encrypted (scrambled) 1 kHz tone at 4.0 kHz deviation into the receiver antenna port of the junction box. The test set and the station must be programmed to the same encryption code.

Step 2. Monitor the receiver audio between Line 2 (+) and Line 2 (–) on the junction box screw terminal strip. Adjust the Decrypted Audio Level (EEPOT No. 0) to yield a level 4 dB higher than that set for clear receiver audio at Line 2.

Step 3. Remove the rf receiver signal from the antenna input port.

4.13 FORWARD AND REFLECTED POWER ALARM POINT ADJUSTMENT PROCEDURE

If this is not a trunking station, proceed to the rf Power Output Adjust Procedure.

Step 1. Connect the station transmit antenna port on the junction box to a wattmeter with a 50 ohm dummy load capable of handling twice rated station power.

Step 2. Key the station by setting the LOC PTT MUXbus bit and adjust the power output to the Forward Power Level trip point. The transmit power output can be adjusted by inserting the supplied tuning tool into the PO POWER SET potentiometer opening in the rf tray front panel. This trip point is user definable and is typically set to 35% of the Rated Station Power Level indicated in Table 4 through Table 7.

Step 3. With the station still keyed, hold the SELECT/SET switch in the SET position and then hold both the PL DIS and ACC DIS switches up until trP appears in the Status display.

Step 4. Release the SET switch and then return the PL DIS and ACC DIS switches to their center position. The first digit on the Status display should now be alternately flashing an F for forward and r for reflected.

Step 5. Toggle the SELECT/SET switch towards the SELECT position while the display is showing an F to set the forward power level trip point. The display will show a number corresponding to the forward power level in the remaining two digits on the display along with the F.

Step 6. Adjust the transmitter power output level to the Reflected Power level trip point. This trip point is user definable and is typically set to 20% of the Rated Station Power Level.

Step 7. With the station still keyed, toggle the SELECT/SET switch towards the SELECT position while the Status display is showing an r in the display. The display will show a number corresponding to the reflected power level in the remaining two digits on the display along with the r.

Step 8. Toggle the SELECT/SET switch towards the SET position to exit the power trip point mode.

Step 9. Deactivate all activated MUXbus bits.

4.14 RF POWER OUTPUT ADJUSTMENT PROCEDURE

Step 1. Connect the station transmit antenna port on the junction box to a wattmeter with a 50 ohm dummy load capable of handling twice the rated station power.

Step 2. Pre-set the rf tray front panel PO POWER SET control R426 fully counter clockwise (CCW) using the supplied tuning tool; then turn R426 1/8 turn clockwise.

Step 3. Remove the rf tray cover and pre-set OVERDRIVE control R453 fully clockwise (CW). If the station is not a high power model (does not have two PA decks), proceed to Step 7.

Step 4. Key the station by setting the LOC PTT MUXbus bit and adjust the rf power output PO POWER SET control to yield the Overdrive Power Level as shown in Table 4 through Table 7. Note that the Overdrive levels in the tables are indicated in parentheses.

Step 5. Turn the OVERDRIVE control slowly CCW until the front panel PA FULL indicator LED just turns off.

Step 6. De-key the station by clearing the LOC PTT MUXbus bit and rotate PO POWER SET fully CCW; then turn PO POWER SET 1/8 turn clockwise.

Step 7. Reinstall the rf tray cover. Key the station by setting the LOC PTT MUXbus bit and adjust the rf power output PO POWER SET control to yield the Rated Station Power Level indicated in Table 4 through Table 7 or the maximum allowed by the FCC license, whichever is less.

Step 8. If the station is not equipped with option C28 (Battery Backup), proceed to Step 12.

Step 9. De-key the station by clearing the LOC PTT MUXbus bit.

Step 10. Remove the rf tray cover and the station ac power source. The station should continue to operate on battery backup.

Step 11. Key the station by setting the LOC PTT MUXbus bit and adjust the rf power CUTBACK control R409 to yield 50% of the Rated Station Power Level indicated in Table 4 through Table 7.

Step 12. Deactivate all activated MUXbus bits. Disconnect all test equipment.

Step 13. Replace the rf tray cover and restore the station ac power source.

Table 4. Rated Power Levels for VHF Digital MSF 5000 Models

Model	with Duplexer (C182)	with Single Circulator (C265)	with Duplexer & Single Circulator (C182 & C265)	Standard
C73CXB	75	100	60	125
C93CXB	N/A	300 (385)	N/A	350 (430)
C93CXB with 220 V ac 50 Hz	N/A	260 (340)	N/A	300 (380)

NOTES: All power levels are listed in watts.
All power levels indicated are with 110 V ac, 60 Hz power supply, except where noted.
Power levels in parentheses are Overdrive Power Levels (see text).

Table 5. Rated Power Levels for UHF Digital MSF 5000 Models					
Model	**with Duplexer (C675 or C182)**	**with Duplexer (C597)**	**with Triple Circulator (C676)**	**with Duplexer & Triple Circulator (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 (180)	N/A	N/A	N/A	225 (285)
C84CXB with 220 V ac 50 Hz	125 (160)	N/A	N/A	N/A	200 (260)

Table 6. Rated Power Levels for 800 MHz Digital MSF 5000 Models				
Model	**with Duplexer (TDF6980A)**	**with Triple Circulator (C676)**	**with Duplexer & Triple Circulator (C676 & TDF6980A)**	**Standard**
C35CXB	23	30	21	35
C65CXB	50	60	45	75
C85CXB	100 (150)	125 (180)	90 (130)	150 (220)
C85CXB with 220 V ac 50 Hz	80 (125)	110 (160)	75 (120)	125 (180)

Table 7. Rated Power Levels for Analog Plus MSF 5000 Models				
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 V ac 50 Hz	80 (125)	110 (160)	75 (120)	125 (180)

NOTES: All power levels are listed in watts.
All power levels indicated are with 110 V ac, 60 Hz power supply, except where noted.
Power levels in parentheses are Overdrive Power Levels (see text)

5. ROUTINE MAINTENANCE RECORD

The site alignment procedure described above should be performed at installation, six months after installation, and every twelve months thereafter. In addition, other station parameters should be measured to insure peak station operating efficiency and to observe failure trends early. Table 8 provides a spot to record these station operating parameters at installation and periodic maintenance times. Some entries in the table may not apply to specific stations. The following measurements are recommended:

- TX, RX, and PA Meter Readings
- Receiver sensitivity
- Line Levels
- RF Power Levels

In addition, if the station is equipped with the C28 (Battery Charger) option, the battery's state of charge should be checked.

Table 8. Station Parameter Record

Date	(Installation)							
Measurement	**Measured Value**	**Measured Value**	**Measured Value**	**Measured Value**	**Measured Value**	**Measured Value**	**Measured Value**	**Measured Value**
TX Meter 1								
TX Meter 2								
TX Meter 3								
TX Meter 4								
TX Meter 5								
RX Meter 1								
RX Meter 2								
RX Meter 3								
RX Meter 4								
RX Meter 5								
FPA Meter 1								
FPA Meter 2								
FPA Meter 3								
FPA Meter 4								
FPA Meter 5								
FPA Meter 6								
DPA Meter 1								

Table 8. Station Parameter Record								
DPA Meter 2								
DPA Meter 3								
DPA Meter 4								
DPA Meter 5								
Forward Power								
Reflected Power								
Line 1 Level								
Line 2 Level								
Comparator Input Level								
12 dB SINAD								
Battery Voltage								

NOTES:

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☐ **Basic Logic Circuit Guide** 68P81105E88
Describes the basic logic circuits used in Motorola Communications digital equipment and the logic notational scheme used in our instruction manuals.

☐ **"Digital Private-Line" Binary-Coded Squelch** 68P81106E83
Contains fundamentals of "Digital Private-Line" system operation, circuit operation and servicing techniques.

☐ **Safe Handling of CMOS Integrated Circuit Devices** 68P81106E84
Describes special handling techniques needed to prevent irrepairable damage from static charges encountered with normal handling of CMOS devices.

☐ **Reducing Noise Interference in Mobile Two-Way Radio Installations** 68P81109E33
Defines the major sources of noise encountered in a mobile radio installation and suggests methods of remedying them.

☐ **Anti-Skid Braking Precautions** 68P81109E34
Provides installation suggestions and a detailed checkout procedure for installation of mobile radios in vehicles with anti-skid braking systems.

☐ **Removal and Replacement of Chip Components on Circuit Boards** 68P81113E77
Contains general information and repair procedures relative to chip-type (leadless) components.

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