VIKING® VX
UHF LTR-Net™
25W-110W Repeater

Part No. 242-20X4-613

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VIKING® VX
UHF LTR-Net™ REPEATER
PART NO. 242-20x4-613

E.F. Johnson Company designs and manufactures two-way radio equipment to serve a wide variety of communications needs. EFJohnson® produces equipment for the mobile telephone and land mobile radio services which include business, industrial, government, public safety, and personal users.

LAND MOBILE PRODUCT WARRANTY

The manufacturer's warranty statement for this product is available from your product supplier or from the E.F. Johnson Company, 299 Johnson Avenue, Box 1249, Waseca, MN 56093-0514. Phone (507) 835-6222.

WARNING

DO NOT operate the transmitter in the frequency band 406 - 406.1, this band is reserved for use by distress beacons.

DO NOT allow the antenna to touch or come in very close proximity with the eyes, face, or any exposed body parts while the radio is transmitting.

DO NOT operate the transmitter of a mobile radio whena person outside the vehicle is within one (1) meter of the antenna.

DO NOT operate the transmitter of a stationary radio (base station, repeater or marine radio) when a person is within one (1) meter of the antenna.

DO NOT operate the radio in explosive or flammable atmospheres. The transmitted radio energy could trigger blasting caps or cause an explosion.

DO NOT operate the radio without the proper antenna installed.

DO NOT allow children to operate or play with this equipment.

NOTE: The above warning list is not intended to include all hazards that may be encountered when using this radio.

This device complies with Part 15 of the FCC rules. Operation is subject to the condition that this device does not cause harmful interference. In addition, changes or modification to this equipment not expressly approved by E.F. Johnson Company could void the user's authority to operate this equipment (FCC rules, 47CFR Part 15.19).

SAFETY INFORMATION

Proper operation of this radio will result in user exposure below the Occupational Safety and Health Act and Federal Communication Commission limits.

The information in this document is subject to change without notice.

E.F. Johnson Company will not be liable for any misunderstanding due to misinformation or errors found in this document.

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SECTION 1 INTRODUCTION AND OPERATION

1.1 SCOPE OF MANUAL

This service manual provides installation, operation, programming, service, and alignment information for the VIKING® VX LTR-Net® Repeater, Part No. 242-20X4-613.

1.2 REPEATER IDENTIFICATION

The repeater identification number is printed on a label that is affixed to the inside of the repeater cabinet. The following information is contained in that number:

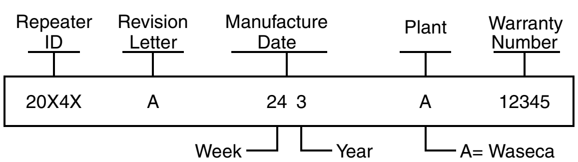


Figure 1-1 REPEATER IDENTIFICATION

1.3 MODEL NUMBER BREAKDOWN

The following breakdown shows the part number scheme used for the Viking VX.

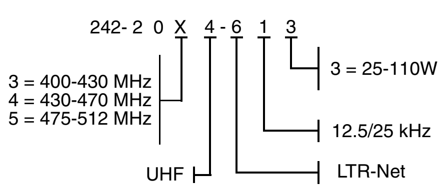


Figure 1-2 PART NUMBER BREAKDOWN

1.4 REPEATER DESCRIPTION

The VIKING VX repeater is designed for operation in a LTR-Net and LTR system. It operates on the UHF channels from 380-520 MHz. Channel spacing is 12.5 kHz and RF power output is adjustable from 25 to 110 watts.

This repeater is modular in design for ease of service. There are separate assemblies for the logic cards, receiver, exciter, power amplifier and power supply sections.

This repeater is programmed with a laptop or personal computer using the repeater software, Part No. 023-9998-459.

1.4.1 TRUNKED SYSTEM

A trunked radio system, as defined by the FCC, is a "method of operation in which a number of radio frequency pairs are assigned to radios and base stations in the system for use as a trunk group". Trunking is the pooling of radio channels where all users have automatic access to all channels reducing waiting time and increasing channel capacity for a given quality of service.

Trunking concepts are based on the theory that individual subscribers use the system a small percentage of the time and that a large number of subscribers will not try to use the system at the exact same time.

1.4.2 LTR-NET TRUNKED SYSTEM

LTR-Net repeater operation is automatic and is similar to a LTR repeater in which a logic module performs the call functions and communicates over-the-air to subscriber units. There must be one repeater for each RF channel and each repeater contains a logic module responsible for signaling on its own channel. Logic modules then share information with all other repeaters in the system via inter-repeater communication.

System control is accomplished by the exchange of data messages between radio and repeater. The LTR-Net system trunks up to 20 channels by utilizing continuous subaudible digital data applied to the RF carrier simultaneously with voice modulation. Therefore, no dedicated control channel is required and all channels are used for voice communications for maximum system efficiency. Each radio is assigned a Home Channel which sends system commands to specified radios. There are normal words and special function words. The special function words are used to initiate special calls; Telephone, Unique ID, and Data by Unique ID. The special function words are also used for command calls: Interrogate, Kill, Reassign, Electronic Serial number Authentication, Registration, De-Registration, etc.

Since each repeater is responsible for signaling on its own channel, this approach lends itself well to a distributed processing logic controlled approach requiring only a small logic unit within each repeater. These processors share information over a communication path. This architecture permits each repeater to be autonomous. A failure in one repeater leaves the remainder of the system intact and operational.

The repeaters may be connected to a larger system. This allows the system to perform some of the previously mentioned calls. The Switch may communicate from one LTR-Net Locality to another. The system equipment may be centrally located or distributed at each Locality. A Locality is a set of repeaters that are interconnected to pool the channels in a trunked channel group.

1.5 LTR-Net SIGNALING

The repeater covered by this manual utilizes LTR-Net signaling. This signaling provides advanced features such as 65504 Unique ID codes, five levels of access priority, home channel backup, and over-the-air mobile reprogramming. LTR-Net signaling and repeater control is provided by the Main Processor Card. The repeater connects to the 3000 Series Switch using a phone line or some other type of link. The Switch provides overall system control (see Sections 1.14 and 5 for more information on LTR-Net equipment and features).

1.6 ACCESSORIES

The accessories available for the Viking VX LTR-Net repeater are listed in Table 1-1. A brief description of some of these accessories follows.

2000 Series Service Kit- This kit includes an extender card, extender cables, TIC bias cable and programming cable. These items are used when tuning the repeater and while troubleshooting.

Battery Backup Option - It includes the +26V DC battery backup module that resides in the power supply and the necessary interconnect cabling to connect the repeater to the batteries (see Section 2.5).

Two Foot Cable - This is a 2’ RG-58 coax cable with BNC male connectors for the HSDB (High Speed Data Bus).

Six Foot Cable - This is a 6’ RG-58 coax cable with BNC male connectors for the HSDB (High Speed Data Bus).

Custom Frequency - This is a factory frequency programming and repeater setup.

PGMR 2000 Programming Software - 3.5" programming disk used to program the repeater.

External Speaker/Microphone - This is a speaker and microphone combination that plugs into the MAC connectors. The microphone provides local audio and push-to-talk, while the speaker provides local audio adjusted with the volume control.

Table 1-1 ACCESSORIES

Accessory	Part No.
2000 Series Service Kit*	250-2000-230
Programming Cable Kit	023-2000-195
Battery Back-Up Option**	023-2000-835
2’ RG-58 BNC M-M HSDB cable	023-4406-505
6’ RG-58 BNC M-M HSDB cable	597-3001-214
Custom Frequency Programming & Setup	023-2000-100
PC Programmer PGMR Software	023-9998-459
Service Microphone	589-0015-011
50 ohm Termination HSDB	023-4406-504

*Includes: extender card, extender cables, TIC bias cable and programming cable kit.
** 26V DC input with cable

1.7 PRODUCT WARRANTY

The warranty statement for this transceiver is available from your product supplier or from the Warranty Department, E.F. Johnson Company, 299 Johnson Avenue, Box 1249, Waseca, MN 56093-0514. This information may also be requested by phone from the Warranty Department. The Warranty Department may also be contacted for Warranty Service Reports, claim forms, or any questions concerning warranties or warranty service by dialing (507) 835-6970.

1.8 FACTORY CUSTOMER SERVICE

The Customer Service Department of the E.F. Johnson Company provides customer assistance on technical problems and the availability of local and factory repair facilities. Regular Customer Service hours are 7:30 a.m. - 5:30 p.m. Central Time, Monday - Friday. The Customer Service Department can be reached using one of the following telephone numbers:

Toll-Free: (800) 328-3911
(From within continental United States only)

International: (507) 835-6911

FAX: (507) 835-6969

E-Mail: First Initial/Last Name@efjohnson.com
(You need to know the name of the person you want to reach. Example: dthompson@efjohnson.com.)

NOTE: Emergency 24-hour technical support is also available at the 800 and preceding numbers during off hours, holidays, and weekends.

When your call is answered at E.F. Johnson Company, you will hear a brief message informing you of numbers that can be entered to reach various departments. This number may be entered during or after the message using a tone-type telephone. If you have a pulse-type telephone, wait until the message is finished and an operator will come on the line to assist you. When you enter some numbers, another number is requested to further categorize the type of information you need.

You may also contact the Customer Service Department by mail. Please include all information that may be helpful in solving your problem. The mailing address is as follows:

E.F. Johnson Company
Customer Service Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

1.9 FACTORY RETURNS

Repair service is normally available through local authorized E.F. Johnson Land Mobile Radio Service Centers. If local service is not available, the equipment can be returned to the factory for repair. However, it is recommended that you contact the Field Service Department before returning equipment. A service representative may be able to suggest a solution to the problem so that return of the equipment would not be necessary. If using the toll-free number in the preceding section, enter "2".

Be sure to fill out a Factory Repair Request Form #271 for each unit to be repaired, whether it is in or out of warranty. These forms are available free of charge by calling the repair lab (see Section 1.8) or by requesting them when you send a unit in for repair. Clearly describe the difficulty experienced in the space provided and also note any prior physical damage to the equipment. Then include a form in the shipping container with each unit. Your phone number and contact name are very important because there are times when the technicians have specific questions that need to be answered in order to completely identify and repair a problem.

When returning equipment for repair, it is also a good idea to use a PO number or some other reference number on your paperwork in case you need to call the repair lab about your unit. These numbers are referenced on the repair order and it makes it easier and faster to locate your unit in the lab.

Return Authorization (RA) numbers are not necessary unless you have been given one by the Field Service Department. They require RA numbers for exchange units or if they want to be aware of a specific problem. If you have been given an RA number, reference this number on the Factory Repair Request Form sent with the unit. The repair lab will then contact the Field Service Department when the unit arrives.

1.10 REPLACEMENT PARTS

E.F. Johnson replacement parts can be ordered directly from the Service Parts Department. To order parts by phone, dial the toll-free number and then enter "1" as described in Section 1.10. When ordering, please supply the part number and quantity of each part ordered. E.F. Johnson dealers also need to give their account number.

If there is uncertainty about the part number, include the designator (C112, for example) and the model number of the equipment the part is from (refer to Section 1.2).

You may also send your order by mail or FAX. The mailing address is as follows and the FAX number is shown in Section 1.8.

E.F. Johnson Company
Service Parts Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

1.11 INTERNET HOME PAGE

The E.F. Johnson Company has a home page on the World Wide Web that can be accessed for information on such things as products, systems, and regulations. The address is http://www.efjohnson.com.

1.12 SOFTWARE UPDATES/REVISIONS

All inquiries concerning updated software, its installation and revisions should be directed to the Customer Service Department (see Section 1.8).

1.13 REPEATER OPERATION

1.13.1 MAIN PROCESSOR CARD (MPC)

Refer to Figure 1-4.

Programming Jack

J1 provides input connection from the computer and the "flash memory" in the MPC. The programming information in an IBM® PC programs the MPC directly from the serial card through an interconnect cable to the COM1 or COM2 port.

Reset

S1 provides a manual reset of the Main Processor Card (MPC). A manual reset causes a complete power-up restart.

Display and LEDs

Each combination of DS1 display read-out and CR4/CR5 indication refers to an active alarm. See Table 1-2 for alarms and definitions. LED indications: CR1 is blinking; MPC is operational, CR2 on; 380-470 MHz, off is 475-520 MHz and CR5 on; indicates an LTR Repeater.

1.13.2 TEST MODE

When the Repeater is in Test mode the safety measures are disabled. Therefore, if the Repeater is keyed for an extended period and the power amplifier temperature increase, thermal shutdown will not occur. There are pop-up windows that appear in the Test mode screens to alert the user that there is an alarm and action should be taken.

RF Thermal Sense Alarm Condition Exists

NOTE: Safety measures are disabled

Ok

Figure 1-3 ALARM IN TEST MODE

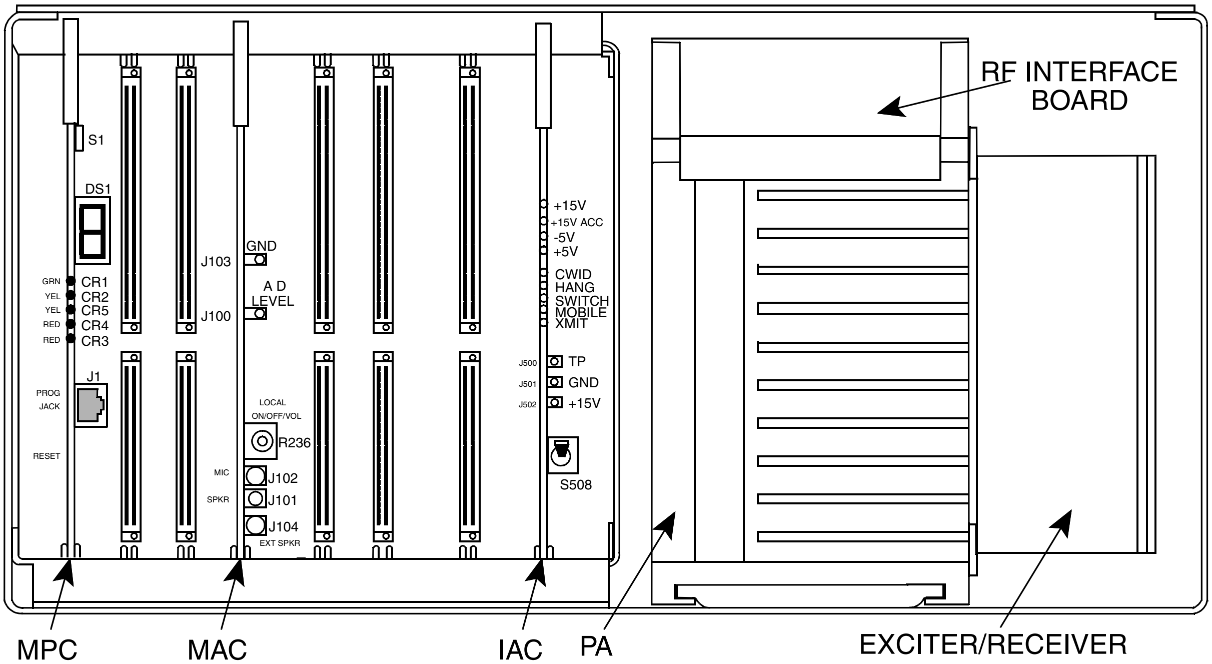


Figure 1-4 REPEATER CARDS

Table 1-2 ACTIVE REPEATER ALARMS

Alarm No.	DS1	CR3	CR4	Definition
0	0	Off	On	Test Mode
1	1	Off	On	IAC input 1 Active
2	2	Off	On	IAC input 2 Active
3	3	Off	On	IAC input 3 Active
4	4	Off	On	IAC input 4 Active
5	5	Off	On	IAC input 5 Active
6	6	Off	On	IAC input 6 Active
7	7	Off	On	IAC input 7 Active
8	8	Off	On	IAC input 8 Active
9	9	Off	On	MAC Processor Alarm
10	A	Off	On	HSDB Processor/Cable Alarm
11	B	Off	On	IRDB Cable Alarm
12	C	Off	On	RNT/CIM Channel Problem Alarm
13	D	Off	On	TIC Processor Alarm
14	E	Off	On	MMC Processor Alarm
15	F	Off	On	VNC Alarm
16	0	On	Off	AC Power Failure
17	1	On	Off	Battery Power Failure
18	2	On	Off	Power supply thermal sense
19	3	On	Off	Fan 1 current out of specification
20	4	On	Off	Fan 2 current out of specification
21	5	On	Off	IAC mismatch
32	0	On	On	RF shutdown
33	1	On	On	RF Half Power Mode
34	2	On	On	Thermal sense in RF portion
35	3	On	On	RF Finals 1-2 power out failure
36	4	On	On	RF Finals 3-4 power out failure
37	5	On	On	RF VSWR Failure
38	6	On	On	Normal Synthesizer Tx Lock failure
39	7	On	On	Normal Synthesizer Rx Lock failure
40	8	On	On	HS Synthesizer Tx Lock failure
41	9	On	On	HS Synthesizer Rx Lock failure
42	A	On	On	RF Quarter Power Alarm

1.13.3 MAIN AUDIO CARD (MAC)

Refer to Figure 1-4.

External Speaker Jack

J104 provides repeater audio output to an external speaker. The local volume control adjusts the volume level of this speaker.

Speaker/Microphone Jacks

J102 provides audio input from a microphone. J101 provides the receive audio to the microphone.

Local On/Off/Volume Control

R236 provides control of the receive audio output to J101 and J104. Turning this control clockwise past the detent applies voltage to the local audio amplifier.

A D Level Test Point

J100 provides audio/data level output for test level checks.

Ground

J103 is connected to ground for test equipment when monitoring test point J100.

1.13.4 INTERFACE ALARM CARD (IAC)

Refer to Figure 1-4.

Voltage Test Output

J502 provides a +15V test point on the IAC.

Ground

J501 is connected to ground for test equipment when monitoring voltage test point J502.

A D Level Test Point

J500 provides a test point to monitor audio and data levels, AC fail and thermal sensor.

Power Supply On/Off Switch

S508 turns the power supply DC voltages on and off from the IAC in the front of the repeater.

Power Indicator

CR501 indicates the +5V supply is at normal level and applied to the IAC. CR524 indicates -5V supply is at normal level and applied to the IAC. CR523 indicates the +15V accessory supply is at normal level. CR525 indicates that the +15V supply is at normal level and applied to the IAC.

CWID Indicator

Indicates that the CW Identification is being transmitted on the lowest-frequency repeater. The CWID is a continuous-wave (CW) transmission of the station call letters in Morse Code to satisfy the station identification requirement. The CWID is programmed into the repeater memory. This indicator also is used when an alarm is transmitted with Morse code.

Hang Indicator

Indicates that the hang word is being transmitted by the repeater. This word is transmitted on calls in which the channel is held for the duration of the call and not just for the duration of the transmission. The hang word tells the mobiles to stay on the same channel and not re-access the system when responding to a call.

Switch Call Indicator

The Switch Call Indicator on the IAC shows that a Switch-To-Mobile transmission is in progress (see Figure 7-30.)

Mobile Call Indicator

Mobile-to-repeater transmission in progress is indicated by the Mobile Call Indicator.

Xmit Indicator

This indicates that the repeater transmitter is keyed by the logic.

1.13.5 POWER SUPPLY

The 2000 Series Repeater Power Supply is a quad output 800W supply with power factor correction. A battery back-up module, PN 023-2000-830, can be added to the power supply to provide automatic battery revert in the event of AC power failure (see Section 2.4) The Battery Back-Up module charges the batteries when AC is present at the power supply (see Section 2.5 and 8.6).

1.14 LTR-Net SYSTEM COMPONENTS

1.14.1 INTRODUCTION

The main components in a LTR-Net system are shown in Figure 1-5. An LTR-Net system can be designed to meet the requirements of almost any user. The following are LTR-Net features.

- With LTR-Net signaling, advanced features such as up to 65504 Unique ID codes, automatic mobile identification, home channel backup, and five levels of access priority are available.
- Users of different types of radio equipment can talk to each other.
  Example: a Conventional mobile channel could talk to a mobile operating on a LTR-Net (trunked) 900 MHz channel.
- Wide area radio coverage can be provided so that a mobile could talk to another mobile that is using a repeater that may be hundreds of miles away. That repeater may be part of the same LTR-Net system or another LTR-Net system. Phone line or other types of links can be used to provide the communication path.

LTR-Net systems are not restricted to a specific type of signaling. Example: an entire LTR-Net system could be designed using Conventional channels which use tone- or digitally-controlled squelch. The various types of signaling can also be mixed in a system.

Example: There could be:

10-channels using LTR-Net signaling
5-channels using LTR® signaling
5-channels using Conventional signaling

Check with your Johnson representative for more information concerning the capabilities of LTR-Net systems.

The following sections provide a brief description of the LTR-Net components see Figure 1-5.

1.14.2 MOBILE TRANSCEIVERS

The mobile and handheld transceivers used in a LTR-Net system must be compatible with the type of signaling in use and also the frequency range.

LTR-Net transceivers can be programmed for LTR and Conventional operation. However, some LTR transceivers can only be programmed for LTR and Conventional operation. The main difference between LTR-Net and LTR only versions of the same model is the software in the microprocessor.

1.14.3 REPEATERS

NOTE: The Summit QX does not require a separate LTR-Net logic drawer.

The repeater model used in a LTR-Net system is determined by frequency range, 900 MHz use the Summit QX 2009 repeaters. There is one repeater for each RF channel.

Inter-Repeater Data Communication

Data communication between LTR-Net or LTR repeaters is via a high-speed data bus. This bus cable is installed in a daisy-chain manner between repeaters. If both LTR-Net and LTR repeaters are located at a Locality, only like types are connected together. Up to 20 LTR-Net or 20 LTR repeaters can be interconnected (see Section 2.9 for connecting the data bus).

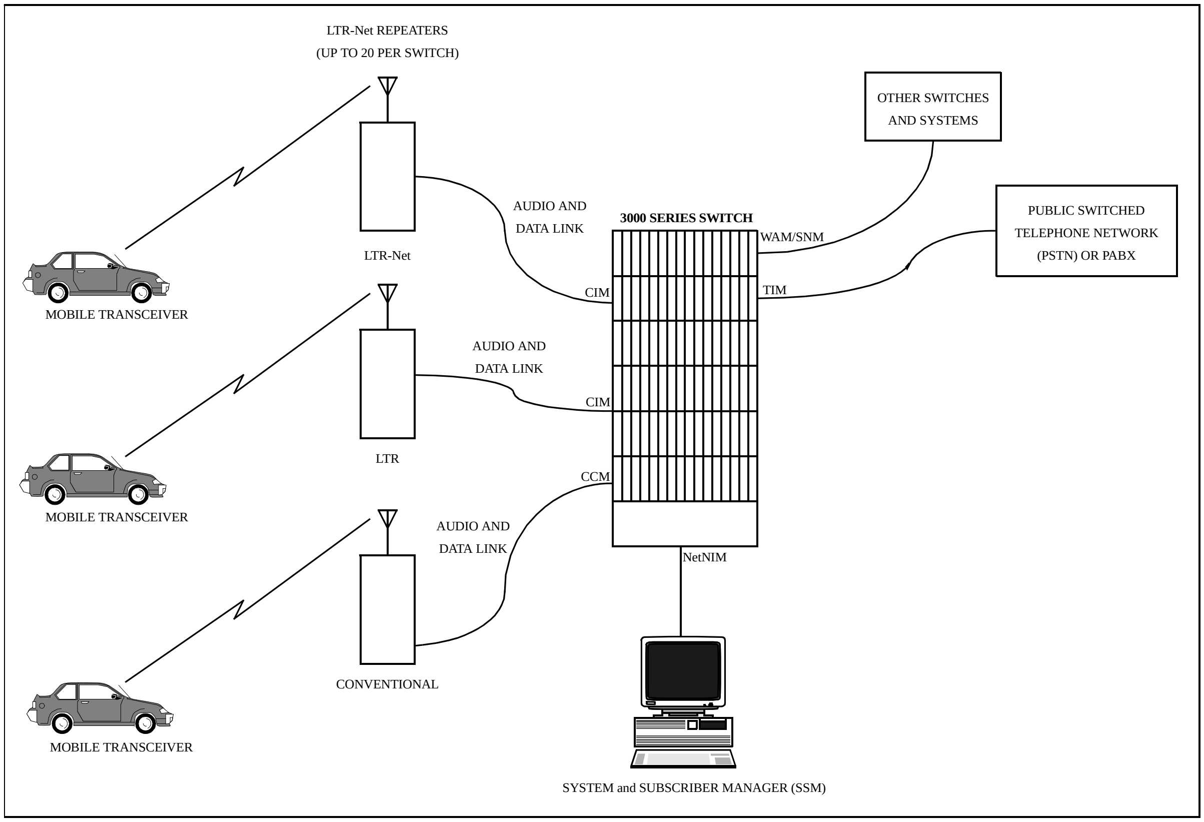


Figure 1-5 LTR-Net SYSTEM COMPONENTS

Repeater Connection To Switch

The repeaters can be located at the same Locality as the Switch or they may be located at a Locality that is many miles from the Switch. A voice and data link is required between the repeaters and Switch. This link can be a direct connection, phone lines, microwave, RF transceiver, fiber optic, or some other type of link. This link is connected to the repeater terminal block on the back of the repeater.

The voice link routes transceiver voice to and from the Switch. The voice must be routed to the Switch when a call involves a dispatcher, telephone interconnect, or another RF channel or LTR-Net system. If the call is a mobile-to-mobile call on the same RF channel, the voice is simply repeated by the repeater (it is also routed to the Switch but is not connected to anything). The voice path input/output port interfaces with a standard 4-wire, 600 ohm phone line.

The data link allows the Switch to control the repeater. With mobile-to-repeater calls, the data fed to the Switch is used to determine what routing is required for the call. On Switch-to-mobile calls, the data fed to the repeater allows the Switch to operate the repeater like a base station.

There are three different types of links that can be selected for the data path between each repeater and the Switch. The MPC is programmed for the type of link used (see Section 2.11).

- A 4-Wire voice-grade link can be used that is similar to the audio link. The data is then sent as tones using FSK modulation.
- RS-232 serial inputs and outputs are available for direct connection or connection to a link that accepts RS-232 data.

- Data can be modulated as in '1' and then sent over the voice path using a Blank and Burst technique. Only one 4-wire link is then needed between each repeater and the Switch.

1.14.4 SWITCH

The Switch can connect several different forms of communication together to form a communication network that requires the Call Processor. It has up to six shelves with 12 or 16 device slots each (72 or 96 slots available) and up to three racks (for 216 or 288 slots). Many different modules are available to complete the network. Some modules have specific device slot requirements.

1.14.5 CALL PROCESSOR AND SYSTEM AND SUBSCRIBER MANAGER

The Call Processor, along with the System and Subscriber Manager, controls the LTR-Net System. The Call Processor (CP) is an IBM® PC or compatible computer that is running the EFJohnson management program. The System and Subscriber Manager software is used by the System Administrator to program, control and continuously monitor Switch operation, and provides logging of information for billing purposes.

The System and Subscriber Manager (SSM) is a program that executes on an IBM PC or compatible computer. The function of the SSM is to manage the database information that the Call Processor uses in its operation. The SSM has the capability to generate reports from the logged information of the CP. The SSM also has the ability to setup and initiate such activities as Dynamic Reprogramming of certain mobile parameters (Group 11), disabling (Kill) of lost or stolen mobiles and many other functions.

1.14.6 LOCALITY

A Locality is the location where one or more repeaters are housed. Trunked system repeaters are connected to the same high-speed data bus and are required to be located close together. LTR-Net can have a maximum of 20 repeaters at a Locality. One CIM (Channel Interface Module) is required for each LTR-Net repeater. A CCM (Conventional Channel Module) is required for a conventional channel.

1.14.7 HOME REPEATER CHANNEL

All LTR-Net mobiles have one of the Locality repeaters assigned as their "Home Repeater". This repeater handles the data and audio unless a failure causes the Status Repeater to take over. The Group ID calls use the Home Repeater number in identifying the mobiles (see Section 1.15.3).

1.14.8 STATUS REPEATER CHANNEL

The Status Repeater Channel is one repeater at a Locality designated to transmit update information for all calls occurring at that Locality. The Status repeater is a "Home Repeater" backup usually not assigned voice traffic.

1.14.9 MONITOR REPEATER CHANNEL

This is the repeater channel that a mobile is currently monitoring for update messages. This repeater may be either the mobile's Home Repeater or the Locality Status Repeater. A special algorithm is used by the mobile to determine which is to be monitored. Generally, it is the last repeater that a valid data message was detected on.

1.14.10 HOME CHANNEL ALIASING

The LTR-Net Home Channel Aliasing feature increases the number of addresses available on a Locality for Group calls. It does this by allowing calls to be programmed on non-exisent Home repeaters.

Each Home repeater can be programmed with 1-239 Group ID codes. Assume a Locality has four active repeaters and one of these is the Status repeater (that is normally not assigned as a Home repeater). The number of calls that can be programmed are then as follows:

Without Aliasing - 3 x 239 or 717 calls
With Aliasing - 20 x 239 or 4780 calls

When a call is placed on a non-existent Home repeater, the subscriber unit automatically uses the next lower numbered active repeater.

NOTE: Since this feature does not increase system capacity, adding too many users may result in unsatisfactory operation due to frequency busy conditions.

1.14.11 TELEPHONE INTERCONNECT AND DATA TRANSMISSION

Mobile transceivers can be used to access the PSTN (Public Switched Telephone Network). However, this interconnect operation must be on a secondary basis to dispatch operation. An exception is when the trunked system or channel is assigned exclusively to one user.

Mobiles may place telephone calls through the PSTN (Public Switch Telephone Network) or a PABX (Private Automatic Branch Exchange) using the Interconnect special call. When the Call Processor detects a mobile placing an interconnect call, it checks to see if it is authorized that service determined by the System and Subscriber Manager and what type of call it is making. If it is authorized, the Switch completes the connection through the TIM (Telephone Interface Module) to the telephone network. The Call Processor performs the record keeping needed for billing.

Data transmission and paging are also allowed on these frequencies. It also must be secondary to voice communication. Refer to applicable FCC rules and regulations for more information.

1.14.12 PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)

If interconnect calls are to be placed by mobiles or landside users to mobiles, the Switch is connected to the PSTN (Public Switched Telephone Network). The specific mobiles which can place calls and other interconnect parameters are determined by how the System Manager programs the System and Subscriber Manager/Call Processor and by the programming of each mobile transceiver.

1.14.13 PRIVATE AUTOMATIC BRANCH EXCHANGE (PABX)

The system has the ability to connect to a PABX or PBX. This allows mobile originated calls to use the dial access codes and the least cost routing facility of the PABX/PBX.

1.14.14 PULSE CODE MODULATION (PCM)

PCM typically runs on the voice buses at 2.048 MHz. The Switch provides 32-Time Slots for sending of audio.

1.15 LTR-Net FEATURES

1.15.1 STANDARD AND SPECIAL CALLS

There are two types of calls with LTR-Net signaling; Standard Calls and Special Calls. Group ID codes 1-239 are Standard (dispatch) calls, and Group ID codes 240-247 are Special Calls.

As previously stated, up to 239 Group ID codes are assignable on each Home repeater. When a transceiver monitors its Home or Status repeater, it receives data messages containing a Home repeater number, Group ID, and Unique ID code (refer to Section 1.15.2). When it detects its Home repeater and a Group ID from 1-239 that it is programmed to decode, it unsquelches and the call is received. The correct Unique ID code does not need to be detected to receive a Standard Call. Standard Calls are limited to other transceivers assigned to the same Home repeater. However, each selectable system of a transceiver can be programmed with a different Home repeater to allow calls to mobiles assigned to other Home repeaters if desired.

If a Group ID from 240-247 is received, a Special Call is indicated and the transceiver will respond according to the type of call. Special calls are used to perform many of the special LTR-Net features described in this section. Examples of Special Calls are calls to a specific transceiver (Unique ID), Group (Directed Group) or Telephone Interconnect. Others are Interrogate, Interconnect, and Transceiver Disable. Generally, a transceiver must decode its Unique ID code to respond to a Special Call.

1.15.2 UNIQUE ID CODES

Each transceiver is programmed with a Unique ID code in addition to Group ID codes. Unique ID codes are assigned on a system-wide basis, not on a repeater basis as with Group IDs. Up to 65504 Unique ID codes can be assigned per Switch.

Whenever a transceiver makes a call, it always transmits its Unique ID in addition to a Group ID. Any control point equipped with a decoder and display capable of listening to that transceiver can then display the ID of that unit. This provides automatic identification of transceivers making calls.

Unique IDs also permit individual mobile units to be called using the special calls described in the preceding section. Calls can also be made to individual transceivers using standard call Group IDs 1-239 if an ID is assigned to only one transceiver.

1.15.3 GROUP IDENTIFICATION CALLS

The Group ID (1-239) is assigned to each LTR-Net Home Repeater. A "standard" Group ID call is accepted by a mobile if its Home Repeater and Group ID are in the data message. A "special" calls are Telephone Interconnect calls, UID calls and Directed Group calls (Auxiliary calls). Telephone Interconnect Calls are assigned a Token Group ID (240-247) assigned by the repeater upon request from a mobile. Telephone Interconnect calls, Unique ID calls and Directed Group Calls all require the System and Subscriber Manager/Call Processor to provide authorization.

1.15.4 ALARM FORWARDING TO SWITCH

Repeater alarms are routed to the CIB (Channel Interface Bus) to be detected by the Call Processor and the System and Subscriber Manager.

1.15.5 MONITOR BUSY

This is used in UHF repeaters only. The Monitor Busy feature checks the receive channel frequency for activity before allowing the repeater to transmit. If Allow LTR is selected, this parameter is not available.

NOTE: MPC software Version 2.02 and earlier will not support Monitor Busy.

SPECIFICATIONS

GENERAL[1]

Frequency Ranges	380-400, 400-430, 430-470, 470-512, 480-520 MHz Transmit/Receive
Dimensions	9.125" H x 17" W x 20.9" D
AC Voltage/Frequency	100-240V AC/50-60 Hz
AC Current	0.38A (Standby), 1.4A (25W), 5A (110W)
AC Input Power	45W (Standby), 170W (25W), 560W (110W)
DC Current at 26.5V DC (Low Power)	6.3A (25W), 16.5A (110W)
Number of Channels	1 (Synthesized, programmable)
Channel Spacing	12.5 kHz/25 kHz selectable
Channel Resolution	6.25 kHz
Temperature Range	-30°C to +60°C (-22°F to +140°F)
Duty Cycle	Continuous
FCC Type Acceptance	ATH2422004 (25 kHz)
FCC Compliance	Parts 15, 90

RECEIVER

12 dB SINAD	0.35 µV
20 dB Quieting	0.50 µV
Signal Displacement Bandwidth	±1 kHz (12.5 kHz), ±2.0 kHz (25 kHz)
Adjacent Channel Rejection	-85 dB (12.5 kHz), -90 dB (25 kHz)
Intermodulation Rejection	-85dB
Spurious & Image Rejection	-100 dB
Audio Squelch Sensitivity	12 dB SINAD
Audio Response	+1/-3 dB TIA
Audio Distortion	Less than 3% at 0.5W/16 ohms
Local Audio Power	0.5W/16 ohms
Audio Sensitivity	±0.75 kHz (12.5 kHz), ±1.5 kHz (25 kHz)
Hum & Noise Ratio	-50 dB
Frequency Spread	2 MHz
Frequency Stability	±1 PPM -30°C to +60°C (-22°F to +140°F)
Modulation Acceptance Bandwidth	±3.5 kHz (12.5 kHz), ±7.0 kHz (25 kHz)

TRANSMITTER

RF Power Out	380-470 MHz 110W (Default setting), 25-110W (Variable Set Point)
	470-520 MHz 100W (Default setting), 25-100W (Variable Set Point)
Spurious Emissions	-90 dBc
Harmonic Emissions	-90 dBc
Audio Deviation	±1.6 kHz (12.5 kHz), ±3.5 kHz (25 kHz)
LTR Data Deviation	±0.8 kHz (12.5 kHz), ±1 kHz (25 kHz)
CWID Deviation	±1 kHz (12.5 kHz), ±2 kHz (25 kHz)
Repeat Deviation	±0.8 kHz (12.5 kHz), ±1.5 kHz (25 kHz)
Audio Response	+1/-3 dB TIA
Audio Distortion	Less than 2%
Hum & Noise (TIA)	-50 dB (12.5 kHz), -55 dB (25 kHz)
Frequency Spread	6 MHz
Frequency Stability	±1 PPM -30°C to +60°C (-22°F to +140°F)
Emission Designators	16K0F3E, 16K0F3D, 16K0F1D

These general specifications are intended for reference and are subject to change without notice. Contact the Systems Applications consultants for guaranteed or additional specifications.

SECTION 2 INSTALLATION

2.1 INTRODUCTION

Information in this section tells how to set up the repeater for operation in an LTR-Net system. It is assumed that the repeater has been previously aligned at the factory or as described in the alignment procedure in Section 7.

Even though each repeater is thoroughly aligned and tested at the factory, it is good practice to check performance before it is placed in service. This ensures that no damage occurred during shipment and that the repeater is otherwise operating properly. Performance testing is described in Sections 7.1, 7.2, 7.3 and 7.4.

2.1.1 SITE PREPARATION AND ANTENNA INSTALLATION

Site preparation and antenna installation are not within the scope of this manual. Basic installation requirements are discussed in the "Dealer Guide To Site Preparation", Part No. 004-8000-100. Factory installation is also available. Contact your Johnson representative for more information.

2.2 ENVIRONMENT

The following conditions should be considered when selecting a site for the Repeater.

Operating Temperature.

-30°C to +60°C (-22°F to +140°F).

Humidity

Less than 95% non-condensing relative humidity at 50°C.

Air Quality

For equipment operating in a controlled environment with the Repeaters rack mounted, the airborne particles must not exceed 30 $\mu g/m^3$.

For equipment operating in an uncontrolled environment with the Repeaters rack mounted, the airborne particles must not exceed 100 $\mu g/m^3$.

NOTE: If the Repeater is installed in an area that exceeds these environmental conditions, the site should be equipped with air filters to remove dust and dirt that could cause the equipment to overheat.

When the repeaters are installed in an environment that contains small airborne particles, e.g. grain dust or salt fog, the repeater cabinets need to be sealed. A heat exchanger, i.e. air conditioner, is then required to cool the cabinets. The air conditioners must be suited for the environment. Each repeater (110W) requires >2400 BTU/hr dissipation to maintain exterior cabinet temperature.

2.3 VENTILATION

The RF modules and the power supply are equipped with fans, controlled by thermostats, that force air through the equipment for cooling. The air flow is from the front to the back of the equipment. This permits the Repeaters to be stacked or rack mounted (see Figure 2-3). There are a few considerations when installing Repeaters to provide adequate air circulation.

- The Repeaters should be mounted with a minimum of 6”clearance between the front or back of the cabinet for air flow. The power supply requires a minimum of 18” at the back of the Repeater for removal.

NOTE: Repeaters should not touch. Leave a minimum of one empty screw hole (approximately 1/2") between repeaters vertically especially for bottom ventilation slots in high power repeaters.

- Cabinet enclosures must provide air vents for adequate air circulation.

- Temperature and humidity must be considered when several Repeaters are installed at a site. This might require air conditioning the site.

2.4 AC POWER

The AC power source to the Johnson VIKING VX Repeater can be 120V AC or 240V AC. Nothing need be done to the power supply for 240V AC operation. However, a 240V AC outlet requires that the 120V AC power plug be replaced. A locking AC power cord is provided for the supply.

The 120V AC cord is a standard 3-wire grounded cord used with a standard AC wall outlet. The outlet must be capable of supplying a minimum of 560W. With the nominal 120V AC input, the source must supply 5A for each 110W repeater and should be protected by a circuit breaker. It is recommended that all of the repeaters in a rack should not be on the same breaker in order to provide one operational repeater in the event a breaker trips. An AC surge protector is recommended for all equipment.

Each Repeater requires an outlet, so for a 5-channel system, a minimum of 5 outlets is required. An additional three outlets should be added for test equipment. The outlets must be within 3 feet of each Repeater cabinet. Future system expansion should be considered when electrical work is being planned for the initial system.

The VIKING VX Repeater power supply can be equipped with an optional 24V DC back-up in the event of AC power failure. Since the transmitter will remain on full power, if desired, the DC power source must have a current capability of about 20A per 110W repeater or 100A for 5 - 110W repeaters. The multicoupler requires another 0.5A for a total system requirement at 24V DC of 100.5A for 110W repeaters.

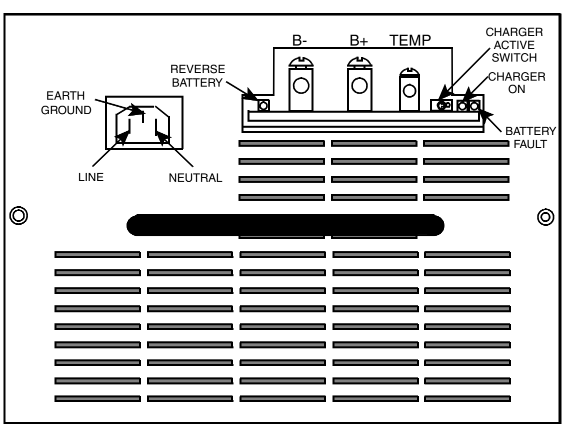


Figure 2-1 BATTERY BACKUP CONNECTOR

2.5 BATTERY BACKUP

If the power supply is equipped with battery backup, screw lugs are provided on the front of the power supply for battery connections (see Figure 2-1). A switch is provided for charging the battery or can be off if a separate battery charger is used. A battery temperature sensor connection is also provided. The temperature sensor cable is shown in Figure 2-2. LED indicators are provided to show Reverse Battery connection, Charger On/Off and Battery Fault.The temperature sensor is required to adjust the charging voltage over temperature.

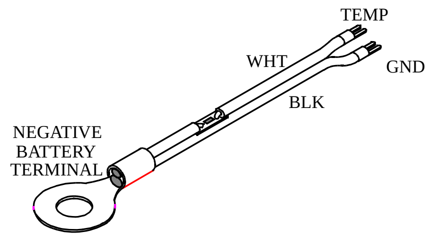


Figure 2-2 TEMPERATURE SENSOR CABLE

2.6 800W POWER SUPPLY

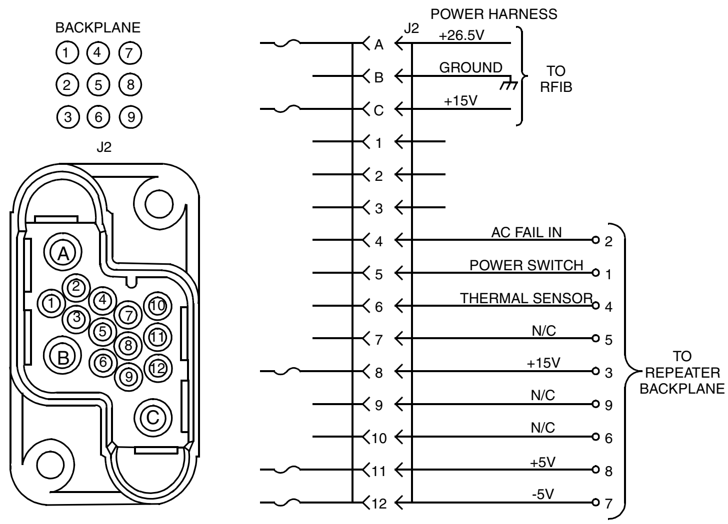
The power supply has four voltage output levels (see Table 2-1). Each voltage is set to ±1% at +25°C (+77°F). The output of this supply is capable or running any 2000 series repeater.

Each output is overload protected such that the power supply current limits and automatically resets when the overload is removed (see Table 2-1).

Each output is over voltage protected such that the power supply shuts down when an over voltage condition exists, usually when a component in the supply has failed (see Table 2-2). The power supply must be manually reset by toggling the Enable Line or removing AC power for more than 10 seconds.

Table 2-1 OUTPUT VOLTAGES

Voltage	Current	Wattage
+26.5V	22A	583W
+15V	5A	75W
+5.2V	5A	26W
-5V	1A	5W



POWER CABLE CONNECTOR AND SCHEMATIC

Table 2-2 OVER VOLTAGE

Voltage	Range
+26.5V	+32V to +33V
+15V	+16V to +18V
+5.2V	+6V to +7V
-5V	-6V to -7V

2.6.1 AC INPUT REQUIREMENTS

AC Input Voltage:	100-240V AC
Line Frequency:	50-60 Hz
AC In-rush:	60A maximum
Overall Efficiency:	>70% at 100V AC
	>80% at 240V AC
Lightning protection:	6kV for < 1ms
Power Factor:	>0.97 at full load
Brown Out Voltage:	80V AC
Temperature	-30°C - +60°C (full power)

Power factor correction per IEC555. The Power supply has the following safety agency approvals pending: UL1950, CSA22.2-950, TUV EN60950 (IEC950)

When the AC input voltage is below 90V AC, the maximum output power is decreased to keep the input current constant. If a battery back-up is installed, the batteries take over when the AC input voltage falls below 80V AC (dependent on power output).

The AC input connector is an IEC connector equipped with a locking mechanism.

The operating temperature range is -30°C to +60°C (-22°F to +140°F), i.e. the same as the repeater. The fan is thermostatically controlled by the internal temperature. When the internal heatsink temperature reaches +45°C (113°F) the fan turns on. When the heatsink temperature drops below +35°C (95°F) the fan turns off. If the internal heatsink temperature reaches +90°C (+194°F) the power supply turns off until the heatsink temperature drops below +85°C (+185°F). The over-temperature shutdown and restart are automatic.

2.7 GROUNDING

CAUTION

PROPER SITE GROUNDING AND LIGHTNING PROTECTION ARE VERY IMPORTANT TO PREVENT PERMANENT DAMAGE TO THE REPEATER.

As in any fixed radio installation, measures should be taken to reduce the possibility of lightning damage to the Viking VX equipment. Proper grounding eliminates shock hazard, protects against electromagnetic interference (EMI) and lightning.

Ground each piece of equipment separately. Do not ground one piece of equipment by connecting it to another grounded piece of equipment. A good DC ground must be found or created at the site. Rooftop site grounds can be researched through the building management or architects. Tower site grounds must be made with grounding rods. The many techniques for providing adequate grounds for towers and poles and for installing building ground bus lines are beyond the scope of this manual. Refer to National Electrical Code article 250 "Grounding Techniques," article 800 "Communications Systems" and follow local codes.

The ground bus should be routed to the floor area within 5 feet of the system with a runner of 6 AWG or larger solid copper wire or 8 AWG stranded copper wire.

The outer conductor of each transmission line at the point where it enters the building should be grounded using 6 AWG or larger solid copper wire or 8 AWG stranded wire.

Secondary protection (other than grounding) provides the equipment protection against line transients that result from lightning. There are two types of secondary protection, RF and Telephone Line. Use the same wire sizes as specified for coaxial cables for any ground connections required by the secondary protectors.

RF

An RF protector keeps any lightning strike to the antenna feed line or tower from damaging the Repeaters. Install this protection in-line with the combiner and antenna feed line.

RF protectors are selected by calculating the maximum instantaneous voltage at the output of the combiner. Do this by using the following equation.

$V_P = 1.414 (X) (\sqrt{P(50)})$

where:

V_P = Voltage at the output of the combiner.
P = repeater output in watts

X=	for	VSWR=
1.05		1.10 : 1
1.09		1.20 : 1
1.13		1.30 : 1
1.17		1.40 : 1
1.20		1.50 : 1
1.30		1.86 : 1

Example: Repeater power output of 60W with a VSWR of 1.3 : 1 (for this VSWR, X = 1.13):

$V_P = 1.414 (1.13) (\sqrt{60(50)})$
$V_P = 1.59782 (\sqrt{60(50)})$
$V_P = 1.59782 (54.772256)$
$V_P = 87.52V$

Telephone Line

There are four types of protection suppressors for telephone lines; Gas Tube, Silicon Avalanche Diode, Metal Oxide Varistor and Hybrid.

The hybrid protector is ideal for E.F. Johnson equipment, and is strongly recommended. A hybrid suppressor combines several forms of protection not available in just one type of device. For example, a high-speed diode reacts first, clamping a voltage strike within 10 ns, a heavy duty heat coil reacts next to reduce the remainder of the current surge, and a high-powered three-element gas tube fires, grounding Tip and Ring.

2.7.1 PROTECTION GUIDELINES

Follow these guidelines for grounding and lightning protection. Each Repeater installation site is different; all of these may not apply.

- Ensure that ground connections make good metal-to-metal contact (grounding rod, grounding tray, metal conduit) using #6 gauge solid wire or braided wire straps.

- With surge protectors, ensure that ground wires go directly to ground, and not through other equipment.
- Run the ground wire for RF coax protectors directly to ground.
- With coax protectors, ensure maximum instantaneous voltage does not exceed the rated voltage.
- Do not run ground wires parallel to any other wiring (e.g. a ground wire parallel to a telephone line), except other ground wires.
- Double check all equipment for good ground and that all connections are clean and secure.

2.8 UNPACKING AND INSPECTION

E.F. Johnson ships the Repeater securely crated for transportation. When the Repeater arrives, ensure the crates remain upright, especially if storing the crates temporarily.

When unpacking the Repeater, check for any visible damage or problems caused by shipping. If there is obvious damage from shipping mishaps, file claims with the carrier. If there appears to be any damage caused before shipping, file a claim with E.F. Johnson. Contact Customer Service for assistance (see Section 1.8).

If everything appears undamaged, remove the Repeater equipment from the crate, using normal precautions for unpacking.

NOTE: Do not discard the packing materials. If you must return an item; use the same packing materials and methods (including static protective bags for circuit cards) to repack the equipment. You are responsible for proper repacking. E.F. Johnson cannot be responsible for damage to equipment caused by negligence.

NOTE: Repeaters should not touch, leave a minimum of one empty screw hole (approximately 1/2") between repeaters vertically especially for bottom ventilation slots in high power repeaters.

NOTE: Each repeater should be grounded separately by connecting a ground bus from the ground lug on the back side of the RF module to the ground bar on the rack (see Figure 2-7).

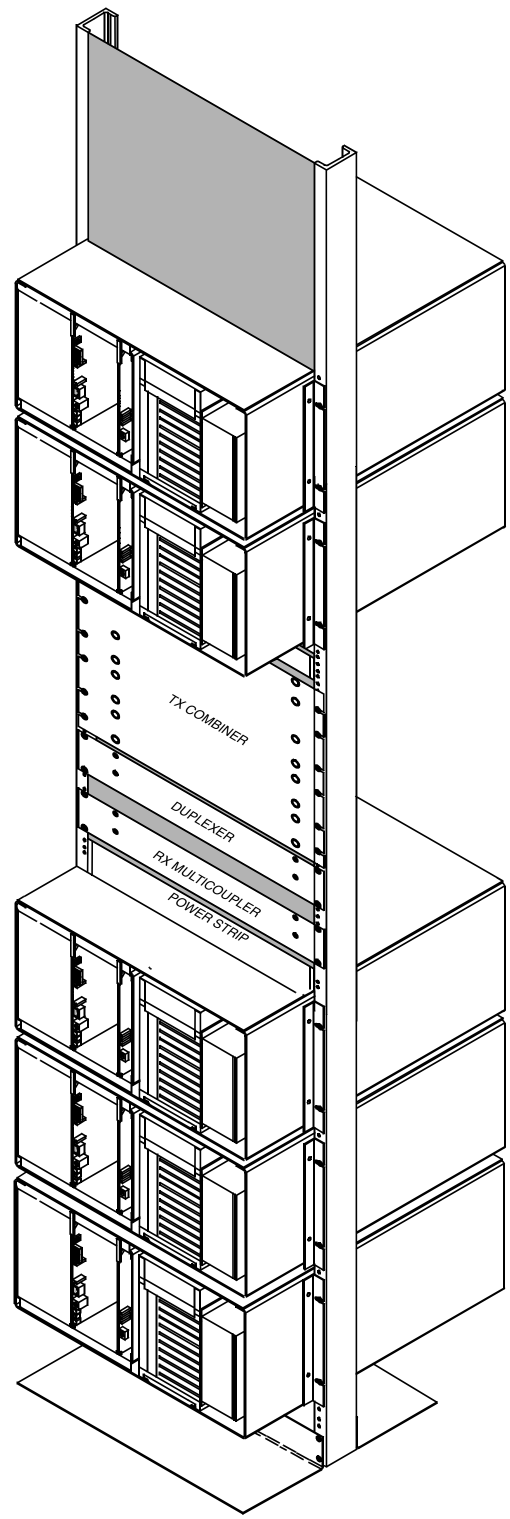


Figure 2-3 RACK MOUNTED REPEATERS

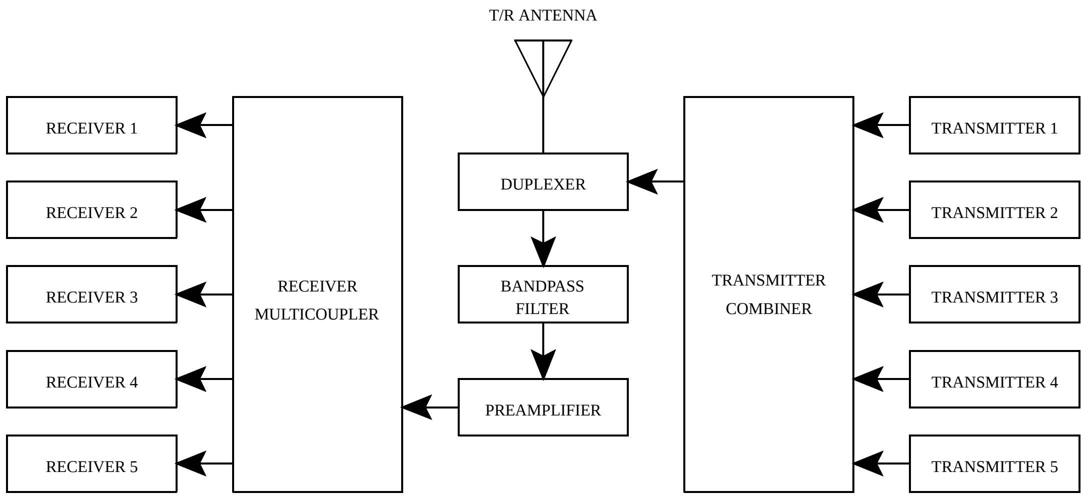


Figure 2-4 5-CHANNEL COMBINING SYSTEM

2.9 REPEATER DATA BUS INSTALLATION

The repeaters are interconnected by a balanced line High-Speed Data Bus (HSDB) consisting of a six conductor cable. The total length of the HSDB cannot exceed 500 feet. Connect the cables in daisy-chain fashion to modular connector A5 on the back of the repeater (see Figure 2-16). A 50 ohm termination is not required for VIKING VX repeaters.

2.9.1 MPC DATA BUS SWITCH SETTINGS

Switch settings on the MPC for the two types of installations require S2 and S3 sections to be switched as indicated in Figure 2-5.

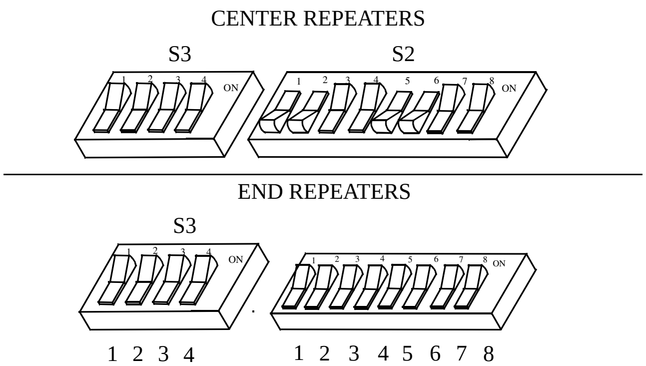


Figure 2-5 MPC DATA BUS SWITCHES

2.9.2 MPC DATA BUS JUMPER SETTINGS

Refer to Figure 2-6 for crystal selection and HSDB Code selections jumper placement. Jumper J5, pins 1-2 selects 11.059 MHz for LTR-Net (J5, pins 2-3 selects 12 MHz crystal for Standard LTR). The jumper on J4, pins 5-6 connects EPROM U14, pin 27 to ground for LTR-Net (J4, pins 3-4 connects EPROM U14, pin 27 (A14) to +5V for Standard LTR single-ended 5V data bus).

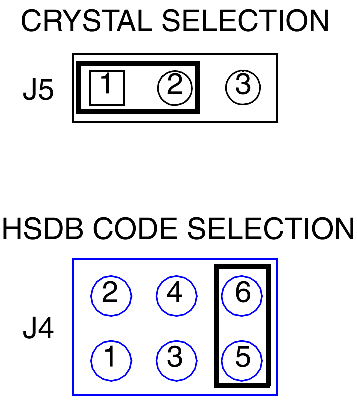


Figure 2-6 MPC JUMPERS

Jumper J4 must be placed with the following guidelines: J4, pins 5-6 for operation with the RJ-11 to RJ-11 cable 200X systems (see Section 4.5.6).

2.10 CONNECTING RECEIVE AND TRANSMIT ANTENNAS

Receive and Transmit antenna connector locations are shown in Figure 2-7. Although each transmitter and receiver could be connected to a separate antenna, this is usually not done because of the large number of antennas required by a multiple repeater installation. Therefore, an antenna combining system is usually used. An example of a combining system for a five-channel system is shown in Figure 2-4. The amount of power loss introduced by a combiner depends on the type of combiner used. If it has a loss of 3 dB, power output to the antenna is reduced by half.

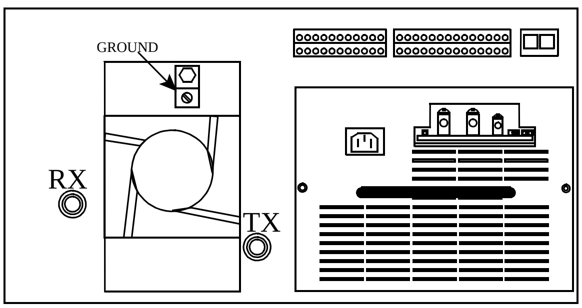


Figure 2-7 ANTENNA CONNECTIONS

2.11 CONNECTING AUDIO/DATA LINK TO SWITCH

A communication link of some type is required between the Switch and each repeater. This link allows the Switch to control the repeater and also routes audio between the Switch and repeater. Various types of links can be used, such as phone line, RF transceiver, microwave, or fiber optic Refer to Section 1.14.3 for more information. The repeater connection point is terminal block J2 on the back panel (see Figures 2-8 and 2-12). The information which follows describes the installation of these links.

2.11.1 VOICE LINK

The voice link is always connected and it should be a standard 4-wire, 600 ohm balanced voice- grade link. It can be non-metallic, i.e. DC continuity is not required. If the repeaters and Switch are located at the same site, direct connection can be used as long as the line is less than approximately 300 feet.

Connect the voice link to terminals 1-2 and 3-4 (see Figure 2-8 and 2-4).

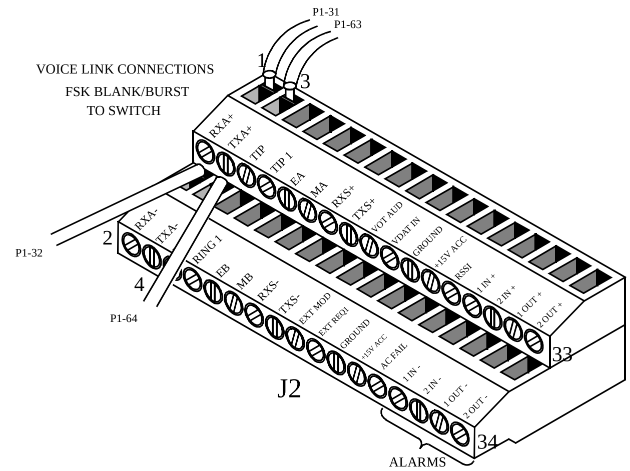


Figure 2-8 TERMINAL BLOCK J2

2.11.2 DATA LINK

One of these three methods can be used for installing the data link.

NOTE: See Section 7 for Link Alignment.

1. Separate 4-wire link can be used that is similar to that used for voice. The data is then encoded by FSK and sent as tones.

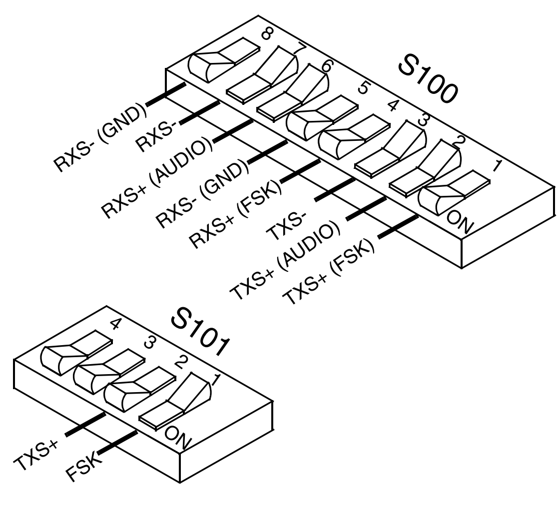


Figure 2-9 MAC DIP SWITCH SETTINGS FOR 4-WIRE LINK

2. A separate RS-232 serial link can be used.

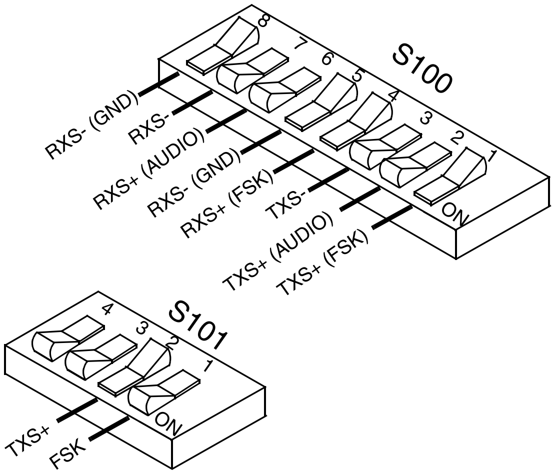


Figure 2-10 MAC DIP SWITCH SETTINGS FOR RS-232 LINK

3. The FSK data can be sent over the voice link using a Blank and Burst technique. No separate data link is then required.

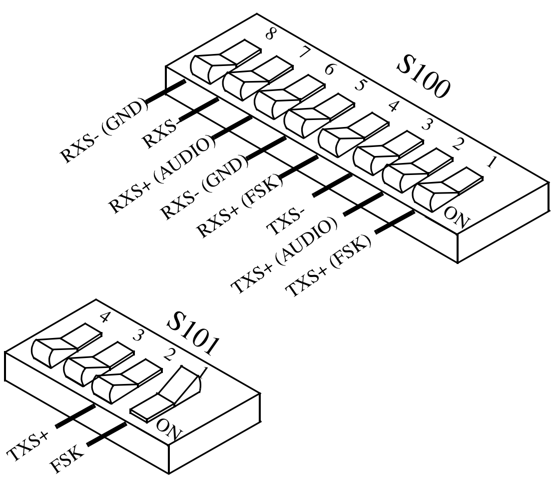


Figure 2-11 MAC DIP SWITCH SETTINGS FOR BLANK AND BURST LINK

Select the type of link being used, refer to Figure 2-8 and 2-4 and make the connections to terminals 1-2 and 3-4.

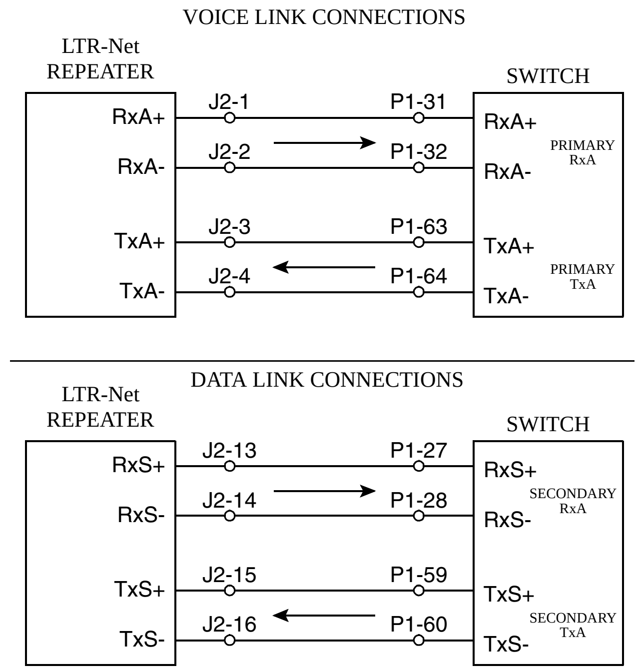


Figure 2-12 LTR-Net VOICE/DATA LINK

2.12 RANGE/BANDWITH INDICATOR RESISTORS

Zero ohm resistors R311-R318 on the receiver board are used for identification of the frequency range and bandwidth only. If R311/R312 are both installed, this indicates that parts for both IFs are installed and either one can be selected using jumpers on J203, J204 and J205 (see Sections 6.1.4 and 6.1.5). One zero ohm resistor (R313-R318) is used to indicate the frequency range.

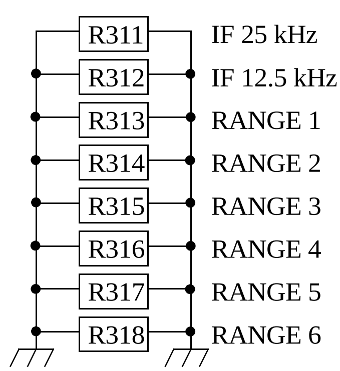


Figure 2-13 INDICATOR RESISTORS

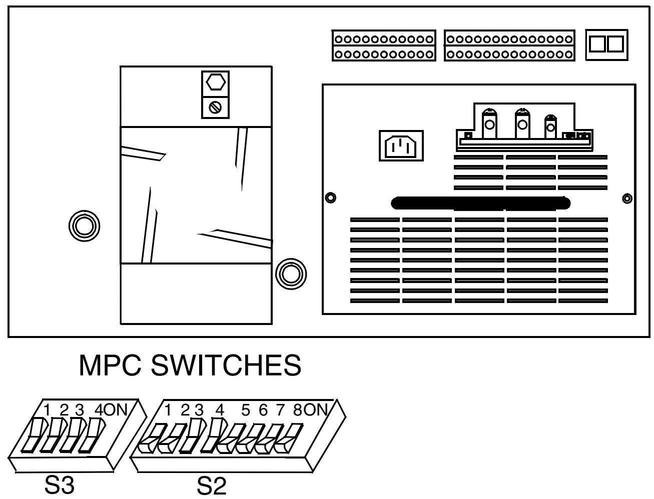


Figure 2-14 SINGLE REPEATER INSTALLATION

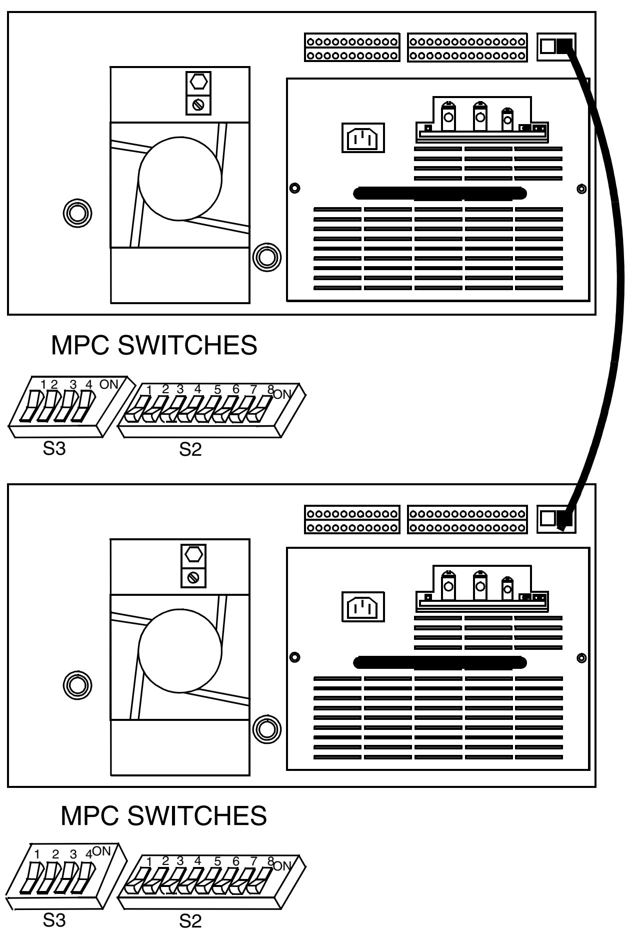


Figure 2-15 TWO REPEATER INSTALLATION

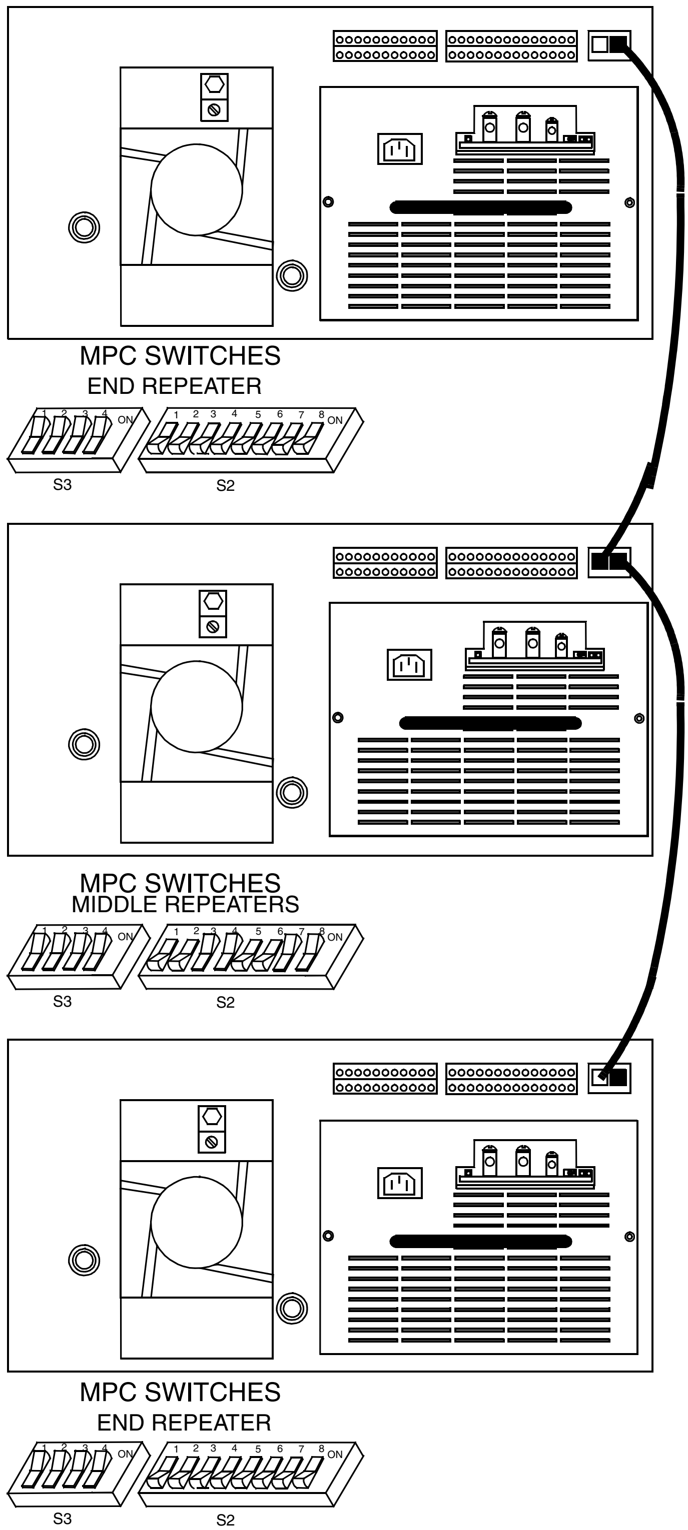


Figure 2-16 THREE OR MORE REPEATERS INSTALLATION

SECTION 3 SOFTWARE

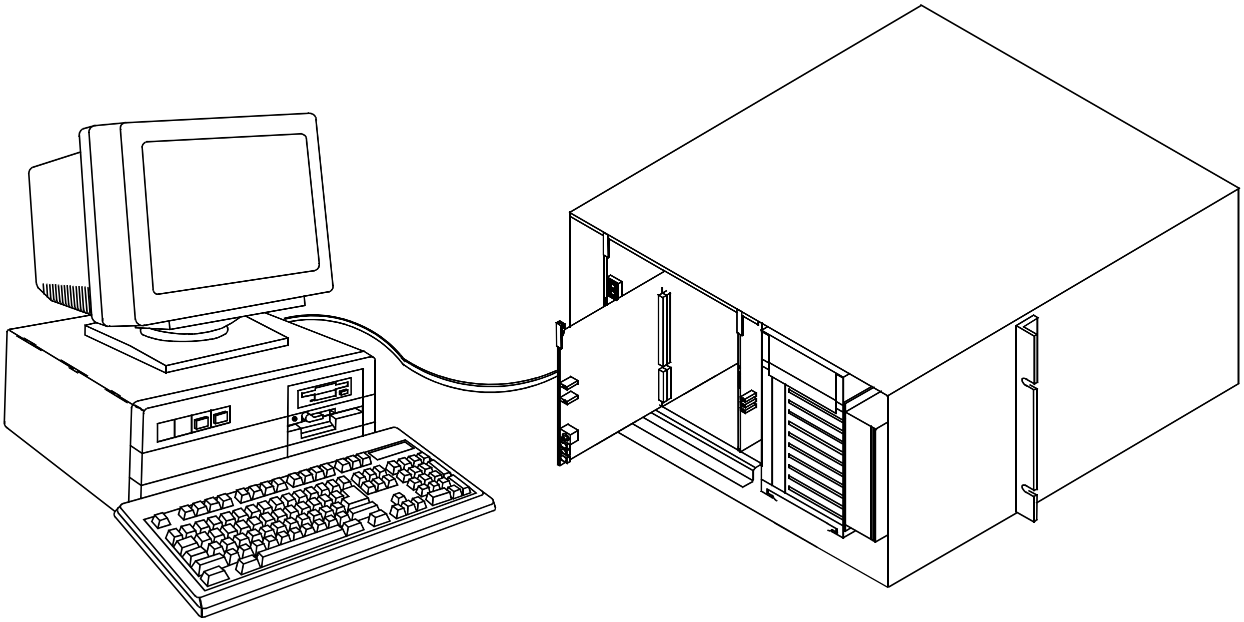


Figure 3-1 PROGRAMMING SETUP

3.1 INTRODUCTION

3.1.1 PROGRAMMING SETUP

The following items are required to program the repeater. The part numbers of this equipment are shown in Section 1, Table 1-1. A programming setup is shown above.

The LTR-Net Programmer on 3.5 inch disk, Part No. 023-9998-459, uses Windows NT 4.0 or later, or Windows 95 or later on a personal computer to program the EEPROM Memory in the Main Processor Card (MPC).

The computer is connected directly from the serial card to the MPC. The interconnect cables used are shown in Figure 3-2. The DB-9 to 8-pin modular adapter is connected to the serial port of the computer and an interconnect cable connects the adapter to the MPC.

NOTE: These connections are for the IBM computer and may differ from an IBM compatible. In which case, consult the manuals for your computer for serial card outputs and connections.

3.1.2 MINIMUM COMPUTER REQUIREMENTS

The LTR-Net Programmer requires Windows NT 4.0 or later, or Windows 95 or later that meets the following minimum requirements.

- 16M of memory
- 486 or faster microprocessor
- The personality program and help file are supplied on a 3.5", 1.44M diskette only. Therefore, a computer with a hard disk drive and 3.5" (1.44M) floppy drive is required.
- One unused serial port
- Color monitor

Although the program uses color to highlight certain areas on the screen, a monochrome (black and white) monitor or LCD laptop also provide satisfactory operation. Most video formats are supported. An unused serial port is required to connect the repeater to the computer. One or two serial ports are standard with most computers. One port may be used by the mouse.

3.1.3 PROGRAMMING CABLES

The cables from the repeater to the computer are not included.

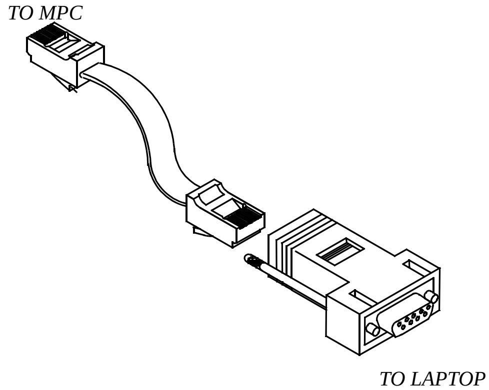


Figure 3-2 LAPTOP INTERCONNECT CABLE

3.1.4 EEPROM DATA STORAGE

The data programmed into the MPC is stored by an EEPROM memory. Since this type of device is nonvolatile, data is stored indefinitely without the need for a constant power supply. A repeater can be removed from the site or even stored indefinitely without affecting programming. Since EEPROM memory is also reprogrammable, a new device is not needed if programming is changed.

3.1.5 GETTING STARTED

NOTE: Before starting you should already know how to start Windows NT®, format and make backup copies of disks, copy and delete files, and run programs. If you are unfamiliar with any of these actions, refer to the Windows NT manual for your computer for more information (see Section 5).

Follow the computer instructions for loading the disk. The computer needs to have RS-232C capability, for example, the Serial Card in slot "COM1" or "COM2".

The LTR-Net Programmer is used to configure repeaters for proper operation with the LTR-Net protocol.

From the repeater standpoint, an LTR-Net system consists of one or more repeaters installed in a Locality, a 3000 Series Switch and the necessary interconnects and programming to provide LTR-Net operation (see Section 2).

The LTR-Net Programmer defaults to using COM1 at 9600 baud to communicate with a repeater, however this can be changed by selecting Utilities -> COM Port Setup from the menu, or by clicking on the COM toolbar button (see Section 4.7.1).

When you first start the programmer, you should create a Locality file with the information you wish to program into repeaters at that Locality. See "How Do I ... Create A New Locality File" for information on performing this function.

NOTE: All repeaters installed in a given Locality use the same Locality information, but each has its unique repeater information programmed.

3.1.6 LIMITATIONS

The LTR-Net Programmer requires Windows NT 4.0 or later, or Windows 95 or later.

In order to read data from a repeater, a Locality file must first be loaded from disk, or create and save a Locality file. Only one Locality file may be loaded at a time.

The LTR-Net Programmer supports COM1 through COM4, and all of the baud rates currently supported by the MPC. Since the number of data bits, stop bits, and the parity are fixed in the MPC, these cannot be changed in the programmer.

3.2 MISCELLANEOUS SOFTWARE INFORMATION

3.2.1 MINIMUM FREE MEMORY REQUIRED

Approximately 2MB of free memory is required to run this program. If not enough is available, there may be other programs that are also being loaded into conventional memory. These programs can be closed to make more space available.

3.2.2 SOFTWARE INSTALLATION

- Making a Backup Copy

When the programming software is received, make a backup copy and store the master in a safe place. To make a copy of the distribution disk with Windows NT or Windows 95 Explorer, right click the floppy drive icon and select Copy Disk.

- Creating a Windows Shortcut or Program Icon

To run the program from Windows NT or Windows 95, a shortcut icon can be created that can then be double clicked to start the program. To create this shortcut icon, select Start -> Settings -> Taskbar. Then select the Start Menu Programs tab and click the Add button. Information is then displayed to complete the process.

3.2.3 STARTING THE PROGRAM

There are several ways to start the LTR-Net Programmer. First, the program can be started by double clicking on the shortcut icon. This starts the program with an empty information file (Locality file). A Locality file contains all of the programming information for all repeaters installed at a Locality.

A second method of starting the program is to use the Explorer to change to the directory containing Locality files, then double click on one of those Locality files. This starts the programmer and automatically loads the selected file. This is normally the most convenient method to start the program, as it pre-loads all of the repeater data for a Locality.

Once files have been opened or saved from within the programmer, those filenames will show up in the taskbar Documents selection. allowing the program to be started by selecting the desired Locality file from the Start menu.

Refer to Section 4 for detailed information about the LTR-Net Programmer's contents and Section 5 for the parameters and their descriptions for the Locality and Repeater programming.

3.3 ALIGNMENT SOFTWARE

The software for the LTR-Net repeater programs the MPC to open and close the audio/data gates necessary for the alignment selected from the Test-Full Repeater menu.

Under the menu heading TEST, are the alignment procedures for the PA (see Section 7.4 or 7.5), Receiver (see Section 7.2), Exciter (see Section 7.3) and overall Full Repeater (see Section 7.6) including the MAC card (see Figure 3-3).

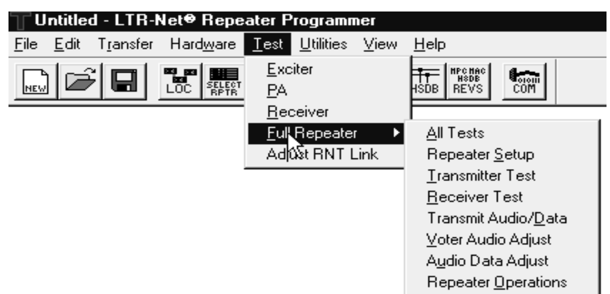
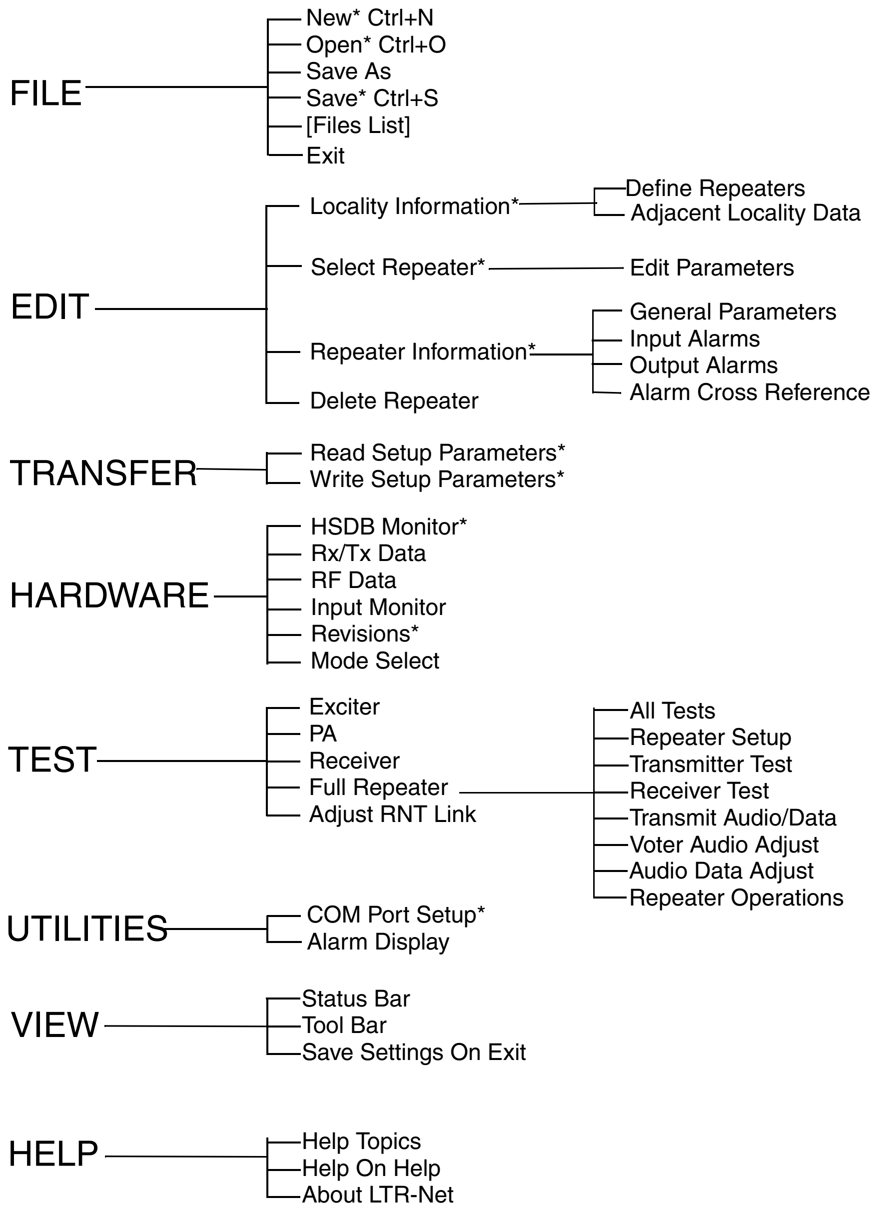


Figure 3-3 REPEATER TEST MENU

Refer to Section 7 for alignment procedures as shown in the program, alignment points diagrams and test setup diagrams.

3.4 HELP

Help screens are available for most parameters and options in this program. Whenever a parameter or options clarification is needed, press the Help button and a help screen will pop-up on the screen.



* Denotes an associated icon in the Tool Bar

Figure 3-4 PROGRAMMING FLOWCHART

SECTION 4 PULL DOWN MENUS

4.1 MENU DISPLAYS

The menus available are listed at the top of the screen (see Figure 4-1). Move the cursor with the mouse to highlight the menu name. Press the left mouse key to view the menu and the mouse to scroll through the menu. Call up the highlighted selection by pressing the left mouse button. The Toolbar provides one-click access to some of the most frequently used menu selections.

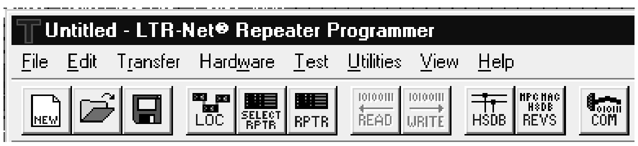


Figure 4-1 MAIN MENU

4.2 FILE MENU

This menu manipulates new or existing files into directories and saves files to be called up at another time.

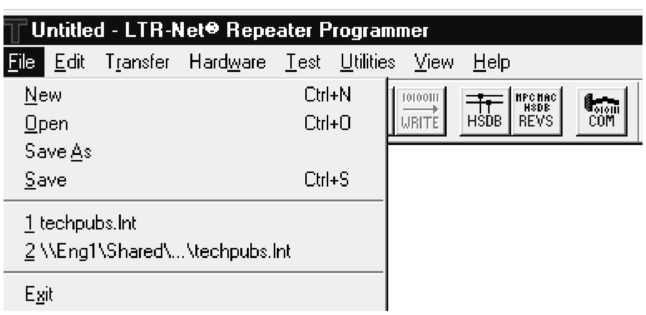
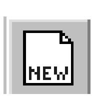


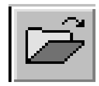
Figure 4-2 FILE MENU

4.2.1 NEW



This menu selection has an equivalent icon in the toolbar and shortcut key Ctrl+N. This menu selection or icon erases all Locality and Repeater information in the programmer and loads factory defaults. If the current data has been changed, selecting File -> New or the icon provides the opportunity to save the data before loading the defaults.

4.2.2 OPEN



This menu selection has an equivalent icon in the toolbar and shortcut key Ctrl+O. This menu selection or icon opens a Locality file and loads its information into the programmer. It brings up a list of Locality data files to select from.

4.2.3 SAVE AS

This menu selection saves the edited version of an existing file loaded in the buffer under a new filename or gives a new file created in the Edit menu a filename.

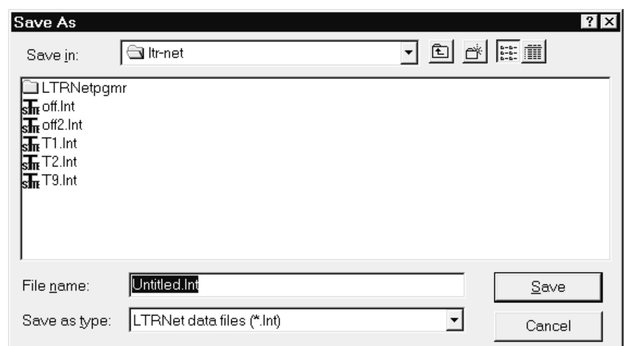
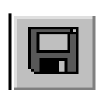


Figure 4-3 OPEN / SAVE AS / SAVE FILE

4.2.4 SAVE



This menu selection has an equivalent icon in the toolbar and shortcut key Ctrl+S.

4.2.5 EXIT

Exits the repeater program and returns to Windows NT. See Section 4.8.3, View -> Save Setting On Exit to save the toolbar location (size and shape) as well as the main window location and size when the programmer is opened.

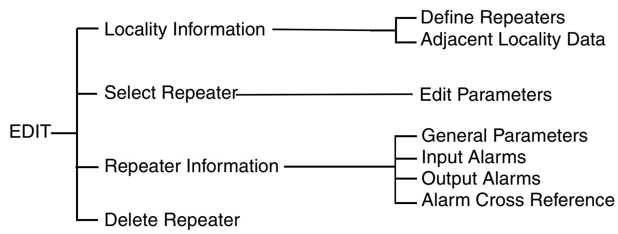


Figure 4-4 EDIT PROGRAMMING FLOWCHART

4.3 EDIT

This menu is used to create new files and set or change the repeater operating parameters. The filename for the Locality and relevant data is shown in the Title Bar and Status Bar (see Section 4.8.1).

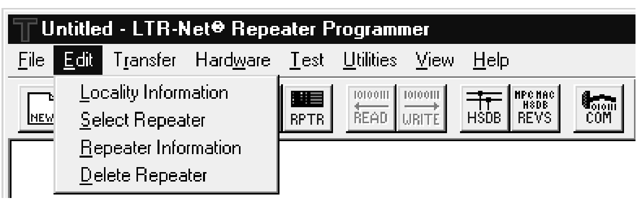
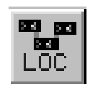


Figure 4-5 EDIT MENU

4.3.1 LOCALITY INFORMATION

This menu selection has an equivalent icon in the toolbar. This menu selection or icon brings up the Locality information screens to Define Repeaters and Adjacent Localities.



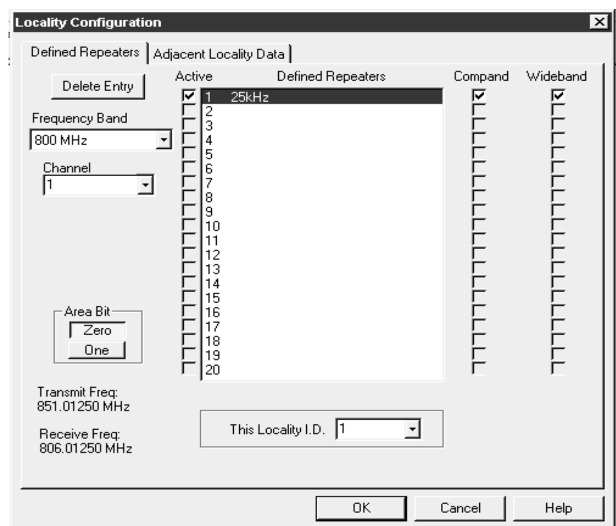


Figure 4-6 LOCALITY CONFIGURAITON

Table 4-1 DEFINE REPEATERS PARAMETERS

Delete Entry	Removes the selected Defined Repeater from the list.
Frequency Band	Selects the Locality frequency band, 380 MHz Base, 430 MHz Base or 470 MHz Base.
Transmit Frequency	Enter the transmit frequency within the band selected.
Receive Frequency	Enter the receive frequency within in the band selected.
Area Bit	If the coverage area includes more than one Switch the area bit is used, this is normally 0.
Active	Click on this box to activate the selected Defined Repeater.
Defined Repeaters	Click on a repeater number, then select the channel number and the data is displayed.
Compand	Click on this box if the Companding option is used.
BW Limited	Default is 25 kHz bandwidth, click on this box to select 12.5 kHz bandwidth.
OK	Saves the current selections shown and closes the window.
Cancel	Disregards all changes and closes the window.
Help	Displays the Help screen for the parameters in this window.

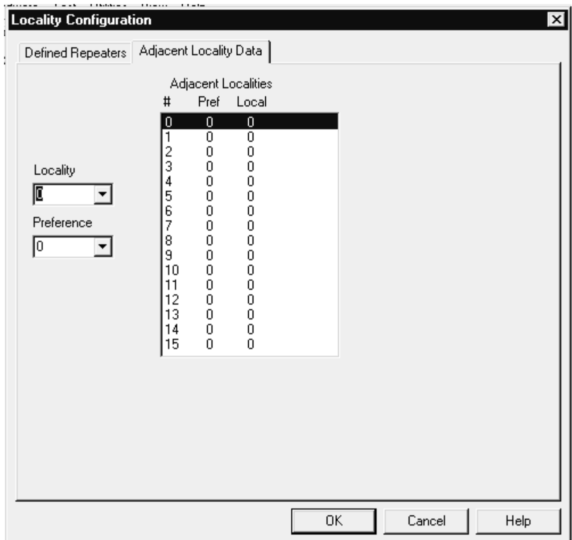


Figure 4-7   ADJACENT LOCALITY DATA

- Select the Locality ID number for the Locality currently being defined.
- Select a Locality ID for each of the closest Adjacent Localities (0-15).
- Select a Preference number for each Adjacent Locality number as an alternative when leaving the range of this Locality.

4.3.2 SELECT REPEATER

This menu selection has an equivalent icon in the toolbar. This menu selection or icon selects a repeater from the currently defined repeaters within this Locality (see Figure 4-8). Move the cursor with the mouse to highlight the repeater filename and double-click the mouse to open the Edit Parameters window.

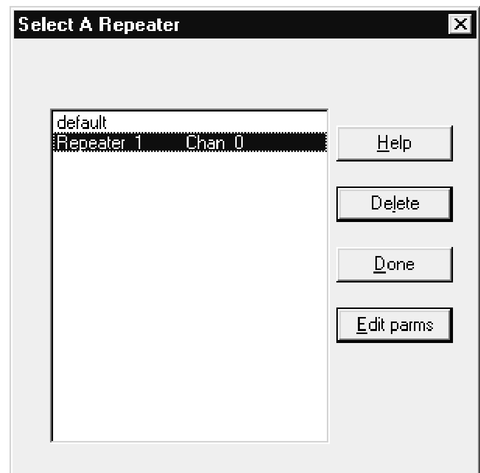
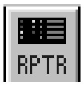


Figure 4-8   SELECT REPEATER

Table 4-2   ADJACENT LOCALITY PARAMETERS

This Locality ID	0-1023	This is the ID of the Locality currently being defined.
Locality	0-1023	The Locality ID number of a neighboring Locality.
Preference	1-15	A scale number for the best alternative Locality (1 = Highest, 15 = Lowest).
# (Number)	0-15	Choice of 16 neighboring Localities that can pick-up transmissions.

4.3.3 REPEATER INFORMATION



This menu selection has an equivalent icon in the toolbar. This menu selection or icon brings up the parameter pages for the selected repeater. It allows entry of information specific to this repeater.

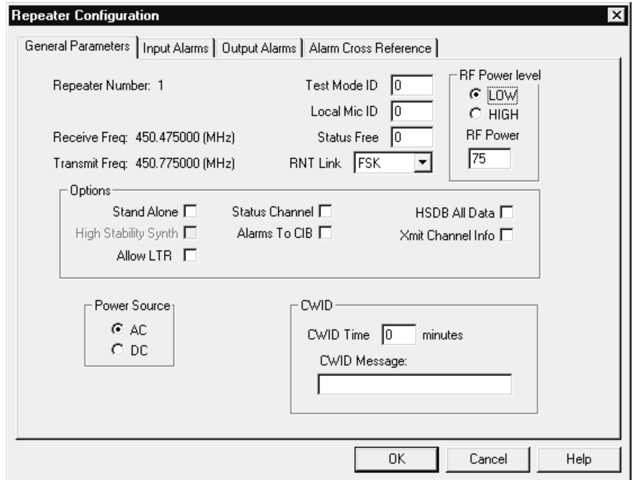


Figure 4-9 REPEATER CONFIGURATION

Table 4-3 GENERAL PARAMETERS

Repeater Number	1-20	Repeater number was established in Locality Configuration.
Receive Frequency		Frequency was determined in Locality Configuration.
Transmit Frequency		Frequency was determined in Locality Configuration.
Test Mode ID	0-239	Group ID transmitted when the Repeater is in the Test Mode.
Local Mic ID	0-239	Group ID transmitted when the local microphone PTT is active.
Status Free	0=never 20=always	When the number of free channels falls below this value, Status Channel can be used for voice.
RNT Link	None FSK Dig BnB	Data Signaling type for 3000 Series Switch. Frequency Shift Keying RS-232 Blank and Burst (FSK)
RF Power Level	25-110W	Power level in watts for transmit power output.
Options	Stand Alone	Selected if the repeater is permitted to operate without a connection to the 3000 Series Switch.
	Allow LTR	Selected if standard LTR protocol is allowed.
	Status Channel	One repeater at a Locality is designated to transmit update information for all calls occurring at that Locality. Normally not assigned as a Home repeater.
	Alarm to CIB	Routes repeater alarms to the Channel Interface Bus to be detected by the Call Processor and the System and Subscriber Manager.
	Monitor Busy (UHF repeaters only)	Checks the receive channel frequency for activity before allowing the repeater to transmit. Not available if Allow LTR is selected. *NOTE: Not supported in MPC software Version 2.02 and earlier.*
	HSDB All Data	Repeater receives all the data on the High Speed Data Bus.
	Xmit Channel Info	Repeater sends updates on all repeaters installed in this Locality.
Power Source	AC, DC	The type of primary power source for the Repeater.
CWID Time	0=disabled, 1-30 min	The time interval between CWID transmissions.
CWID Message	Station call letters	This is the FCC station call letters (15 characters/numbers).
OK		Saves the current selections shown and closes the window.
Cancel		Disregards all changes on any of these four screens and closes the window.
Help		Displays the Help screen for the parameters in this window.

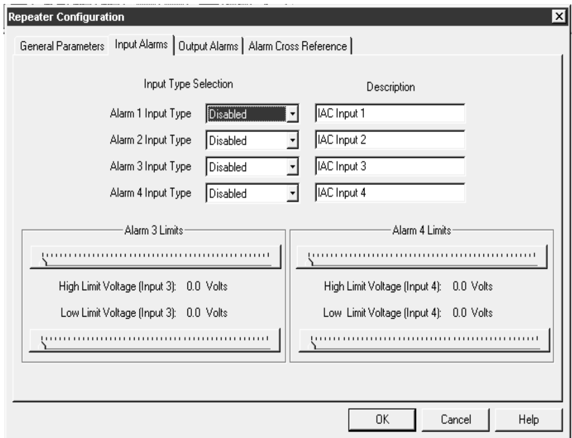


Figure 4-10 INPUT ALARMS

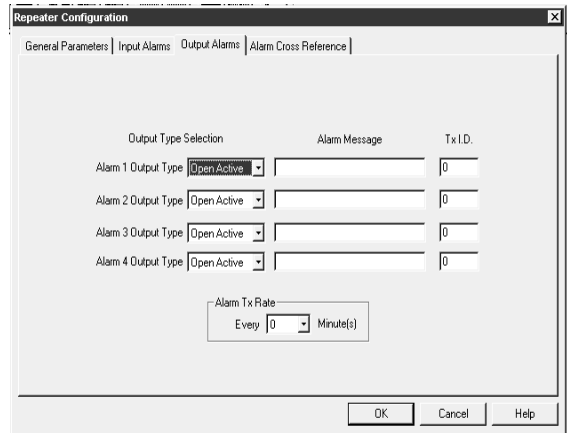


Figure 4-11 OUTPUT ALARMS

Input Alarms

There are four Input Alarms that can be activated by external devices (see Section 6.13). These inputs can be Disabled, Energized or De-Energized. Alarms 3 and 4 can also be Analog Inputs.

- Disabled - The input alarm line is inactive.
- Energized - An open circuit external to the repeater activates the alarm.
- De-energized - A closed circuit external to the repeater activates the alarm.
- Analog - Select the Low and High Limit pairs to trip an Analog Input Alarm. The High Limit must be greater in value than the Low Limit (0.0V-5.0V in 0.1V steps).
- Alarm Description - This is a text string (up to 15 characters) to describe the alarm. The description is automatically changed on the Cross Reference Window.

Output Alarms

Select the operation of the Output Alarm. The available types are:

- Open Active - An active alarm opens (no contact) the output lines.
- Closed Active - An active alarm closes (contact) the output lines.
- Alarm Message

This is a text string (up to 15 characters) to describe the alarm. This text string is sent via Morse code if the alarm input is programmed with a Tx ID and an output is selected in the Cross Reference menu (see Figure 4-13). The Alarm Message is automatically transferred to the Cross Reference window.

- Transmit ID

Each of the 4-alarm outputs can be assigned a Group ID from 1-239. The default setting is 238, 0 (zero) for disabled. This Group ID and the Repeater number identify an alarm that is active. This ID can be programmed into a transceiver so that when the alarm is active, the alarm description is received in Morse code.

- Alarm Transmit Rate

This sets the time interval for transmitting the alarm message in Morse code (0-30 min). If more than one alarm is active, this is the inter-alarm time.

Cross Reference

The cross reference screen selects the Output Alarm that is activated by each Input Alarm. There are up to:

- 48 alarms (0-47)
- 4 (hardware) External Input Alarms
- 18 (software) Internal Alarms (see Table 1-2).
- 26 unused

There are 4 Output Alarms. An alarm condition on any input can cause an Output Alarm. This window configures which Input Alarm activates an Output Alarm.

NOTE: More than one alarm condition can share the same output alarm (see Figure 4-13).

Show Alarm Map

This window displays an Alarm Map that displays those Alarm Outputs that have been mapped in bold type. Double-clicking on these outputs lists the Alarm Inputs that have been assigned to that output.

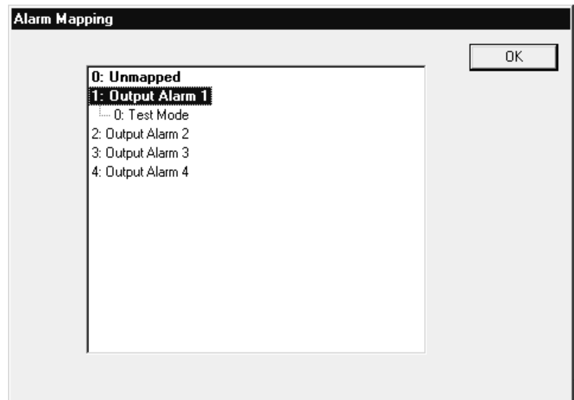


Figure 4-12 ALARM MAPPING

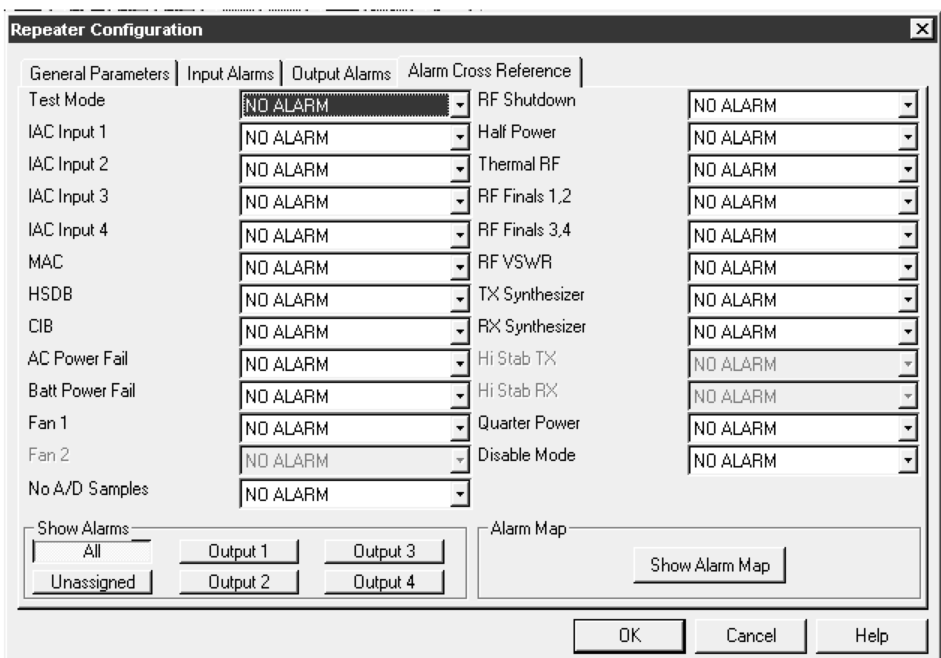


Figure 4-13 ALARM CROSS REFERENCE

4.3.4 DELETE REPEATER

Select the Repeater number to delete from this Locality and press the Delete button.

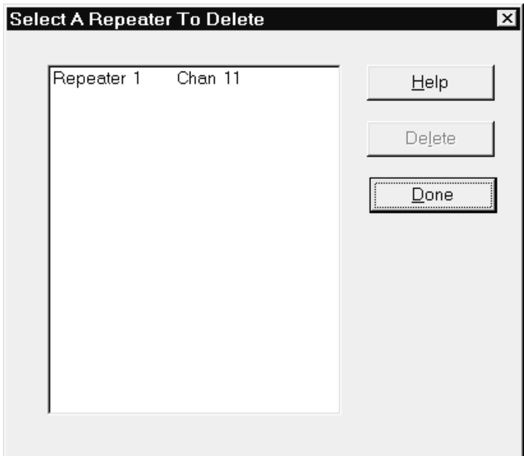


Figure 4-14 DELETE REPEATER

4.4 TRANSFER

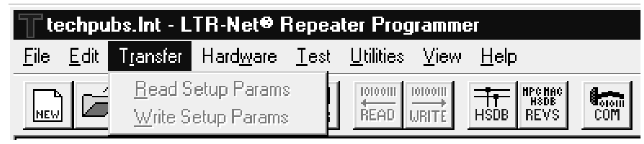
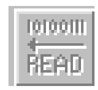


Figure 4-15 TRANSFER MENU

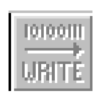
4.4.1 READ SETUP PARAMETERS



This menu selection has an equivalent icon in the toolbar. This menu selection or icon reads the contents of the EEPROM memory of a repeater and loads it into a buffer. The contents of the buffer may then be displayed to show the programming of the repeater.

NOTE: This button is only available if a Locality file is loaded and a repeater is connected.

4.4.2 WRITE SETUP PARAMETERS



This menu selection has an equivalent icon in the toolbar. This menu selection or icon sends the contents of a Locality file to a connected repeater and programs the EEPROM memory in the Main Processor Card (MPC).

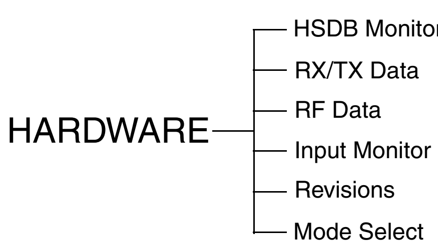


Figure 4-16 HARDWARE PROGRAMMING FLOWCHART

4.5 HARDWARE

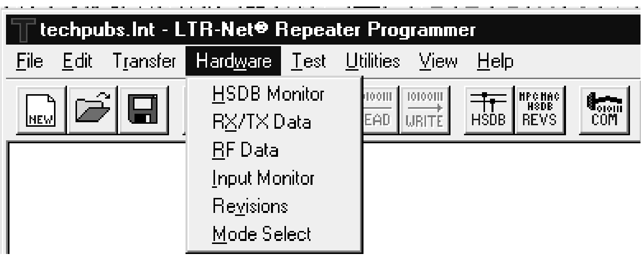


Figure 4-17 HARDWARE MENU

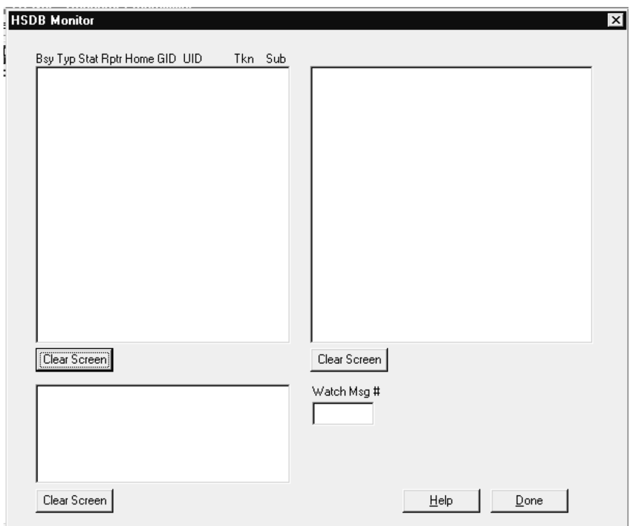
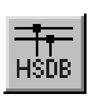


Figure 4-18 HSDB MONITOR

4.5.1 HSDB MONITOR



This menu selection has an equivalent icon in the toolbar. This menu selection or icon brings up the monitor window to view information from the High Speed Data Bus (HSDB). The HSDB connects all repeaters at a Locality and continually sends updates on the status of each repeater. This information window provides a list of all repeaters (1 to 20) at the Locality. If a repeater is not sending data, IDLE is next to the repeater number. The data sent by the repeater is used to determine the Home, GID and UID of destination (mobile) users to receive the call placed by the originator.

The Home column refers to the Home repeater number of the originator, therefore, the Repeater and Home numbers may not be the same number. The GID column refers to the Group ID of the talk group of the originator. The UID is the Unique ID used to identify the originator of Special Calls. Special Call information is listed in the Token and Subtype columns.

4.5.2 RECEIVE/TRANSMIT DATA

This is an information screen used at the repeater Locality while the computer (laptop) is connected to the MPC in the repeater being monitored (see Figure 4-19). This information is contained in the receive data stream exchanged between the repeater and the destination user (mobile/portable) and the data content of the repeater transmit data stream. The message contains data received from the destination and data sent to the mobile/portable by the repeater. The repeater receives the destination's: Unique ID, Home Repeater Number, Group ID, Priority and Status. The time stamp is included because messages are sent continually and this provides a reference for when a data exchange took place. The information sent to the destination in the update message from the repeater includes: Description/Group, Channel In Use, Home Repeater Number, Free Channel and Time Stamp.

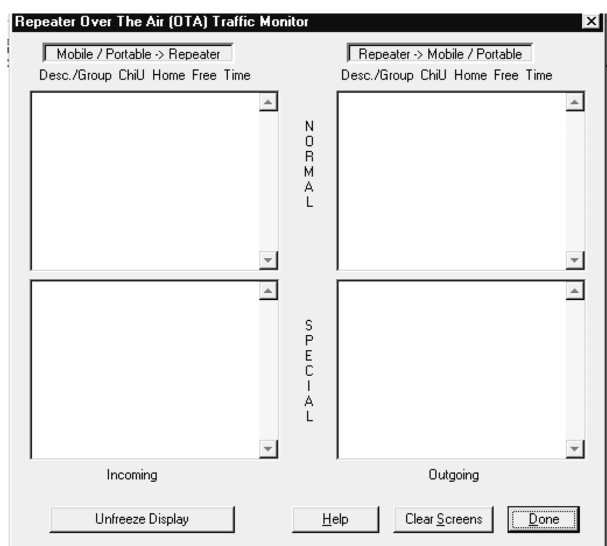


Figure 4-19 REPEATER TRAFFIC MONITOR

4.5.3 RF DATA

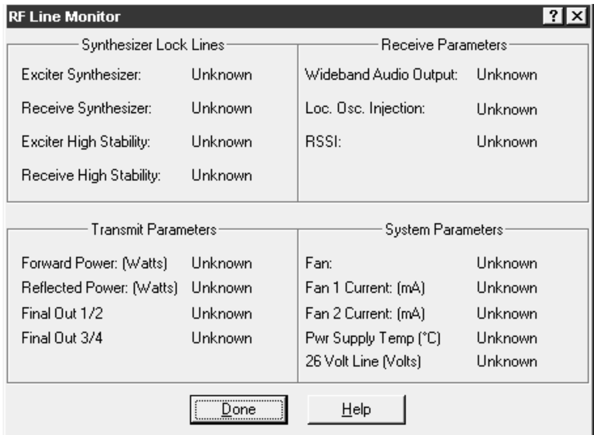


Figure 4-20 RF DATA

The RF Line Monitor window shows the state of the lines (see Figure 4-19). These lines are monitored by the A-D converter in the IAC. The normal values for each line are defined as follows.

Synthesizer Lock Lines:	
Exciter Synthesizer	Yes, No
Receive Synthesizer	Yes, No
Exciter High Stability	Yes, No
Receive High Stability	Yes, No
Wideband Audio Output	approx. 200
LO Injection	approx. 200
RSSI	20-150
Fan 1 Current	100-200, 0
Fan 2 Current	100-200, 0
Transmit Parameters:	
Forward Power (Low Power	25-110 Watts
Reflected Power	0-6 Watts
Final Out 1-2 (ratio)	approx. equal
Final Out 3-4 (ratio)	approx. equal
Chassis Temp	27°C-55°C
Fan	On or Off
Power Supply Temp	22°C-45°C
Battery Voltage	21V-28V

Values with no label are the actual A-D reading. To calculate the voltage on the line, divide the value by 51. Example: Value ÷ 51 = Volts. Any variation from the above values may indicate a problem in that area. Values in this window are relative measurements only.

4.5.4 INPUT MONITOR

This window monitors the two Analog Input lines. It is only used with the 4-Alarm Type IAC, and only if Input 3, Input 4 or both are programmed for "Analog". In addition to the actual or measured value, the Low/High limit data are also displayed. These limits are programmed in the "Edit -> Repeater Information -> Input Alarms" screen (see Figure 4-13). If one of these inputs is not programmed "Analog", the data for that input is blanked.

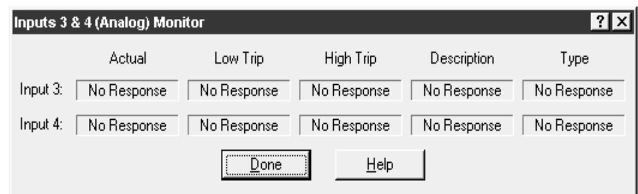
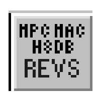


Figure 4-21 INPUT MONITOR

4.5.5 REVISIONS



This menu selection has an equivalent icon in the toolbar. This menu selection or icon displays the current firmware revision information for the MPC, MAC and HSDB. The format is R.V (revision.version) for all modules. The MPC information also includes the release date of the software and the serial number of the repeater. The HSDB version in Figure 4-22 is for J4, pins 5-6 connected in the MPC for LTR-Net (J4, pins 3-4 connected in the MPC are for standard LTR).

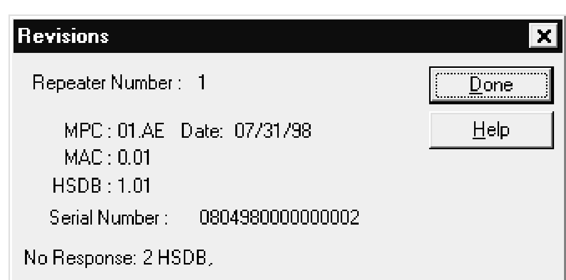


Figure 4-22 REVISIONS

4.5.6 MODE SELECT

The Mode Select window places the repeater either in the Normal mode, Test mode or Diagnostic mode. In the Normal mode, the repeater operates as a normal repeater. In the Test mode or Diagnostic Mode the repeater transmits a test word. This test word is the Test Mode ID setup in the Repeater Information (see Section 4.3.3).

C A U T I O N

While in the test or diagnostics mode the repeater is "Busy", therefore it is important to place the repeater in ***Normal mode*** *when the Test Mode is no longer required.*

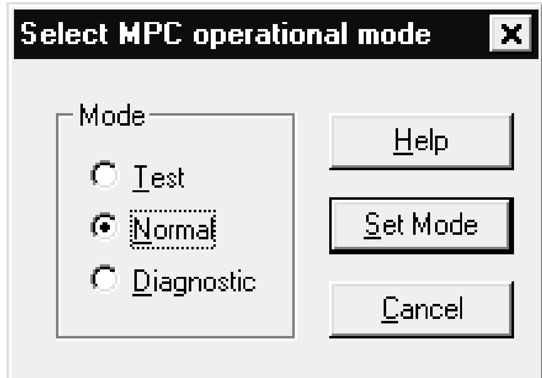


Figure 4-23 MODE SELECT

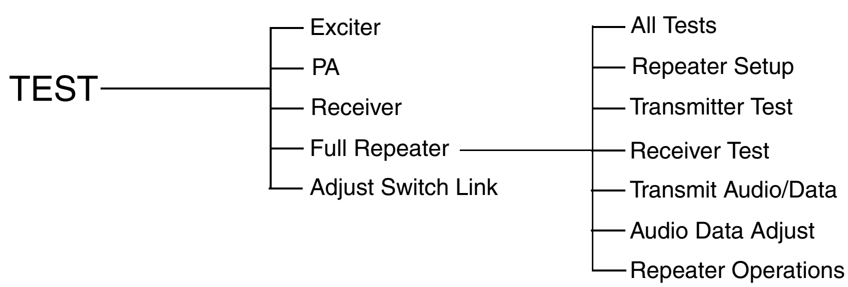


Figure 4-24 TEST PROGRAMMING FLOWCHART

4.6 TEST

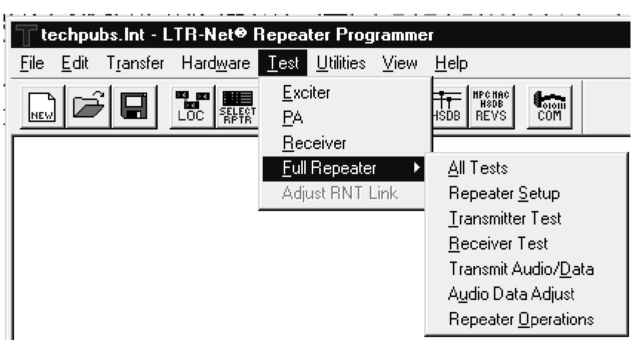
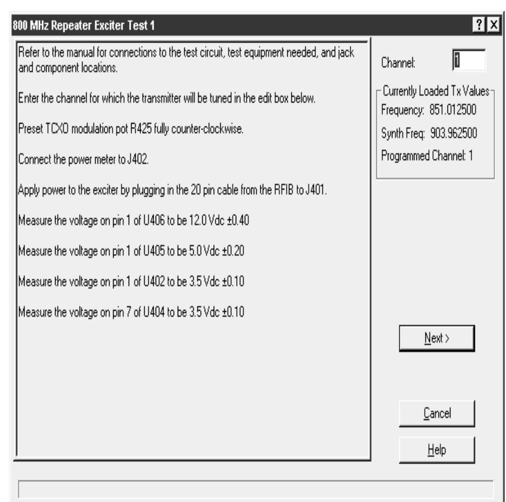


Figure 4-25 TEST MENU



NOTE: Some screens may require scrolling down to read the complete procedure.

4.6.1 EXCITER

This menu selection walks through the Exciter alignment windows. Refer to Section 7.3 for the Exciter alignment and Figure 7-2 for an alignment points diagram and Figure 7-10 for a test setup of the Exciter.

4.6.2 POWER AMPLIFIER

This menu selection walks through the Power Amplifier and RF Interface Board alignment windows. Refer to Sections 7.4 and 7.5 for the PA and RFIB alignment in this manual and Figures 7-3, 7-4, and 7-5 for alignment points diagrams and Figures 7-11 and 7-8 of the Power Amplifier.

4.6.3 RECEIVER

This menu selection walks through the Receiver alignment windows. Refer to Section 7.2 for the Receiver alignment in this manual and Figure 7-1 for an alignment points diagram and Figure 7-9 of the Receiver.

4.6.4 FULL REPEATER

This menu selection walks through the full repeater alignment windows. The Receiver and Exciter portions are performance tests and adjustments. The Audio and Data portions are level adjustments for the Main Audio Card (MAC). Refer to Figure 7-28 for an alignment points diagram for the MAC.

4.7 UTILITIES

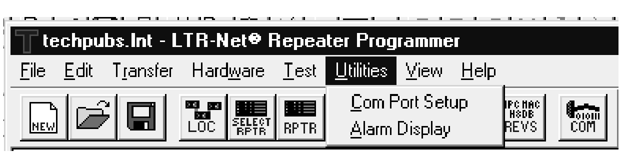


Figure 4-26 UTILITIES MENU

4.7.1 COM PORT SETUP

This menu selection has an equivalent icon in the toolbar. This menu selection or icon allows changes to the COM port or baud rate used to send and receive data from the attached Repeater MPC. An interface cable connects the Repeater to the computer (see Figure 4-27).

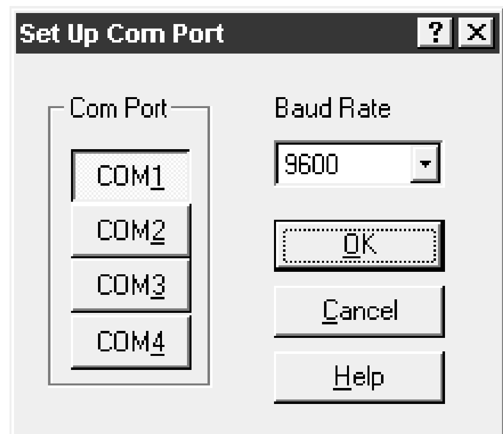


Figure 4-27 SETUP COM PORT

4.7.2 ALARM DISPLAY

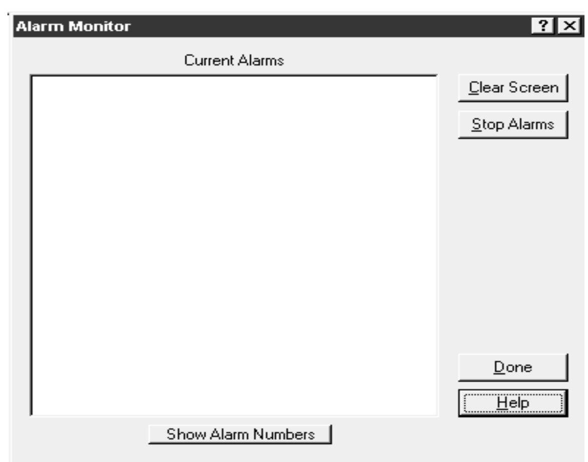


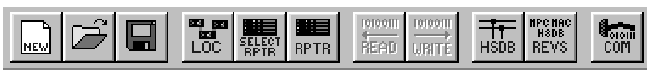
Figure 4-28 ALARM MONITOR

4.8 VIEW

4.8.1 STATUS BAR

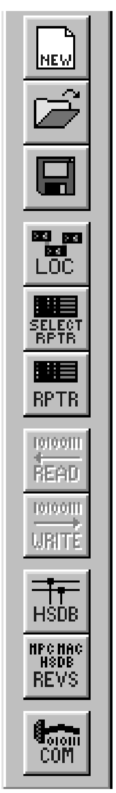
The Status Bar is located at the bottom of the screen that displays information about the repeater.

4.8.2 TOOLBAR



The toolbar may be detached (floating) from the main window by dragging the toolbar to a new location with the mouse. It may also be resized (and reshaped) to suit individual preferences. The toolbar may also be moved to any edge of the programmer screen in this manner.

ICON Definitions (left to right)



ICON	Menu	see Section
	File -> New	4.2.1
	File -> Open	4.2.2
	File -> Save	4.2.4
	Edit -> Locality Information	4.3.1
	Edit -> Select Repeater	4.3.2
	Edit -> Repeater Information	4.3.3
	Transfer -> Read Setup Parameters	4.4.1
	Transfer -> Write Setup Parameters	4.4.2
	Hardware -> HSDB Monitor	4.5.1
	Hardware -> Revisions	4.5.5
	Utilities -> COM Port	4.7.1

4.8.3 SAVE SETTINGS ON EXIT

When the menu item View -> Save Settings on Exit is selected, the toolbar location (size and shape) as well as the main window location and size are saved and re-used when the programmer is opened.

4.9 HELP

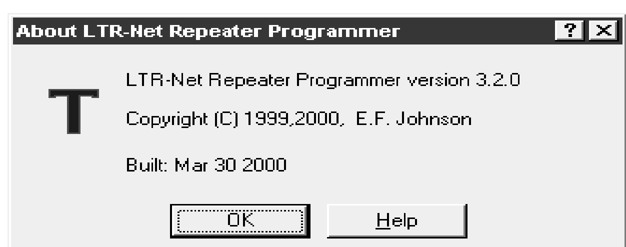
4.9.1 HELP TOPICS

This window contains the contents file of help topics, the index of help topics and a find topic screen.

4.9.2 HELP ON HELP

This window provides information on how to use help.

4.9.3 ABOUT LTR-NET



This menu selection provides information about the programmer software.

SECTION 5 REPEATER PROGRAMMING

5.1 OVERVIEW

The information in this section will assist the user in operating the programmer.

5.1.1 GETTING STARTED

The LTR-Net Programmer is used to configure repeaters for proper operation with the LTR-Net protocol.

From the repeater standpoint, an LTR-Net system consists of one or more repeaters installed in a Locality, a 3000 Series Switch and the necessary interconnects and programming to provide LTR-Net operation.

The LTR-Net Programmer defaults to using CIM1 at 9600 baud to communicate with a repeater. However, this can be changed by selecting Utilities -> COM Port Setup from the menu or by clicking on the 

toolbar button.

When the programmer is first started, create a Locality file with the information to program into repeaters at that Locality (see How Do I ... Create a new Site File for information on performing this function, Section 5.3.1).

NOTE: All repeaters installed in a given Locality use the same Locality information, but each has its unique repeater information programmed.

5.1.2 STARTING THE PROGRAM

There are several ways to start the LTR-Net Programmer.

The most convenient method to start the program, pre-loads all the repeater data for a Locality. To do this, use the Explorer to change to the directory containing the Locality Files, then double-click on one of those Locality Files. This starts the programmer and automatically loads the selected file.

Another method of starting the program is by double-clicking on the shortcut  icon. This starts the program with an empty information file (Locality File). A Locality File contains all of the programming information for all repeaters installed at a Locality.

Once files are opened or saved from within the programmer, those filenames appear in the taskbar Documents selection. This allows starting the program by selecting the desired Locality File from the Start Menu.

5.1.3 USING THE TOOLBAR

The Toolbar provides one-click access to some of the most frequently used menu selections (see Section 4.8.2).

5.1.4 LIMITATIONS

The LTR-Net Programmer requires Windows NT 4.0 or later, or Windows 95 or later.

In order to read data from a repeater, first load a Locality File from disk, or create and save a Locality File. Only one LOcality File may be loaded at a time.

The LTR-Net Programmer supports COM1 through COM4, and all of the baud rates currently supported by the MPC. Since the number of data bits, stop bits, and parity are fixed in the MPC, these cannot be changed in the programmer.

5.2 LOCALITY SETUP

The Locality Setup window Defines Repeaters and Sets up Adjacent Locality Data.

5.2.1 GENERAL PARAMETERS

These repeater parameters select the frequency band for the repeater and the channel number. There are 920 channel numbers with transmit/receive frequencies assigned (see Appendix A). The area bit is used to identify a specific system if more than one is operating in a geographical area. Defined repeaters are designated active or inactive in the Locality from this window.

Also included in Locality Setup window are the Input Alarms, Output Alarms and Alarm Cross Reference (see Section 4.7.2).

5.3 HOW DO I

5.3.1 CREATING A NEW SITE FILE

NOTE: At any point in the programming sequence, if the Help button is pressed, a help screen appears.

- Select one of the following:
  File -> New pull down menu
  Ctrl+N
  icon.
  This erases all Locality and Repeater information in the programmer and load factory defaults.

- Select one of the following:
  File -> Locality Information pull down menu
  icon.
  This defines all repeaters in this Locality for frequency band, channel number and activates the unique parameters for each repeater. Define the Adjacent Locality Data for mobiles leaving this Locality area.

- Select one of the following:
  File -> Save pull down menu
  Ctrl+S
  icon.
  This assigns a filename to this Site File and the filename appears in the File pull-down menu and in the Open file window.

5.3.2 OPEN AN EXISTING SITE FILE

Select one of the following:
File -> Open pull down menu
Ctrl+O or icon

Double-click on the filename or click on the filename and click on Open.

5.3.3 MODIFY AN EXIXTING SITE FILE

- Open the existing file to modify (see Section 5.3.2).
- Make the changes to the file.
- Save the file by selecting one of the following:
  File -> Save
  Ctrl+S or icon.

5.3.4 ADD A REPEATER

- Open the Site File where the repeater is to be added. Select Edit -> Locality Information or icon.
- Enter the repeater frequency band, channel number and activate the repeater.
- Select Edit -> Select Repeater or icon.
- Enter the Repeater Setup information.
- Save the file by selecting one of the following:
  File -> Save
  Ctrl+S or icon.

5.3.5 CHANGE A REPEATER NUMBER

- Open the Site File where the repeater is to be added. Select Edit -> Locality Information or icon.
- In the Define Repeaters window, select the new repeater number and add the new information.
- Select the old repeater number and press delete entry.
- Select Edit -> Select Repeater or icon.
- Enter the Repeater Setup information.
- Save the file by selecting one of the following:
  File -> Save
  Ctrl+S or icon.

SECTION 6 CIRCUIT DESCRIPTION

6.1 RECEIVER

6.1.1 INTRODUCTION

The receiver is a double conversion type with intermediate frequencies of 52.95 MHz and 450 kHz. The first injection frequency is phase locked to a temperature compensated crystal oscillator (TCXO) with a frequency stability of ±1.0 PPM from -30° to +60°C (-22° to +140°F). Two 3-pole bandpass filters in the front-end reject signals outside the receive band. Two 4-pole crystal filters and two 4-pole ceramic filter establish receiver selectivity (see block diagram Figure 6-1).

6.1.2 REGULATED VOLTAGE SUPPLIES

The +15V DC power source is supplied by the repeater power supply. The +15V supply enters the receiver on J201, pin 1. U302 provides the +12V DC receive voltage to the RF and IF amplifiers. U303 supplies +12V DC to the first and second injection amplifiers. U304 supplies +12V DC to the remaining RF circuits. U301 supplies +6V DC to the remaining circuits.

6.1.3 HELICAL FILTERS, RF AMPLIFIER

The receive signal enters the receiver on coaxial connector A201. A helical filter consisting of L102, L103 and L104 is a three-pole bandpass filter tuned to pass only a narrow band of frequencies within the 380-520 MHz band. This filter also attenuates the image and other unwanted frequencies.

Impedance matching between the helical filter and RF amplifier Q101 is provided by C103, L106, and C104. Q101 amplifies the receive signal to recover filter losses and increases receiver sensitivity. Biasing for Q101 is provided by R102/Q102/R107/R108 and C112 provides RF bypass. Additional filtering of the receive signal is provided by 3-pole helical filter L108-L110. L107/C113/C114 match the output from Q101 to 3-pole helical filter L108-L110.

6.1.4 12.5 KHZ IF

First Mixer and Crystal Filter

First mixer U101 mixes the receive frequency with the first injection frequency to produce the 52.95 MHz first IF. Since high-side injection is used, the injection frequency is 52.95 MHz above the receive frequency. Jumper J203 selects between a 12.5 kHz IF and a 25 kHz IF. Install jumper plug P203 on J203, pins 2-3 to select the 12.5 kHz IF. The output of U101 is matched to Z211 at 52.95 MHz by L211, C236 and C237.

Z211A and Z211B form a two-section, four-pole filter with a center frequency of 52.95 MHz and a -3 dB bandwidth of 8 kHz. This filter attenuates adjacent channels and other signals close to the receive frequency. The filter sections are a matched pair and the dot on the case indicates which leads connect together. Matching with Q202 is provided by C241, L213 and C240.

IF Amplifier, Crystal Filter

Q202 amplifies the 52.95 MHz IF signal to recover filter and mixer losses and improve receiver sensitivity. Biasing for Q202 is provided by R236/R233/R234/R235 and C242/C243/C246 provide RF bypass. The output of Q202 is matched to crystal filter Z212 at 52.95 MHz by C245, C247 and L214.

Z212A and Z212B form a two-section, four-pole filter with a center frequency of 52.95 MHz and a -3 dB bandwidth of 8 kHz. This filter establishes the selectivity of the receiver by further filtering the 52.95 MHz IF. The filter sections are a matched pair and the dot on the case indicates which leads connect together. Matching with U203 is provided by C250, C251, C252, L216 and R237.

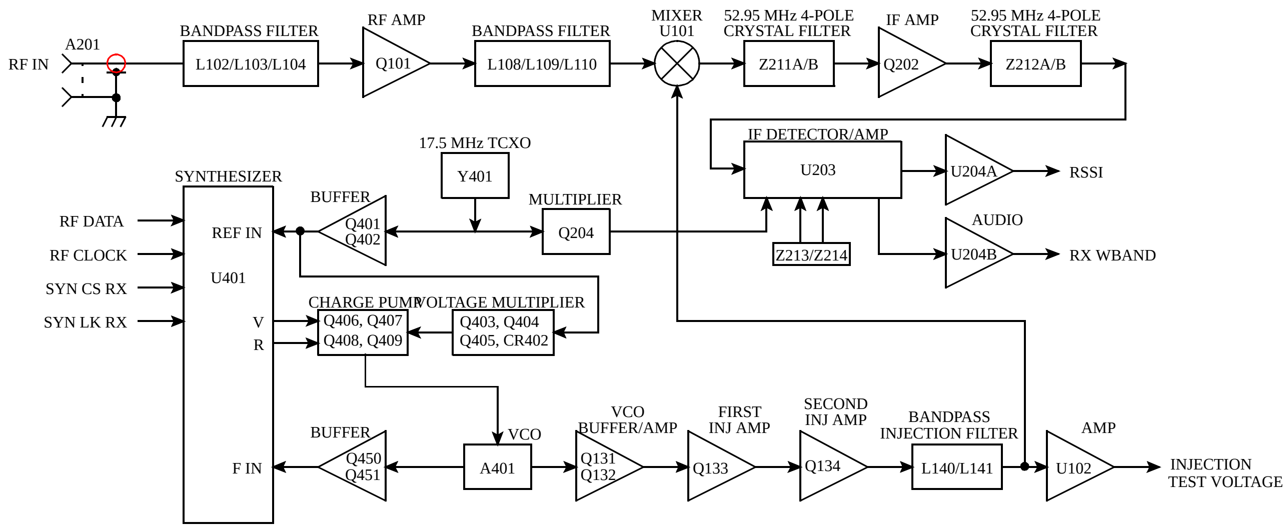


Figure 6-1 12.5 kHz IF RECEIVER BLOCK DIAGRAM

Second Mixer/Detector

As shown in Figure 6-2, U203 contains second oscillator, second mixer, limiter, detector and RSSI circuitry. The 52.95 MHz IF signal is mixed with a 52.5 MHz signal produced by TCXO Y401 and tripler Q204. The 17.5 MHz (±1 PPM) output of Y401 is fed through C275 to tripler Q204. The tripler passes the third harmonic at 52.5 MHz to the oscillator input of U203.

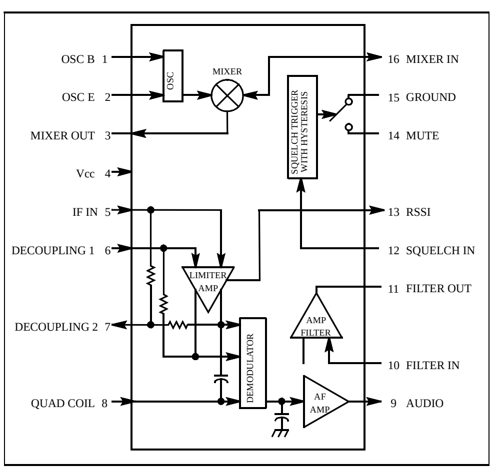


Figure 6-2 U201/U203 BLOCK DIAGRAM

Biasing of Q204 is provided by R258, R259 and R260. RF choke L222 blocks the flow of RF through R261. An AC voltage divider formed by C280/C281 matches Q204 to the highpass filter. The third harmonic of the TCXO frequency is then used to drive the OSC B input at 52.5 MHz. L223, C282 and L224 form a high pass filter to attenuate frequencies below 52.95 MHz. C283 and C284 match the output of the filter to U203.

The 450 kHz second IF is then fed to ceramic filter Z213/Z214, then into the IF amplifier. The center frequency of Z213/Z214 is 450 kHz with a bandwidth of 9 kHz used to attenuate wideband noise. The limiter amplifies the 450 kHz signal 92 dB which removes any amplitude fluctuations.

From the limiter the signal is fed to the quadrature detector. An external phase-shift network connected to U203, pin 8, shifts the phase of one of the detector inputs 90° at 450 kHz (the other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted signal. The detector, which has no output with a 90° phase shift, converts the phase shift into an audio signal. Z215 is adjusted to provide maximum undistorted output from the detector. The audio signal is then fed out on U203, pin 9.

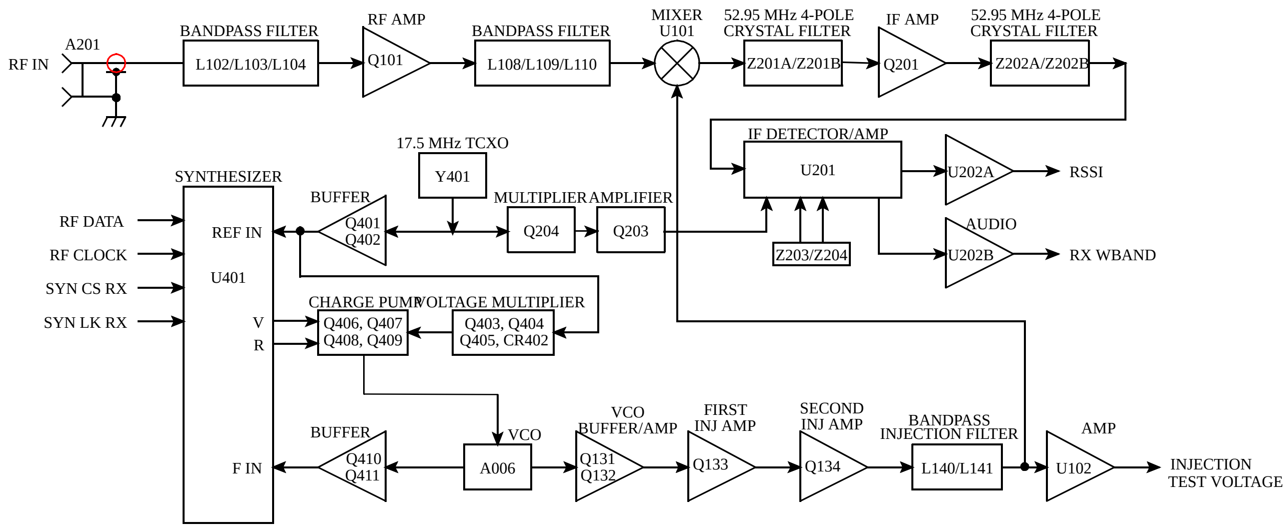


Figure 6-3 25 kHz IF RECEIVER BLOCK DIAGRAM

Wideband Audio Amplifier

U204B amplifies the detected audio and data signal. R244/R245/R246 set the gain of the amplifier and R247/R248/R249/R250/RT204 provide a DC reference level. C261 bypasses the 450 kHz IF signal and C262 bypasses other frequencies. The output signal is adjusted by R253 and fed to J205, pin 3. Install jumper plug P205 on J205, pins 2-3 to select the 12.5 kHz audio to be routed to J201, pin 9.

RSSI Amplifier

U203, pin 13 is an output from an internal RSSI (receive signal strength indicator) circuit which provides a current proportional to the strength of the 450 kHz IF signal. The RSSI output is buffered through U204A and the level is adjusted by R221. The DC output signal is then fed to J204, pin 3. Install jumper plug P204 on J204, pins 2-3 to select the 12.5 kHz RSSI to be routed to J201, pin 7.

6.1.5 25 KHZ IF

First mixer U101 mixes the receive frequency with the first injection frequency to produce the 52.95 MHz first IF. Since high-side injection is used, the injection frequency is 52.95 MHz above the receive frequency. Jumper J203 selects between a 12.5 kHz IF and a 25 kHz IF. Install jumper plug P203 on J203, pins 1-2 to select the 25 kHz IF. The output of U101 is matched to the crystal filter at 52.95 MHz by L201, C201 and C202.

Z201A/B form a two-section, four-pole filter with a center frequency of 52.95 MHz and a -3 dB bandwidth of 15 kHz. This filter attenuates adjacent channels and other signals close to the receive frequency. The filter is a matched pair and the dot on the case indicates which leads connect together. Matching with Q201 is provided by C205, L203 and C206.

IF Amplifier, Crystal Filter

Q201 amplifies the 52.95 MHz IF signal to recover filter and mixer losses and improve receiver sensitivity. Biasing for Q201 is provided by R204/R201/R202/R203 and C207/C209/C211 provide RF bypass. The output of Q201 is matched to crystal filter Z202A at 52.95 MHz by C210, C212 and L204.

Z202A/B form a two-section, four-pole filter with a center frequency of 52.95 MHz and a -3 dB bandwidth of 15 kHz. This filter establishes the selectivity of the receiver by further filtering the 52.95 MHz IF. The filter sections are a matched pair and the dot on the case indicates which leads connect together. Matching with U201 is provided by C215, C216, C217, L206 and R205.

Second Mixer/Detector

As shown in Figure 6-2, U201 contains second oscillator, second mixer, limiter, detector and RSSI circuitry. The 52.95 MHz IF signal is mixed with a 52.5 MHz signal produced by TCXO Y401, tripler Q204 and amplifier Q203. The 17.5 MHz (±1 PPM) output of Y401 is fed through C275 to tripler Q204. The tripler passes the third harmonic at 52.5 MHz to amplifier Q203. Amplifier Q203 amplifies the 52.5 MHz signal for the oscillator input of U201.

Biasing of Q204 is provided by R258, R259 and R260. RF choke L222 blocks the flow of RF through R261. An AC voltage divider formed by C280/C281 matches Q204 to the highpass filter. L223, C282 and L224 form a high pass filter to attenuate frequencies below 52.95 MHz. C283 and C284 match the output of the filter to U203. The third harmonic of the TCXO frequency is lightly coupled to amplifier Q203 through C270, R262 and C265. Biasing of Q203 is provided by R254, R255, R256 and R257. The amplified 52.5 MHz output is passed to U201 OSC B input through C271.

The 450 kHz second IF is then fed to ceramic filter Z203/Z204, then into the IF amplifier. The center frequency of Z203/Z204 is 450 kHz with a bandwidth of 15 kHz used to attenuate wideband noise. The limiter amplifies the 450 kHz signal 92 dB which removes any amplitude fluctuations.

From the limiter the signal is fed to the quadrature detector. An external phase-shift network connected to U201, pin 8, shifts the phase of one of the detector inputs 90° at 450 kHz (the other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted signal. The detector, that has no output with a 90° phase shift, converts the phase shift into an audio signal. Z205 is adjusted to provide maximum undistorted output from the detector. The audio signal is then fed out on U201, pin 9.

Wideband Audio Amplifier

U202B amplifies the detected audio and data signal. R212/R213/R214 set the gain of the amplifier and R215/R216/R217/R218 and RT202 provide a DC reference level. C226 bypasses the 450 kHz IF signal and C227 bypasses other frequencies. The output signal is adjusted by R220 and fed to J205, pin 1. Install jumper plug P205 on J205, pins 1-2 to select the 25 kHz audio to be routed to J201, pin 6.

RSSI Amplifier

U201, pin 13 is an output from an internal RSSI (receive signal strength indicator) circuit which provides a current proportional to the strength of the 450 kHz IF signal. The RSSI output is buffered through U202A and the level is adjusted by R219. The DC output signal is then fed to J204, pin 1. Install jumper plug P204 on J201, pins 1-2 to select the 25 kHz RSSI to be routed to J201, pin 7.

6.1.6 VCO (A006)

The Voltage-Controlled Oscillator (VCO) is formed by Q802 circuitry and a resonator consisting of Z801. The VCO oscillates in a frequency range from 433-572 MHz. Biasing of Q802 is provided by R805, R806, R807 and R808. AC voltage divider C806, C807 and C808 initiates and maintains oscillation and matches Q802 to the tank circuit. The ceramic resonator is grounded at one end to provide shunt inductance to the tank circuit.

The VCO frequency is controlled in part by DC voltage across varactor diode CR802. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. The control line is RF isolated from tank circuit by choke L802. The amount of frequency change produced by CR802 is controlled by series capacitor C804.

6.1.7 ACTIVE FILTER

Q801 functions as a capacitance multiplier to provide filtering of the 12V supply to Q802. R803 and R804 provide transistor bias, and C812 provides the capacitance that is effectively multiplied by the gain of Q801. If a noise pulse or other voltage change appears on the collector, the base voltage does not change because of C812. Therefore, the base current does not change and transistor current remains constant. R805 decouples the VCO output from AC ground. L803 is an RF choke and C810, C811, C813 and C814 provide RF bypass.

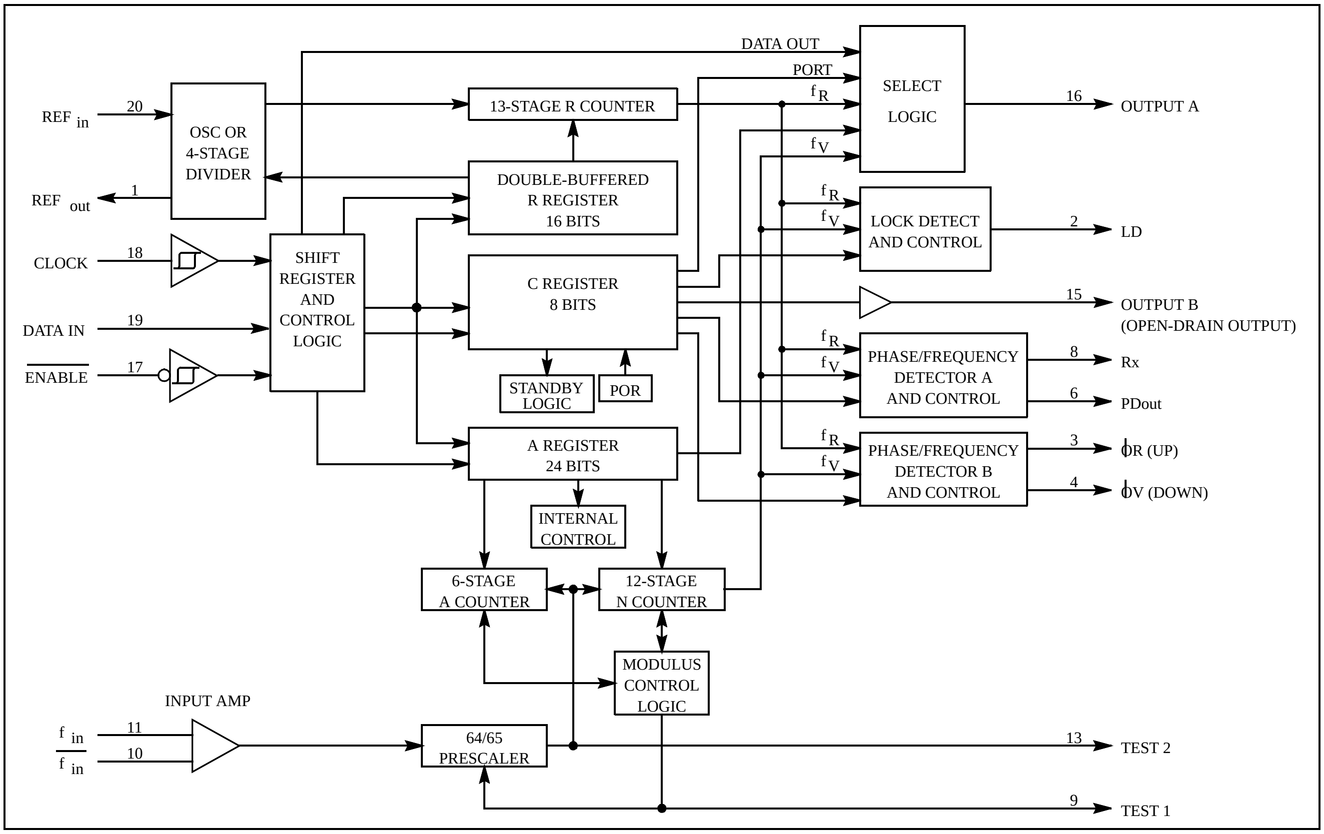


Figure 6-4 SYNTHESIZER BLOCK DIAGRAM

6.1.8 BUFFER

A cascode amplifier formed by Q410/Q411 provides amplification and isolation between the VCO and Synthesizer. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is coupled from the VCO RF output on pin 5. DC blocking and coupling to the VCO is provided by C455 and to the buffer by C456.

Bias for the amplifier is provided by R442, R445, R446 and R277. Q411 is a common-emitter amplifier and Q410 is a common-base with C458 and C457 providing RF bypass. L405 provides some filtering of the cascode output. R448 lowers the Q of L405. The output of the amplifier is coupled by C442/C441 to U401, pin 11.

6.1.9 SYNTHESIZER

The inputs/outputs of synthesizer U401 are shown in Figure 6-4. The output signal from the synthesizer loop is the receiver first injection frequency. This signal is produced by a VCO (voltage-controller oscillator). The frequency of this oscillator is controlled by a DC voltage. This DC voltage is generated by integrating the pulses from the phase detector in synthesizer chip U401.

Frequencies are selected by programming counters in U401 to divide by a certain number. This programming is provided through J201, pins 12, 18 and 20. The frequency stability of the synthesizer is established by the ±1.0 PPM stability of TCXO Y401. The output of this oscillator is stable from -30°C to +60°C (-22°F to +140°F).

The VCO frequency of A401 is controlled by a DC voltage produced by integrating the phase detector output pulses of U401. The phase detector senses the phase and frequency of the two input signals (f_V and f_R) and causes the VCO control voltage to increase or decrease if they are not the same. When the frequencies are the same the VCO is "locked" on frequency.

One input signal to the phase detector in U401 is the reference frequency (f_R). This is the 17.5 MHz TCXO frequency divided by the R (reference) counter to the channel spacing or 6.25 kHz.

The other input to the phase detector in U401 is from the VCO frequency divided down by the "N" counter and prescaler in synthesizer U401 to 6.25 kHz. The "N" counter is programmed through the synthesizer data line on J201, pin 20. U401 is programmed so that the phase detector input (f_V) is identical to the reference frequency (f_R) (6.25 kHz) when the VCO is locked on the correct frequency.

The synthesizer contains the R (reference), N, and A counters, phase and lock detectors and counter programming circuitry. Frequencies are selected by programming the three counters in U401 to divide by assigned numbers. The programming of these counters is performed by circuitry in the Main Processor Card (MPC), which is buffered and latched through the Interface Alarm Card (IAC) and fed into the synthesizer on J201, pin 20 to Data input port U401, pin 19.

Data is loaded into U401 serially on the Data input port U401, pin 19. Data is clocked into the shift registers a bit at a time by a low to high transition on the Clock input port U401, pin 18. The Clock pulses come from the MPC via the IAC to J201, pin 18.

As previously stated, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO-derived input to the phase detector (f_V) is the same frequency as the TCXO-derived input (f_R) which is 6.25 kHz.

The f_R input is produced by dividing the 17.5 MHz TCXO frequency by 2800. This division is done by the "R" counter in U401. The counter always divides by 2800 regardless of the channel frequency. This produces a reference frequency (f_R) of 6.25 kHz. Since the VCO is on frequency (receive frequency plus 52.95 MHz) and no multiplication is used, the channel frequencies change in 6.25 kHz steps and the reference frequency (f_R) is 6.25 kHz for all frequencies selected by this receiver.

The f_V input is produced by dividing the VCO frequency using the prescaler and N counter in U401. The prescaler divides by 64 or 65. The divide number of the prescaler is controlled by the N and A counters in U401.

The N and A counters function as follows: both the N and A counters begin counting down from their programmed number. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. While the A counter is counting down, the prescaler divides by 65. Then when the A counter is halted, the prescaler divides by 64.

Example:

Assume a receive frequency of 450.025 MHz. Since the VCO is 52.95 MHz above the receive frequency it must be 502.975 MHz. To produce this frequency, the N and A counters are programmed as follows:
N = 1257   A = 28

NOTE: Section 8.2.5 describes how the N and A counter numbers can be calculated for other channels.

To determine the overall divide number of the prescaler and N counter, the number of VCO output pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 65 for 65 x 28 or 1,820 input pulses. It then divides by 64 for 64 x (1257 - 28) or 78,656 input pulses. The overall divide number K is therefore (78,656 + 1,820) or 80,476. The VCO frequency of 502.975 MHz divided by 80,476 equals 6.25 kHz which is the f_R input to the phase detector. The overall divide number K can also be determined by the following formula:
K = 64N + A

Where,
N = N counter divide number and
A = A counter divide number.

6.1.10 BUFFER AMPLIFIER

A cascode amplifier formed by Q401 and Q402 provides amplification and also isolation between the TCXO and Synthesizer U401. A cascode amplifier is used because it provides high reverse isolation. The input signal to this amplifier is from TCXO Y401. C405 provides DC blocking. Bias for the amplifier is provided by R404, R406, R407, R408 and R409. L401 is an RF choke. RF bypass is provided by C403, C401 and C407. The output of Q401/Q402 is coupled to U401 by C432.

6.1.11 LOCK DETECT

When the synthesizer is locked on frequency, the Lock Detect output on U401, pin 2 is a logic high voltage with very narrow negative-going pulses. Then when the synthesizer is unlocked, these pulses become much wider, the width may vary at a rate determined by the frequency difference of f_V and f_R. The lock detect pulses are applied to J401, pin 14 and sent to the RF Interface on J103, pin 14 for detection and sampling in the IAC.

6.1.12 CHARGE PUMP, LOOP FILTER

The charge pump circuit charges and discharges C450, C451 and C452 in the loop filter to provide the 21V VCO control voltage (see Section 6.1.13). Pulses which control the charge pump are fed out of U401, pins 3/4. When both phase detector inputs are in phase, these output signals are high except for a very short period when both pulse low in phase. If the frequency of the f_R input to the phase detector is higher than that of the f_V input (or if the phase of f_R leads f_V), the VCO frequency is too low. The negative-going pulses on the f_V output (pin 4) then become much wider and the f_R output (pin 3) stays essentially high. If the frequency of the f_V input is greater than f_R (VCO frequency too high), the opposite occurs.

Q406 and Q407 are drivers which make the 5V levels and polarity of U401 phase detector outputs compatible with the high voltage supply to Q408 and Q409. Capacitors C444 and C446 momentarily bypass R432 and R437 when negative-going pulses occur. This speeds up the turn-off time of Q406 and Q407 by minimizing the effect of the base charge.

When a negative-going pulse occurs on pin 4, Q406 turns on which turns on Q408. Q408 sources current to charge up the loop filter capacitors C450/C451, thereby increasing the VCO control line voltage. When a negative-going pulse occurs on pin 3, Q407 turns on which turns on Q409. Q409 sinks current to discharge the loop filter capacitors C450/C451 thereby decreasing the VCO control line voltage. The source current from Q408, when it is on, equals the sink current from Q409, when it is on.

6.1.13 VOLTAGE MULTIPLIER

The 17.5 MHz from Y401 is amplified by Q401/Q402 and passed to the reference input of synthesizer U401, pin 20. This signal is also coupled from the output of Q401/Q402 through C408 to amplifier Q403. Biasing for Q403 is provided by R410, R411 and R412. The output of Q403 is direct coupled to switching transistors Q404/Q405.

When Q405 is turned on and Q404 if off, C409 is grounded on the side connected to the emitter of Q405. This allows the other side of C409 to charge from the 12V supply through R414, CR402 to C409. When Q404 turns on and Q405 is off, C414 charges up to approximately 12V plus the voltage that was stored across C809 from the last cycle. The output voltage is 21V due to voltage loss in the transistor and diodes. C413 is an RF bypass and C414 charges to 21V to stabilize the voltage. The 21V output is filtered by C415/L403/C416 to remove the 17.5 MHz ripple. The 21V output is applied to the charge pump Q408/Q409 and the VCO control line.

6.1.14 BUFFER AMPLIFIER

A cascode amplifier formed by Q131 and Q132 provides amplification and also isolation between the VCO and Receiver RF stages. A cascode amplifier is used because it provides high reverse isolation. The input signal to this amplifier is coupled from VCO A401 by C131. C131 also provides DC blocking. Bias for the amplifier is provided by R134, R133, R138, R132, R131 and R136. L131 is an RF choke and R135 sets the RF output impedance of the cascode. RF bypass is provided by C143, C142, C141, C140, C139, C138, C133, C134, C135 and C136. The output of Q131/Q132 is matched to the Receiver RF stages by a section of microstrip, C144, signal pad R139/R140/R141, C145, C146 and L133. C145 couples the signal to the input of the first injection amplifier.

6.1.15 FIRST AND SECOND INJECTION AMPLIFIERS

U303 provides the +12V source for these amplifiers. First injection amplifier Q133 is biased by CR131, R143, R144, R145 and R146. C148, C151, C149 and C150 provide RF bypass from the DC line. L134 on the collector is an RF choke. Q133 is matched to the 50 ohm signal pad R147, R148 and R149 by lowpass filter C152/L135/C153, C154. C155, L136, L156, L137, C157 and a section of microstrip match Q134 to the 50 ohm signal pad.

Second injection amplifier/buffer Q134 is similar in design to Q133. The output of Q134 is matched to 50 ohms by L134/C162/C163 and C164 provides DC blocking. L140/L141 are tuned to the receive frequency plus 52.95 MHz and passed to Mixer U101. This injection frequency is also coupled through C165 to the injection test voltage circuit U102A. CR133, R158, R159 provide DC input to U102A, pin 3. The output of U102A, pin 1 is connected to J201, pin 13 for a receive injection test point and to the RF Interface Board on J103, pin 13.

6.2 EXCITER

6.2.1 VCO (A007)

The Voltage-Controlled Oscillator (VCO) is formed by Q802, associated circuitry and a resonator consisting of Z801. The VCO oscillates in a 40 MHz frequency band somewhere between 380-520 MHz depending on the model of the repeater. Biasing of Q802 is provided by R805, R806 and R807. An AC voltage divider formed by C807 and C808 initiates and maintains oscillation. C806 couples Q802 to resonator Z801. Resonator Z801 provides the shunt inductance of the tank circuit. The shunt capacitance of the tank circuit is made primarily of C803/C804 in series with CR801/CR802. RF choke L804 completes the DC bias path to ground.

The VCO frequency is controlled in part by DC voltage across varactor diode CR802. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. The control line is RF isolated from tank circuit by choke L802. The amount of frequency change produced by CR802 is controlled by series capacitor C804.

The frequency is modulated in a similar manner. The transmit audio/data signal is applied across varactor diode CR803 to vary the VCO frequency at an audio rate. C815/C816 in series with CR803 determine the amount of modulation produced by the audio signal.

6.2.2 ACTIVE FILTER

Q801 functions as a capacitance multiplier to provide filtering of the 12V supply to Q802. R803 and R804 provide transistor bias, and C812 provides capacitance that is effectively multiplied by the gain of Q801. If a noise pulse or other quick voltage change appears on the collector, base voltage does not change significantly because of C812. Therefore, the base current does not change and transistor current remains constant. R805 decouples the VCO output from AC ground. L803 is an RF choke and C810, C811, C813, C814 and C809 provide RF bypass.

6.2.3 VCO/TCXO FREQUENCY MODULATION

Both the VCO and TCXO are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U403 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (at the lower audio frequencies inside the closed loop bandwidth of the synthesizer). If only the TCXO frequency was modulated, the VCO would not track the higher audio frequencies (those beyond the closed loop bandwidth of the synthesizer). However, by modulating both the VCO and TCXO a flat audio response is achieved. Potentiometers R425 and R446 balance the modulating signals.

There are two 3.5V sources on the Exciter board; one is a reference for the modulation amplifier to the VCO, the other is for the modulation amplifier to the TCXO.

The reference voltage on U402B, pin 5 is also on buffer U407B, pin 5 to J401, pin 9 and RFIB connector J102, pin 9. The voltage leaves the RFIB on J101, pin 14 to J2, pin 27 on the backplane, to the bottom connectors via pin 7 and finally to the MAC on P100, pin 7.

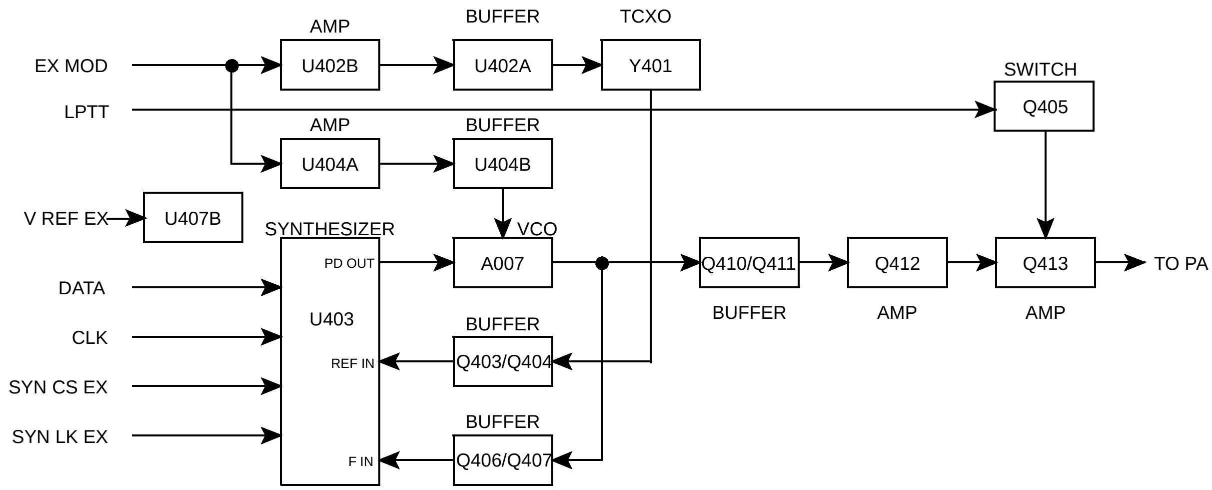


Figure 6-5 EXCITER BLOCK DIAGRAM

With reference to the ground on the Exciter, the 3.5V reference stability is maintained by U126B/C/D on the MAC. The 3.5V DC passes through summing amplifier U129B and transmit modulation gate U118D to P100, pin 29 (Tx MOD). P100, pin 29 is connected to backplane connector J2, pin 8 and RFIB connector J101, pin 22 to J102, pin 13. The transmit modulation and 3.5V reference enter the Exciter on J401, pin 13 and are routed to U402B, pin 6. R425 sets the TCXO modulation level. The modulation signal and the 3.5V DC are applied to U402A, pin 2.

6.2.4 BUFFER

A cascode amplifier formed by Q406/Q407 provides amplification and also isolation between the VCO and synthesizer. A cascode amplifier is used because it provides high reverse isolation. The input signal to this amplifier is tapped from the VCO RF output. DC blocking to the VCO is provided by C441 and to the buffer by C433. Bias for the amplifier is provided by R451, R453, R454 and R455. Q407 is a common-emitter amplifier and Q406 is a common-base with C432 providing RF bypass. L403 decouples the output from AC ground and R452 lowers the Q of L403. The amplifier is coupled by C429 to U403, pin 11.

6.2.5 SYNTHESIZER

The inputs/outputs of synthesizer U403 are shown in Figure 6-4. The synthesizer output signal is the transmit frequency. This signal is produced by a VCO (voltage-controller oscillator) that is frequency controlled by a DC voltage produced by synthesizer chip U403. This DC voltage is filtered by a loop filter made up of C805, C806 and R804 in the VCO circuitry.

Frequencies are selected by programming counters in U403 to divide by a certain number. This programming is provided through J401, pins 12, 19 and 20. The frequency stability of the synthesizer is established by the ±1.0 PPM stability of TCXO Y401. This oscillator is stable from -30°C to +60°C (-22°F to +140°F).

The VCO frequency of A007 is controlled by a DC voltage produced by the phase detector in U403. The phase detector senses the phase and frequency of the two input signals and causes the VCO control voltage to increase or decrease if they are not the same. When the frequencies are the same, the VCO is then "locked" on frequency.

The synthesizer contains the R (reference), N, and A counters, phase and lock detectors and counter programming circuitry.

One input signal to the phase detector in U403 is the reference frequency (f_R). This frequency is the 17.5 MHz TCXO frequency divided by the reference counter to the channel spacing or 6.25 kHz. The other input signal (f_V) is the VCO frequency divided by the "N" counter in U403. The counters are programmed through the synthesizer data line on J401, pin 20. Each channel is programmed by a divide number so that the phase detector input is identical to the reference frequency (f_R) when the VCO is locked on the correct frequency.

Frequencies are selected by programming the three counters in U403 to divide by assigned numbers. The programming of these counters is performed by circuitry in the Main Processor Card (MPC), buffered and latched through the Interface Alarm Card (IAC) and fed into the synthesizer on J401, pin 20 to Data input port U403, pin 19.

Data is loaded into U403 serially on the Data input port U403, pin 19 when U403, pin 17 is low. Data is clocked into the shift registers a bit at a time by a low to high transition on the Clock input port U403, pin 18. The Clock pulses come from the MPC via the IAC to J401, pin 19.

As previously stated, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO-derived input to the phase detector (f_V) is the same frequency as the TCXO-derived input (f_R). The f_R input is produced by dividing the 17.5 MHz TCXO frequency by 2800. This produces a reference frequency (f_R) of 6.25 kHz. Since the VCO is on frequency and no multiplication is used, the frequencies are changed in 12.5 kHz steps. The reference frequency is 12.5 kHz for all frequencies selected by this Exciter.

The f_V input is produced by dividing the VCO frequency using the prescaler and N counter in U403. The prescaler divides by 64 or 65. The divide number of the prescaler is controlled by the N and A counters in U403. The N and A counters function as follows:

Both the N and A counters begin counting down from their programmed number. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. While the A counter is counting down, the prescaler divides by 65. Then when the A counter is halted, the prescaler divides by 64.

Example: To illustrate the operation of these counters, assume a transmit frequency of 450.250 MHz. Since the VCO is the channel frequency for transmit this frequency is used. To produce this frequency, the N and A counters are programmed as follows:

N = 1125   A = 40

To determine the overall divide number of the prescaler and N counter, the number of VCO output pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 65 for 65 x 40 or 2,600 input pulses. It then divides by 64 for 64 x (425 - 40) or 69,440 input pulses. The overall divide number K is therefore (69,440 + 2,600) or 72,040. The VCO frequency of 450.250 MHz divided by 72,040 equals 6.25 kHz which is the f_R input to the phase detector. The overall divide number K can also be determined by the following formula:

K = 64N + A

Where,

N = N counter divide number and

A = A counter divide number.

NOTE: Section 8.2.5 describes how the N and A counter numbers can be calculated for other channels.

6.2.6 BUFFER AMPLIFIER

A cascode amplifier formed by Q403 and Q404 provides amplification and isolation between the TCXO and Synthesizer U403. A cascode amplifier is used because it provides high gain, high reverse isolation and consumes only a small amount of power. The input signal to this amplifier is coupled from TCXO Y401, pin 5 by C420. C420 also provides DC blocking. Bias for the amplifier is provided by R430, R431, R432, R433 and R428. L402 is an RF choke. RF bypass is provided by C416, C418 and C419. The output of Q403/Q404 is coupled to U403, pin 20 by C417.

6.2.7 BUFFER AMPLIFIER

A cascode amplifier formed by Q406 and Q407 provides amplification and also isolation between the VCO and Synthesizer U403. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is coupled from VCO A007, pin 6 by C433. C433 also provides DC blocking. Bias for the amplifier is provided by R450, R451, R453, R454 and R455. L403 is an RF choke. RF bypass is provided by C430, C431 and C479. The output of Q406/Q407 is coupled to U403, pin 11 by a non-polarized capacitor formed by C429/C499.

6.2.8 LOCK DETECT

When the synthesizer is locked on frequency, the Lock Detect output on U403, pin 2 is a high voltage with narrow negative-going pulses. When the synthesizer is unlocked, the negative-going pulses are much wider, the width may vary at a rate determined by the frequency difference of f_V and f_R.

The locked or unlocked condition of the synthesizer is filtered by R440/C423 and applied to J401, pin 16, then sent to the RF Interface on J102, pin 16 for detection.

6.2.9 BUFFER AMPLIFIER

A cascode amplifier formed by Q410/Q411 provides amplification and also isolation between the VCO and exciter RF stages. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is tapped from VCO A007, pin 4 by C441. C441 also provides DC blocking. Bias for the amplifier is provided by R464, R465, R466, R467 and R468. L406 is an RF choke and R483 lowers the Q of the coil. RF bypass is provided by C434, C442, C445, C443, C444 and C480. The output of Q410/Q411 is matched to the Exciter RF stages by a section of microstrip, C446, signal pad R459/R460/R461, C498, C450 and L408.

6.2.10 RF AMPLIFIERS

RF amplifier Q412 is biased by CR402, R469, R470, R471 and R472. C448 provides RF bypass from the DC line. L409 is an RF choke to the supply line. Q412 is matched to the 50 ohm signal pad by low pass filter C449/L410/C451, C503 and signal pad R473/R474/R475.

RF amplifier/buffer Q413 is similar in design to Q412. The collector voltage of Q413 is switched by Q405. When the Logic Push-To-Talk (LPTT) on J401, pin 11 is low Q405 turns on and conducts the 15V supply to the collector of Q405 and to Q413. The output of Q413 is matched to 50 ohms by C509, L412, C510, and C465 provides DC blocking. A 3 dB attenuator R490/R491/R492 follows amplifier Q413. The RF output of the Exciter is on coaxial connector J402 to the Power Amplifier.

6.3 110W POWER AMPLIFIER

6.3.1 AMPLIFIER/PREDRIVER

RF input to the PA from the Exciter is through a coaxial cable and connector to WO511. C501 couples the RF to signal pad R501/R502/R503 that connects the input to U501. U501 is a 6W amplifier/pre-driver operating in the 380-520 MHz range.

Power control is connected to WO505 from the RF Interface board (RFIB). RF is filtered from the control voltage line by various capacitors to U501, pin 2. This control voltage regulates the RF output of the amplifier on U501, pin 5 to approximately 5W.

6.3.2 DRIVER

The output of U501 passes through several sections of 50 ohm microstrip and matching capacitors to the gate of Q501. Driver Q501 is a MOSFET amplifier with a normal output of approximately 22W. Supply voltage is RF bypassed by various capacitors. L501, C541, C542 and microstrip match the output of the driver to 35 ohms. The RF is applied to the input of the splitter and to the finals.

6.3.3 FINAL AMPLIFIERS

Q502 and Q503 are combined 60W amplifiers. The 22W RF input from the driver Q501 is applied to a 70.7 ohm Wilkinson splitter and then to the gate of each MOSFET amplifier. The 60W outputs on the drain of the amplifiers are combined using a Wilkinson combiner. Q502 has a half-wave transmission

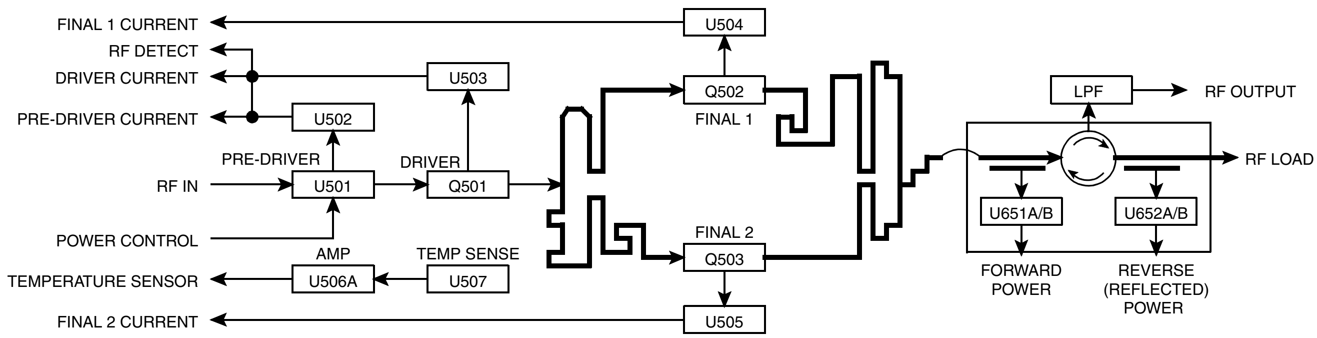


Figure 6-6   110W POWER AMPLIFIER BLOCK DIAGRAM

line on the input and Q503 has a half-wave on the output. These T-lines are used to drive the 60W amplifiers out of phase. The output of the combiner is fed from WO513 directly to the forward/reverse power detect board.

The Wilkinson splitter and combiner provide the capability to split the drive input and combine the final outputs while maintaining isolation between the two final amplifiers. The combiner consists of two quarter-wave transmission lines and a balancing resistor. During normal operation, a signal of relatively equal phase and amplitude is present on both ends of the balancing resistor. Therefore, no current flows and no power is dissipated in the balance resistor. If one final failed, the other final of a pair would continue to function.

6.3.4 POWER DETECTORS

The supply current is monitored through a resistor that creates a current output level indicative of the power output. The outputs of U503, U504 and U505 are monitored by the repeater software through the RF Interface Board. If a final amplifier fails, the software will reduce the output power to prevent over-driving the remaining final amplifier.

6.3.5 THERMAL SENSOR

Thermal protection is provided by temperature sensor U507. The operating range of the sensor is from -30° C to 100° C (-22° F to 212° F). Amplifier U506A sends the output of U507 through WO509 to the RF Interface Board. The RFIB reduces the power amplifier to half power (via the MPC) if the temperature reading is too high and turns the fan on and off (not via the MPC). The fan is turned on at approximately 50°C and off again at 42°C.

6.3.6 FORWARD/REVERSE POWER DETECT, CIRCULATOR, LOW-PASS FILTER

The power amplifier output is directly coupled to the forward/reverse power detect board via a jumper. The output then enters the circulator and exits to the low-pass filter board and the antenna jack for a minimum power output of 110W at the default setting. If an antenna is not connected, the circulator connects the output power to R685.

Forward and reverse power are electromagnetically coupled from the input and reflected ports of the circulator. R663/R680 calibrate the forward and reverse sense levels. The sensed levels are coupled to the RF Interface Board and software.

6.4 RF INTERFACE BOARD

The RF Interface Board (RFIB) connects the Receiver, Exciter and Power Amplifier to the backplane and power supply (see Figure 6-7).

The input and output connectors for the RF Interface Board are defined as follows.

6.4.1 POWER CONNECTOR

The power supply is connected to the RF Interface Board when the RF module is inserted into the repeater cabinet (see Figure 10-5). The jack portion of the connection is on the RF Interface Board, the plug portion is attached to the station cabinet.

P101/P102 +26.5V DC - Supply voltage to PA. +26V ±1%, 20A at 110W.

P103 +15V DC - Supply voltage to Exciter, Receiver and Power Control. 15V ±1%, 5.5A max.

P104/P105 GROUND - Ground return for the RF assembly.

6.4.2 SIGNAL CONNECTOR (J101)

This is the signal interface connector (36 pin) that connects the RFIB to the backplane connector J2 (34 pin) through cable assembly A8.

Pin 1 GROUND

Pin 1 carries ground current between the RF Interface board and Backplane board.

Pin 2 PC STR

Pin 2 is the power Control Strobe. This is normally low until after the power control data is shifted into the power control register. Then the strobe line goes high and back to low. The clock or data lines cannot be changed until after the strobe is set.

Pin 3 HS CS EX

Pin 3 is not used at this time.

Pin 4 GROUND

Pin 4 carries ground current between the RF Interface board and Backplane board.

Pins 5-6 UNUSED

Pin 7 RX WBAND

The wide band audio is from the receive audio demodulator U202 and goes to the MAC in the Controller card cage. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the receiver. Little wave shaping is done on the receiver board other than a 31 kHz RC LPF which strips off the 450 kHz IF. Buffering is done with an op-amp.

Pin 8 RF DATA A

Data A (U105, pin 11) is the least significant bit (LSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 9 RF DATA C

Data C (U105, pin 9) is the most significant bit (MSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 10 RF MUX2 INH

The Multiplexer-2 Inhibit (U106, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 2 Multiplexer with a logic high.

Pin 11 RF CLK

The clock will control the synthesizer chip and power control circuit when loading. This pin is a TTL input from the Controller.

Pin 12 HS CS RX

Pin 12 is not used at this time.

Pin 13 RF MUX1 INH

The Multiplexer-1 Inhibit (U105, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 1 Multiplexer with a logic high.

Pin 14 V REF EX

This is the 3.5V reference to the Exciter TCXO. 3.5V from the Exciter is passed from J102, pin 9 to this pin and the backplane. The voltage then passes through the MAC and back to the backplane to J101, pin 22 with the TX MOD. These are connected to J102, pin 13 back to the Exciter.

Pins 15-18 UNUSED

Pin 19 RF MUX3 INH

The Multiplexer-3 Inhibit (U104, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 3 Multiplexer with a logic high.

Pin 20 LPTT

The Logic Push-To-Talk is an open collector from the Controller. It has a sink capability of 20 mA and a maximum voltage rating of 18V. The transmitter should produce power when this pin is a logic low.

Pin 21 SYN CS EX

This input goes low to enable the loading of data into the exciter synthesizer chip U403.

Pin 22 TX MOD

The audio from the MAC in the Controller processes a number of inputs to the station to produce the signals on this pin. This signal goes through the RFIB and then to the Exciter. A 707 mV RMS sine wave (2V P-P) at 1 kHz produces 60% of system deviation in the transmitter. The source impedance is low and the input impedance is less than 10k ohms.

Pin 23 GROUND

Pin 23 carries ground current between the RFIB and Chassis Backplane.

Pin 24 UNUSED

Pin 25 LOGIC CONTROL TO FANS

Pin 25 is in parallel with the temperature sensor.

Pin 26 RF DATA B

The Data B (U105, pin 10) is the middle significant bit in the three multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 27 A D LEVEL

20 lines (of the possible 24) of RF functions sampled are multiplexed to the Controller through this pin using three multiplex chips.

- RF Forward Power Sense
- RF Power Sense Device 1
- RF Power Sense Device 2
- RF Power Sense Device 3
- RF Power Sense Device 4
- RF Reflected Power Sense
- PA Temperature
- Transmit Audio Modulation
- High Stability Exciter Lock Detector
- Exciter Lock Detector
- Receiver Detector Audio
- Receive Signal Strength Indicator
- Receiver Injection Level
- High Stability Receive Lock Detector
- Receiver Lock Detector
- Fan Current 1
- Fan Current 2
- Fan 1 On Sense
- Power Supply Temp
- Battery Voltage

Pin 28 RF DATA

A data pin with TTL levels from the Controller which has the dual role of loading the synthesizer chips and adjusting the power control D/A lines for proper output power. Up to four synthesizer chips and a shift-register could be connected to this pin.

Pin 29 SYN CS RX

This input goes low to enable the loading of data into the receiver synthesizer chip U401.

Pin 30 RSSI

This pin is the Receive Signal Strength Indication to the Controller. This RSSI is used for tune-up of the Receiver front-end during factory test mode. The dynamic range is 60 dB. It has an output from an op-amp with the voltage going from 0.5V to 4.5V. The level has an adjustment in the Receiver.

Pin 31 GROUND

Pin 31 carries ground current between the RFIB and Chassis Backplane.

Pins 32-36 UNUSED

6.4.3 FAN CONNECTOR (J104)

The outputs to the fan connectors are 4-pin plug-in terminals that supply DC voltage. The plug on the fan is a 2-pin connector. The plug-in terminals are located on the back of the RFIB.

Pin 1 FAN 1 LOW

Pin 1 is the ground return for Fan 1.

Pin 2 FAN HI

Pin 2 carries the voltage to Fan 1. The current is 1/4A nominal at 20V to 30V. This pin goes high when the PA heat sensor rises above 50°C and goes low below 45°C.

Pin 3 FAN2 LO

Pin 3 is the ground return for Fan 2.

Pin 4 FAN HI

Pin 4 carries the voltage to Fan 2. The Voltage is 20V-30V at 1/4A nominal. Pin 4 goes high when the PA heat sensor rises above 50°C and goes low below 45°C.

6.4.4 POWER AMPLIFIER CONNECTIONS

WO 115 POWER SENSE

This capacitive feedthrough pin is at +15V DC to the Power Detect Board.

WO 116 +26.5V DC

This capacitive feedthrough pin is at +26.5V DC and carries the PA current, 25A nominal at 110W from P102 to the Power Amplifier board.

WO 117 +26.5V DC GROUND

This capacitive feedthrough pin carries ground current from P105 to the Power Amplifier board. It must be capable of carrying up to 25A.

W118 +15V DC

This capacitive feedthrough pin connects +15V DC P103 to the PA, Exciter, and Forward/Reverse Power Detect boards. Maximum current handling is 6A (4A nominal at 110W).

WO 119 NOT USED

WO 120 CTRL OUT

This capacitive feedthrough pin carries the output of the power control driver on the RFIB to the power control pin of the power module on the Power Amplifier board. The voltage varies from 0V-15V with current as high as 0.5A.

WO 121 FWD PWR

This capacitive feedthrough pin is the forward power sense line. It is a voltage source that is a function of the output power of the Power Amplifier. The voltage level will be between 0V-5V and drive a 10k ohm load. A typical voltage of 3V correlates to 110W out of the PA. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 122 RF OUT 1

This capacitive feedthrough pin is a voltage source that is a function of the output power of U501. The voltage level will be between 0V-5V and drives a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 123 RF OUT 2

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q501. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 124 RF OUT 3

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q502. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 125 RF OUT 4

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q503. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 126 REFL PWR

This capacitive feedthrough pin is the reflected power sense line. It is a voltage indicative of the power reflected due to a mismatch. The voltage produced will typically be such that less than a 3:1 VSWR will not trigger alarms and when VSWR = 6:1 the controller will reduce power. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing. The time to sense and reduce the power takes several seconds.

WO 127 TEMP

This capacitive feedthrough pin is the temperature sense line of the Power Amplifier. It will be a linearly variable function of temperature ranging from 0V-5V output and 0°C to +100°C (+32°F to 212°F) input when driving a 10k ohm load. The primary functions of this line are for fan on/off and PA power reduction. The fan should be turned on at 50°C and off at 45°C. The PA should have power reduced when 90°C (194°F) is reached and with absolute turn-off at 95°C (203°F). This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO147 RF DETECT DRIVER

This senses power out of the driver. It is used to limit the power out of the driver to 0.4 dB over 110W at room temperature.

WO143 +26V DC

This is the +26.5V DC source to the RFIB from P101.

WO144 +15V DC

This is the +15V DC source to the RFIB from P103.

WO145 GROUND

W145 carries ground current from P104 to the RFIB.

6.4.5 EXCITER CONNECTOR (J102)

The connector from the Exciter (J401) to the RF Interface board (J102) links the Exciter to the MPC in the Controller Backplane.

Pin 1 VCC1

The voltage on this pin is a fused +15V ±1%, nominal current of 0.5A. It provides current to the Exciter from the RFIB.

Pins 2-8 GROUND

Pin 9 +3.5V DC

Pin 9 is the +3.5V DC TCXO reference voltage from the Exciter to the MAC.

Pin 10 GROUND

Pin 11 LPTT

The Logic Push-To-Talk (LPTT) is an open collector from the Controller. It has a sink capability of 20 mA nominal and a voltage rating of 18V maximum. The transmitter should produce power when this pin is a logic low.

Pin 12 SYN CS EX

Pin 12 is the Exciter synthesizer chip select. It allows data input to the synthesizer chip when the line is pulled to a logic low.

Pin 13 TX MOD

The audio from the MAC in the Controller processes a number of inputs to the station per the TIA specifications to produce the signal on this pin. This signal goes through the RFIB to the Exciter. A 707 mV RMS (2V P-P) sine wave at 1 kHz provides 60% of system deviation in the transmitter. The DC voltage on the line is 3.5V ±0.1V. The source impedance should be low (output of an op-amp or analog switch < 200 ohms) and the input impedance will not be less than 10k ohms.

Pins 14-15 GROUND

These pins carry ground current between the RFIB and the Exciter board.

Pin 16 SYN LK EX

Pin 16 is the Exciter synthesizer lock detector output. The synthesizer is locked with a TTL logic high state.

Pin 17 HS LK EX

Pin 17 is not used at this time.

Pin 18 HS CS EX

This input is not used at this time.

Pin 19 RF CLK

The clock controls the Exciter synthesizer when loading. The input source in the Controller is TTL with the speed determined by the synthesizer chip. There could be as many as four synthesizers and a shift register.

Pin 20 RF DATA

Pin 20 is a data pin from the Controller which has the dual role of loading the synthesizer chip and adjusting the power control D/A lines for proper output power. The data has TTL levels. Up to four synthesizer chips and a shift register could be connected to this pin.

6.4.6 RECEIVER CONNECTOR (J103)

The connector from the Receiver (J201) to the RF Interface board (J103) links the Receiver to the MPC in the Controller Backplane.

Pin 1 VCC1

Pin 1 is fused +15V ±1% with a nominal current of 1A provides current from the RFIB to the Receiver.

Pins 2-6 UNUSED

Pin 7 RSSI

This pin is the Receive Signal Strength Indicator (RSSI) to the Controller. The RSSI is used for tune-up of the Receiver front-end during test mode. The dynamic range is 60 dB. Output is from an op-amp with the voltage going from 0.5V to 4.5V. The level has an adjustment in the Receiver (see Section 6.1.4 or 6.1.5).

Pin 8 UNUSED

Pin 9 RX WBAND

The receive wide band audio is from the demodulator and goes to the Main Audio Card (MAC) in the Controller card cage. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the Receiver. Little wave shaping is done on the Receiver board other than a 31 kHz RC LPF which strips off the 450 kHz IF. Buffering is done with an op-amp which can drive a 10k ohm load.

Pin 10 UNUSED

Pin 11 GROUND

Pin 11 carries ground current between the RFIB and the Receiver board.

Pin 12 SYN CS RX

Pin 12 is the Receiver synthesizer chip select. This chip is the same part as used in the Exciter. A low enables loading the Synthesizer.

Pin 13 RX INJ

This pin is the power sense for the Receiver injection. It is a linear voltage source that is a function of the injection power. The voltage level will be between 0V - 5V and be able to drive a 10k ohm load.

Pin 14 SYN LK RX

Pin 14 is the main synthesizer lock detector output for the Receiver. The synthesizer is locked with a TTL logic high state.

Pin 15 GROUND

Pin 15 carries ground current between the RFIB and the Receiver board.

Pin 16 HS CS RX

Pin 16 is not used at this time.

Pin 17 GROUND

Pin 17 carries ground current between the RFIB and the Receiver board.

Pin 18 RF CLK

The clock controls the Receiver synthesizers when loading. The input source in the Controller is TTL with the speed determined by the synthesizer chip.

Pin 19 HS LK RX

Pin 19 is not used at this time.

Pin 20 RF DATA

Pin 20 is a data pin from the Controller which has the dual role of loading the synthesizer chips and adjusting the power control D/A lines for proper output power. The data has TTL levels. Up to four synthesizer chips and a shift register could be connected to this pin.

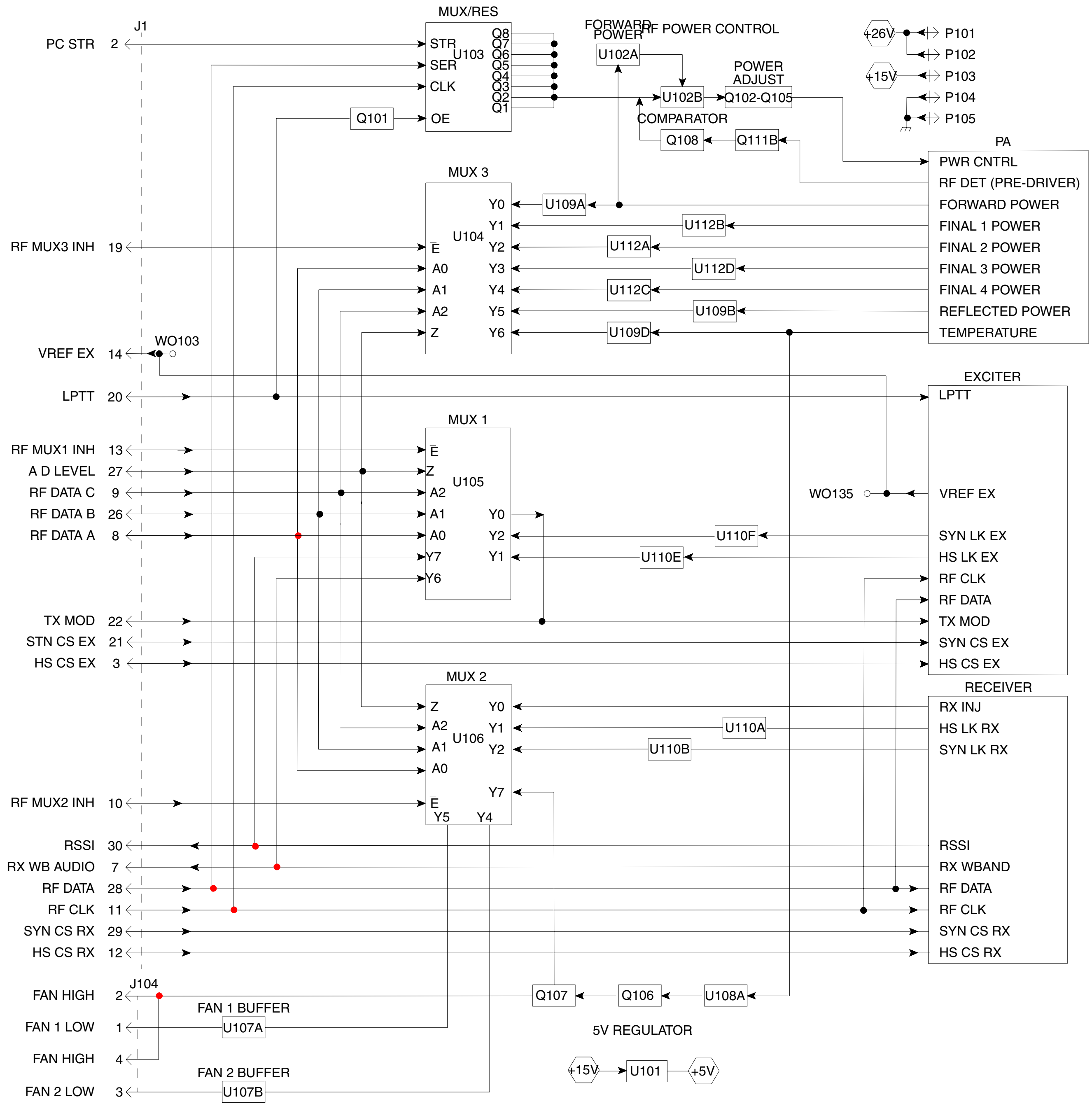


Figure 6-7   RF INTERFACE BOARD BLOCK DIAGRAM

6.5 800W POWER SUPPLY

WARNING

This power supply contains voltage potentials greater than 400V. Considering the dangerous voltages and the complexity of the switch-mode power supply, it is strongly recommended the power supply be returned to E.F. Johnson for repair (see Section 1.8).

6.5.1 FILTER BOARD

AC power is brought into the power supply through the IEC connector in the front of the power supply (see Figure 2). This connector is attached to the EMI filter assembly, Part No. 023-2000-820. The filter contains common mode and differential mode filtering such that the supply complies with FCC Class-A regulations. In addition to the filter components (C1, C2, L1, C3, C4, L2, C5) R1 is used to discharge the filter capacitors when AC is removed. Metal-oxide varistors (RV001/RV002) are placed across the line on the input and output of the EMI filter that clamp transients on the AC line to prevent damage to the power supply. The AC power is fused with F001 after the connector and before the filter. Replace fuse with a 15A/250V (314015) fuse.

At the output of the filter board is a bridge rectifier. The rectifier is heat sunk to the filter bracket through a Grafoil thermal interface pad. Filtered AC power is connected to the main board via wires W001 and W003. Filter and rectified current is brought to the main board via wires W004 and W005. The safety ground is connected from the filter board to a stud in the chassis through W002.

6.5.2 POWER FACTOR CORRECTION

The power factor switching frequency is set at 87.5 kHz, ±5 kHz. The average current mode boost converter is comprised of L107, Q101, CR145, C110, C111. Half of U102 is used for power factor correction. RT101/RT102 are negative temperature coefficient thermistors that limit the in-rush current to C110/C111. The resistor network connected to CR104 charges up C106/C107 to +18Voff the line. This provides the bias voltage required to start the controller IC U102. Once the IC turns on current is being switched on L107. A small tap winding on L107 provides sustaining current to the U102. When AC is first connected it could take several seconds for C106/C107 to charge to +14V before the unit starts.

U102 samples the input voltage through R105/R106/R107; the input current through T103/T104/CR146/CR108/R113/R114; and the output voltage through the divider at R127. U102 modulates the duty cycle to MOSFET Q101 such that the input current is shaped like and in phase with the input voltage. The controller has two feedback loops; a voltage loop to keep the 400V constant and a current loop to keep input current correct. Compensation for the current error amp is C120/R141/C121 on U102, pin 1. Compensation for the voltage error amp is provided by C127/C142/C126 on U102, pin 16. U102, pin 4 and associated circuitry automatically adjust the Power Factor Correction (PFC) for input voltage (100-240V AC), line frequency (50-60 Hz) and load on the power factor.

NOTE: The output voltage of the power factor section is at 400V DC. This voltage is bled off slowly. After turning off, it can take more than 5 minutes to discharge.

6.5.3 MAIN PULSE WIDTH MODULATOR

The +26.5V output is created from a two-transistor forward converter Q116/Q118. It uses the 400V output of the power factor correction on C110/C111 for an input voltage. The same controller IC (U102) drives the +26.5V stage. This stage runs at exactly twice the power factor correction frequency and uses trailing edge modulation. The pulse width modulator uses the PFC supplied current for modulation scheme that reduces ripple current in C110/C111.

The output of the IC, U102, pin 11 is fed to a level shifting gate drive network comprised of C139, C140, T106, C136, C197, C137 and C228. Each MOSFET (Q116, Q118) of the two-transistor forward converter has a gate protection zener diode CR117, CR120 respectively. In addition, each power MOSFET has a gate turnoff network.

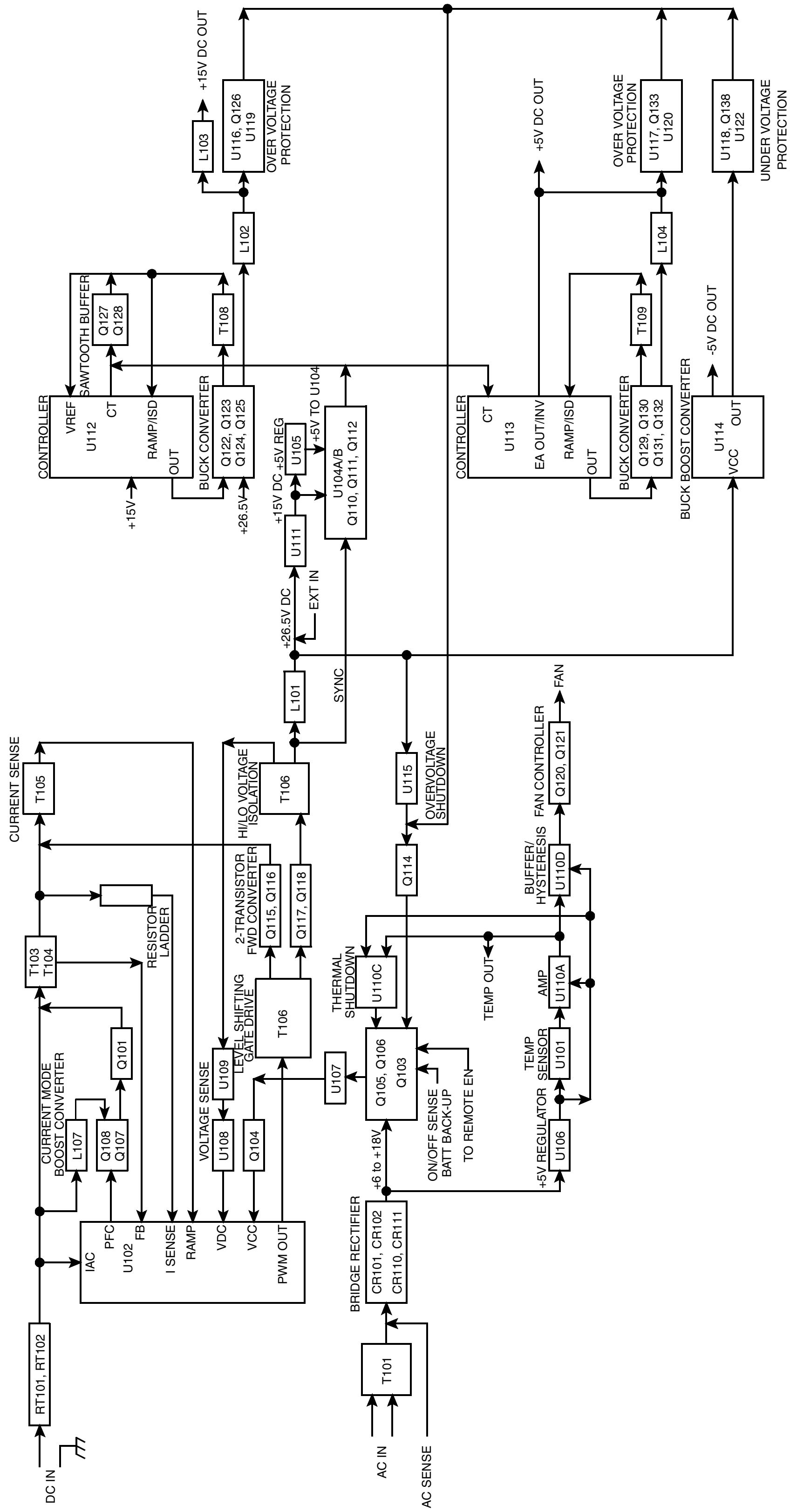


Figure 6-8 POWER SUPPLY BLOCK DIAGRAM

In operation, the power MOSFETs Q116, Q118 are on for approximately one-third of the period providing current to the primary side of T107. During that time CR121 is forward conducting and charging L101. When the MOSFETs are switched off, the magnetizing current of T107 continues to flow through CR118, CR119. These diodes place 400V across the transformer in opposite polarity that resets the transformer core. During the off period CR128 is free wheeling and L101 is discharging. Transformer T107 provides the isolation between the low voltage and high voltage sections.

The +26.5V pulse width modulator is peak current mode controlled. This type of converter requires current and voltage sense. T105, CR112, R125, R146 and C125 provide the current sense circuit. The voltage sense circuit is U109 and the associated circuitry on the isolated side of the supply.

An opto-isolator is used to cross the boundary from high to low voltage sections. In the event of an over-voltage condition (>+32V) U115 and associated components turn the power supply off. This shutdown mechanism latches the power supply Off. The enable line must be turned Off for 10 seconds for the power supply to reset. T106 has a tap to provide current to the optional battery back-up (Part No. 023-3-2000-830). The +26.5V is available at the high current output connector to the power supply and it also powers the +15V, +5V and -5V converters through F102.

6.5.4 SYNCHRONIZING CIRCUITS

The +15V and +5V sections run at the same frequency as the +26.5V pulse width modulator. In order for a beat note not to be produced, a sync circuit is used. If two converters are not synchronized, the difference frequency may show up at an undesired location in the repeater.

Divider R151/R152 samples the output of the main pulse width modulator. When Q116 and Q118 turn on, the output on U104A, pin 3 goes high. C138, R176, CR122 along with U104B creates a very narrow pulse on U104B, pin 6. Q110, Q111 and Q112 level shift and buffer this pulse. When the narrow pulse is presented to the timing capacitor of the +15V and +5V converters, the cycle terminates and a new one starts. This forces the +15V and +5V converters to run at the same frequency and is slightly delayed from the +26.5V converter.

6.5.5 FAN AND THERMAL SHUTDOWN

The voltage supply to the thermal measurement circuit is generated from transformer T101 and the associated bridge rectifier consisting of CR101, CR102, CR110 and CR111 and bulk storage capacitor C101. This voltage is approximately +9V when the AC voltage is at 120V AC.

NOTE: This DC voltage is dependent on the input AC voltage.

U106 provides a very accurate +5V required for proper operation of the temperature sense circuit. A precision temperature sensor (U101) is mounted to the +26.5V rectifier heatsink. The output of this sensor is 10 mV/°C with a ±1% accuracy. This voltage is amplified by U110A with precision resistors R183/R184 setting the gain.

The output of gain stage U110A is fed to the computer interface via WO116 to monitor power supply temperature with the programmer. The output of U110A, pin 3 is also connected to the thermal shutdown circuit U110C, R135, R136, R137, R138 and R139. If the heatsink temperature reaches 92°C (198°F) the output of U110C, pin 8 goes high and saturates Q103. When Q103 is turned on U107 is turned off and the power supply turns off. The remote voltage is always present so when the heatsink temperature drops to 80°C (176°F) the power supply restarts. The high temperature condition would only exist if the fan was blocked or faulty.

The output of U110A, pin 1 also connects to the fan controller. U110D with the associated resistors provides a means to turn the fan on/off. Transistors Q120/Q121 provide current gain and a voltage level shift to run the fan. The fan turns on when the heatsink reaches approximately 45°C (113°F) and turns off again when the temperature reaches 35°C (95°C). In normal operation the fan turns on and off.

6.5.6 +15V CONVERTER

The input voltage to this "Buck" DC/DC converter is the main +26.5V output fused through F102. The bias voltage for the controller IC U112, pin 15 is provided by a +15V regulator U111. The basic buck converter consists of MOSFET Q125, Schottky diode CR126 and storage inductor L102. C165, C166, C167, L103, C169 and C170 filter the output voltage and attenuate the ripple at the switching frequency (160 kHz). The capacitors are an integral part of the feedback loop. The duty cycle is approximately 60%.

The +15V buck converter is peak current mode controlled. T108 samples the inductor current while MOSFET Q125 is on. The sampled current is translated to a voltage via CR127, R209 and R210.

Because the MOSFET is a high-side switch, a charge pump is required to get the gate voltage above the input voltage. The charge pump operates as follows. When the output from IC U112, pin 14 is low, capacitor C162 is charged through CR124, R198, R199, R200 and Q122/Q123 are off. When U112, pin 14 goes high, the capacitor stays charged and CR124 is reverse biased. Q122/Q123 are turned on forward biasing CR125 and applying a gate-to-source voltage of approximately +12V. During this time Q124 is off. When U112, pin 14 goes low, Q124 turns on and rapidly discharges the gate capacitance.

Resistors R231/R208 coupled with C164 provide snubbing for Schottky diode CR126.

Because the +15V converter operates at greater than 50% duty cycle, slope compensation is required. Capacitor C176 is the time capacitor for this converter and R223 is the resistor that sets the charge current. A sawtooth wave is present on the high side of C176 that is buffered by Q127/Q128. The resistor divider network of R315, R227, R229 and R232 provide the correct amount of compensation for stable operation and current limiting.

The output voltage is sampled by R215, R216 and R217 and sent to the inverting side of the error amplifier internal to the controller IC on U112, pin 1. Voltage loop compensation is set by C174, C175 and R221.

Sync pulse is added into the low side of C176 via C172 and R225. The free running frequency of the 15V converter (approximately 145 kHz) is set about 10% lower than the 26.5V converter. This longer duty cycle allows the sync circuit to synchronize the converter.

Over voltage is sensed using U116 as a reference and amplifier, CR129 acts as a crowbar on the output. Once the crowbar is turned on, opto-isolator U119 is activated to shutdown the power supply. The enable line must be toggled or AC voltage removed for 10 seconds to reset the power supply.

6.5.7 +5V CONVERTER

Operation of the +5V "Buck" DC/DC converter is the same as the +15V, except slop compensation is not required. Some values are different to get the 5.2V DC and current limit to 6A. The duty cycle is approximately 20%.

6.5.8 -5V CONVERTER

The -5V "Buck-Boost" converter scales and inverts the voltage. This converter is free running at approximately 75 kHz. The output switch and controller are built into the 5-leg TO-220 IC U114. L105 is the storage inductor. C204, R270 and R271 close the voltage feedback loop and are set for optimum stable transient response. C208/C209 reduce output ripple. Under-voltage protection is required on this stage and works the same as the over-voltage protection of the +15V and +5V buck converters, but has opposite polarity.

6.5.9 POWER SUPPLY REPAIR AND ALIGNMENT

If a power supply fails it is typically a Power MOSFET or Power Diode. In some cases the MOSFET gate may short and cause some of the driver circuits to be damaged. When replacing heat sunk components it is advisable to replace the sil-pad thermal interface material at the same time. The mounting hardware must be replaced exactly as built in the factory. The mounting screws for the power semiconductors MUST BE torqued to 4-5 in/lbs. Under torque and over torque can shorten the life of the semiconductor.

The majority of the voltage and current limits are set with fixed value components in the power supply. However, the +26.5V, +15V and +5.2V supplies are adjustable. When certain components are replaced, the voltages must be adjusted. The voltages should be set at light load (i.e. repeater in the Receive mode).

1. The +26.5V supply can be adjusted with R174 when any of the following components are replaced: R173, R174, R175, U109, U108, U102, R143, R170 or R171.

2. The +15V supply can be adjusted with R216 when any of the following components are replaced: R215, R216, R217 or U112.

3. The +5.2V supply can be adjusted with R254 when any of the following components are replaced: R253, R254, R255 or U113.

6.6 BATTERY BACK-UP MODULE

6.6.1 OPERATION

When a battery back-up module is installed in a power supply it performs the function of running a repeater in the absence of AC voltage. When AC is present it can be used to charge a pair of lead-acid batteries in series. The charger is a temperature compensated constant voltage charger. The maximum output current from the charger is 2.2A. The charger works when AC is present and the repeater is enabled. The charger switch on the battery back-up module must be "On". The temperature compensation thermal sensor is part of 023-2000-223 battery back-up module cable assembly.

When AC is low or not applied to the 023-2000-800 power supply the battery input takes over if the voltage is within range. The input voltage to the battery back-up module acts as the 26.5V supply and the other voltages in the power supply also are present, +15, +5.2 and -5V. When AC is restored, the battery back-up module disengages automatically. The change over from battery to AC or AC to battery may cause the repeater to reset, depending on battery condition and load status.

NOTE: When using a generator, the DC voltage must be between 23-28.5V (26.5V DC is recommended) and ripple voltage less than 1% or approximately 0.25V P-P.

6.6.2 CHARGER

The charger charges the batteries when the repeater is on and switch S101 is "on". A tap off of the main transformer of the power supply through wire W104 and a +26.5V line via wire W102 are what supply the charger with the necessary voltage to charge the batteries. The tap off of the transformer is biased by the +26.5V and then filtered through L101, C105 and C119. Since the tap from the power supply is not a regulated voltage, bleeder resistors R136/R137 dissipate some power when the batteries are fully charged. No load situation, the peak voltage of the tap is approximately 63V, is not impressed across the 50V capacitors C105/C119. During a battery charging condition the line voltage to the charger on U107, pin 2 should be about 35V.

While charging batteries, if the charge voltage is varied with respect to the temperature of the batteries, the lifetime of the batteries is increased dramatically. Figure 6-9 shows the algorithm used in float charge applications for two 12V lead-acid batteries in series. Figure 6-9 shows that the charge voltage should be 27.3V DC ±0.15V at 25°C (77°F) with -55 mV/°C temperature compensation.

An LM317M linear voltage regulator (U107) is used to create the temperature compensated charge voltage. This device is capable of delivering 2.2A of continuous current to the batteries.

To create a temperature compensated voltage an op amp (U104) is used as a voltage gain device from a temperature probe attached to the batteries (part of 023-2000-223). This op amp with R148/R149 defines the slope for the algorithm of Figure 6-9. The output of the temperature compensation is attached to the adjust pin of U107. R138-R140 allow the output voltage to be set properly at a given ambient temperature. F101 is a 4A resettable fuse used to prevent thermal run away in the event of U107 failure. If the output current to the batteries exceeds 4A this fuse opens. Once the current drops below 100 mA, the fuse closes automatically.

NOTE: If any of the charging components are replaced, R140 needs to be adjusted to set the output (battery back-up battery terminals) voltage to 27.3V ±0.15V when temperature sensor is at 22°C (71.6°F).

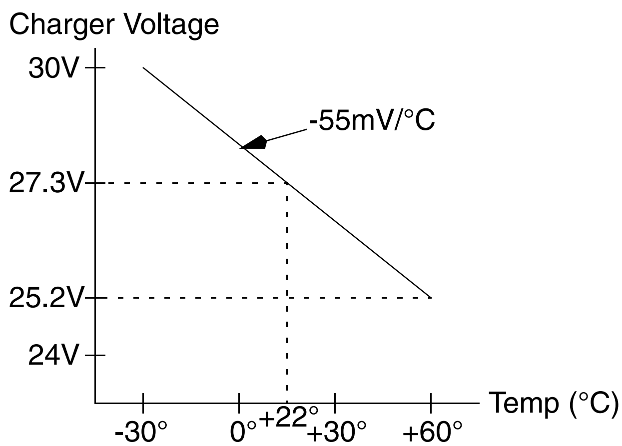


Figure 6-9 NO LOAD CHARGE VOLTAGE vs. TEMPERATURE

6.6.3 REVERSE BATTERY PROTECTION

To obtain reverse battery protection a number of techniques were implemented. Q108/Q110 are arranged in a Darlington configuration to isolate the output capacitors C109-C111 from conducting in the event the batteries are connected backwards. This circuit also provides a means to turn the battery charger off in case the user wants to run the repeater off of another DC source. S101 opens the base of Q105 which turns off Q104. CR111 is a green light emitting diode (LED) located on the right hand side of the battery back-up module when looking at the front of the power supply that tells the user the charger is in charge mode and is marked "On".

To notify the user that the batteries are connected improperly R101/CR101 are connected in series across the batteries. CR101 is a red LED that lights when the batteries are connected backwards and is located on the left hand side of the battery back-up module when looking at the front of the power supply. This LED is marked "Reverse Bat.". CR113 eliminates a path for the reverse battery current through the relay and over/under voltage protection circuitry.

NOTE: Exceeding -30V across the battery back-up terminals with the power supply on will destroy Q105.

6.6.4 ENGAGING THE RELAY

The main purpose of the Battery Back-Up Module (BBM) is that when the power supply loses AC line voltage, a pair of series connected 12V lead acid batteries (approximately 26.4V) or other 23-28.5V DC source will engage to the supply allowing the repeater to operate. To perform this function a voltage comparator (U101) is used to monitor the charge tap coming from the power supply.

A 2.5V reference voltage is supplied to the comparator from U102. The transformer tap voltage is smoothed and divided by CR114, C118, R116, R121 and R122. The values for these components were calculated so that when the AC line voltage is dropped to 70V AC, the output of the comparator turns Q103/Q102 on which in turn engages the relay K101. The relay is capable of 30A which delivers the battery energy to the power supply via W102 with the return line being W103.

NOTE: When AC is restored, the relay disengages and the charger automatically begins to charge the batteries.

6.6.5 OVER/UNDERVOLTAGE SHUTDOWN

U101 is a quad comparator IC used to create the overvoltage and undervoltage shutdown circuitry. If the batteries are drained sufficiently enough such that the voltage of the batteries drops below 20.3V DC the output of the comparator goes low and turns Q102 off. By turning Q102 off the batteries are switched out of the circuit. The batteries cannot be switched back into the repeater until the voltage rises to 22.6V DC. This operation is in place to protect the repeater and the batteries. In the event the batteries are over charged, or the repeater is driven by the generator that has the voltage set too high, the relay will disengage above 30.5V DC. In order to switch the batteries back to the repeater, the voltage must drop below 29V DC.

In an overvoltage or undervoltage situation, whether AC is present or not, the red LED (CR105) lights until the problem is rectified. This light is located on the right-hand side of the battery back-up module when looking at the front of the power supply and is marked BAT-BAD.

6.6.6 BBM FAN CONTROL

The voltage supply to the thermal measurement circuit is taken from the 26.5V DC line into the BBM. A precision temperature sensor U106 is mounted on the PC board near a screw into the BBM bracket which transfers heat to the sensor. The output of this sensor is 10 mV/°C with a ±1% accuracy. This voltage is amplified by U105 with resistors R153/R154 setting the gain.

The output of this gain stage (pin 1) is fed to another gain stage that performs as a comparator. The output (pin 7) will go high when the heatsink temperature reaches 45°C and will go low when the temperature goes below 35°C. This output is sent to the power supply through Q106 to turn the fan on and off.

6.7 CARD RACK

The card rack provides slots for up to eight logic cards; including Main Processor Card (MPC), Main Audio Card (MAC) and the Interface Alarm Card (IAC). The IAC has a notch in the card to accommodate a pin in Slot-8 so that no other card can be plugged into this slot.

On the back of the card rack is the Backplane with plug-in connectors to the cards and cables to the RF modules, Power Supply and External Connector Board.

Refer to the component layout and schematic diagram in Section 10 for more information on the repeater backplane.

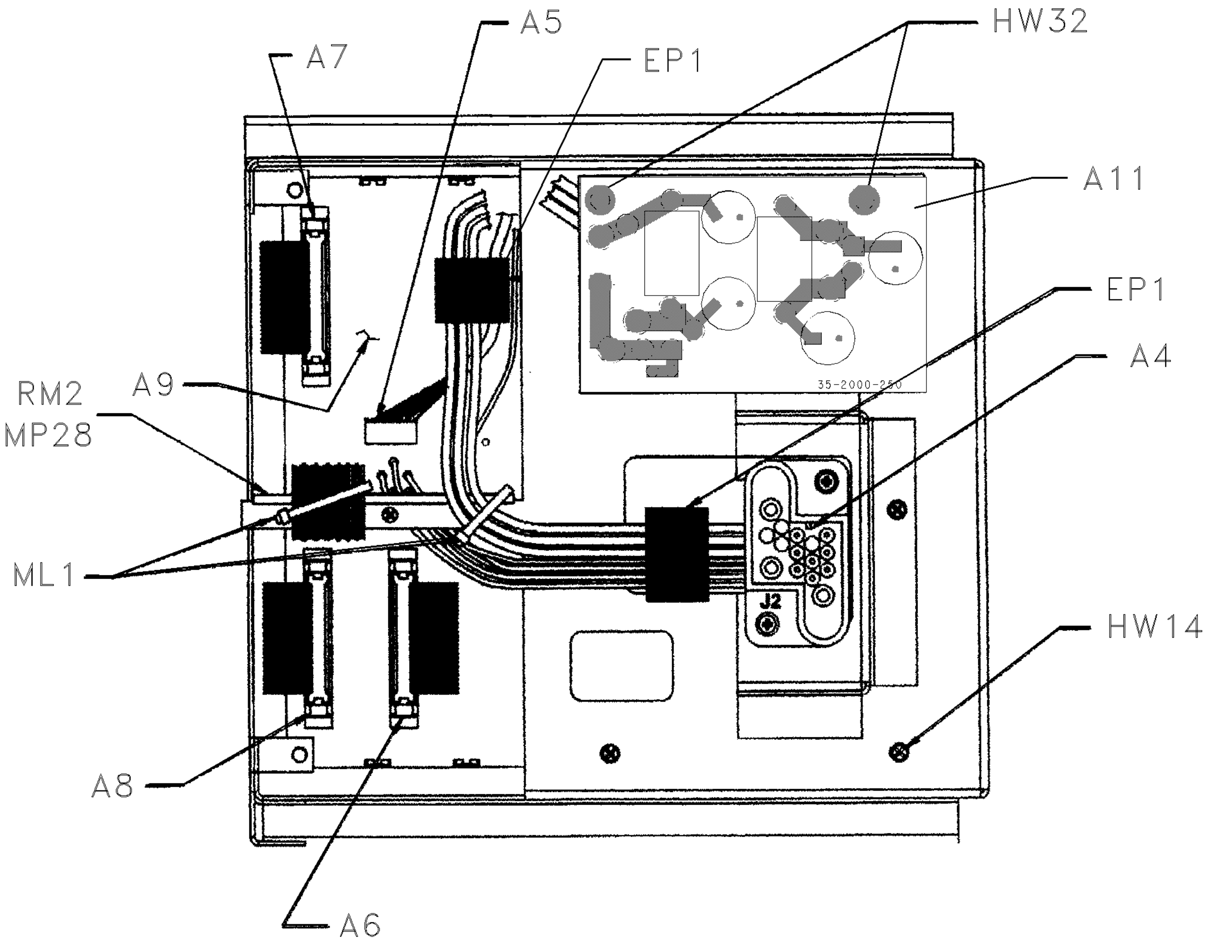


Figure 6-10 BACKPLANE CONNECTORS

6.8 EXTERNAL CONNECTOR BOARD

The external connector board (A10) is the interface for the alarm outputs, connecting repeaters through the high speed data bus.

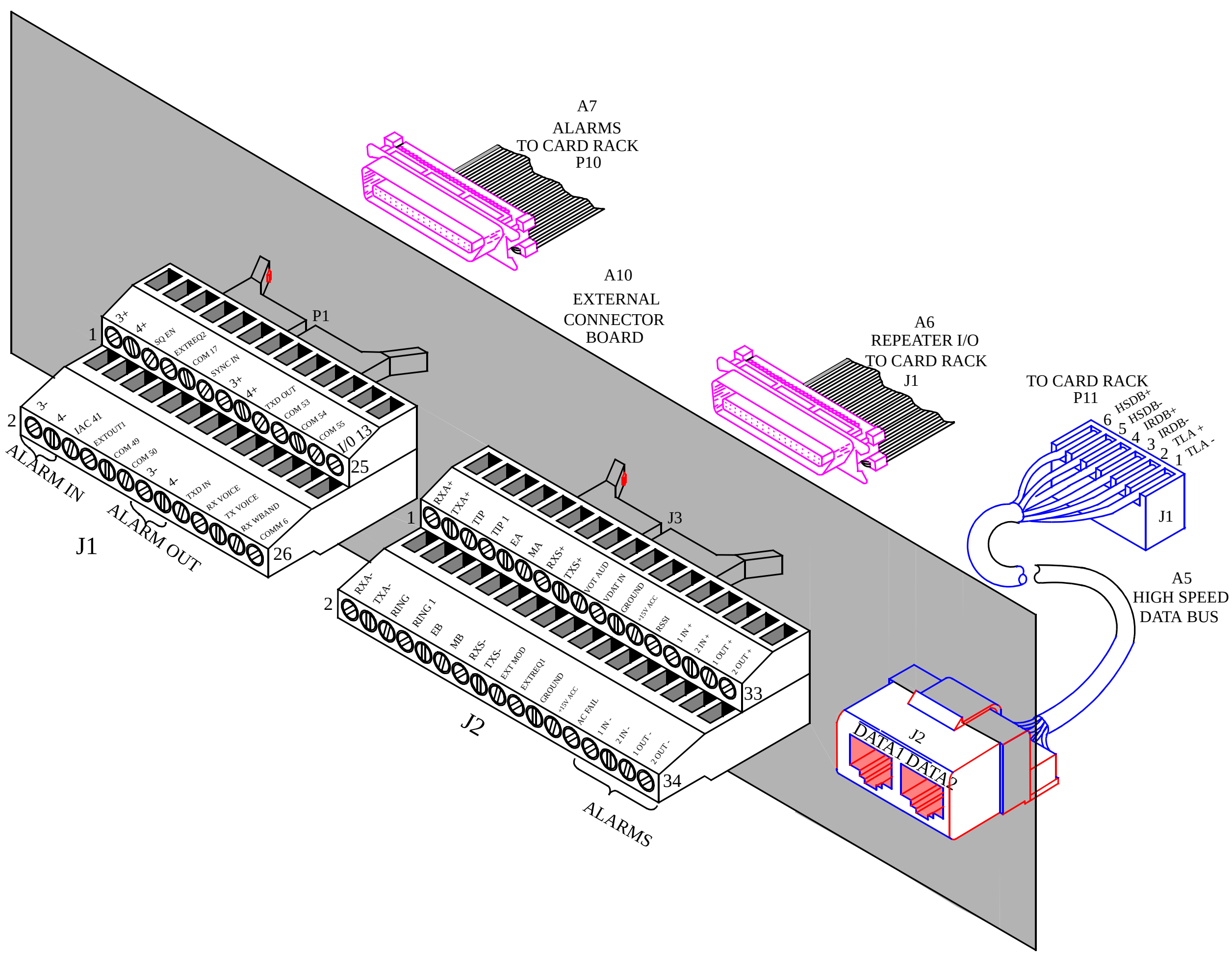


Figure 6-11   EXTERNAL CONNECTOR BOARD

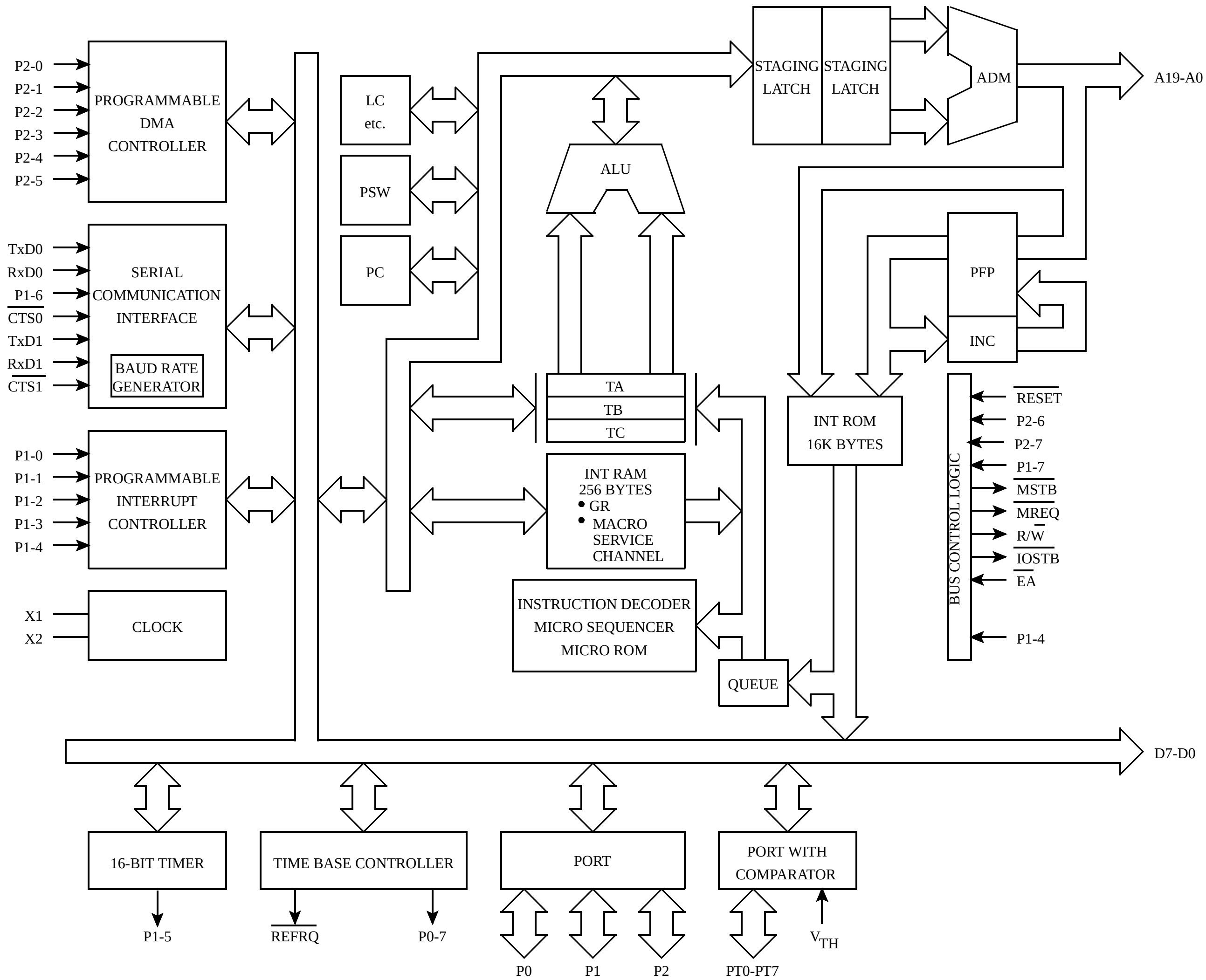


Figure 6-12 U27 BLOCK DIAGRAM

6.9 MAIN PROCESSOR CARD

6.9.1 INTRODUCTION

The Main Processor Card (MPC) connects to the computer with repeater software to program the repeater parameters, sets and reads the alarms, handles communication between repeaters, maintains the audio gating for the MAC, handles initialization requests from cards and contains the repeater RF data for the Receiver, Exciter and CWID.

Control functions for each repeater are performed by the Main Processor in the MPC installed in each repeater. The MPC contains the main software and control over the repeater via microprocessor U27 (see Figure 6-17).

Information is exchanged between repeaters via a High-Speed Data Bus (HSDB) that interconnects all the MPCs. This control technique is called distributive processing and it eliminates the need for a separate system controller at each site. The HSDB processor (U13) on the MPC provides these control functions. The MPC also contains:

- Flash Memory, RAM, non-volatile EEPROM.
- I/O chip select to allow the addressing of data latches for Input/Output.
- Read/Write selection to be sent and received on the Controller Backplane.
- Clock line, data line and chip select line from the IAC to load the Receiver and Exciter synthesizers.
- Serial communication circuitry and processes for the High Speed Data Bus (HSDB).
- Asynchronous parallel communication to the other cards, i.e. alarm input and output circuitry.
- AC Power Failure indication from the IAC.
- Provides an output from the IAC to the power amplifier to control the output power.
- Exciter Logic Push-To-Talk (PTT).
- Receiver synthesizer lock, Exciter synthesizer lock, thermal level from the power amplifier, VSWR level from the PA, forward power level, RSSI signal level, audio levels from the MAC, Receiver and Exciter from the IAC.

6.9.2 MAIN CONTROLLER MICROPROCESSOR

U27 contains the main software and control over the repeater (see Figure 6-12).

The main controller (U27) is a VLSI (Very Large Scale Integration) CMOS 16-bit single chip computer with an 8-bit external data bus. This processor has software compatibility with the V20 (8086/8088), faster memory access, superior interrupt processing ability, and enhanced control of internal peripherals. This ROMless processor has a variety of on-chip components including 256 bytes of RAM, serial and parallel inputs/outputs, comparator port lines and timers.

Eight banks of registers are mapped into internal RAM below an additional 256-byte special function register (SFR) area that is used to control on-chip peripherals. Internal RAM and the SFR area are together and can be relocated anywhere in the 1M-byte address space. This maintains compatibility with existing system memory maps.

The two microprocessors and USART (U22) are reset by integrated circuit U17. Reset occurs when power is turned on, when the 5V supply drops below a threshold level or the reset switch (S1) is active.

When a microprocessor is reset, several internal registers are cleared and the program is started over from the beginning. Low-voltage reset prevents improper operation resulting from low-voltage conditions.

When power is turned on, the RESET output U17, pin 6 is initially high and the inverted RESET output U17, pin 5 is initially low. Once the 5V supply stabilizes, these outputs remain in these states for approximately 100 ms to ensure that reset occurs.

This time delay is set by capacitor C14 connected to U17, pin 3. If the 5V supply drops below a nominal level, the RESET outputs change states and microprocessor operation is interrupted until the 5V supply returns to normal. C3 prevents fast transients on the 5V supply from causing reset.

Manual reset can be accomplished by pressing push-button switch S1. When U17, pin 2 goes low, U17 goes into the reset sequence described.

6.9.3 HIGH SPEED DATA BUS MICROPROCESSOR (U13)

The HSDB processor (U13) on the MPC provides the interface with the HSDB. It monitors data on this bus and also transmits data on to this bus when necessary. Information on this bus indicates which repeaters are in use and also which mobiles are using the system. This information is used by the repeater to encode data messages to the mobiles that are monitoring that channel. These messages also include information on which repeater is free and current system priority.

Microprocessor U13 is an 8052 that uses external EPROM (Erasable Programmable Read Only Memory) U14, an 8-bit device that stores the program. The microprocessor uses 2k x 8 EPROM and 64k x 8 RAM. The RAM (Random Access Memory) is used for temporary data storage. The HSDB processor is configured by the Main Processor.

The internal data bus of the microprocessor has four input/output ports. These ports have eight lines each, giving a total of 32 input/output lines. These ports are designated P0, P1, P2, P3. P0 is used as a data bus. Ports P1 and P2 are always used as general purpose inputs/outputs. P3 is used for specialized functions, i.e. a serial port (RxD/TxD) and interrupt (INT).

The operating speed of the microprocessor is set by an 11.059 MHz clock generated by Y2. This clock frequency is divided down by an internal divider to provide a machine cycle time of 1.08 µs. Most program instructions are executed in one machine cycle and none require more than four machine cycles.

The microprocessor U13 communicates with the main processor (U27) through U9 and U10. U9 is a Transmit FIFO (First In First Out) and U10 is a Receive FIFO. This combination makes up an asynchronous parallel-to-parallel interface to the Main Processor.

Microprocessor U13 also calculates the current system priority for the channel. This priority is from the programming software responses and the current priority is sent to the main processor. U13 also reads repeater number and channel number information in memory. U13 also determines the current free repeater and includes that information in the data sent to the Main Processor.

6.9.4 CHIP SELECT DECODERS (U15/U4)

Chip select decoders select the peripheral chip to read from or write to.

6.9.5 P1 SIGNAL CONNECTOR

This is the signal interface connector P1 (64 pin) that connects the Address and Data buses and control lines to the backplane connector.

Pins 1-10 ADDRESS BUS
Pins 33-42

This provides a path between the MPC main processor and the external memory on the MPC and the other cards in the Controller. This bus retrieves information programmed into memory for the operation of the repeater.

Pins 11-14 DATA BUS
Pins 43-46

The data bus provides a means of transferring data to and from the CPU on the MPC, memory storage on each card and peripheral devices in and out of the MAC and IAC.

Pin 15 MREQ

MREQ is a memory request line operates in conjunction with the Read/Write lines. These provide the ability to read from or write to the main processor memory on the MPC.

Pin 16 MSTB

MSTB is a memory strobe line used during MPC main processor Read/Write operations to external memory on the MPC and other cards plugged into the backplane.

Pins 17-20 UNUSED

Pin 21 LPTT

The Logic Push-To-Talk is an open collector from the Controller. It has a sink capability of 20 mA and a maximum voltage rating of 18V. The transmitter should produce power when this pin is a logic low. Transmit indicator is on the IAC and is controlled independently of the LPTT.

Pins 22-23 UNUSED

Pins 24/56 HSDB+/HSDB-

This interconnects all repeaters to provide an exchange of information. This control technique is called distributive processing and eliminates a separate system controller at each site. Information on this bus indicates which repeaters are in use and also which mobiles are using the system. This information is used by the repeater to encode data messages to the mobiles that are monitoring that channel. These messages also include information on which repeater is free and current system priority.

Pins 25-26 UNUSED

Pins 27/59 -5V IN

This is the -5V input to the MPC from the power supply via the Controller backplane.

Pins 28-29 +5V IN
Pins 60-61

This is the +5V input to the MPC from the power supply via the Controller backplane.

Pins 30/62 +15V IN

This is the +15V input to the MPC from the power supply via the Controller backplane.

Pins 31-32 GROUND
Pins 63-64

This is the ground connection to the MPC from the power supply via the Controller backplane.

Pin 47 READ

Read is used with the MREQ line to read data from the main processor and external memory.

Pin 48 WRITE

Write is used with the MREQ line to write data to the main processor and external memory.

Pins 49-55 UNUSED
Pins 57-58

6.9.6 J1 COMPUTER CONNECTOR

J1 is the MPC connection to the computer or modem.

Pin 1	Ground
Pin 2	Computer Tx
Pin 3	Computer Rx
Pin 4	Modem DCD

6.9.7 J2 MEMORY SELECT

J2 is jumpered to select either the Flash memory or the EPROM memory. Flash memory is ultra-fast data storage. The normal setting is pin 1 to pin 2.

Pin 1	+12V
Pin 2	U25, pin 1 Vpp
Pin 3	+5V

6.9.8 J3 BAUD RATE

J3 is jumpered to select the baud rate from the computer to the MPC, these two baud rates must be the same (see Figure 6-17). The baud rate of the computer can be found from the command line by requesting /b, /h or /? (see Section 4.7.1). To change jumper J13: Power off the station. Move P3 to the proper rate. Power on the station.

6.9.9 S2/S3 HSDB SETTINGS

These switches configure; the HSDB for RS-485 or single-ended 5V operation, indicate if the Viking VX repeaters are connected to existing repeaters or only Viking VX repeaters, and if the repeater is an end repeater termination. Refer to Sections 2.9 and 7.4.8.

6.9.10 J4 EPROM MEMORY LOADING

This jumper selects EPROM memory loading for LTR systems. The LTR setting is pin 3 to pin 4.

6.9.11 J5 HSDB SPEED

J5 is jumpered to select the data bus speed. J5, pins 2/3 select the LTR 12 MHz crystal.

6.9.12 J6 WATCHDOG

This jumper enables or disables the watchdog timer for reset. Normal operating mode is P6 jumpering J6, pins 2/3. This jumper should not be moved or removed.

6.10 MAIN AUDIO CARD

6.10.1 INTRODUCTION

This control card stores the information required to operate the routing of audio and data from the inputs of the repeater to the outputs. Data is received on the address bus from the MPC for the operations to perform. The Audio/Data microprocessor and the latches open and close gates to route a path for the audio or data.

Audio control functions for each repeater are performed by the Main Processor in the MPC. The MPC contains the software and maintains control over the repeater via microprocessor U27. The audio/data microprocessor passes received data to the main processor, and it is given the programmable parameters for the gates.

Information is exchanged between the cards in the Controller Backplane via a data bus and an address bus. The address bus provides the link between the main processor and the chip and the address latches on the MAC. These latches control the octal latches that select the audio and data gates. The data bus is the link between the Main Processor and the Audio/Data Processor on the MAC. The Main Processor controls the data to the octal latches and opens and closes the gates required to route audio/data in and out of the repeater.

The MAC also contains:

- The audio interface between the receiver and exciter and to the external connections.
- The receive audio filtering with de-emphasis.
- The squelch filter and detector.
- Slow decay timing circuit that controls a mute gate on the main receive audio.
- A filter, DC restoration and slicer circuitry for detecting the subaudible data.
- The fast squelch and data fed to the microprocessor that decodes the data and uses the squelch line as a data qualification signal.
- Transmit audio filter and limiter with pre-emphasis.

6.10.2 AUDIO/DATA MICROPROCESSOR

This Audio/Data microprocessor is on the MAC card and is used to decode LTR data received from the mobiles. The LTR data is applied to U111, pin 8 (P1.7 input). When a word is successfully decoded the data is then sent to U161 (Tx FIFO) and transmitted on the data bus in parallel to the main processor on the MPC.

When it is time to transmit the CW Identification, the main processor on the MPC sends the identification to U111 via the data bus and U160 (Rx FIFO). The CWID is sent to the Tx Data Amplifier and Filter. The output of the filter is summed with the transmit audio and sent to the Exciter.

U111 also uses six octal latches to provide additional input and output lines. Latch U107/U108 provide outputs which allow U111 to control various audio gates. These gates control the CWID, FSK data, and receive/transmit audio signals.

Latch U106 provides outputs which allow U111 to route signals to the Audio/Data Test Point by switching gates on and off. U106 also provides adjustment of the selected EEPOTs.

U155-U156 allow U111 to select the EEPOT to adjust with chip select lines. These latches also provide routing of some audio/data signals through gates.

In addition, U111 controls the receive and transmit audio gates, receiver squelch, several front-panel indicators, and other functions. U111 encodes the data messages transmitted to mobiles monitoring that channel, and controls transmitter keying.

6.10.3 RECEIVE AUDIO

The Receive Wide Band Audio (RX WBAND) signal from the Receiver is fed into the MAC on P100, pin 27. This audio signal includes; audio, LTR data, and noise. The audio processing circuit provides filtering and amplification of the audio signal before it is routed to the outputs on the MAC card.

A low-pass filter consisting of U121A/B attenuates frequencies above 3 kHz. This removes high-frequency noise from the audio signal. From the filter the signal is fed to amplifier U122A to increase the level before the high-pass filter to preserve adequate hum and noise ratio.

From the audio amplifier the signal is fed to a high-pass filter consisting of U122B/C/D. This filter attenuates frequencies below 300 Hz which removes data present in the wide band audio signal. These filters are configured to act like large inductors. The signal is then fed to U163A which provides 6 dB per octave de-emphasis.

Audio gates U113B/C/D permit noise squelch circuit, control logic, and audio switch to control gating of the audio signal. The control signal from the noise squelch circuit is applied to U113B through U113D. When a carrier is detected, this input is high and U113B passes the signal. Programming determines the gating of audio. When audio is passed by U113B/C and U114A, the audio can be routed through other gates to various outputs (see Section 6.10.6).

6.10.4 RECEIVE SQUELCH CIRCUITRY

The receive wide band audio includes audio, data and noise. The squelch circuit detects this noise to determine receive signal strength. When no carrier or a weak carrier is received, there is a large amount of noise present. Conversely, when a strong carrier is present, there is very little noise present.

U135A is a high-pass filter which attenuates frequencies below approximately 30 kHz so that only high-frequency noise is passed. This noise is amplified by U135B and U123A. A level control adjusts the gain of amplifier U135B. The gain of U123A is partially set by a thermistor to compensate for circuit gain and noise level changes caused by temperature variations.

The amplified noise is then applied to a bridge rectifier. The difference between bridge rectifier outputs is applied to the inputs of U123B. The output of U123B is positive-going pulses. These pulses are applied to U123C which is a Schmitt trigger. When the input signal rises above the reference the output goes low and causes the reference voltage to decrease slightly adding hysteresis to the triggering level. This hysteresis prevents intermittent squelching when the receive signal strength is near the threshold level.

The output of U123C is applied to U123D and Logic Squelch to Audio/Data Gate U159B and audio/data processor U111. Gate U159B routes the squelch output to the Audio/Data Test Point J100. U123D functions as a timing buffer. The output of U123D is applied to Receive Squelch Active Gate U113D. When this gate is closed, the squelch circuit controls Normal Receive Gate U113B to block receive audio if no signal is present.

6.10.5 RECEIVE DATA CIRCUITRY

The receive wide band audio signal is the unfiltered output of discriminator U202 in the Receiver. Therefore, this signal contains audio, LTR data, and noise. A low-pass filter formed by U124A/B attenuates frequencies above 150 Hz by 24 dB per octave so that only the data frequencies are passed. From the filter the signal is fed to amplifier U125A. The gain of U125A is adjusted by a level control. The output of U125A can be routed through Data To Audio/Date Gate U159C and the Audio/Data Test Point J100.

DC restoration circuit converts the data signal from AC floating near ground to a digital signal at levels of 0 and 4.5V. U125B/C provide the reference voltage on the inverting input of comparator U125D. Positive peak detector U125B handles the positive-going peaks of the data signal. Negative peak detector U125C handles the negative-going peaks of the data signal.

The voltage on non-inverting input to U125D is midway between the positive- and negative-going peaks. The data input is on the non-inverting input of U125D. When the data signal rises above the reference voltage, the output goes high. Conversely, when the input voltage drops below the reference voltage, the output goes low. The receive data is then passed to audio/data processor U111.

6.10.6 RECEIVE AUDIO PROCESSING

The receive audio signal is fed into the MAC on P100, pin 27. When a mobile-to-mobile call is received, Repeat Gate U153C is enabled and the receive audio signal is routed through Transmit Option Gate U158C to the input of the transmit audio buffer U164B to be retransmitted. Repeat Gate U153C is controlled by processor U111 through latch U107. A logic 1 on the control input causes the signal to be passed.

When the received audio must be routed to the backplane (i.e. for other cards), Receive Voice Gate U115B is enabled by processor U111/latch U108 and passes the audio signal to amplifier U120B. Receive To Backplane (RX TO BP) U115C is enabled and passes the amplified audio to the backplane.

When the audio received must be routed to the external speaker or speaker/microphone, Local Audio Mute Gate U114D is enabled by U111/latch U108. The audio is passed to local audio output amplifier U132. The gain of U132 is adjusted by the local audio volume control and on/off switch.

6.10.7 VOTER AUDIO

When used, the Receive audio from the voter receiver comes into the MAC on P100, pin 25. Amplifier U120A sets the gain of the signal and the output is routed to Voter Audio Mute Gate U115A. The gate is controlled by A/D processor U111/latch U108. If the gate is enabled, the audio goes to the Receive Mute Gate U113C and passes throughout the MAC Card.

6.10.8 COMPANDOR OPTION

The compandor option enhances the receive and transmit audio when used in conjunction with the Telephone Interface Card (TIC) in LTR systems.

The filtered Receive Audio passes through the Receive Mute Gate U113C to the expander input on A301, pin 1. The expand output of A301, pin 2 is coupled to the audio outputs by U114C.

The TX-VOICE from P100, pin 32, passes through TX Voice Gate U158A to the expander input on A301, pin 5. The compressed output of A301, pin 4 is passed to the TX Audio Buffer.

6.10.9 TRANSMIT AUDIO

PTT switch (Q101/Q102) provides local microphone Push-To-Talk (PTT) indication to U105. U105 then tells U111 via the data bus that the local microphone PTT has been activated.

U164A amplifies the microphone audio signal to provide the correct input level to U164B. Local Microphone Mute Gate U117C is controlled by A/D processor U111/latch 106. The function of U117C is to mute the local microphone audio when the local microphone PTT switch is pressed. This prevents interference if the microphone remains live when the PTT switch is pressed.

Buffer U164B combines the microphone audio signal from U164A with the audio signal from the Repeat Gate U153C.

U127B/C form a high-pass filter that attenuates frequencies below 300 Hz to prevent interference with the LTR data applied at U129B. Pre-emphasis at 6 dB per octave is provided by an RC combination before the signal is fed to the Limiter U127D.

Limiter U127D and rectifiers form a precision limiter which prevents over modulation caused by high-level input signals. With normal input levels, the output of a bridge rectifier follows the input of the bridge. When a high-level signal is applied to the bridge, the bridge opens and the output of the bridge is limited to a specific level.

The output of the limiter passes to a composite 6-pole splatter filter formed by U127A, U128D and U128A separated by buffers U128B and U128C.

The output from U128A is fed to Normal Modulation Mute Gate U118B that is controlled by A/D processor U111/latch U106. When enabled, the gate passes transmit audio to EEPOT U149. U149 is an electronically adjustable potentiometer that adjusts the gain of transmit audio amplifier U129C. The gain of U129C can only be adjusted through the software. Therefore, a computer must be attached to the MAC card when levels are set.

The output of U129C is fed to summing amplifier U129B where it is combined with LTR transmit data and CWID when present. The gain of audio and data are the same so unity gain is produced. The output signal is fed to the TCXO where it frequency modulates the transmit signal.

6.10.10 TRANSMIT AUDIO PROCESSING

Transmit voice from the backplane comes into the MAC on P100, pin 32. When used this signal passes to the transmit voice amplifier U130A. The output level of the amplifier is adjusted by a level control. The output of U130A is applied to another transmit voice amplifier U130B and Transmit Voice Gate U158A. U158A is controlled by A/D processor U111/ latch U107. When enabled, the gate passes the voice to Transmit Option Gate U158C and on to the transmit audio buffer U164B. Transmit Voice amplifier U130B is adjusted by a level control. The output is fed to Transmit Net Gate U153B. Gate U153B is controlled by A/D processor U111/latch U155.

6.10.11 TRANSMIT DATA AND CWID PROCESSING

The data signal is produced by A/D processor U111 on Transmit Data and Transmit Shape outputs. The transmit shape output is normally the opposite logic level of the transmit data output when data is transmitted. However, the bit before a logic transition occurs, the transmit shape output is the same logic level as the transmit data output. This results in a logic 1 level that is slightly higher and a logic 0 that is slightly lower. This pulse shaping minimizes interference between data bits when the data is filtered by the low-pass filter.

The data from U111 is fed to buffer U126A and Transmit Data Enable Gate U117B. Gate U117B is controlled by A/D processor U111 directly. When enabled this gate passes the data to EEPOT U151. U151 is an electronically adjustable potentiometer that adjusts the gain of transmit audio amplifier U126B. The gain of U126B can only be adjusted through the software. Therefore, a computer must be attached to the MAC card. U126B provides the required signal level at the output of the low-pass filter. A relatively stable DC bias voltage for U126C/D is required because these stages are DC coupled to the transmit TCXO (see Section 6.2.3) and changes in bias voltage can cause fluctuations in the transmit frequency.

U126C/D form a low-pass filter that attenuates square-wave harmonics in the data signal above 150 Hz to prevent interference with the audio band. From this filter the signal is fed to summing amplifier U129B and combined with the transmit audio signal. The output of U129B is fed to Transmit Modulation Mute Gate U118D. This gate is controlled by A/D processor U111/latch U106. When enabled, transmit audio and data are passed to the Exciter modulation input and the transmit TCXO.

When needed the External Modulation input on P100, pin 11 is fed to External Modulation Mute Gate U118C. Gate U118C is controlled by A/D processor U111/latch U106. When enabled, this gate passes the modulation on pin 11 to the summing amplifier U129B and gate U118D to the modulation input of the Exciter.

The repeater on the lowest frequency channel in each system must periodically transmit the station call letters as a continuous-wave identification encoded by Morse Code. This identification is programmed with the Edit Parameters software.

The CWID output is controlled by A/D processor U111/latch U107. This output is fed to CWID tone generator U100B/A and turns the tone generator on and off to create the Morse Code. From the tone generator the signal is fed to bandpass filter U129A. This filter passes the 800 Hz fundamental present in the signal. The output of the filter is jumpered by P106 on J106, pins 2/3 and P107 on J106, pins 4/5 to the summing amplifier and applied to gate U118D, and to the modulation input of the Exciter.

The input and output connectors for the MAC are defined as follows.

6.10.12 P101 SIGNALING CONNECTOR

The signal interface connector P101 (64 pin) connects the Address and Data buses and control lines to the backplane connector. See Figures 6-18 and 6-19.

Pins 1-10 ADDRESS BUS
Pins 33-42

This provides a path between the MPC main processor and the processor and memory of the MAC. This bus retrieves information programmed into memory for the operation of the MAC.

Pins 11-14 DATA BUS
Pins 43-46

This data bus provides a means of transferring data to and from the processor on the MAC with peripheral devices in the MAC.

Pin 15 MREQ

A memory request line operates in conjunction with the Read/Write lines. These provide the ability to read from or write to the processor memory.

Pin 16 MSTB

The memory strobe line is used for MAC processor Read/Write operations to external memory.

Pins 17-20 UNUSED

Pin 21 LPTT

The Logic Push-To-Talk is not used.

Pins 22-23 UNUSED

Pins 24/56 HSDB +/-

The High Speed Data Bus interconnects the Viking VX repeaters. A 50 ohm termination is required if Viking VX repeaters are used with existing repeaters and the interface.

Pins 25/57 UNUSED

Pin 26 TLA DB

The Trunk Line Accounting Data Bus is used for telephone interconnect calls.

Pins 27/59 -5V IN

This is the -5V input to the MPC from the power supply via the Controller backplane.

Pins 28-29 +5V IN
Pins 60-61

This is the +5V input to the MPC from the power supply via the Controller backplane.

Pins 30/62 +15V IN

This is the +15V input to the MPC from the power supply via the Controller backplane.

Pins 31-32 GROUND

Pins 63-64

This is the ground connection to the MPC from the power supply via the Controller backplane.

Pin 47 READ

Read is used with the MREQ line to read data from the processor and external memory.

Pin 48 WRITE

Write is used with the MREQ line to write data to the processor and external memory.

Pins 49-55 UNUSED

Pin 58 VOTER DATA IN

This is used in a Voter system. Data from the voter site is injected at this pin.

6.10.13 P100 EXTERNAL OUTPUTS

Connector P100 contains the audio and data outputs to the terminal block on the back of the Repeater cabinet. These outputs are connected to other external devices. The input and output connectors for the connector are defined as follows.

Pins 1-6 UNUSED

Pin 7 3.5V

This is the 3.5V DC TCXO reference voltage from the Exciter to the MAC.

Pin 8 TX DATA OUT

This output contains trunking signaling data and CWID data when enabled at jumper J106 and used with external optional equipment.

Pin 9 TX DATA IN

This input would normally contain trunking signaling data, CWID data, and an externally summed in signal. This input is enabled at J106 and is used with external optional equipment.

Pin 10 EXT REQ1

This input provides for external requests from optional equipment.

Pin 11 EXT MOD

This input provides for external wide band modulation of the Exciter with out any filtering. This input is not used at this time.

Pins 13-26 UNUSED

Pin 27 RX WB AUDIO

The Receive Wide Band Audio from the Receiver audio demodulator through the RF Interface Board. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the receiver.

Pin 28 A D LEVEL

This is the Audio/Data Level output.

Pin 29 TX MOD

The output of this pin is produced by audio and data inputs to the Repeater to produce the signals on this pin. This signal goes through the RFIB and then to the Exciter.

Pin 30 UNUSED

Pin 31 RX VOICE

This is receive audio output connected to the backplane.

Pin 32 TX VOICE

This is transmit audio input connected to the repeat gate.

6.10.14 J100 A D LEVEL TEST POINT

This test point located on the front card edge is used during alignment to monitor audio and data.

6.10.15 J101 SPEAKER/MICROPHONE

This jack is used in conjunction with J102 when a combination speaker/microphone is used during setup and testing of the repeater.

6.10.16 J102 LOCAL MICROPHONE

This jack is used for a microphone to key the Exciter and inject transmit audio.

6.10.17 J103 GROUND

This jack provides a ground connection for the MAC when monitoring the test points.

6.10.18 J104 EXTERNAL SPEAKER

This provides an external speaker connection at the repeater site for monitoring.

6.10.19 J105 WATCH DOG

J105 enables or disables the watchdog timer for reset. Normal operating mode is P105 jumpering J105, pins 2/3. Do not move or remove this jumper.

6.10.20 J106 TX DATA PATH

Jumpers P106/P107 connect J106, pins 1-2 and 3-4 for external options that need the Tx Data signal. Normal operation connects J106, pins 2-3 and 4-5.

6.10.21 A301 COMPANDOR CONNECTIONS

EP101	Expand In
EP102	Expand Out
EP103	Ground
EP104	Compress Out
EP105	Compress IN
EP106	+5V

6.11 INTERFACE ALARM CARD

This card utilizes the information required to operate the alarms designated in the programming of the repeater. Data is received on the address bus from the MPC for the; operation to perform, the processor and external memory, open and close relays on the outputs, and receive alarm indications on the inputs. This information is either routed to external devices or alarm outputs can be wired to alarm inputs (see Figure 6-16).

The Interface Alarm Card (IAC) contains 4-input contacts and 4-output contacts. The 4-inputs can be disabled, energized or de-energized. The 4-output relays are dry contacts that have a 2A rating and can be either normally open or normally closed.

The electromechanical relay outputs are comprised of eight SPDT (normally open) relays. The relays are all open at power-on. Data to the relay is latched by a write to the base address.

The IAC activates relays when alarm trigger events occur. The IAC monitors for alarm activity in the system and can set the various output relays as defined by the user during programming. When an external alarm is set it can be monitored from a remote location. Refer to Section 4.3.3 for alarm programming.

6.11.1 RELAY OUTPUTS

The alarm relay outputs are provided via a terminal block on the back of the repeater (see Figures 6-13 and 6-14).

The alarm outputs are on the terminal block at the rear of the repeater.

6.11.2 ISOLATED INPUTS

The isolated alarm inputs are provided via a terminal block on the back of the repeater (see Figures 6-13 and 6-14).

The isolated inputs are driven by either AC or DC signals. The active high inputs can be set by switches to be polarity sensitive, non-polarity sensitive or add a resistance in series to dissipate unused power (see Figure 6-15).

The active low inputs can also be set for either +5V or +15V operation when a ground closure is required to provide an active alarm.

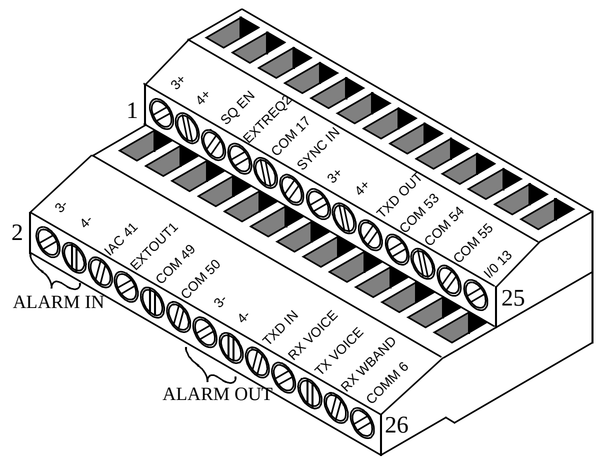


Figure 6-13 4 I/O J1 ALARM OUTPUTS

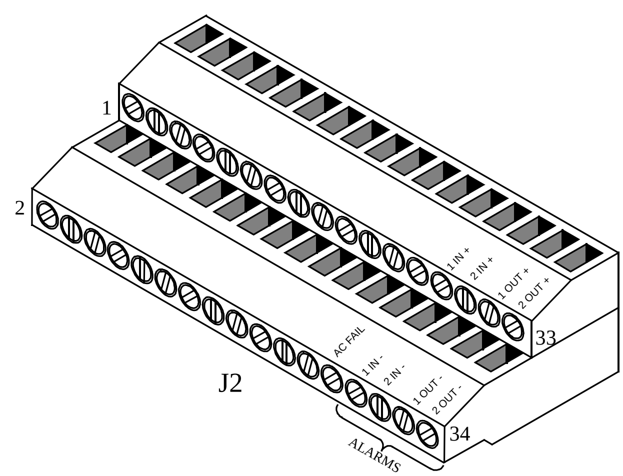


Figure 6-14 4 I/O J2 ALARM OUTPUTS

Standard 12V/24V AC control transformer outputs can be accepted as well as DC voltages. This input voltage range is 5-24V RMS. External resistors connected in series may be used to extend the input voltage range.

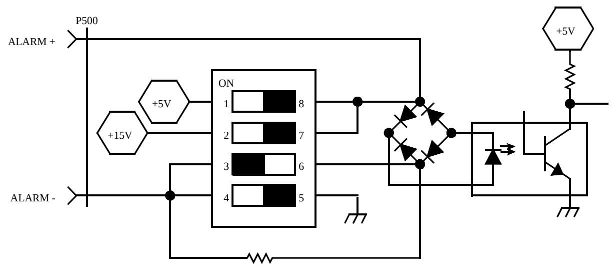


Figure 6-15 S500-S503

6.11.3 ALARM INDICATORS

There are three forms of alarm indicators from the repeater. One form is the two red LEDs and display combination on the MPC. Refer to Table 1-2 for the combinations and definitions of the active alarms.

Another form is the output relay to the terminal blocks at the rear of the repeater where outputs can be wired to external devices or to alarm inputs.

The third form is the output relay and to transmit a 15-character description of the alarm over-the-air to a remote location. The description is sent in Morse code with a transmit ID assigned during programming. A transceiver programmed with this ID can monitor the repeater and alert the system owner when an alarm occurs.

6.11.4 ALARM FUNCTIONS

The alarms can be configured in various modes to alert the system owner to conditions and hazards with the equipment and the repeater site facility. A few of the possibilities are shown in Figure 6-16. In this example the input alarm 2 of Repeater 1 is connected to the door of the building, input alarm 3 of Repeater 5 is connected to the fire alarm system, the AC fail alarm (#16 see Table 1-2) is mapped to alarm 2 output so it can be transmitted (see Figure 6-16) and the output alarm 1 of Repeater 1 is connected to the input alarm 1 of Repeater 2 and so on until the output alarm 1 is fed back to the input alarm 1 of Repeater 1. Then the RF Shutdown alarm (#32) is mapped for alarm 1 in each repeater. This configuration allows Repeater 2 to give an alarm when Repeater 1 has an RF Shutdown alarm output, etc.

The input alarms are given a 15-character description during programming and a Transmit ID. These are used when an input alarm is activated to send a Morse code message consisting of the description over the air to a monitoring transceiver programmed with this ID.

There are 40 internal alarms that can be included in the output alarm configuration (see Table 1-2). These alarms can also be programmed to send an output as shown in the cross reference screen of the alarm configuration menu (see Figure 4-13). Among these alarms are the thermal sense from the PA and the AC fail alarm output on the terminal block at the rear of the repeater to activate the battery backup.

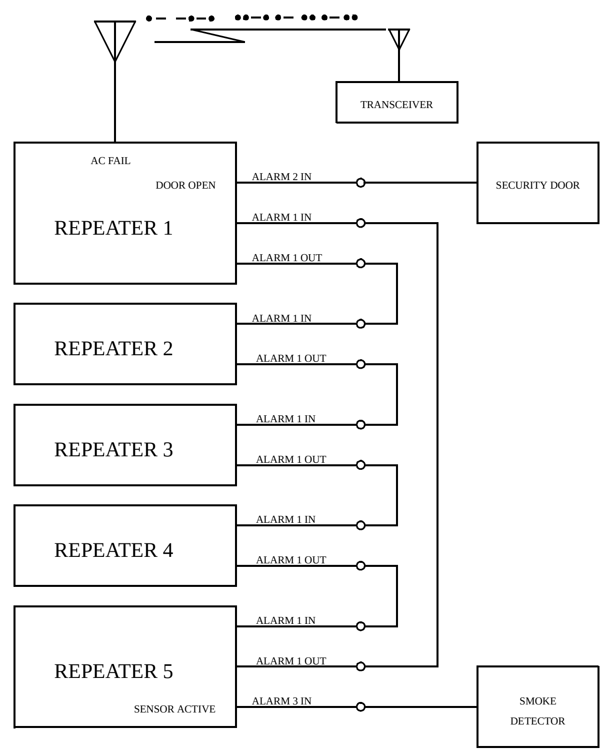


Figure 6-16 ALARM EXAMPLE

6.11.5 P500 SIGNALING CONNECTOR

The input and output connectors for the IAC are defined as follows. The signal interface connector P500 (64 pin) connects the Address and Data buses and control lines to the backplane connector. See Figure 6-20.

Pins 1-4 ADDRESS BUS (A12-A19 Only)
Pins 33-36

This address bus provides a path between the MPC main processor and the latches and multiplexers of the IAC. This bus retrieves information programmed into the MPC memory for the operation of the IAC.

Pins 5/37 ALARM 1 IN +/ALARM 1 IN -

This is an input received from a connection to an external device as a specific alert condition.

Pins 6/38 ALARM 2 IN +/ALARM 2 IN -

This is an input received from a connection to an external device as a specific alert condition.

Pins 7/39 ALARM 3 IN +/ALARM 3 IN -

This is an input received from a connection to an external device as a specific condition.

Pins 8/40 ALARM 4 IN +/ALARM 4 IN -

This is an input received from a connection to an external device as a specific alert condition.

Pin 9 SQUELCH ENABLE

This is an output to rear connector J1. It can be configured for inverted output, non-inverted output or logic controlled non-inverted output.

Pin 10 EXTERNAL REQ 2

This is an input received from a connection to an external device.

Pins 11-14 DATA BUS
Pins 43-46

This data bus provides a means of transferring data to and from the latches and multiplexers on the IAC with peripheral devices in the IAC.

Pin 15 MREQ

A memory request line operates in conjunction with the Read/Write lines. These lines read from or write to the MPC processor memory.

Pins 16/17 UNUSED

Pin 18 SYNC IN

This is an input received from a connection to an external device.

Pins 19/51 ALARM 1 OUT +/ALARM 1 OUT -

This is an output to an external device to perform a specific function.

Pins 20/52 ALARM 2 OUT +/ALARM 2 OUT -

This is an output to an external device to perform a specific function.

Pins 21-23 UNUSED

Pins 24/25 +15V ACCESSORY

This DC supply is an output to an external device through rear connector J1.

Pins 26/58 +15V FILTERED

This DC supply is an output to an external device through rear connector J1.

Pins 27/59 -5V IN

This is the -5V input from the power supply via the Controller backplane.

Pins 28-29 +5V IN
Pins 60-61

This is the +5V input to the MPC from the power supply via the Controller backplane.

Pins 30/62 +15V IN

This is the +15V input to the MPC from the power supply via the Controller backplane.

Pins 31-32 GROUND
Pins 63-64

This is the ground connection to the MPC from the power supply via the Controller backplane.

Pins 41-42 UNUSED

Pin 47 READ

Read is used with the MREQ line to read data from the MPC processor and external memory.

Pin 48 WRITE

Write is used with the MREQ line to write data to the MPC processor and external memory.

Pins 49-50 UNUSED

Pins 53-55 UNUSED

Pin 56 THERMAL SENSOR

The Thermal Sensor monitors the PA temperature and creates an alarm condition if the temperature exceeds the limit.

Pin 57 POWER SWITCH

Pin 57 turns the voltage from the power supply to the Repeater on and off. This pin is connected to the on/off toggle switch S508.

6.11.6 P501 EXTERNAL OUTPUTS

Connector P501 contains data and control outputs to the terminal block on the back of the Repeater cabinet. These outputs are connected to other external devices.

The input and output connectors for the connector are defined as follows.

Pins 1/17 ALARM 3 OUT +/ALARM 3 OUT -

Pins 2/18 ALARM 4 OUT +/ALARM 4 OUT -

These are outputs to external devices to perform a specific function.

Pin 3 RX WBAND

Receive Wide Band Audio from the Receiver audio demodulator through the RF Interface Board. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the receiver.

Pins 4-6 UNUSED

Pin 7 EXT OUT 1

This is an external output to rear connector J1.

Pin 8 RF CLOCK

The clock will control the synthesizer chips and power control circuit when loading. This pin is a TTL input from the Controller.

Pin 9 AC FAIL IN

This input from the AC supply is used by the AC fail output to indicate that the AC has been interrupted.

Pin 10 SYN CS RX

This is the chip select pin for the main receiver synthesizer chip. This chip is the same part as used in the Exciter. A low loads the synthesizer.

Pin 11 UNUSED

Pin 12 RF MUX 1 INH

The Multiplexer-1 Inhibit (U105, pin 6) is a CMOS input from the Controller that inhibits (disables) the Multiplexer-1 output with a logic high.

Pin 13 RF MUX 2 INH

The Multiplexer-2 Inhibit (U106, pin 6) is a CMOS input from the Controller that inhibits (disables) the Multiplexer-2 output with a logic high.

Pin 14 RF MUX 3 INH

The Multiplexer-3 Inhibit (U104, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 3 Multiplexer with a logic high.

Pin 15 PC STR

The Power Control Strobe is normally low until after the power control data is shifted into the power control register. Then the strobe line goes high and back to low. The clock or data lines cannot be changed until after the strobe is set.

Pin 16 HS CS EX

This is the Exciter high stability synthesizer chip select. A low enables loading the high stability synthesizer loop. This pin is only used on high stability equipped units.

Pins 19-21 UNUSED

Pin 22 BUF RX WBAND

This is buffered Receive Wide Band Audio from the receiver audio demodulator through the RF Interface Board. The typical amplitude is 387 mV RMS (-6 dBm) and 5V DC with Standard TIA Test Modulation into the receiver. This is an output to the rear connector J1.

Pin 23 AC FAIL OUT

This is an indication that the AC power has been interrupted.

Pin 24 UNUSED

Pin 25 HS CS RX

This is the receiver high stability synthesizer chip select. A low enables loading the high stability synthesizer loop. This pin is only used on high stability equipped units.

Pin 26 SYN CS EX

Pin 26 is the exciter main Synthesizer Chip Select that allows input of data to U403 when the line is pulled to logic low.

Pin 27 UNUSED

Pin 28 A D LEVEL

20 lines (of the possible 24) of RF functions sampled are multiplexed to the Controller through this pin using three multiplex chips.

Pin 29 RF DATA A

Data A (U105, pin 11) is the least significant bit (LSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 30 RF DATA B

Data B (U105, pin 10) is the middle significant bit in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 31 RF DATA C

Data C (U105, pin 9) is the most significant bit (MSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 32 RF DATA

This is a data pin with TTL levels from the Controller which has the dual role of loading the synthesizer chips and adjusting the power control D/A lines for proper output power. Up to four synthesizer chips and a shift-register could be connected to this pin.

6.11.7 J500 A D LEVEL TEST POINT

20 lines (of the possible 24) of RF functions sampled are multiplexed to the Controller through this pin using three multiplex chips.

6.11.8 J501 GROUND

J501 is an IAC ground reference for test points.

6.11.9 J502 +15V

J502 is a voltage test point.

6.11.10 POWER SWITCH

S508 turns the power supply DC voltage on and off from the front of the IAC.

6.11.11 J505 SQUELCH ENABLE OUTPUT

P505 jumpers J505, pins 1/2 to configure the squelch enable output for an inverted output. P505 jumpers J505, pins 2/3 to configure the squelch enable output for a non-inverted output. P505 jumpers J505, pins 3/4 to configure the squelch enable output for a non-inverted output under the control of U503.

Figure 6-17 MAIN PROCESSOR CARD BLOCK DIAGRAM

Figure 6-18   MAIN AUDIO CARD LOGIC BLOCK DIAGRAM

Figure 6-19 MAIN AUDIO CARD AUDIO BLOCK DIAGRAM

Figure 6-20 INTERFACE ALARM CARD BLOCK DIAGRAM

SECTION 7 ALIGNMENT AND TEST PROCEDURES

7.1 RECEIVER ALIGNMENT

CRITICAL ADJUSTMENT

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

Refer to Figure 7-1 for component locations. Refer to Figure 7-7 for equipment needed and setup diagram. Select "RECEIVER" from the "TEST" menu in the Repeater Software.

7.1.1 PRETEST

Preset L102, L103, L104, L108, L109, L110, L140 and L141 tuning screws about 1/4 inch above the top of the casting.

For 12.5 kHz operation, place jumper plugs P203, P204 and P205 across pins 2-3 of J203, J204 and J205.

For 25 kHz operation, place jumper plugs P203, P204 and P205 across pins 1-2 of J203, J204 and J205.

7.1.2 VOLTAGE MEASUREMENTS

Apply power to the Receiver by plugging the 20-pin cable from the RF Interface Board into J201 (see Figure 7-1).

Measure the voltages at the following pins.

U301, pin 1	+6V DC ±0.2V
U302, pin 1	+12V DC ±0.4V
U303, pin 1	+12V DC ±0.4V
U304, pin 1	+12V DC ±0.4V
R402/R403 junction	+3.5V DC ±0.1V

7.1.3 PROGRAM TUNE-UP CHANNEL

For Receivers operating between:
403-427 MHz, 433-467 MHz or 473-509 MHz.

1. Using the PC and software, program the Synthesizer for the Receive frequency.

2. Tune the VCO capacitor C803 for +7V DC ±0.05V at TP401.
   Increase the receive frequency by 1 MHz. The voltage on TP401 shall be less than 10.5V.
   Decrease the receive frequency by 1 MHz. The voltage on TP401 shall be greater than 3.5V.

3. Alternately tune L140 and L141 in 1/2-turn to 1-turn increments until a voltage is measured at TP101. At that time, tune L140 for a peak, then L141 for a peak.

4. Retune L140/L141 for a peak at TP101.

For Receivers operating within 3 MHz of the top of the receive band (427-430, 467-470 or 509-512 MHz).

1. Program the Synthesizer for the *Highest* receive frequency (i.e. 430, 470 or 512 MHz).

2. Set the control line voltage for 12V at TP401. Check 3 MHz *below* the programmed frequency (i.e. 427, 467 or 509 MHz) to verify that the control voltage at TP401 is *greater than* 2V. The repeater receiver can now be programmed for the desired operating frequency.

For Receivers operating within 3 MHz of the bottom of the receive band (400-403, 430-433 or 470-473 MHz).

1. Program the Synthesizer for the *Lowest* receive frequency (i.e. 400, 430 or 470 MHz).

2. Set the control line voltage for 2V at TP401. Check 3 MHz *above* the programmed frequency (i.e. 403, 433 or 473 MHz) to verify that the control voltage at TP401 is *less than* 12V. The repeater receiver can now be programmed for the desired operating frequency.

NOTE: The Channel Frequency and Synthesizer Frequency appear at the bottom of the screen.

7.1.4 RECEIVER FREQUENCY ADJUST

1. Place a pick-up loop (sniffer) or RF probe connected to a frequency counter near L139.

2. Set Y401 (TCXO) for the Injection Frequency ±50 Hz (Inj Freq = chnl freq + 52.95 MHz).

7.1.5 VCO TEST

1. The software programs the synthesizer for 1 MHz above the receive channel.

2. The voltage on TP401 should be < 10V.

3. Record the voltage on TP101 __________.

4. The software programs the synthesizer for 1 MHz below the receive channel.

5. The voltage on TP401 should be > 4V.

6. Record the voltage on TP101 __________.

7. If the voltages recorded in Steps 3 and 6 are not within ±0.2V, tune L141 as required to balance the voltage readings.

8. The software programs the synthesizer for the receive frequency.

7.1.6 FRONT END ADJUSTMENTS

NOTE: Verify that the appropriate IF jumpers (J203, J204, J205) are selected.

1. Set the signal generator to the receive frequency at a level sufficient to produce an output voltage at TP201 or J201, pin 7 (RSSI Output).

2. Tune L102, L103, L104, L108, L109 and L110, then repeat, for a peak voltage at TP201. Decrease the generator output level to maintain a 2-3V reading at TP201.

FOR 12.5 kHz CHANNELS:

NOTE: Perform this test if C239 and C249 are placed on the board.

1. Set the generator to an RF level sufficient to produce 2V DC at TP201.

2. Remove any modulation from the signal generator.

3. Increase the signal generator RF frequency 2.5 kHz.

4. Adjust C239 for peak DC voltage at TP201.

5. Adjust C249 for peak DC voltage at TP201.

6. Reset the signal generator to the tune-up frequency.

7. Set the signal generator to 100 µV into the receiver with a 1 kHz tone at ±1.5 kHz deviation.
   (1000 µV at the generator with 20 dB pad gives 100 µV at the receive antenna.)

8. Tune Z215 for 2V ±0.05V at U203, pin 9.

9. Tune R253 for 387 mV RMS, ±5 mV RMS, at TP202.

10. Adjust R248 for 2V ±0.05V at TP202.

11. Connect a distortion analyzer to TP202.

12. Tune L211, L213, L214 and L216 for minimum distortion <5%, (typically <3%).

13. Repeat Step 12 then Steps 8, 9 and 10.

7.1.7 AUDIO DISTORTION

1. Plug a 16 ohm load at J101 or J104 on the MAC (Main Audio Card).

2. Connect a distortion analyzer to the 16 ohm load.

3. Measure the distortion of the receive audio at J101 or J104 on the MAC with the local volume control set to 2.8V RMS.

4. The reading shall be less than 3%.
   (Typically less than 1%.)

5. Measure receive sensitivity at J101 or J104 on the MAC.

6. The reading should be less than 0.35 µV.
   (Typically 0.25 µV.)

7. The software programs the synthesizer for 1 MHz above the Receive frequency.

8. Receive sensitivity should be less than 0.35 µV. (Typically less than 0.30 µV.)

9. The software programs the synthesizer for 1 MHz below the Receive frequency.

10. Receive sensitivity should be less than 0.35 µV. (Typically less than 0.30 µV.)

11. Adjust the signal generator level to produce 15 dB SINAD.

12. Adjust R221 for 0.5V ±0.02V at TP201.

FOR 25 kHz CHANNELS:

NOTE: Perform this test if C204 and C214 are placed on the board.

1. Set the generator to an RF level sufficient to produce 2V DC at TP201.

2. Remove any modulation from the signal generator.

3. Increase the signal generator RF frequency 5 kHz.

4. Adjust C204 for peak DC voltage at TP201.

5. Adjust C249 for peak DC voltage at TP201.

6. Reset the signal generator to the tune-up frequency.

7. Set the generator to 100 µV into the receiver with a 1 kHz tone at ±3 kHz deviation.
(1000 µV at the generator with 20 dB pad gives 100 µV at the receive antenna.)

8. Tune Z205 for 2V ±0.05V at U201, pin 9.

9. Tune R220 for 387 mV RMS, ±5 mV RMS, at TP202.

10. Adjust R216 for 2V ±0.05V at TP202.

11. Connect a distortion analyzer to TP202.

12. Tune L201, L203, L204 and L206 for minimum distortion <5%, (typically <3%).

13. Repeat Step 12 then Steps 8, 9 and 10.

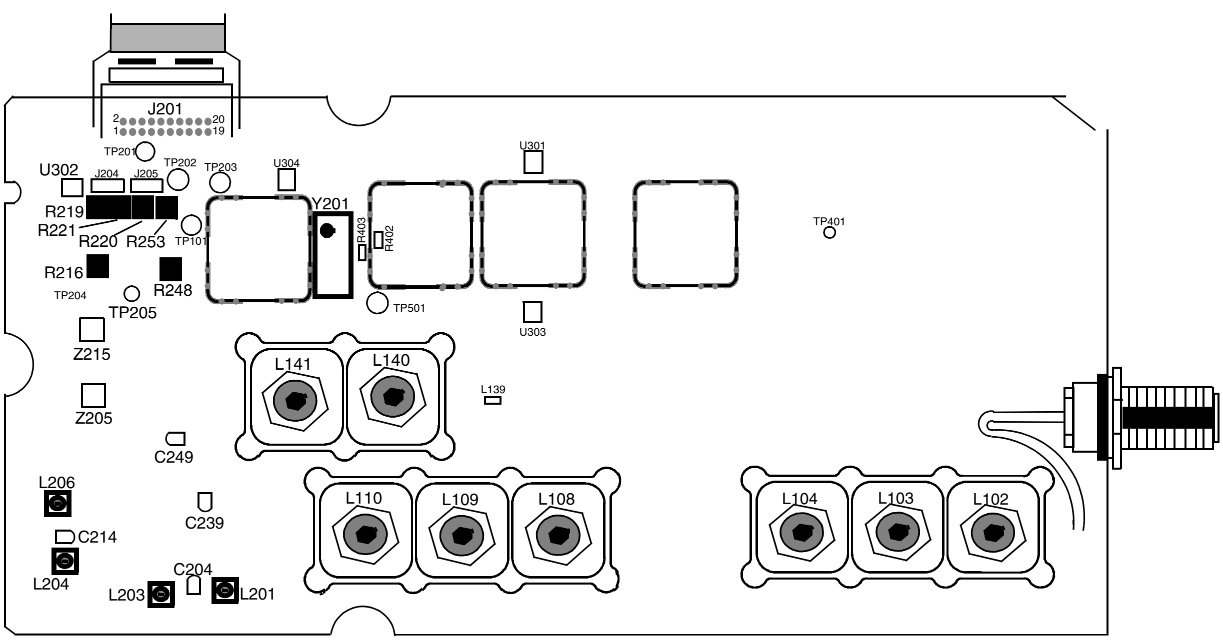


Figure 7-1 RECEIVER ALIGNMENT POINTS

7.1.8 AUDIO DISTORTION

1. Plug a 16 ohm load at J101 or J104 on the MAC (Main Audio Card).
2. Connect a distortion analyzer to the 16 ohm load.
3. Measure the distortion of the receive audio at J101 or J104 on the MAC with the local volume control set to 2.8V RMS.
4. The reading shall be less than 3%. (Typically less than 1%.)
5. Measure receive sensitivity at J101 or J104 on the MAC.
6. The reading should be less than 0.35 µV. (Typically 0.25 µV.)
7. The software programs the synthesizer for 1 MHz above the Receive frequency.
8. Receive sensitivity should be less than 0.35 µV. (Typically less than 0.30 µV.)
9. The software programs the synthesizer for 1 MHz below the Receive frequency.
10. Receive sensitivity should be less than 0.35 µV. (Typically less than 0.30 µV.)
11. Adjust the signal generator level to produce 15 dB SINAD.
12. Adjust R219 for 0.5V ±0.02V at TP201.

7.2 EXCITER ALIGNMENT

CRITICAL ADJUSTMENT

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

Refer to Figure 7-2 for component locations and Figure 7-8 for equipment needed and setup diagram.

WARNING

SAFETY MEASURES ARE DISABLED IN TEST MODE. ALARMS ARE ACTIVE. HOWEVER, FEATURES SUCH AS THERMAL SHUTDOWN IN THE PA ARE DISABLED.

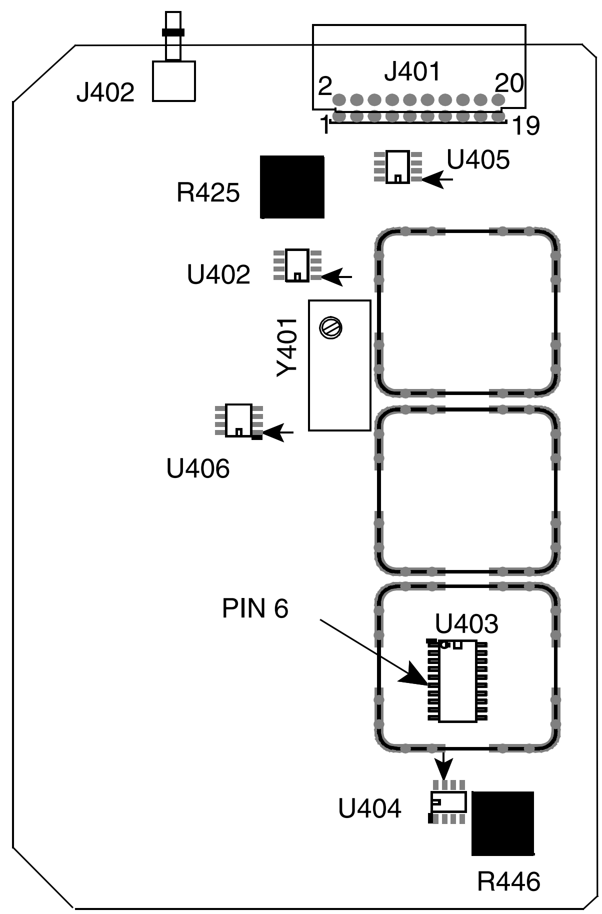


Figure 7-2 EXCITER ALIGNMENT POINTS

7.2.1 PRETEST

1. Set TCXO modulation adjust R425 fully counterclockwise.
2. Connect the power meter to J402.

7.2.2 VOLTAGE MEASUREMENTS

Apply power to the Exciter by plugging the 20-pin cable from the RF Interface Board into J401.

Measure the voltages at the following pins.

U406, pin 1	+12V DC ±0.4V
U405, pin 1	+5V DC ±0.2V
U402, pin 1	+3.5V DC ±0.1V
U404, pin 7	+3.5V DC ±0.1V

7.2.3 PROGRAM TUNE-UP CHANNEL

For Exciters operating between:
406-424 MHz, 436-464 MHz or 476-506 MHz.

1. Using the PC and software, program the Synthesizer for the Transmit frequency.

2. Use the "Turn on carrier" button to key the Exciter.

3. Tune the VCO capacitor C803 for +4.5V DC ±0.05V at TP1 (U403, pin 6).
   Increase the transmit frequency by 3 MHz. The voltage on TP1 shall be less than 7.5V.
   Decrease the transmit frequency by 3 MHz. The voltage on TP401 shall be greater than 2V.

4. Measure the Power Output of the Exciter at J402. Reading should be > +18 dBm.

5. Use the "Turn on carrier" button to unkey the Exciter.

For Transmitters operating within 6 MHz of the top of the transmit band (424-430, 464-470 or 506-512 MHz).

1. Program the Synthesizer for the *Highest* transmit frequency (i.e. 430, 470 or 512 MHz).

2. Use the "Turn on carrier" button to key the Exciter.

3. Set the control line voltage for 7.5V at TP1.
   Check 6 MHz *below* the programmed frequency (i.e. 424, 464 or 506 MHz) to verify that the control voltage at TP1 is *greater than* 2V. The repeater receiver can now be programmed for the desired operating frequency.

4. Use the "Turn on carrier" button to unkey the Exciter.

For Transmitters operating within 6 MHz of the bottom of the transmit band (400-406, 430-436 or 470-476 MHz).

1. Program the Synthesizer for the *Lowest* transmit frequency (i.e. 400, 430 or 470 MHz).

2. Set the control line voltage for 2V at TP1.
   Check 6 MHz *above* the programmed frequency (i.e. 406, 436 or 476 MHz) to verify that the control voltage at TP1 is *less than* 7.5V. The repeater receiver can now be programmed for the desired operating frequency.

7.2.4 VCO TEST

1. The software programs the synthesizer for 3 MHz above the Tune-Up frequency.

2. Use the "Turn on carrier" button to key the Exciter.

3. The voltage on U403, pin 6 should be < 7V.
   Power output should be > +18 dBm.

4. Use the "Turn on carrier" button to unkey the Exciter.

5. The software programs the synthesizer for 3 MHz below the Tune-Up frequency.

6. Use the "Turn on carrier" button to key the Exciter.

7. The voltage on U403, pin 6 should be > 2.5V.
   Power output should be > +18 dBm.

8. Use the "Turn on carrier" button to unkey the Exciter.

9. The software programs the synthesizer for the Transmit Channel.

7.2.5 TCXO FREQUENCY ADJUST

1. Connect a 10 dB pad and frequency counter to J402.

2. Use the "Turn on carrier" button to key the Exciter.

3. Tune TCXO Y401 for the Transmit Channel Frequency, ± 50 Hz.

4. Use the "Turn on carrier" button to unkey the Exciter.

7.2.6 TRANSMIT MODULATION ADJUST

1. Connect a 10 dB pad and modulation analyzer to J402.

2. Press the "FM" and "3 kHz LPF" switches of the modulation analyzer.

3. Inject a 1 kHz sine wave at 400 mV RMS into P100, pin 32 on the MAC.

4. Adjust U149 with "Up/Dn" and "PgUp/PgDn" keys for 707 mV RMS on P100, pin 29. This waveform should be a "clean" sine wave.

   NOTE: This test changes the Tx audio deviation limit. To correct the limit, perform adjustment per Section 7.4.6.

5. Use the "Turn on carrier" button to key the Exciter.

6. Set R446 for ±3 kHz deviation (25 kHz channels) or ±1.5 kHz deviation (12.5 kHz channels).

7. Use the "Turn on carrier" button to unkey the Exciter.

8. Adjust U151 with "Up/Dn" and "PgUp/PgDn" keys for a 2V P-P square wave on P100, pin 29.

   NOTE: This test changes the Tx audio deviation limit. To correct the limit, perform adjustment per Section 7.4.6.

9. Use the "Turn on carrier" button to key the Exciter.

10. Set R425 for "best" square wave as observed on the modulation analyzer output to the oscilloscope.

NOTE: Ensure that the oscilloscope is "DC" coupled and the Modulation Analyzer has the 3 kHz LPF switch set but NOT the 300 Hz HPF or 50 Hz HPF switches set.

11. Use the "Turn on carrier" button to unkey the Exciter.

12. Connect a 10 dB pad and modulation analyzer to J402.

13. Press the "FM" and 3 kHz LPF switches of the modulation analyzer.

14. Inject a 1 kHz sine wave with a level of 400 mV RMS into P100, pin 32.

15. Adjust U149 for 707 mV RMS on P100, pin 29. This waveform should be a clean sine wave.

16. Press the spacebar to key the Exciter.

17. Repeat Step 6.

18. Press the spacebar to unkey the Exciter.

7.3 110W POWER AMPLIFIER ALIGNMENT

7.3.1 INTRODUCTION

Refer to Figures 7-4 and 7-5 for component locations. Refer to Figure 7-9 for equipment needed and setup diagram. Select "PA" from the "TEST" menu in the Repeater Software.

IMPORTANT NOTE

No field alignment is required. Adjustments in Sections 7.3.2 and 7.3.3 are part of a new unit production test procedure. They should only be performed as required on "out-of-warranty" and "field-repaired" units. Broken seals on R76, R611 or R661 will void the warranty! Full power control range of 25-110W is controlled by the repeater configuration parameters under the Edit-Setup Parameters menu selection.

The adjustments in Section *7.3.2* provide for proper matching for the output of Q501 and set a protective limit on the drive to the final transistors. This limit is approached only under certain unusual operating or repair conditions. However, improper adjustment may impair normal operation of the PA, especially at temperature extremes.

No other adjustments are necessary in this case. Replacement of U501, Q801, Q502 or Q503 requires adjustments shown in Section Figure 7.3.3 Replacement of active components within the power control circuitry of the RF Interface Board would require Section 7.3.3 adjustments.

These adjustments are necessary only if repairs are made and such repairs are likely to affect the sensitivity/calibration of the forward or reverse power detectors (e.g. replacement of detector diodes CR601/CR651 or of the entire forward/reverse power detector assembly). Replacement of components within the power control circuitry of the RF Interface Board are unlikely to affect the calibration of the power control.

*NOTE: Replacement of Q501, Q502, Q503 or U501 does **not** require the adjustments in this Section.*

7.3.2 DRIVER TUNING AND LIMIT ADJUSTMENTS

1. Connect an antenna or dummy load to the RF port (50 ohm impedance).

2. Connect the:
   Power supply ground lead to P105
   +15V DC lead to P103
   +26.5V DC lead to P101
   36-pin cable to J101 on the RFIB

3. Set the signal generator to +19 dBm ±0.1 dB. Connect the signal generator to A9.

4. Use the "Turn on carrier" button to key the PA.

5. Monitor the voltage on R45 on the RFIBand set R76 for 1.3V DC (see Figure 7-5).

7.3.3 POWER AMPLIFIER TUNING

This procedure assumes that either:

- The carrier is chosen and the coaxial cable from the exciter is putting out +19 dBm

OR

- A test signal is being injected to the PA with +19 dBm.

Connect an antenna or dummy load to the RF port (50 ohm impedance).

400-430 MHz use 415 MHz 110W
430-470 MHz use 460 MHz 110W
470-512 MHz use 490 MHz 100W

1. Set R510, R521 and R530 on the PA board full **clockwise** before applying power to the PA (or PA deck and RFIB assembly), see Figure 7.3.

2. Set Forward Power Adjust R611 and Reflected Power Adjust R661 on the power detector board fully **counterclockwise** (see Figure 7.3).

3. Monitor the voltage on R45 on the RFIBand set R76 for 1.3V DC (see Figure 7-5). This sets the current limit point for driver Q501 at hot temperatures.

4. Set each of the quiescent currents for Q501, Q502 and Q503 for 100 mA (DC) each.

5. Program the power output as follows:

   400-430 MHz 110W
   430-470 MHz 110W
   470-512 MHz 100W

6. Use the "Turn on carrier" button to key the PA. Output power will be approximetly 80W.

7. Monitor the voltage on U501, pin 2 (power control voltage) and tune C600 for **minimum** voltage (see Figure 7.3).

8. Set Forward Power Adjust R611 for rated power (110W or 100W).

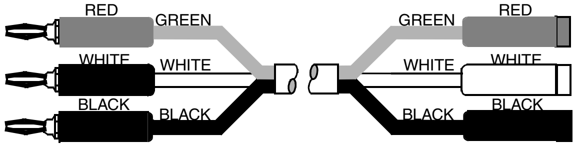
9. Use the "Turn on carrier" button to unkey the PA.

10. Disconnect the antenna or dummy load from the RF port.

11. Use the "Turn on carrier" button to key the PA. *NOTE: This will not harm the PA.*

12. Adjust Reverse Power Calibration Pot R661 for equal voltages on W121 and W126 on the RFIB or for equal Forward and Reverse Power (see Figure 7-5).

13. Use the "Turn on carrier" button to unkey the PA.



(INCLUDED IN 2000 SERIES SERVICE KIT 250-2000-230)

Figure 7-3 POWER EXTENDER CABLES

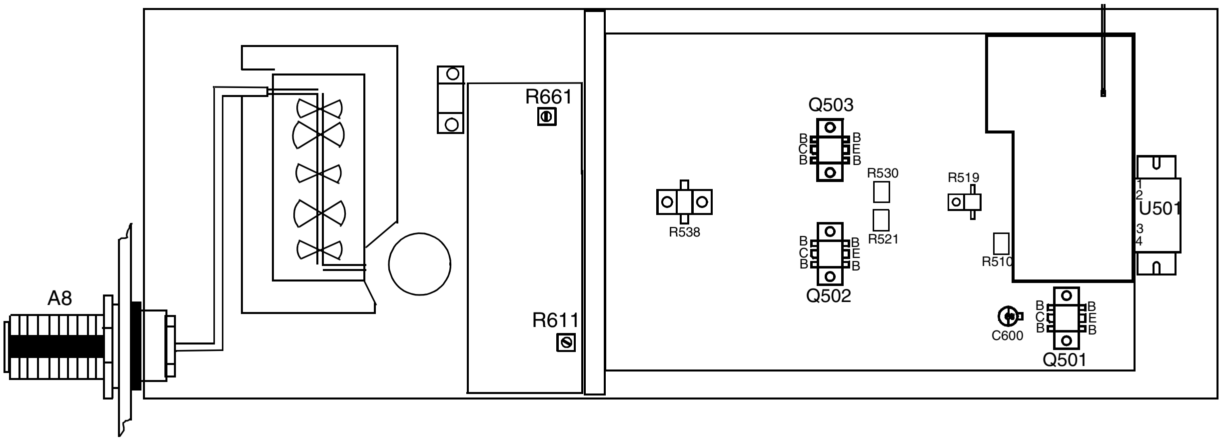


Figure 7-4   110W POWER AMPLIFIER ALIGNMENT POINTS

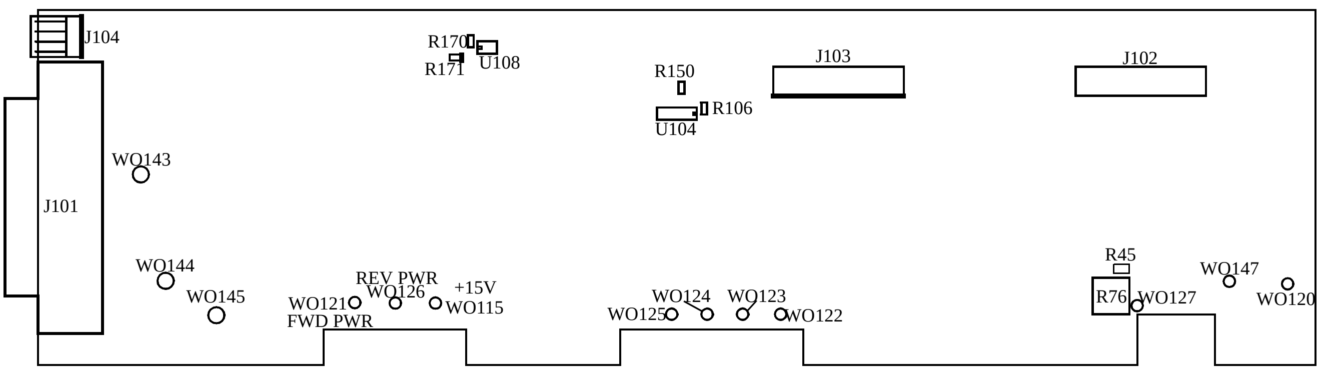


Figure 7-5   RF INTERFACE BOARD ALIGNMENT POINTS

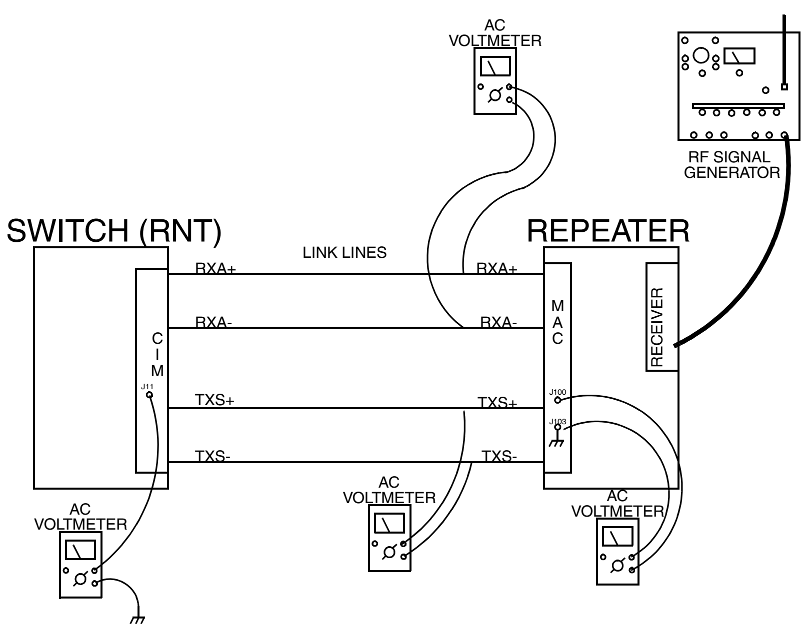


Figure 7-6   REPEATER TO CIM TEST SETUP

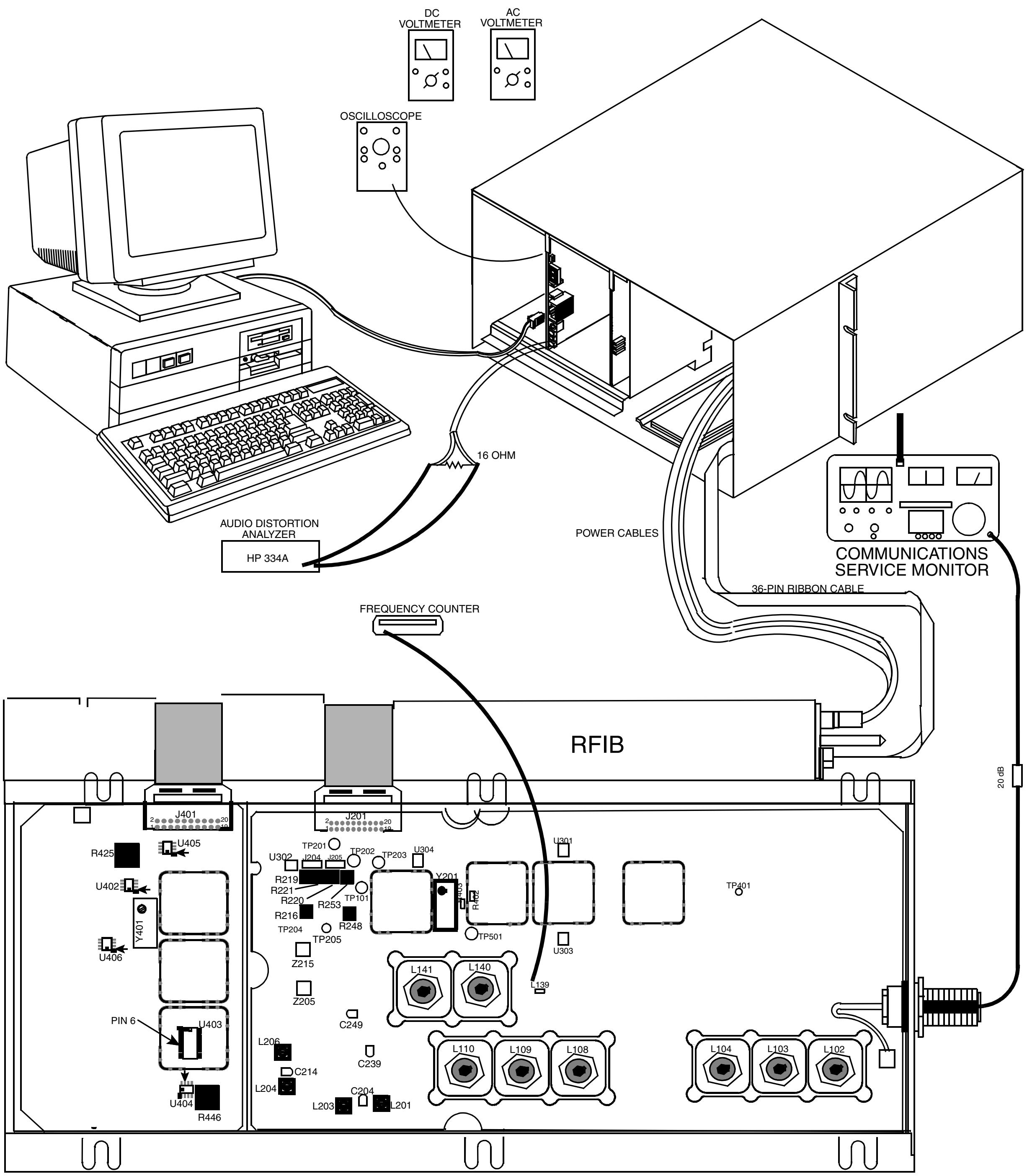


Figure 7-7   RECEIVER TEST SETUP

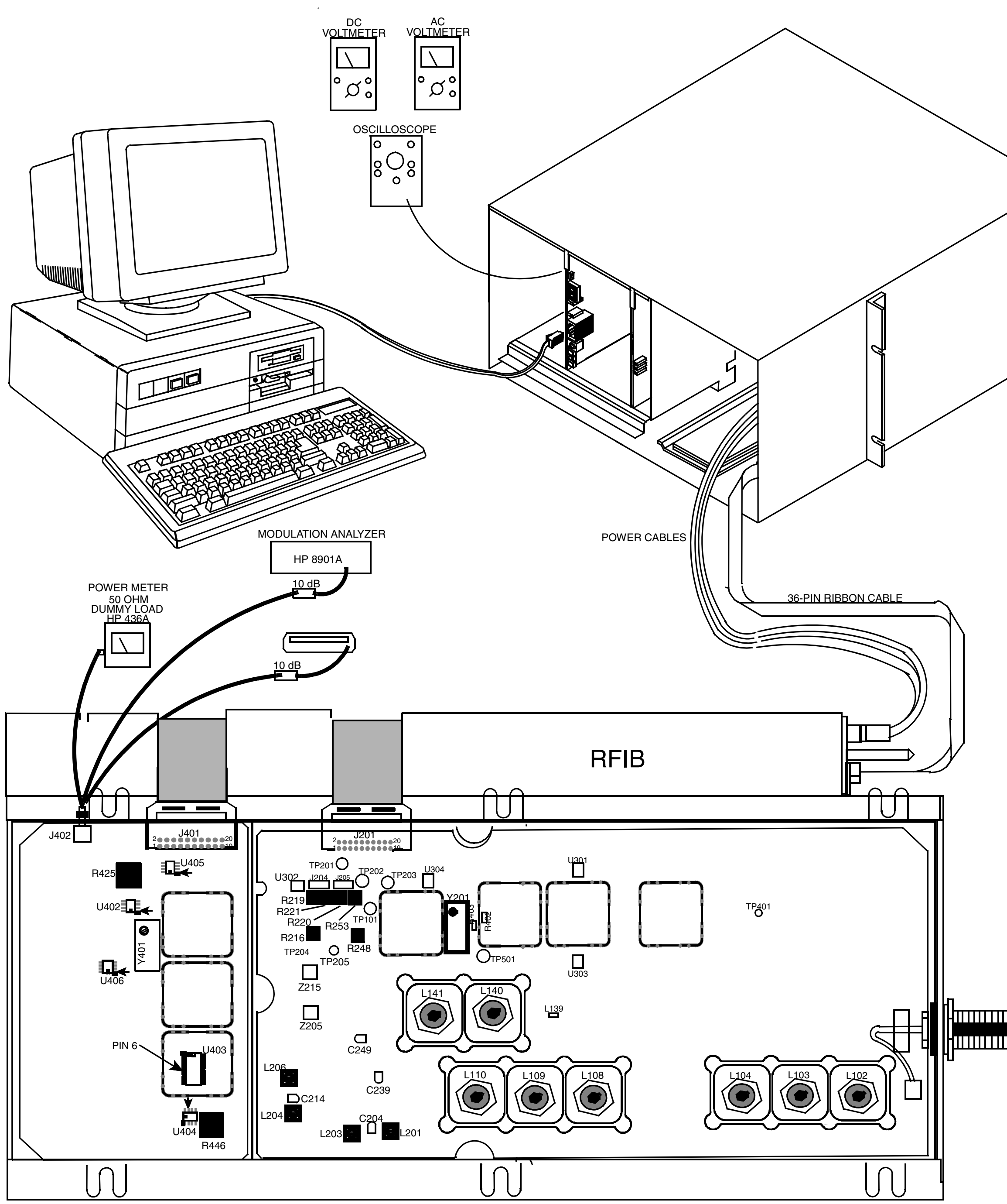


Figure 7-8 EXCITER TEST SETUP

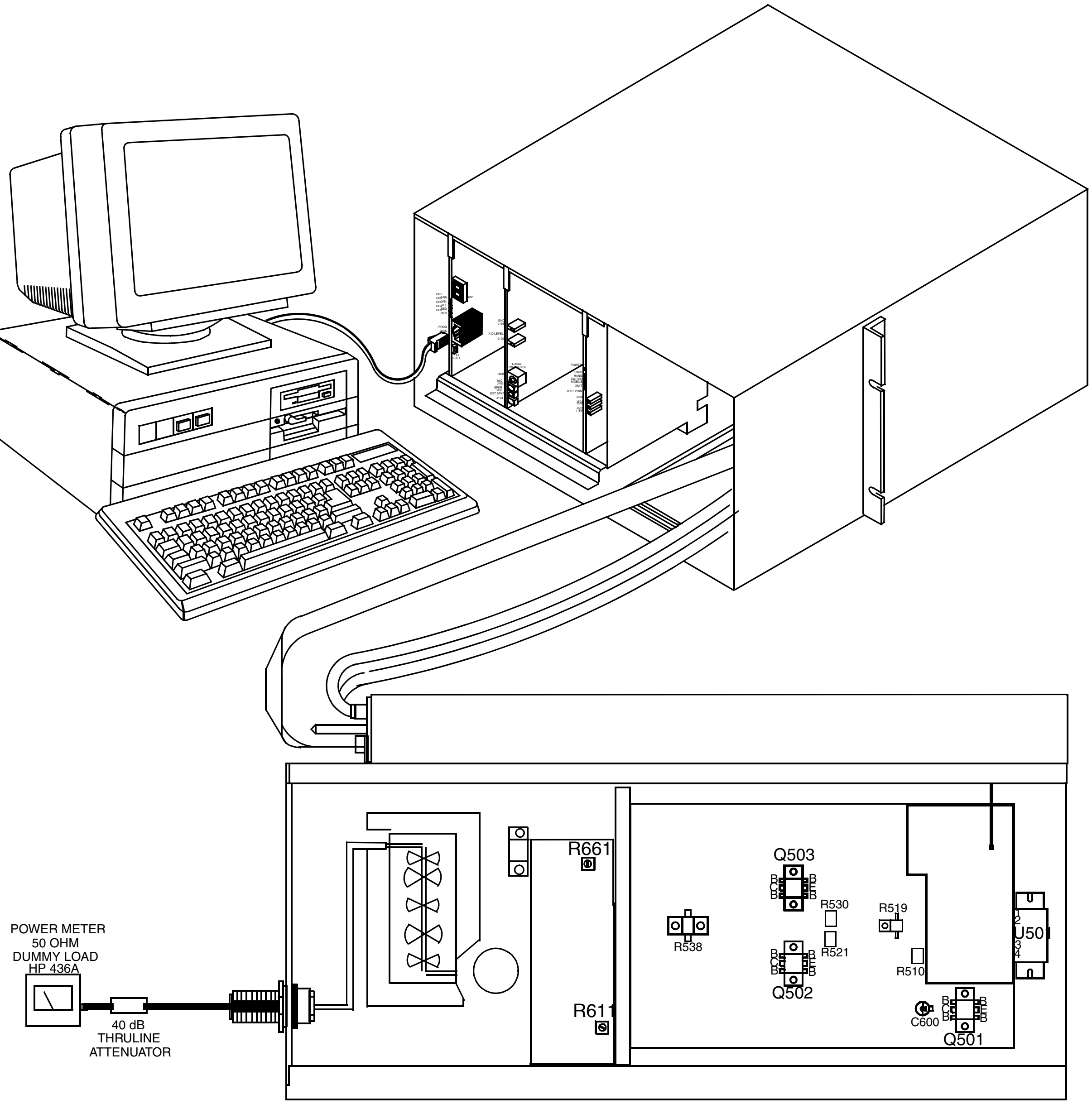


Figure 7-9   110W POWER AMPLIFIER TEST SETUP

7.4 FULL REPEATER ALIGNMENT

7.4.1 PERFORMANCE TEST PROGRAM

1. Select the TEST - FULL REPEATER - ALL TEST and press Enter.

7.4.2 REPEATER SETUP

The VIKING VX repeater has been pretested at the factory, therefore only performance tests are required to check the repeater. Refer to test setup diagrams for equipment and cabling diagram.

Turn on the repeater power supply switch (S508) in the IAC or engage the locking lever (see Figure 7-25).

The baud rate for communications between the Universal Station and the PC Programmer is user configurable using J3 on the MPC. The factory default is 9600 baud.

The operating code has been programmed at the factory. The parameters are programmed into the MPC. If these parameters have changed or are incorrect, exit this test and reprogram the repeater.

It may be necessary to remove the RF assembly from the chassis and connect via extension cables for some of the tests or adjustments.

NOTE: All audio generators and audio voltmeters are unbalanced unless specifically stated otherwise. All references to J2 refer to the green connector on the back of the repeater.

7.4.3 TRANSMITTER TEST/ADJUSTMENTS

<u>Transmit Mode</u>

1. Use the "Turn on carrier" button to key the repeater.
2. The Transmit LED on the IAC should turn on to indicate the repeater is transmitting (see Figure 7-25).
3. Use the "Turn on carrier" button to unkey the repeater.

<u>Transmit TCXO Frequency Adjustment</u>

CRITICAL ADJUSTMENT

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

1. Use the "Turn on carrier" button to key the repeater.
2. Check the frequency of the transmitted signal. The frequency should be ±50 Hz of the channel frequency.
3. Adjust the frequency with Y401 (TCXO) on the Exciter (see Section 7.2.5).
4. Use the "Turn on carrier" button to unkey the repeater.

<u>Transmitter Output Power Adjustment</u>

1. Use the "Turn on carrier" button to key the repeater.
2. Check the transmit output power. The power can be adjusted from the computer using the Power Control Indicator. The test equipment should be calibrated for ±2W.
3. Use the "Turn on carrier" button to unkey the repeater.
4. Use a jumper wire to ground pin 7 (PTT_N) to pin 21 (GND) on J2 on the back of the cabinet (see Figure 7-12). The transmitter should key up and achieve rated power.
5. Remove the wire. The transmitter should unkey.

7.4.4 RECEIVER TESTS/ADJUSTMENT

NOTE: Jumper J103 selects between a 12.5 kHz IF and a 25 kHz IF.

NOTE: If this is a voting repeater, it is not equipped with a receiver.

Receiver TCXO Frequency Adjustment

CRITICAL ADJUSTMENT

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

1. Check the receiver injection frequency by using a "sniffer" pickup loop, or RF probe connected to a suitable frequency counter placed near L139 in the Receiver (see Section 7.1.4).

2. Adjust Y201 (TCXO) on the Receiver to within ±50 Hz of the channel frequency + 52.95 MHz.

Receiver Audio Distortion Measurement

1. Adjust the RF generator for 100 µV into the Receiver with a modulation tone of 1 kHz at ±3 kHz deviation (25 kHz channels) or ±1.5 kHz deviation (12.5 kHz channels).

2. **On the MAC**, insert test cables into J100/J103 and connect to an AC voltmeter.

3. Adjust R237 for 0 dBm (775 mV RMS).

4. **On the MAC**, connect a 16 ohm load and distortion analyzer to J101 or J104.

5. Adjust R236 for 2.8V RMS and measure the distortion. Distortion should be < 3%.

Receiver Hum and Noise Measurement

1. Adjust the RF generator for 100 µV into the Receiver with a modulation tone of 1 kHz at ±3 kHz deviation (25 kHz channels) or ±1.5 kHz deviation (12.5 kHz channels).

2. **On the MAC**, connect a 16 ohm load and distortion analyzer to J101 or J104.

3. Adjust R236 for 2.8V RMS.

4. Remove modulation from the RF generator. The measured level must be ≤ -50 dB.

Receiver SINAD Measurement

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz deviation (25 kHz channels) or ±1.5 kHz (12.5 kHz channels).

2. **On the MAC**, connect a 16 ohm load and distortion analyzer to J101 or J104.

3. Adjust R236 for 2.8V RMS.

4. Re-adjust RF level for 12 dB SINAD.
   12 dB SINAD reading should be ≤ 0.35 µV.

Receiver Squelch Adjustment

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz (25 kHz channels) or ±1.5 kHz deviation (12.5 kHz channels).

2. **On the MAC**, connect a 16 ohm load and distortion analyzer to J101 or J104.

3. Adjust R236 for 2.8V RMS.

4. Set the RF generator output for 5 dB SINAD.

5. **On the MAC**, adjust R234 so the Receiver just squelches.

6. Increase the RF generator output until the Receiver unsquelches. Reading should be ≤ 10 dB SINAD.

Receiver Data Level Adjustment

1. Adjust the RF generator for 100 µV into the receiver with a 100 Hz tone at ±1 kHz (25 kHz channels) or ±800 Hz deviation (12.5 kHz channels).

2. **On the MAC**, insert test cables into J100/J103 and connect to an AC voltmeter.

3. Adjust R235 to achieve 340 mV RMS.

Local Speaker/Microphone Check

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz deviation (25 kHz channels) or ±1.5 kHz (12.5 kHz channels).

2. **On the MAC**, plug a Speaker/Microphone into J101/J102.

3. Adjust R236 until the 1 kHz tone is heard.

Receiver Desense Check

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz deviation (25 kHz channels) or ±1.5 kHz (12.5 kHz channels).

2. **On the MAC**, connect a 16 ohm load and distortion analyzer to J101 or J104.

3. Adjust R236 for 2.8V RMS.

4. Re-adjust the RF generator output for 12 dB SINAD.

5. Use the "Turn on carrier" button to key the transmitter.

6. SINAD should not degrade more than 1 dB or to no less than 11 dB SINAD.

7. Use the "Turn on carrier" button to unkey the transmitter.

Receiver Miscellaneous Tests (Optional)

Several additional tests may be performed on the Repeater Receiver as listed below:

- Signal Displacement Bandwidth
- Adjacent Channel Rejection
- Offset Channel Selectivity
- Intermodulation Rejection
- Spurious Rejection
- Audio Response
- Audio Sensitivity

Perform the Test desired using the appropriate RF Generators, modulation frequencies and levels, RS-232 levels and test probes following the latest TIA document measurement procedures.

7.4.5 RECEIVER RSSI ADJUSTMENT

NOTE: Use this procedure only when an audio analyzer is available.

1. Adjust the RF generator for 0.29 µV into the receiver with a modulation tone of 1 kHz at ±3 kHz deviation.

2. In the Receiver, adjust R261 for 0.8V DC (±0.02V) at TP3.

7.4.6 TRANSMIT AUDIO/DATA LEVEL ADJUSTMENTS

NOTE: All audio generators and audio voltmeters are ***unbalanced*** *unless specifically stated otherwise.*

Audio Deviation Limit Adjustment

1. **On the MAC**, apply a 1 kHz tone at -3 dBm (548 mV RMS) to P100, pin 32.

2. Insert test cables into J100/J103 and connect to an AC voltmeter.

3. Use the "Turn on carrier" button to key the transmitter.

4. Adjust R305 for 0 dBm (775 mV RMS).

5. Use the "Turn on carrier" button to unkey the transmitter.

6. **On the MAC**, apply a 1 kHz tone at +7 dBm (1.73V RMS) to P100, pin 32. (Set modulation analyzer LPF to 3 kHz.)

7. Use the "Turn on carrier" button to key the transmitter.

8. Adjust U149 with the Level Control buttons to set the maximum allowed deviation at ±3.5 kHz deviation (25 kHz channels) or ±1.6 kHz (12.5 kHz channels).

9. Use the "Turn on carrier" button to unkey the transmitter.

10. Remove the signal from P100, pin 32.

Repeat Audio Level Adjustment

NOTE: Audio Deviation Limit Adjustment must be completed before this test.

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±1.5 kHz deviation (25 kHz channels) or ±800 Hz (12.5 kHz channels). Be sure the Modulation Analyzer LPF switch is set to 3 kHz.

2. Use the "Turn on carrier" button to key the transmitter.

3. **On the MAC**, adjust R237 to achieve ±1.5 kHz (±100 Hz) transmit deviation (25 kHz channels) or ±800 Hz (12.5 kHz channels). Be sure the modulation analyzer LPF switch is set to 3 kHz.

4. Use the "Turn on carrier" button to unkey the transmitter.

5. Connect an AC voltmeter to J103 and P100, pin 31 (RX_VOICE).

6. Adjust R238 for -3 dBm (548 mV RMS).

7. Remove the RF generator from the Receiver.

Data Level Adjustment

1. Remove VNC cards if present.
   Set modulation analyzer LPF to 3 kHz.
   Use the "Turn on carrier" button to key the transmitter.

2. Adjust U151 with the Level Control buttons to achieve ±1 kHz (±100 Hz) transmit deviation (25 kHz channels) or ±800 Hz (12.5 kHz channels).

3. Use the "Turn on carrier" button to unkey the transmitter.

Audio/Data Deviation Check

1. **On the MAC**, apply a 1 kHz tone at +7 dBm (1.73V RMS) to P100, pin 32. Set modulation analyzer LPF to 3 kHz.

2. Use the "Turn on carrier" button to key the transmitter.

3. Measured deviation should be ±4.5 kHz (±200 Hz) (25 kHz channels) or ±2.4 kHz (±100 Hz) (12.5 kHz channels).

4. Use the "Turn on carrier" button to unkey the transmitter.

   Disconnect all cables.

CWID Level Check

1. Set modulation analyzer LPF switch to 3 kHz.
   Use the "Turn on carrier" button to key the transmitter.

2. Deviation should be 1.5 kHz to 2.5 kHz (25 kHz channels) or ±0.750 kHz to 1.75 kHz (12.5 kHz channels).

3. Use the "Turn on carrier" button to unkey the transmitter.

Local Speaker/Microphone Check

1. **On the MAC**, plug a Speaker/Microphone into J101/J102. Set modulation analyzer LPF switch to 3 kHz.

2. Use the "Turn on carrier" button to key the transmitter.

3. Press the microphone PTT and say "four" loudly into the microphone.

4. Deviation should measure ±3 to ±3.5 kHz (25 kHz channels) or ±0.75 kHz to 1.6 kHz (12.5 kHz channels).

5. Release the microphone PTT.

6. Use the "Turn on carrier" button to unkey the transmitter.

Transmitter Hum and Noise Ratio (Optional)

NOTE: An HP8901A modulation analyzer is required for this test.

1. On the modulation analyzer press:

   300 Hz HPF
   3000 Hz LPF
   FM
   Pre-Display
   750 µS
   Avg RMS Cal
   .44 (25 kHz channels)
   .22 (12.5 kHz channels)
   dB

2. Use the "Turn on carrier" button to key the transmitter and measure the Hum and Noise Ratio. The reading should be less than -50 dB (12.5 kHz) or -55 dB (25 kHz).

3. Use the "Turn on carrier" button to unkey the transmitter.

Transmit Audio Distortion

1. On the modulation analyzer press:

   FM
   50 Hz
   15 kHz

2. **On the MAC**, apply -11.7 dBm at 1 kHz to P100, pin 32.

3. Use the "Turn on carrier" button to key the transmitter.

4. Adjust audio level to produce ±1 kHz deviation (25 kHz) or ±0.5 kHz (12.5 kHz deviation).

5. On the modulation analyzer select:

   300 Hz
   3 kHz
   750 µs de-emphasis

6. Distortion is < 2%.

LTR Modem Repeat Audio Level Adjust

NOTE: Valid only with LTR modem option.

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±1.5 kHz deviation (25 kHz channels) ±800 Hz (12.5 kHz channels). Be sure the Modulation Analyzer LPF switch is set to 3 kHz.

2. Use the "Turn on carrier" button to key the transmitter.

3. Adjust R305 for ±1.5 kHz ±100 Hz deviation (25 kHz channels) or 800 Hz (12.5 kHz channels) out of the Transmitter.

4. Use the "Turn on carrier" button to unkey the transmitter.

7.4.7 AUDIO/DATA LEVEL ADJUSTMENTS

NOTE: Section 7.4.6 must be completed before any of the following adjustments can be made.

NOTE: All audio generators and audio voltmeters are unbalanced unless specifically stated otherwise.

Voice Audio From Repeater

1. **On the MAC**, set S100 and S101, all Sections OFF.

2. Adjust the RF generator for 100 µV modulated with a 1 kHz tone at ±1.5 kHz deviation.

3. Connect a balanced AC voltmeter with a 600 ohm input impedance between balanced lines RXA+ and RXA- on J2, located on the back of the Repeater.

4. **On the MAC**, adjust R239 for the type of line used.

   Leased Line/Direct Connect (default)
      -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
      -28 dBm (31 mV RMS)

Voice Audio To Repeater

1. Set MAC S100 and S101, all Sections OFF (see Figure 7-10).

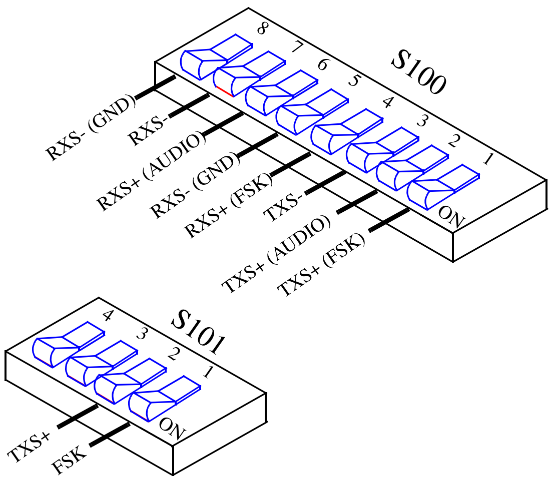


Figure 7-10 S100 SETTING

2. Inject a 1 kHz tone from a balanced 600 ohm source, at the level determined by the type of line used, into TXA+ and TXA- of J2 located on the back of the Repeater (see Figure 7-17).

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

3. Adjust R243 on the MAC to obtain -6 dBm (387 mV RMS) measured at J100/J103.

FSK Data Level Adjustment To Repeater
Separate Data Path (4-Wire) Optional Setting.

1. **On the MAC**, set S100 Sections 1, 4, 5, 8 OFF; 2, 3, 6, 7 ON; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-11).

2. Inject a 1.2 kHz tone from a **balanced** 600 ohm source, at the level determined by the type of line used, into TXS+ and TXS- of J2 located on the back of the Repeater (see Figure 7-12).

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

3. Adjust R242 on the MAC to obtain -10 dBm (245 mV RMS) measured at J100/J103.

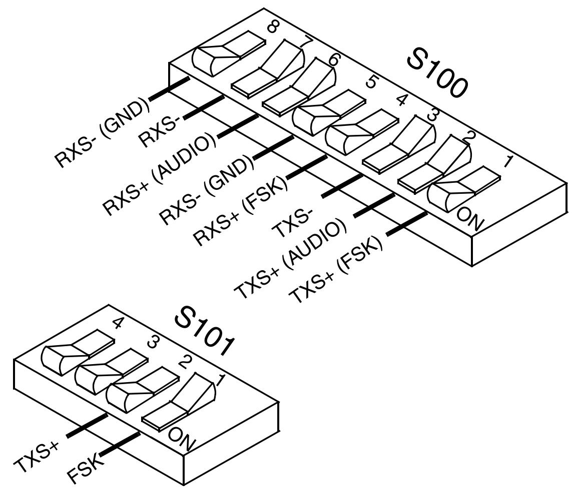


Figure 7-11 S100/S101 SWITCH SETTINGS

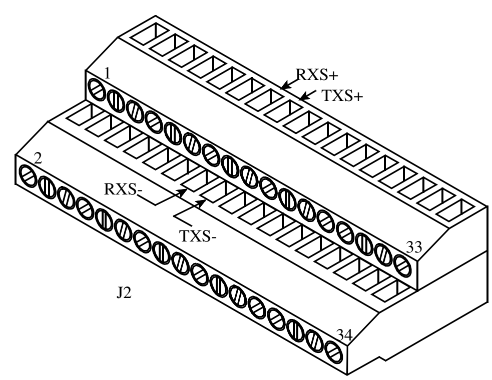


Figure 7-12 J2 TERMINAL BLOCK (SECONDARY)

FSK Data Level Adjustment To Repeater
Data over Voice (2-Wire) Default Setting.

1. **On the MAC**, set S100, all Sections OFF; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-13).

2. Inject a 1.2 kHz tone from a **balanced** 600 ohm source, at the level determined by the type of line used, into TXA+ and TXA- of J2 located on the back of the Repeater (see Figure 7-17).

   Leased Line/Direct Connect (default)
   -22 dBm (62 mV RMS)

   Microwave/T1 (optional)
   -38 dBm (10 mV RMS)

3. **On the MAC**, adjust R242 to obtain -10 dBm (245 mV RMS) measured at J100/J103.

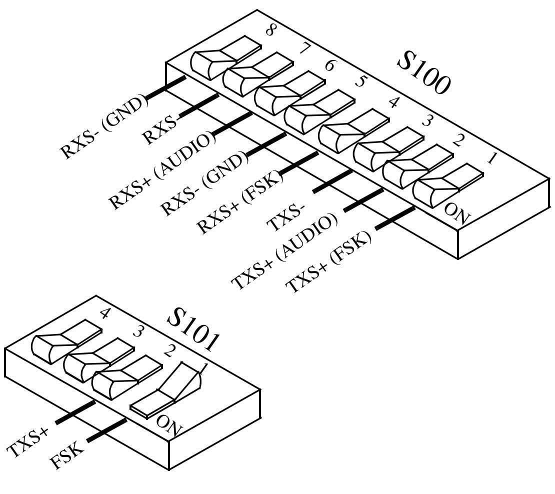


Figure 7-13 SWITCH SETTINGS

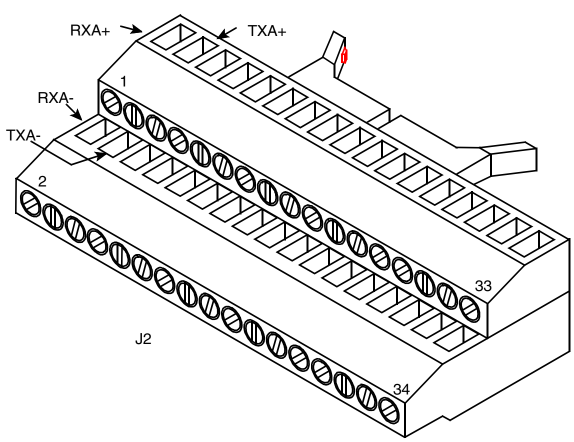


Figure 7-14 J2 TERMINAL BLOCK

<u>FSK Data Level Adjustment From Repeater</u>
Separate Data Path (4-Wire) Optional Setting.

1. **On the MAC**, set S100 Sections 1, 4, 5, 8 OFF; 2, 3, 6, 7 ON; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-13).

2. **On the MAC**, adjust R240 to obtain -16 dBm (123 mV RMS) measured at J100/J103.

3. Press F2 to advance to the next screen.

4. Connect a **balanced** AC Voltmeter with a 600 ohm input impedance between balanced lines RXS+ and RXS- of J2 located on the back of the Repeater (see Figure 7-12).

5. **On the MAC**, adjust R241 for the type of line used.

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

<u>FSK Data Level Adjustment From Repeater</u>
Data over Voice (2-Wire) Default Setting.

NOTE: This adjustment can only be done after Voice Audio To Switch is completed.

1. **On the MAC**, set S100, all Sections OFF; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-13).

2. Connect a **balanced** AC Voltmeter with a 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-17).

3. Adjust R240 on the MAC for the type of line used.

   Leased Line/Direct Connect (default)
   -22 dBm (62 mV RMS)

   Microwave/T1 (optional)
   -38 dBm (10 mV RMS)

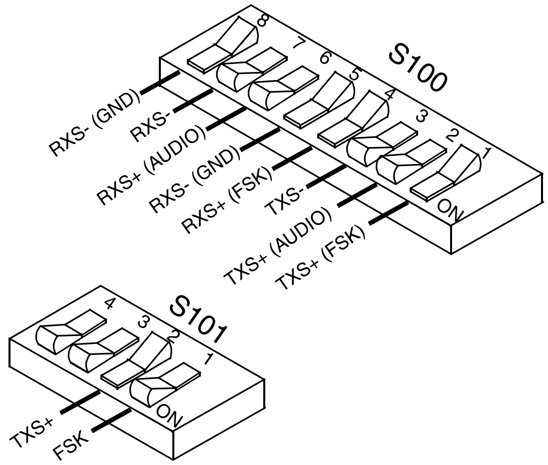


Figure 7-15   S100/S101 RS-232

RS-232 Data To And From Switch (RNT) (Optional)

These are the switch settings only.

1. **On the MAC**, set S100, Sections 2, 3, 6, 7 OFF; 1, 4, 5, 8 ON (see Figure 7-15).

2. **On the MAC**, set S101, Sections 1, 3, 4 OFF; 2 ON (see Figure 7-15).

7.4.8 REPEATER OPERATION

New HSDB Test

1. Switch settings on the MPC for RS-485 operation are shown in Figure 7-16.

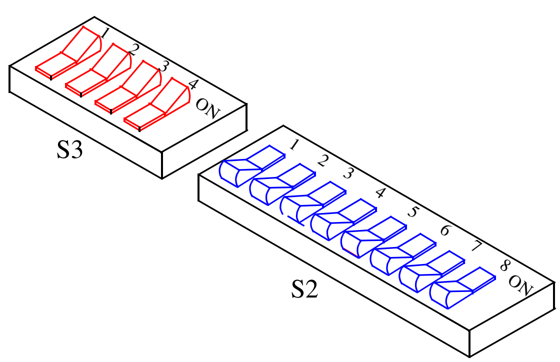


Figure 7-16   NEW HSDB SWITCH SETTINGS

2. Verify that the repeater is programmed for "Stand Alone" mode in Setup Parameters-F4 (see Section 4.3.1).

3. The repeater is now in Normal Operation mode. Verify by the MPC front panel indicators that no HSDB alarms have occurred (Alarm Number 10) see Table 1-2.

Handshake Test

1. Program an LTR portable or mobile for the following parameters.

   Home Repeater - Same as repeater number.
   Area - Same as repeater's area bit.
   Home Repeater's Channel Number - Same as repeater's channel number.
   Group 1 Encode/Decode - 1

2. The repeater is now in Normal Operation mode.

3. Key the radio several times on the programmed System/Group. Access should occur every time. (Proper Tx/Rx antenna connections are assumed.)

Alarm Test

1. The repeater is now in Normal Operation mode.

2. Verify by the MPC front panel indicators that no alarms have occurred (see Table 1-2).

7.5 SWITCH (RNT) INTERFACE

7.5.1 REPEATER SETUP

1. Connect the repeater as shown in Figures 7-6, 7-17 and 7-18.

2. Adjust the repeater for the type of link used for communication back to the CIM in the Switch. The types of links used are:
   Leased Lines (LL)
   Direct Connection (DC)
   Microwave (MW)
   T1 Interfaces (T1)

3. Program the repeater for the specified parameters using the Programmer.

*NOTE: Assume all audio generators and voltmeters to be **unbalanced** unless stated otherwise.*

7.5.2 CIM SETUP

1. Adjust the CIM for the type of link used for communication back to the repeater. The types of links used are:
   Leased Lines (LL)
   Direct Connection (DC)
   Microwave (MW)
   T1 Interfaces (T1)
   Refer to the LTR-Net Switch, Setup and Alignment manual, PN 001-3239-001, for more information on the CIM alignment (see Figure 7-26).

2. Connect the link lines to the Switch and its associated CIM (see Figure 7-18).

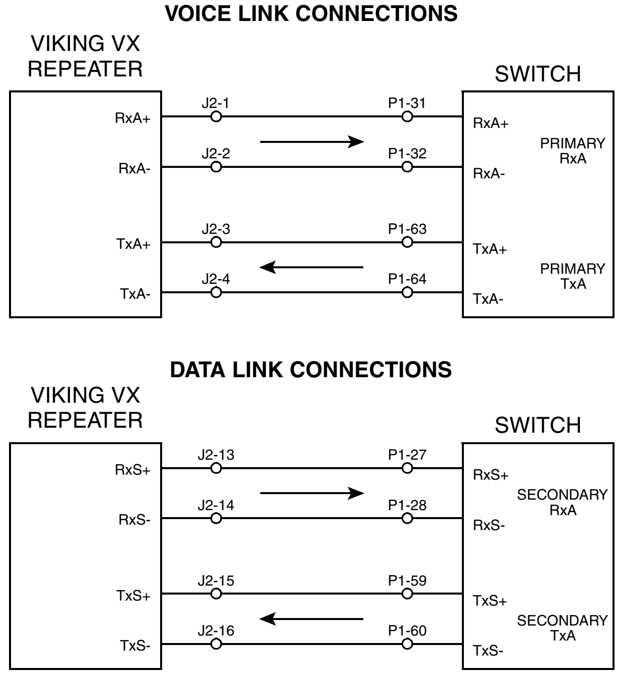


Figure 7-18 VIKING VX VOICE/DATA LINK

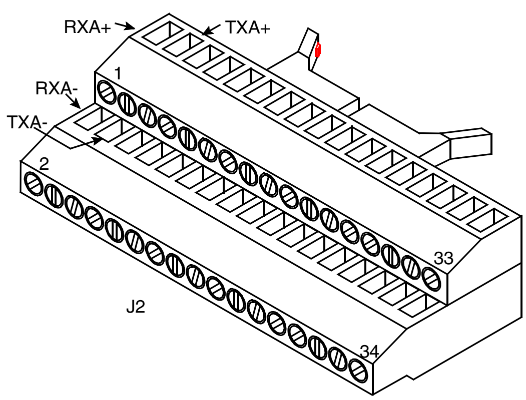


Figure 7-17 J2 CONNECTOR

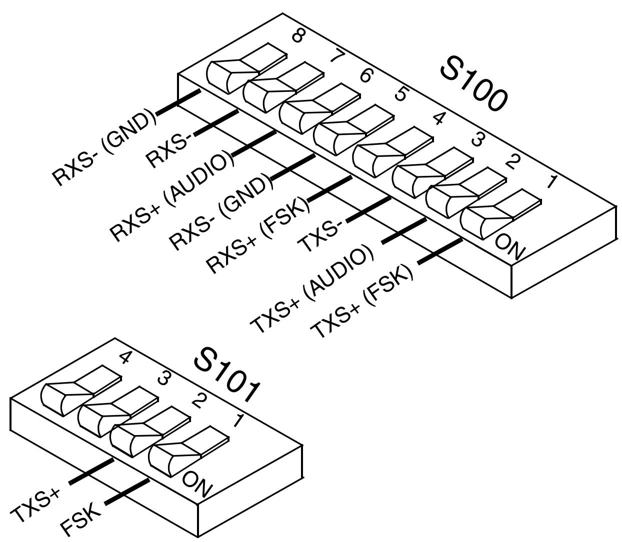


Figure 7-19 S100/S101 SWITCH SETTING

7.5.3 VOICE AUDIO TO SWITCH

1. **On the MAC**, set S100 and S101, all Sections OFF (see Figure 7-19).
2. Connect an RF generator to the receiver.
3. Adjust the RF generator for 100 µV modulated with a 1 kHz tone at ±1.5 kHz deviation.
4. Connect a **balanced** AC Voltmeter with a 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-16).
5. **On the MAC**, adjust R239 for the type of line used.

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

7.5.4 VOICE AUDIO FROM SWITCH

1. **On the MAC**, set S100 and S101, all Sections OFF (see Figure 7-19).
2. **On the CIM** (in the Switch) generate an alignment tone (set S5 to "1") (see Figure 7-26).
3. **On the CIM**, connect a balanced AC voltmeter at J12.
4. **On the CIM**, adjust R44 for the type of line used.

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)
5. **On the MAC**, adjust R243 for -6 dBm (387 mV RMS) measured at J100/J103.

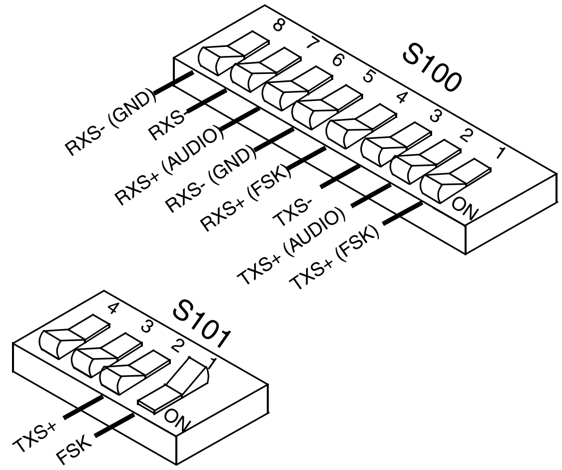


Figure 7-20 MAC SWITCH SETTINGS

7.5.5 BLANK AND BURST - FSK DATA FROM SWITCH

1. On the MAC,
   set S100 all Sections OFF
   set S101, sections 2, 3, 4 OFF
   set S101, section 1 ON (see Figure 7-20).
2. **On the CIM**, (in the Switch) generate an alignment tone (set S5 to a value of "8").
3. **On the CIM**, adjust R86 at TP4 for the type of line used.

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)
4. **On the CIM**, verify at J12 (see Figure 7-26).

   Leased Line/Direct Connect (default)
   -21 dBm (69 mV RMS)

   Microwave/T1 (optional)
   -37 dBm (11 mV RMS)

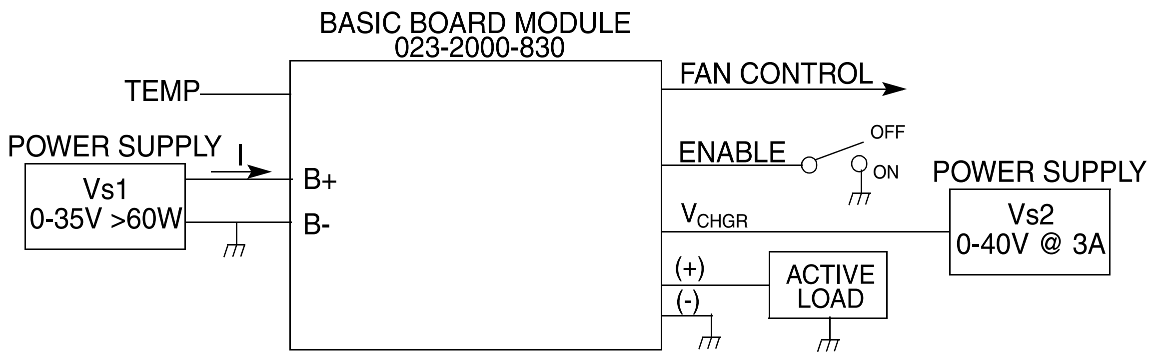


Figure 7-21 BATTERY REVERT TEST SETUP

7.5.6 FSK LINK - FSK DATA LEVEL TO SWITCH

1. On the MAC,
   set S100 all Sections OFF
   set S101, sections 2, 3, 4 OFF
   set S101, section 1 ON (see Figure 7-20).

2. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-17).

3. On the MAC, adjust R240 for the type of line used.

   Leased Line/Direct Connect (default)
   -22 dBm (62 mV RMS)

   Microwave/T1 (optional)
   -38 dBm (10 mV RMS)

7.6 VISUAL CHECK

1. Make sure the heat sunk parts are not shorted to the heat-sink.

2. Verify all electrolytic capacitors are installed correctly.

3. Connect 023-2000-830 Battery Back-Up as shown in Figure 7-21.

7.7 BATTERY REVERT TEST

1. Connect the circuit as shown in Figure 7-21.

2. Turn the active load to current mode at 1A.

3. Turn enable to On, battery fault LED should be on.

4. Increase Vs1 until:
   the relay engages
   the voltage is present on the active load
   the battery fault LED is off.

   This voltage will be 22V DC ±0.5V.

5. Increase Vs1 until:
   the relay disengages
   the LED lights
   no voltage is present at the active load.

   This voltage will be 31V DC ±0.5V.

6. Decrease VS1 until:
   the relay engages
   the LED goes out
   voltage is present at the active load.

   This voltage will be 28V DC ±0.5V.

7. Set Vs1 to 26.5V DC and turn the enable line to OFF. No voltage will be present at the active load.

8. Decrease Vs1 until:
   the relay disengages
   the LED lights
   no voltage is present at the active load.

   This voltage will be 19V DC ±0.5V.

9. With the enable line OFF measure current Is, it should be less than 20 mA.

10. Reverse the polarity of Vs1
    Set to 26.5V DC
    BBM Enable ON

    Reverse Battery LED will light and Is should be less than 50 mA.

11. Disconnect the test setup.

7.8 BATTERY CHARGER SECTION

1. Connect Battery Backup Module as shown in Figure 7-22.

2. Set the active load to 0A and set Vs2 to 40V at 3A.

3. Adjust R140 so the voltage at the active load reads 27.55V DC ±0.1V.

NOTE: The temperature sensor LM335 has to be at 22°C (room temperature).

4. Increase the active load current to 1.8A and verify voltage at the load is greater than 26V.

NOTE: The fan control line will stay at 0V until the heat sink is above 50°C.

5. Set the active load current to zero, shut off Vs2 and disconnect the BBM. Glyptol R140.

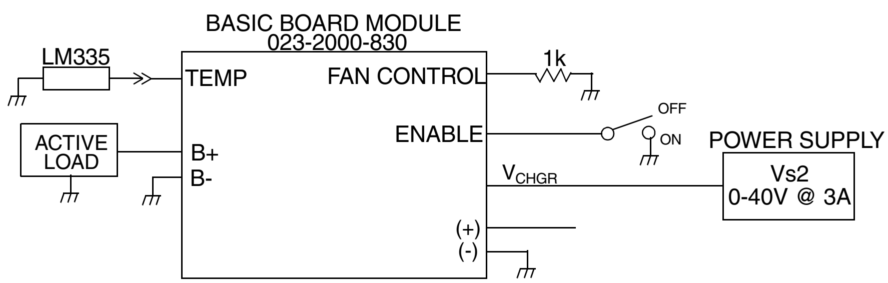


Figure 7-22 BATTERY CHARGER TEST SETUP

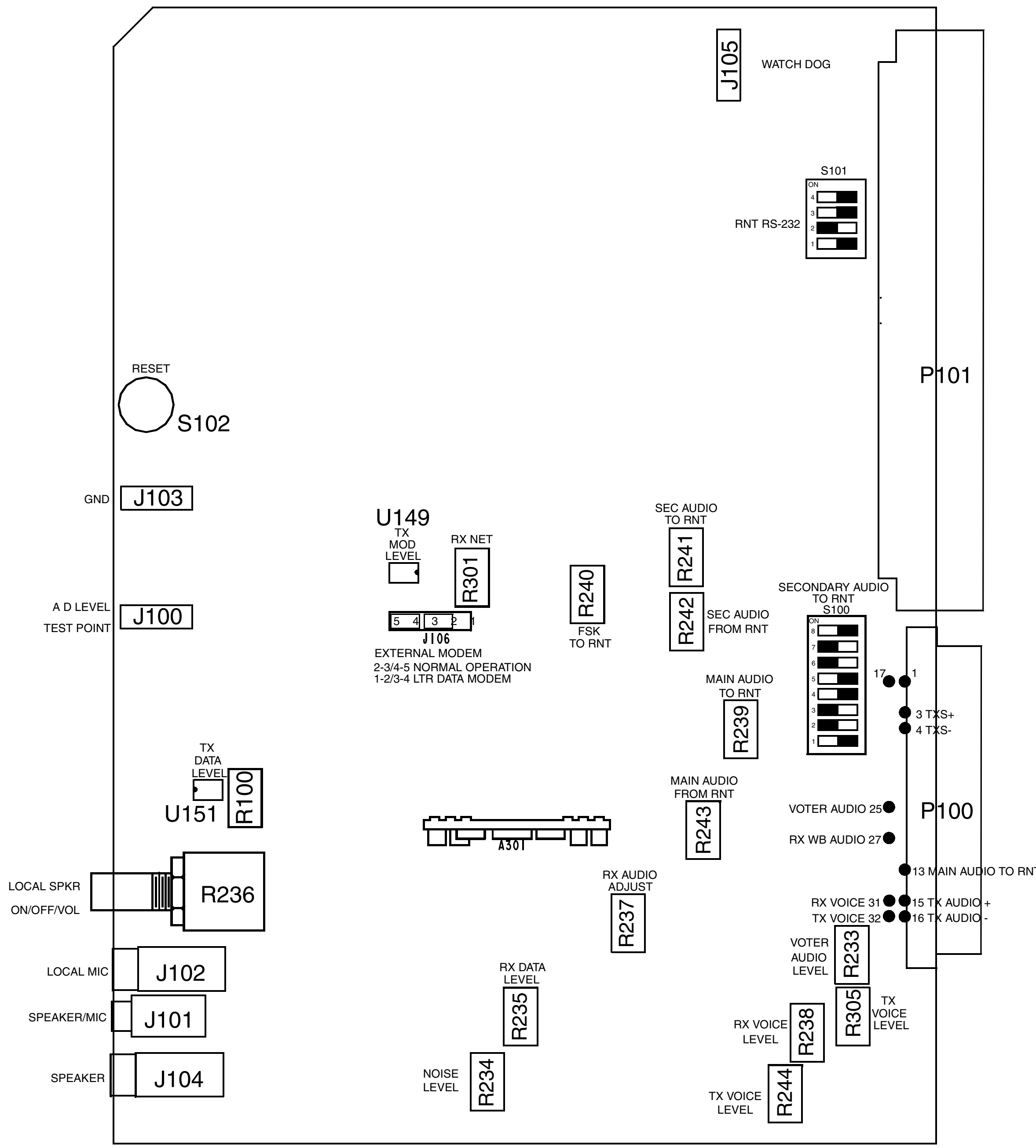


Figure 7-23   MAC ALIGNMENT POINTS

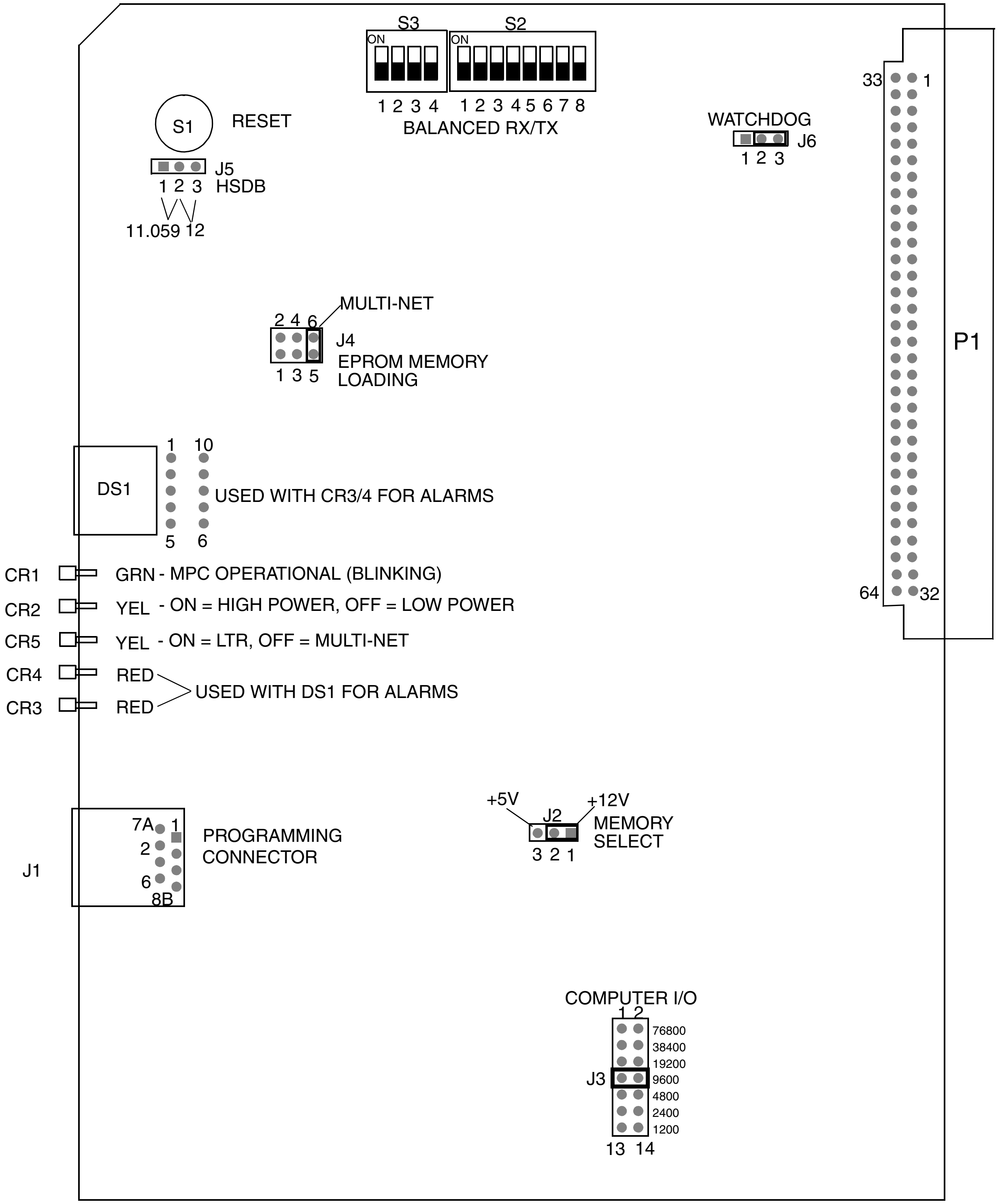


Figure 7-24 MAIN PROCESSOR CARD ALIGNMENT POINTS

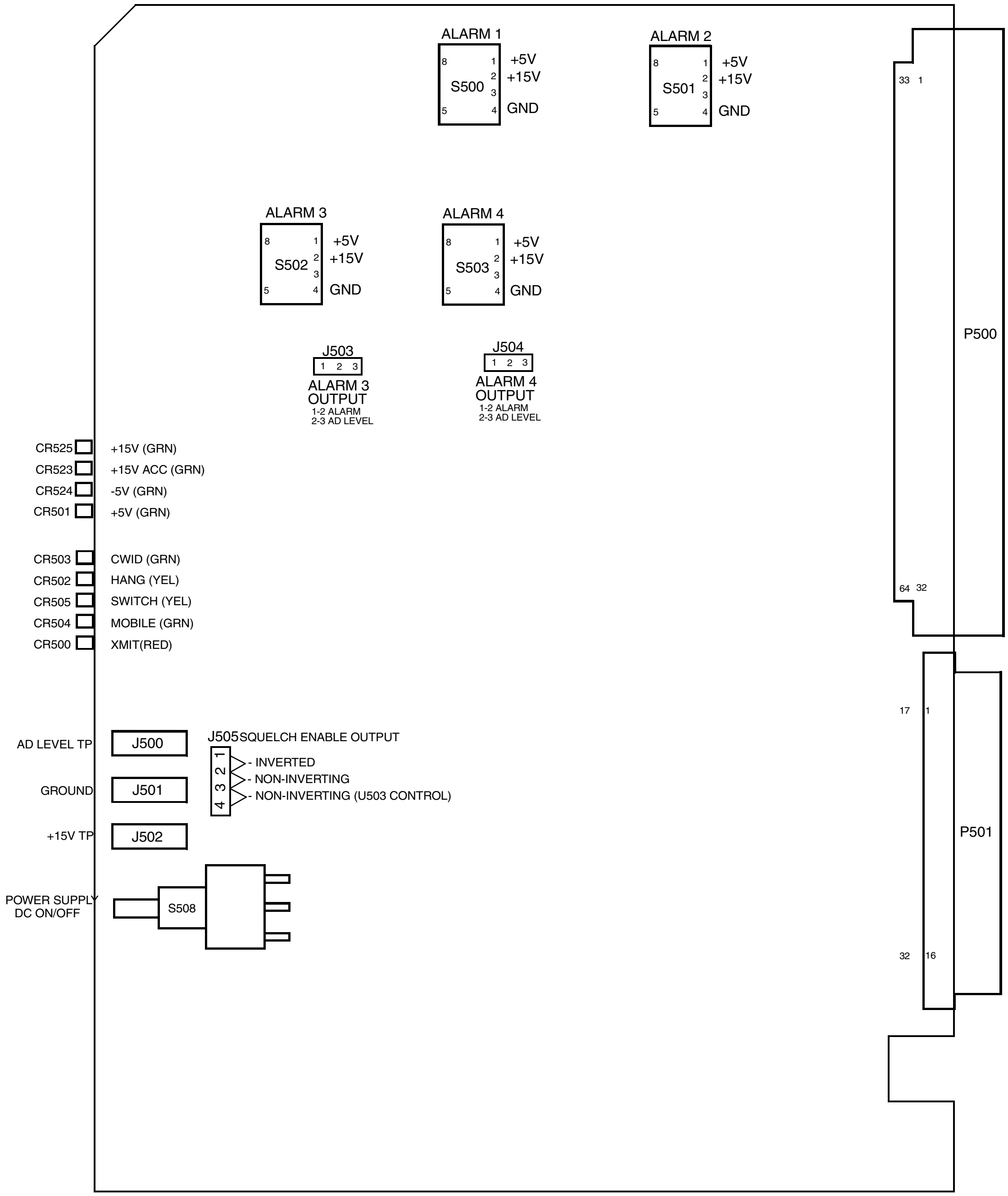


Figure 7-25   INTERFACE ALARM CARD ALIGNMENT POINTS

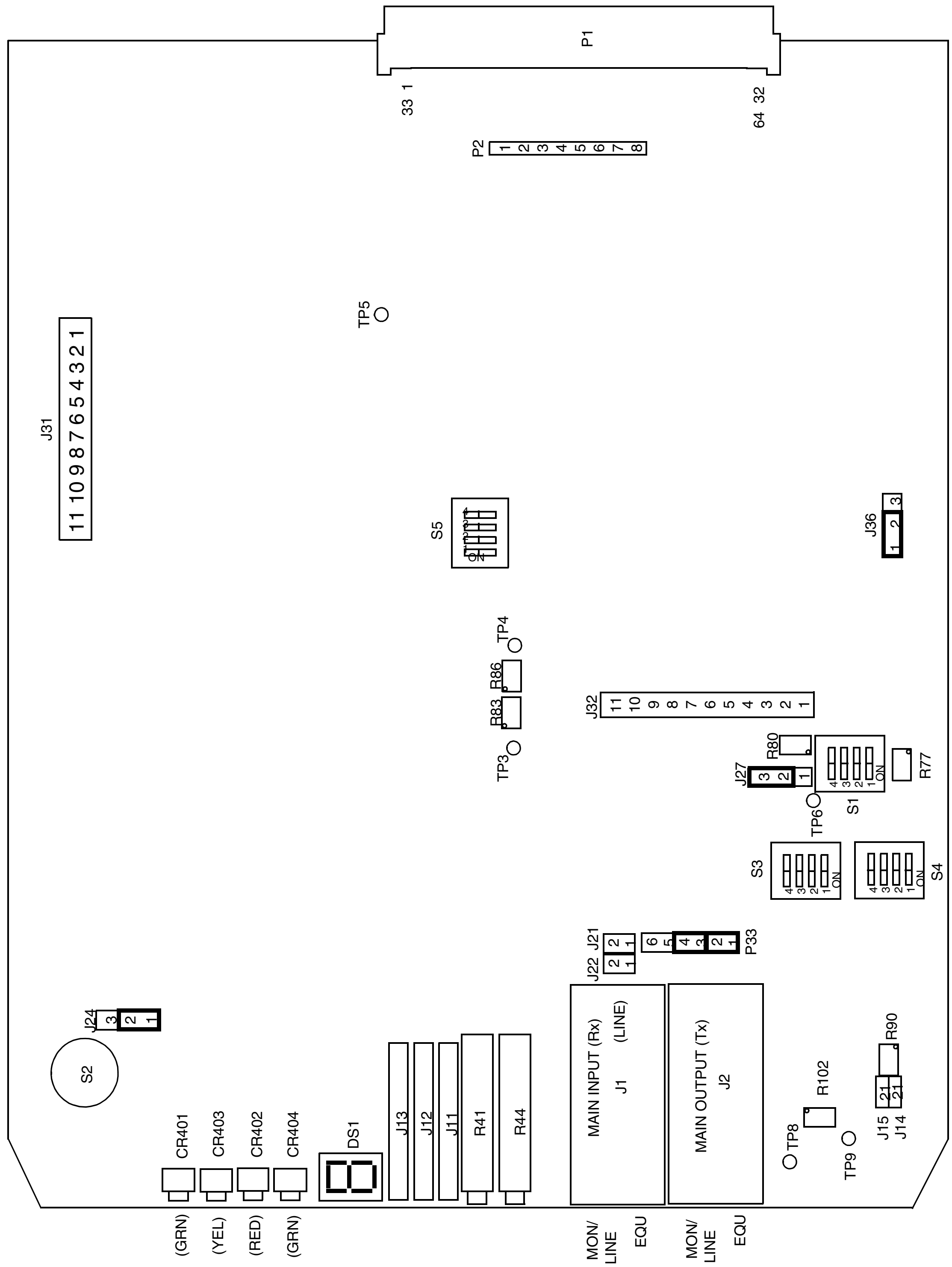


Figure 7-26   CIM ALIGNMENT POINTS

SECTION 8 SERVICING

8.1 INTRODUCTION

8.1.1 PERIODIC CHECKS

This repeater should be put on a regular maintenance schedule and an accurate performance record maintained. Important checks are receiver sensitivity and transmitter frequency, modulation, and power output. It is recommended that repeater performance be checked regularly even though periodic checks are not specifically required by the FCC.

8.1.2 SURFACE-MOUNTED COMPONENTS

A large number of the components used in this repeater are the surface-mounted type. Since these components are relatively small in size and are soldered directly to the PC board, care must be used when they are replaced to prevent damage to the component or PC board. Surface-mounted components should not be reused since they may be damaged by the unsoldering process. For more information on replacing surface-mounted components, refer to the Surface-Mounted Device Handbook, Part No. 001-0576-002.

8.1.3 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

Schematic diagrams and component layouts of the PC boards used in this repeater are located in Section 10. A component locator guide is also provided for both the schematic and board layouts to aid in component location.

8.1.4 REPLACEMENT PARTS LIST

A replacement parts list containing all the parts used in this repeater is located in Section 9. Parts are listed alpha numerically according to designator. For information on ordering parts, refer to Section 1.10.

8.1.5 TCXO MODULES NOT SERVICEABLE

Transmit or Receive TCXOs are not field serviceable because if a part is changed, a factory recalibration must be performed to ensure that it stays within its ±1 PPM tolerance.

8.2 SYNTHESIZER SERVICING

8.2.1 INTRODUCTION

Synthesizer malfunctions can be caused by no VCO output, or the VCO is unlocked. The VCO can be unlocked due to a bad synthesizer chip, an incomplete synthesizer phase-lock loop, or because the synthesizer chip is programmed incorrectly.

To make certain that the synthesizer chip is receiving programming data, pins 17, 18 and 19 of the chip should be monitored during programming. Pin 17 (Enable) will go from a high to a low level. Pin 18 (Clock) will go from low to high in narrow pulses. Pin 19 (Data) goes from high to low with wider data pulses.

When the VCO is locked, the lock detect line of the synthesizer pin 2 is high with very narrow negative-going pulses. These pulses become wider when the VCO is out of lock. When this unlock condition exists either in the Exciter VCO or the Receiver VCO, it is relayed by the RF Interface board and is detected by the MPC via the RF Data lines. The MPC then does not allow the transmitter to key and the receiver cannot unsquelch.

When the VCO is unlocked, the f_R and f_V inputs to the phase detector are not in phase (refer to Sections 6.1.9 and 6.2.5). The phase detector in the synthesizer then causes the VCO control voltage to go to the high or low end of its operating range (Tx VCO 0 or 9V, Rx VCO 0 or 18V). This in turn causes the VCO to oscillate at the high or low end of its range.

As shown in Figures 6-1 and 6-4, a loop is formed by the VCO, buffer, frequency input (F_{IN}) and the phase detector output (PD OUT). Therefore, if any of these components begin to malfunction, improper signals appear throughout the loop. However, correct operation of the counters can still be verified by measuring the input and output frequencies to check the divide number.

Proceed as follows to check the input and output signal of the synthesizer modules to determine if they are operating properly.

8.2.2 TCXO MODULE

Check the signal at TCXO, pin 5. It should be 17.5 MHz for Y201 and Y401 at a level of approximately 3V P-P. If the TCXO is defective, it is not serviceable and must be replaced with a new unit as described in Section 8.1.5.

Measure the signal at pin 20 (Ref In) of the synthesizer chip. It will be approximately 1V P-P. If the signal is low here, the TCXO buffer circuit may be defective.

8.2.3 VOLTAGE CONTROLLED OSCILLATOR (VCO)

Check for VCO output signal with a high impedance RF voltmeter. If there is no output signal, or if the frequency is greatly off, the VCO is defective.

Next, monitor the signal level at pin 11 (F In) of the synthesizer chip. If the signal is less than 100 mV P-P, the VCO buffer is defective.

Lock Detector

When the VCO is locked on frequency, the waveform at pin 2 (Lock Det) should be as follows. When the VCO is unlocked, the negative-going pulses should be much wider than those shown in Figure 8-1. If the lock detect circuit is operating properly, check prescaler input pin 11 (F In).

The operation of the N and A counters can be observed by monitoring pins 16 and 19. Pin 16 (fv) equals fin ÷ (64N+A) = 6.25 kHz if the synthesizer is locked. Pin 9 is the modulus control signal.

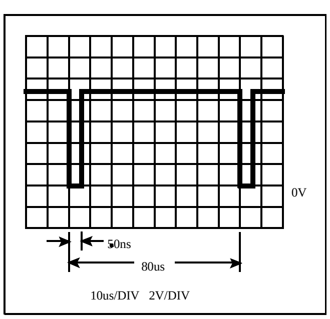


Figure 8-1 LOCK DETECT WAVEFORM

<u>Modulus Control Signal</u>

1. The frequency of the modulus control signal on TEST 1, pin 9 should be equal to the N counter output frequency (either in or out of lock). When the VCO is in lock, this frequency should be 6.25 kHz.

2. The duty cycle of the modulus control signal determines the divide number of the prescaler. The duty cycle (T1 ÷ T2) should be as follows:

   T1 ÷ T2 = A Cntr Div No ÷ N Cntr Div No
   T2 = 160 µs when locked.

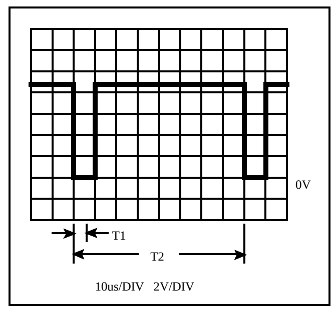


Figure 8-2 MODULUS CONTROL WAVEFORM

If the modulus control signal is not correct, the synthesizer may be defective or the logic may not be programming the correct divide number.

8.2.4 INTERNAL PRESCALER

<u>Checking Prescaler Divide Number</u>

The prescaler divide number can be checked by measuring the input and output frequencies. The prescaler divide number can be calculated as follows. (A and N counter divide numbers are calculated as described in Section 8.2.5.)

Prescaler Divide Number =
64 + (A Cntr Div No ÷ N Cntr Div No)

Example: 450.250 MHz (receive)

Prescaler Div No = 64 + (40 ÷ 496) = 64.080645

Measure the prescaler input frequency at f_{in}, pin 11. Then measure the output frequency at TEST 2, pin 13 and calculate the divide number. If the VCO is not locked on frequency, the divide number should still be correct. The measured frequencies may not be exactly as calculated due to counter accuracy and resolution limitations.

NOTE: The counter should be connected to a high stability reference oscillator.

Example: 450.250 MHz VCO locked on frequency

397.3 (pin 11) ÷ 6.2 (pin 13) = 64.080645

8.2.5 CALCULATING "N " AND "A " COUNTER DIVIDE NUMBERS

"N" Counter

N Counter Divide Number =
Integer (VCO Freq. (MHz) ÷ 0.4)

6.25 kHz (64) ÷ 1 MHz = 0.4

EXAMPLE: 450.025 MHz (receive)

VCO freq = 450.025 + 52.95 = 502.975 MHz
N Cntr Div No = 502.975 ÷ 0.4 = 127.4375
Integer (whole no.) of 1257.4375 = **1257**

EXAMPLE: 450.250 MHz (transmit)

N Cntr Div No = 450.250 ÷ 0.4 = 1125.625
Integer (whole no.) of 1125.625 = **1125**

"A" Counter
A Counter Divide Number =
(VCO freq (MHz) ÷ .00625) - (N Cntr Div No x 64)

EXAMPLE: 450.025 MHz (receive)

A Cntr Div No = (502.975 ÷ .00625) - (1257 x 64)
= 80,476 - 80,448
= **28**

EXAMPLE: 450.250 MHz (transmit)

A Cntr Div No = (450.250 ÷ .00625) - (1125 x 64)
= 72,040 - 72,000
= **40**

8.3 RECEIVER SERVICING

To isolate a receiver problem to a defective section, start by checking the DC voltages shown in Section 6.4.6 and on the schematic diagram (Section 10). If that does not indicate the problem, perform the performance tests in Section 7.1 to isolate the problem. If the synthesizer is out of lock, the receiver is also nonfunctional because the first injection and IF signals will be incorrect.

8.4 TRANSMITTER SERVICING

To isolate a transmitter problem to a defective section, start by checking the DC voltages shown in Sections 6.4.5 and 6.4.4 and on the schematic diagram (Section 10). If that does not indicate the problem, perform the performance tests in Sections 7.2 and 7.3 to isolate the problem. If the synthesizer is out of lock, the exciter is also nonfunctional because the software will not allow the repeater to transmit.

8.5 POWER SUPPLY SERVICING

The power supply is a switch mode type with very high voltages. It is highly recommended that the power supply be returned to the factory for servicing (see Section 1.8). A parts list, schematic and component layout are provided for those customers that desire to do their own repairs (see Sections 9 and 10).

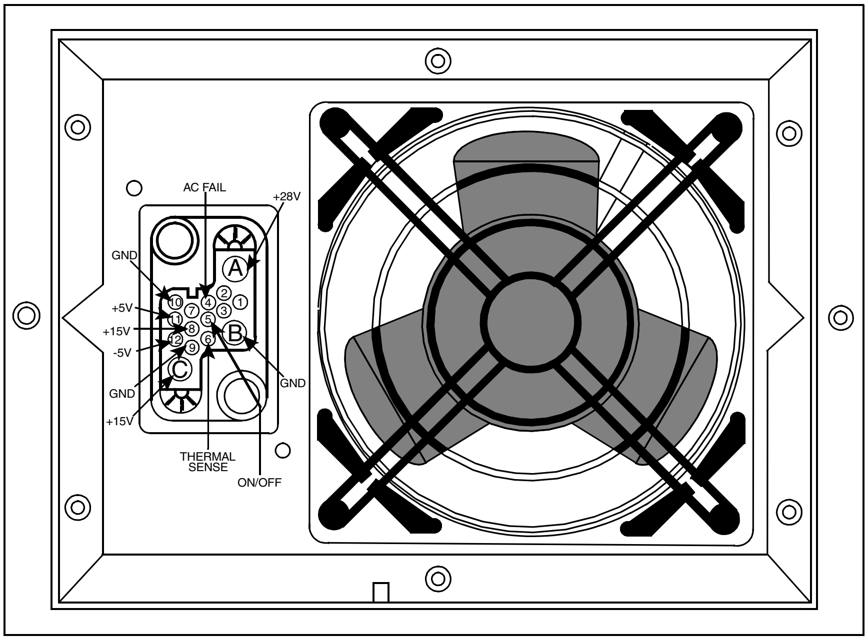


Figure 8-3   POWER SUPPLY REAR VIEW

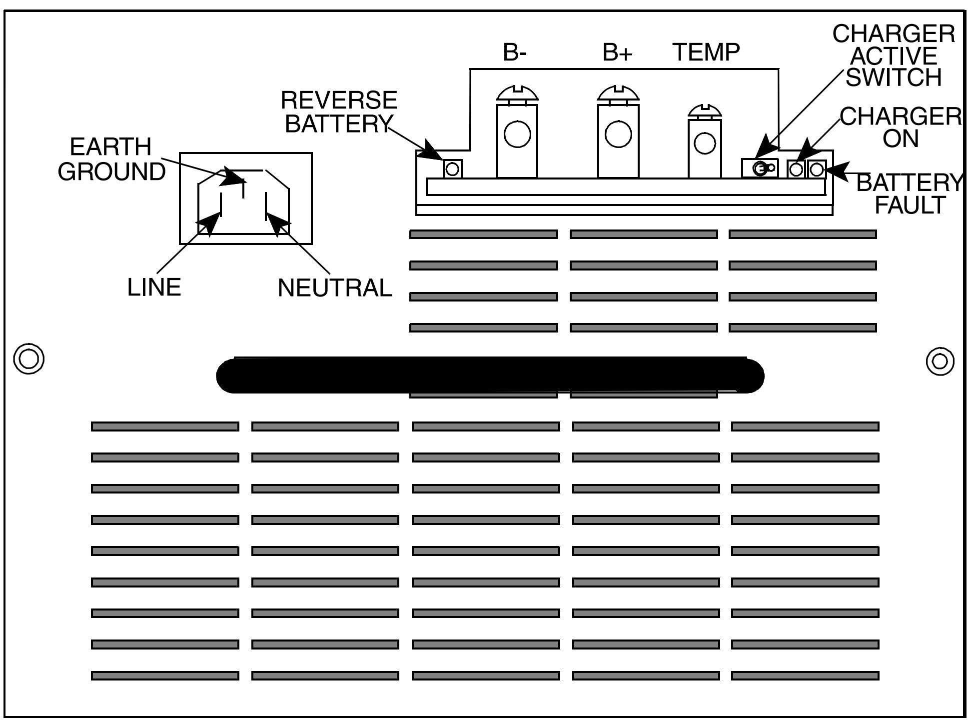


Figure 8-4   POWER SUPPLY FRONT VIEW

Standby Battery Jack

This provides a connection point for a +24V DC standby battery. Current is drawn from the battery only when the repeater enable line is on and AC has failed, or no AC is connected. A trickle charger can be jumpered in to charge the battery when AC returns. The charger jumper is removed when a separate battery charger is used (see Figure 8-4). The standby battery connection to the power supply must be ordered installed from the factory.

NOTE: A small amount (<30 mA) of current is drawn from the batteries with the repeater off. If the repeater is going to be turned off for more than one week (with good batteries connected) the fuse should be removed from the DC cable harness.

8.5.1 VOLTAGE CHECKS

Secondary voltages can be checked at the power supply connector with the power supply removed from the Repeater. First the on/off line must be grounded, jumper pin 5 to ground, then check the supply voltages as shown (see Figure 8-4). If voltages are absent the supply must be sent to the E.F. Johnson Company.

8.6 CHIP COMPONENT IDENTIFICATION

8.6.1 CERAMIC CHIP CAPACITORS (510-36XX-XXX)

Ceramic chip capacitors are identified using either an American or Japanese EIA standard. The values for both standards are shown in Table 8-1.

American EIA Standard

Uses a single letter or number to indicate the value, and the color of this letter or number to indicate the multiplier.

Japanese EIA Standard

Uses a letter to indicate the value followed by a number to indicate the multiplier.

Example: 15 pF capacitor

American - Single Black "E"
Japanese -"E1"

The Japanese EIA Standard may also utilize a bar to indicate the temperature coefficient.

Example: A2 - 100 pF NPO

XX = NPO	$\overline{X}X$ = N150	$X\overline{X}$ = N220
$\underline{XX}$ = N330	$\underline{X}X$ = N470	$X\underline{X}$ = N750
IXX = X7R		

8.6.2 TANTALUM CHIP CAPACITORS (510-26XX-XXX)

Tantalum chip capacitor identification varies with vendor and physical size. The positive (+) end is usually indicated by a colored board or beveled edge. The value and voltage may be indicated by printing on the capacitor or by using a special code.

8.6.3 CHIP INDUCTORS (542-9000-XXX)

Three colored dots are used to indicate the value of chip inductors. The two dots on the left side indicate the first and second digits of the value in nanoHenries, and the single dot on the right side indicates the multiplier (see Table 8-2).

Example: Dots - Brown-Black-Red

10 nH x 100 = 1000 nH (1.0 µH)

The last three digits of the part number are also the value and multiplier. The multiplier digits are shown in Table 8-2.

8.6.4 CHIP RESISTORS

The value of chip resistors is indicated by a number printed on the resistor. A 3-digit number is used to identify ±5% and ±10% resistors, and a 4-digit number is used to identify ±1% resistors.

The 3-digit number used to identify ±5% and ±10% resistors corresponds to the last 3-digits of the E.F. Johnson part number. This number is derived as shown.

Example:

273 27k ohm
339 3.3 ohm

Some resistors with a ±1% tolerance are identified by a 4-digit number and others may not have a marking. When identified with a 4-digit number, the first three digits are the value and the fourth is the multiplier.

Example: 57615.76k ohm

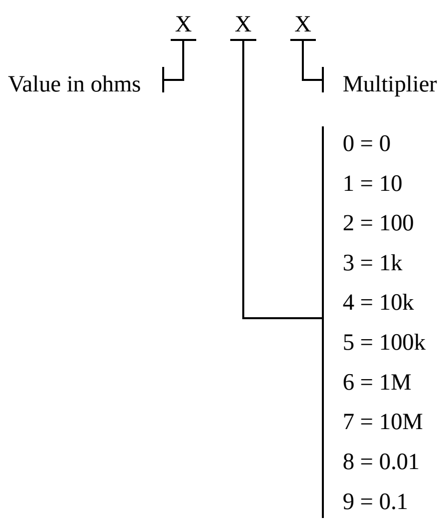
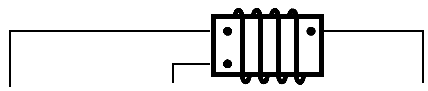


Figure 8-5 3-DIGIT RESISTOR

Table 8-1 CERAMIC CHIP CAP IDENTIFICATION

American EIA Standard		Japanese EIA Standard	
First Letter/ Number	**Value (pF)**	**First Letter/ Number**	**Value (pF)**
A	10	A	1.0
B	11	B	1.1
C	12	C	1.2
D	13	D	1.3
E	15	E	1.5
H	16	F	1.6
I	18	G	1.8
J	20	H	2.0
K	22	J	2.2
L	24	K	2.4
N	27	L	2.7
O	30	M	3.0
R	33	N	3.3
S	36	P	3.6
T	39	Q	3.9
V	43	R	4.3
W	47	S	4.7
X	51	T	5.1
Y	56	U	5.6
Z	62	V	6.2
3	68	W	6.8
4	75	X	7.5
7	82	Y	8.2
9	91	Z	9.1
Color	**Multiplier**	**Second Number**	**Multiplier**
Orange	0.1	0	1
Black	1	1	10
Green	10	2	100
Blue	100	3	1000
Violet	1000	4	10,000
Red	10,000	5	100,000

Table 8-2   CHIP INDUCTOR IDENTIFICATION



Color	1st Digit	2nd Digit	Multiplier (Last PN Digit)
Black	0	0	1 (7)
Brown	1	1	10 (8)
Red	2	2	100 (9)
Orange	3	3	1000 (0)
Yellow	4	4	10,000 (1)
Green	5	5	100,000 (2)
Blue	6	6	---
Violet	7	7	---
Gray	8	8	---
White	9	9	0.1 (6)

8.6.5 CHIP TRANSISTORS AND DIODES

Surface mounted transistors and diodes are identified by a special number that is shown in a table on Section 10.

8.7 BERYLLIUM PRODUCT WARNING

Q501, Q502, Q503, R519, R538 and R668 in the Power Amplifier contain Beryllium (BeO). Inhalation of dust or fumes may cause serious chronic lung disease. Refer to the Material Safety Data Sheets for further details.

8.8 GRAFOIL REPLACEMENT PROCEDURE

When replacing a device that uses Grafoil for the thermal interface, the Grafoil must be replaced. The old Grafoil must be completely removed from the heatsink. To avoid scuffing the heatsink a plastic scraper (e.g. tuning tool) should be used to remove the old Grafoil.

SECTION 9 PARTS LIST

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	VIKING VX UHF 110W REPEATER PART NO. 242-20X4-613	
A 003	400-430 MHz PA/RFIB assem	023-2034-932
A 003	430-470 MHz PA/RFIB assem	023-2044-932
A 003	475-512 MHz PA/RFIB assem	023-2054-932
A 006	400-430 MHz Rx/Tx assembly	023-2034-836
A 006	430-470 MHz Rx/Tx assembly	023-2044-836
A 006	475-512 MHz Rx/Tx assembly	023-2054-836
A 010	2000 series power supply	023-2000-800
HW001	6-32 machine panhead	575-1606-012
MP033	PA hold down bracket	017-2210-032
PA001	Main Processor Card assem**	023-2000-310
PA002	Main Audio Card assem**	023-2000-320
PA003	Interface Alarm Card assem**	023-2000-350
PA004	Repeater enclosure assembly	023-2000-200
U 014	HSDB LTR-Net Software	023-9998-456
W 013	AC power cord 6' 7"	597-1001-013

**Requires Application Engineering authorization to purchase.

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	110W UHF PA/RFIB MODULE PART NO. 023-20X4-932	
A 002	403-470 MHz 175W circulator	585-0590-006
A 002	470-524 MHz 175W circulator	585-0590-007
A 004	PA - Rx/Tx 20-cond ribbon	023-2000-190
A 005	PA - Rx/Tx 20-cond ribbon	023-2000-190
A 008	7.25" cable N-BNC	597-3003-292
A 009	PA RF input coax assembly	597-3002-031
A 011	UHF LPF Rptr to Final	023-2004-600
A 501	UHF feedback top	023-2004-530
A 502	UHF feedback top	023-2004-530
A 503	UHF feedback top	023-2004-530
C 001	1000 pF ±20% 1kV feedthru	510-3149-102
C 002	1000 pF ±20% 1kV feedthru	510-3149-102
C 003	1000 pF ±20% 1kV feedthru	510-3149-102
C 004	1000 pF ±20% 1kV feedthru	510-3149-102
C 005	1000 pF ±20% 1kV feedthru	510-3149-102
C 006	1000 pF ±20% 1kV feedthru	510-3149-102
C 007	1000 pF ±20% 1kV feedthru	510-3149-102
C 008	1000 pF ±20% 1kV feedthru	510-3149-102
C 009	1000 pF ±20% 1kV feedthru	510-3149-102
C 010	1000 pF ±20% 1kV feedthru	510-3149-102
C 011	1000 pF ±20% 1kV feedthru	510-3149-102
C 012	1000 pF ±20% 1kV feedthru	510-3149-102
C 013	1000 pF ±20% 1kV feedthru	510-3149-102
C 527	9.1 pF ±5% NPO 1206 chip (400-430 MHz)	510-3602-919
C 528	47 pF ±5% 250V mica (400-430 MHz)	510-0220-470
	39 pF ±5% 250V mica (430-512 MHz)	510-0220-390
C 529	47 pF ±5% 250V mica (400-430 MHz)	510-0220-470
	39 pF ±5% 250V mica (430-512 MHz)	510-0220-390
C 541	68 pF ±5% 250V mica (400-430 MHz)	510-0220-680
	43 pF ±5% 250V mica (430-512 MHz)	510-0220-430
C 542	68 pF ±5% 250V mica (400-430 MHz)	510-0220-680
	43 pF ±5% 250V mica (430-512 MHz)	510-0220-430
C 543	18 pF ±5% 250V mica (400-430 MHz)	510-0220-180
	22 pF ±5% 250V mica (430-470 MHz)	510-0220-220
	16 pF ±5% 250V mica (475-512 MHz)	510-0220-160
C 546	9.1 pF hi Q .110 cube (400-430 MHz)	510-3663-919
C 547	47 pF ±5% 250V mica (400-430 MHz)	510-0220-470
	51 pF ±5% 250V mica (430-512 MHz)	510-0220-510
C 548	47 pF ±5% 250V mica (400-430 MHz)	510-0220-470
	51 pF ±5% 250V mica (430-512 MHz)	510-0220-510

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 560	68 pF ±5% 250V mica (400-430 MHz)	510-0220-680
	82 pF ±5% 250V mica (430-470 MHz)	510-0220-820
	47 pF ±5% 250V mica (475-512 MHz)	510-0220-470
C 561	68 pF ±5% 250V mica (400-430 MHz)	510-0220-680
	82 pF ±5% 250V mica (430-470 MHz)	510-0220-820
	47 pF ±5% 250V mica (475-512 MHz)	510-0220-470
C 562	18 pF ±5% 250V mica (400-430 MHz)	510-0220-180
	22 pF ±5% 250V mica (430-470 MHz)	510-0220-220
	10 pF ±5% 250V mica (475-512 MHz)	510-0220-100
C 565	9.1 pF hi Q .110 cube (400-430 MHz)	510-3663-919
C 568	47 pF ±5% 250V mica (400-430 MHz)	510-0220-470
	51 pF ±5% 250V mica (430-512 MHz)	510-0220-510
C 569	47 pF ±5% 250V mica (400-430 MHz)	510-0220-470
	51 pF ±5% 250V mica (430-512 MHz)	510-0220-510
C 579	68 pF ±5% 250V mica (400-430 MHz)	510-0220-680
	82 pF ±5% 250V mica (430-470 MHz)	510-0220-820
	47 pF ±5% 250V mica (475-512 MHz)	510-0220-470
C 580	68 pF ±5% 250V mica (400-430 MHz)	510-0220-680
	82 pF ±5% 250V mica (430-470 MHz)	510-0220-820
	47 pF ±5% 250V mica (475-512 MHz)	510-0220-470
C 581	18 pF ±5% 250V mica (400-430 MHz)	510-0220-180
	22 pF ±5% 250V mica (430-470 MHz)	510-0220-220
	10 pF ±5% 250V mica (475-512 MHz)	510-0220-100
C 603	11 pF ±5% NPO 1206 chip (400-430 MHz)	510-3602-110
C 604	12 pF hi Q .110 cube (400-430 MHz)	510-3663-120
C 605	12 pF hi Q .110 cube (400-430 MHz)	510-3663-120
EP500	Jumper RF power detect	016-2228-015
HW003	5/8-24 x 0.094 hex nut NPB	560-9079-028
HW004	5/8 x 0.02 lockwasher int CPS	596-9119-028
J 001	2-pin lock receptacle #22	515-9032-232
J 002	2-pin lock receptacle #22	515-9032-232
L 501	3T 0.250 ID air core	542-0020-093
L 502	3T 0.250 ID air core	542-0020-093
L 503	3T 0.250 ID air core	542-0020-093
PA001	110W PA mechanical assem	023-2004-732
PA008	RF Interface board assembly	023-2008-110
PA009	110W 400-430 MHz PA	023-2034-500
	110W 430-470 MHz PA	023-2044-500
	110W 470-512 MHz PA	023-2054-500
PA010	UHF Fwd/Rev Power Detect	023-2004-660
Q 501*	100W UHF RF power amp	576-0006-119
Q 502*	100W UHF RF power amp	576-0006-119
Q 503*	100W UHF RF power amp	576-0006-119
R 519*	100 ohm 20W flange mount	569-5001-001
R 538*	100 ohm 100W flange mount	569-5001-002
R 668*	50 ohm 250W flange mount	569-5001-003
U 501	13W pwr mod 430-470 MHz	544-4001-065
	13W pwr mod 470-512 MHz	544-4001-068

STATION ENCLOSURE ASSEMBLY
PART NO. 023-2000-200

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 004	Shelf power harness assembly	023-2000-165
A 005	High speed data bus harness	023-2000-170
A 006	Input/Output harness assem	023-2000-175
A 007	Alarm harness assembly	023-2000-180

*** DANGER** Beryllium Product. Inhalation of dust or fumes may cause serious chronic lung disease.

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 008	RF input harness assembly	023-2000-185
A 009	Controller backplane card	023-2000-210
A 010	External connector board	023-2000-220
A 011	Power supply filter board	023-2000-250
CH017	Chassis	017-2210-080
EP001	Ferrite bead	517-2002-008
EP002	Ferrite bead	517-2002-009
EP010	3/8" heat shrink tubing	042-0241-556
EP011	3/8" heat shrink tubing	042-0241-556
HW013	6-32 machine panhead philips	575-1606-014
HW014	6-32 panhead philips ZPS	575-1606-012
HW016	8-32 panhead philips ZPS	575-1608-012
HW017	10-32 machine panhead phil	575-1610-016
HW018	6-19 panhead philips ZPS	575-5606-008
HW019	6-32 machine flathead philips	575-8206-016
HW020	6-32 x 0.094 nut	560-1106-010
HW021	8-32 socket head shield screw	575-9078-106
HW022	8 x 0.032 flat washer NPB	596-2408-012
HW023	#10 flat washer NPB	596-1410-016
HW024	1/2" cable clamp	572-0001-007
HW025	Ratcheting flat wire	572-0011-005
HW026	Floating connector shield	018-1007-028
HW027	Floating connector cushion	018-1132-150
HW029	Speed nut 0.093 stud	537-0002-004
HW030	4-40 shield screw	575-9078-105
HW031	Lens, adhesive	574-3002-115
HW032	6-32 machine panhead philips	575-1606-024
HW033	6 x 0.018 lockwasher	596-1106-009
HW036	High vinyl foot	574-1004-003
J 010	Banana jack assembly .166	108-2302-621
J 011	Banana jack assembly .166	108-2303-621
J 012	Banana jack assembly .166	108-2301-621
MP001	PA floating connector bracket	017-2210-099
MP012	8-32 x 1.15 spacer 0.375	013-1723-221
MP013	Guide pin shield	013-1723-220
MP015	Chassis top cover	017-2210-070
MP017	Door lock rod	013-1723-225
MP018	Mounting ears	017-2210-085
MP019	Door lock cam	017-2210-110
MP020	Front door lens	032-0758-025
MP021	PA slide	032-0758-015
MP022	Front door	032-0758-020
MP024	Slide lock cam	537-9007-012
MP025	Card guide 4.5"	574-9015-006
MP026	PA conn floating plate	017-2226-020
MP028	Flexible grommet	574-0001-025
MP029	Flexible grommet	574-0001-025
MP030	Spacer	013-1723-228
MP031	Spacer	013-1723-229
MP032	Dowel pin guide	013-1723-230
NP001	Nameplate E.F. Johnson	559-5861-163

TRANSCEIVER MECHANICAL
PART NO. 023-2000-205

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
CH252	Transceiver housing	015-0902-010
EP252	0.093 OD RF shield gasket	574-3002-036
HW272	6-32 pan torx ZPS	575-0006-010
HW273	6-32 machine panhead philips	575-1606-016
MP253	Transceiver deck cover	015-0902-015

CONTROLLER BACKPLANE CARD
PART NO. 023-2000-210

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
F 001	4 Amp 250V submin fuse	534-0017-020
F 002	4 Amp 250V submin fuse	534-0017-020
F 003	1 Amp 250V submin fuse	534-0017-014
FH001	Fuse holder	534-0017-001
FH002	Fuse holder	534-0017-001
FH003	Fuse holder	534-0017-001
HW012	Polarizing key box cont	515-7109-010
J 001	34 pin latch ejection header	515-9031-400
J 002	34 pin latch ejection header	515-9031-400
MP001	Round swage spacer 0.5"	312-2483-216
MP002	Round swage spacer 0.75"	312-2483-224
P 001	64-pin DIN female straight	515-7082-201
P 002	32-pin DIN female straight	515-7082-200
P 003	64-pin DIN female straight	515-7082-201

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
P 004	32-pin DIN female straight	515-7082-200
P 005	64-pin DIN female straight	515-7082-201
P 006	32-pin DIN female straight	515-7082-200
P 007	64-pin DIN female straight	515-7082-201
P 008	32-pin DIN female straight	515-7082-200
P 009	32-pin DIN female straight	515-7082-200
P 010	26-pin locking straight header	515-9031-397
P 011	6-pin friction lock conn	515-9031-205
P 012	64-pin DIN female straight	515-7082-201
P 013	32-pin DIN female straight	515-7082-200
P 014	64-pin DIN female straight	515-7082-201
P 015	32-pin DIN female straight	515-7082-200
P 016	64-pin DIN female straight	515-7082-201
P 017	32-pin DIN female straight	515-7082-200
P 018	64-pin DIN female straight	515-7082-201
PC001	PC board	035-2000-210

EXTERNAL CONNECTOR BOARD
PART NO. 023-2000-220

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW001	6-32 ss pem fastener	560-9106-010
HW002	Polarizing key box cnt	515-7109-010
J 001	26-pos terminal block PC mt	515-7110-426
J 002	34-pos terminal block PC mt	515-7110-434
J 003	34-pos latch ejection header	515-9031-400
NP001	External connector label	559-0069-060
P 001	26-pin locking straight header	515-9031-397
PC001	PC board	035-2000-220

POWER SUPPLY FILTER BOARD
PART NO. 023-2000-250

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 001	1000 µF 50V axial low temp	510-4350-102
C 002	1000 µF 50V axial low temp	510-4350-102
C 003	1000 µF 50V axial low temp	510-4350-102
EP020	Ferrite bead	517-2002-007
EP021	Ferrite bead	517-2002-007
PC001	PC board	035-2000-240

RF INTERFACE BOARD
PART NO. 023-2008-110

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 101	.1 µF ±10% X7R chip	510-3606-104
C 102	2.2 µF 20V tantalum SMD	510-2626-229
C 103	4.7 µF 16V tantalum SMD	510-2625-479
C 104	.1 µF ±10% X7R 1206 chip	510-3606-104
C 105	39 pF ±5% NPO 1206 chip	510-3602-390
C 107	2.2 µF 20V tantalum SMD	510-2626-229
C 108	.018 µF ±10% X7R 0805 chip	510-3605-183
C 109	.001 µF ±5% NPO 1206 chip	510-3602-102
C 110	.1 µF ±10% X7R 1206 chip	510-3606-104
C 111	.047 µF ±10% X7R 1206 chip	510-3606-473
C 112	1 µF 35V tantalum SMD	510-2628-109
C 113	.047 µF ±10% X7R 1206 chip	510-3606-473
C 114	1 µF 35V tantalum SMD	510-2628-109
C 115	.047 µF ±10% X7R 1206 chip	510-3606-473
C 116	.01 µF ±10% X7R 1206 chip	510-3606-103
C 117	1000 µF 50V axial low temp	510-4350-102
C 119	.1 µF ±10% X7R 1206 chip	510-3606-104
C 120	.1 µF ±10% X7R 1206 chip	510-3606-104
C 125	.01 µF ±10% X7R 1206 chip	510-3606-103
C 126	.018 µF ±10% X7R 0805 chip	510-3605-183
C 130	.1 µF ±10% X7R 1206 chip	510-3606-104
C 132	.001 µF ±5% NPO 1206 chip	510-3602-102
C 135	.001 µF ±5% NPO 1206 chip	510-3602-102
C 138	.001 µF ±5% NPO 1206 chip	510-3602-102
C 141	.001 µF ±5% NPO 1206 chip	510-3602-102
C 143	.1 µF ±10% X7R 1206 chip	510-3606-104
C 149	.1 µF ±10% X7R 1206 chip	510-3606-104
C 150	.001 µF ±5% NPO 1206 chip	510-3602-102
CR101	Switching SOT-23	523-1504-002
CR103	3.9V zener SOT-23	523-2016-399
CR104	4.7V zener SOT-23	523-2016-479
CR107	5.1V zener SOT-23	523-2016-519
CR108	5.1V zener SOT-23	523-2016-519
CR109	5.1V zener SOT-23	523-2016-519
CR110	5.1V zener SOT-23	523-2016-519
CR111	Dual switching common-cath	523-1504-022
EP101	Terminal lug 2104-06	586-0005-106
EP102	Terminal lug 2104-06	586-0005-106
EP103	Terminal lug 2104-06	586-0005-106
EP104	Terminal lug 2104-06	586-0005-106
EP105	Terminal lug 2104-06	586-0005-106

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
F 101	2A 250V AC sub-min	534-0017-017
F 102	2A 250V AC sub-min	534-0017-017
FH101	Fuse holder PC mount	534-1017-001
FH102	Fuse holder PC mount	534-1017-001
HW105	Polarizing key box cnt	515-7109-010
HW106	Polarizing key box cnt	515-7109-010
HW247	6-32 machine panhead philips	575-1606-012
J 101	36-pin right angle radial	515-0511-001
J 102	20-pin straight low profile	515-9031-376
J 103	20-pin straight low profile	515-9031-376
J 104	4-pin right angle header	515-9035-004
L 101	3 µH filter choke PC mount	542-5007-031
MP101	PA connector mounting shield	032-0758-028
P 101	Banana plug panel mount	108-0753-001
P 102	Banana plug panel mount	108-0753-001
P 103	Banana plug panel mount	108-0753-001
P 104	Banana plug panel mount	108-0753-001
P 105	Banana plug panel mount	108-0753-001
PC100	PC board	035-2008-110
Q 101	Si PNP low noise SOT-23	576-0003-657
Q 102	Si NPN SOT-23	576-0003-600
Q 103	PNP D-pak power	576-0002-603
Q 104	Si NPN low noise SOT-23	576-0003-657
Q 105	Si NPN amp SOT-23	576-0003-658
Q 106	Si NPN SOT-23	576-0003-600
Q 107	PNP D-pak power	576-0002-603
Q 108	Si NPN gen purp sw/amp	576-0001-300
R 045	100 ohm ±5% 1206 SMD	569-0115-101
R 046	100 ohm ±5% 1206 SMD	569-0115-101
R 048	7.5k ohm ±5% 1206 SMD	569-0115-752
R 049	1.5k ohm ±5% 1206 SMD	569-0115-152
R 050	4.99k ohm ±1% 1206 SMD	569-0111-368
R 051	100 ohm ±5% 1206 SMD	569-0115-101
R 052	10k ohm ±5% 1206 SMD	569-0115-103
R 053	10k ohm ±5% 1206 SMD	569-0115-103
R 054	10k ohm ±5% 1206 SMD	569-0115-103
R 055	2.7k ohm ±5% 1206 SMD	569-0115-272
R 056	470k ohm ±5% 1206 SMD	569-0115-474
R 057	10k ohm ±5% 1206 SMD	569-0115-103
R 059	10k ohm ±5% 1206 SMD	569-0115-103
R 061	43k ohm ±5% 1206 SMD	569-0115-433
R 063	10k ohm ±5% 1206 SMD	569-0115-103
R 064	43k ohm ±5% 1206 SMD	569-0115-433
R 065	10k ohm ±5% 1206 SMD	569-0115-103
R 066	43k ohm ±5% 1206 SMD	569-0115-433
R 073	10k ohm ±5% 1206 SMD	569-0115-103
R 074	1k ohm ±5% 1206 SMD	569-0115-102
R 075	1k ohm ±5% 1206 SMD	569-0115-102
R 076	5k ohm single turn trimmer	562-0112-502
R 078	270k ohm ±5% 1206 SMD	569-0115-274
R 079	1k ohm ±1% 1206 SMD	569-0111-301
R 080	1k ohm ±1% 1206 SMD	569-0111-301
R 081	470 ohm ±5% 1206 SMD	569-0115-471
R 082	270k ohm ±5% 1206 SMD	569-0115-274
R 083	1k ohm ±1% 1206 SMD	569-0111-301
R 084	1k ohm ±1% 1206 SMD	569-0111-301
R 085	470 ohm ±5% 1206 SMD	569-0115-471
R 086	270k ohm ±5% 1206 SMD	569-0115-274
R 087	1k ohm ±1% 1206 SMD	569-0111-301
R 088	1k ohm ±1% 1206 SMD	569-0111-301
R 089	470 ohm ±5% 1206 SMD	569-0115-471
R 090	270k ohm ±5% 1206 SMD	569-0115-274
R 091	1k ohm ±1% 1206 SMD	569-0111-301
R 092	1k ohm ±1% 1206 SMD	569-0111-301
R 093	470 ohm ±5% 1206 SMD	569-0115-471
R 094	5.1k ohm ±5% 1206 SMD	569-0115-512
R 095	1k ohm ±5% 1206 SMD	569-0115-102
R 100	100 ohm ±5% 1206 SMD	569-0115-101
R 101	1k ohm ±5% 1206 SMD	569-0115-102
R 102	2.7k ohm ±5% 1206 SMD	569-0115-272
R 103	270k ohm ±5% 1206 SMD	569-0115-274
R 104	270k ohm ±5% 1206 SMD	569-0115-274
R 105	2.7k ohm ±5% 1206 SMD	569-0115-272
R 106	10k ohm ±5% 1206 SMD	569-0115-103
R 107	560 ohm ±5% 1206 SMD	569-0115-561
R 108	2.7k ohm ±5% 1206 SMD	569-0115-272
R 109	1k ohm ±5% 1206 SMD	569-0115-102
R 110	5.1k ohm ±5% 1206 SMD	569-0115-512
R 111	330 ohm ±5% 1206 SMD	569-0115-331
R 112	1k ohm ±5% 1206 SMD	569-0115-102
R 113	1.8k ohm ±5% 1206 SMD	569-0115-182
R 114	1.8k ohm ±5% 1206 SMD	569-0115-182
R 115	470 ohm ±5% 1206 SMD	569-0115-471
R 116	470 ohm ±5% 1206 SMD	569-0115-471
R 117	270 ohm ±5% 1206 SMD	569-0115-271

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 118	20k ohm ±1% 1206 SMD	569-0111-430
R 119	20k ohm ±1% 1206 SMD	569-0111-430
R 120	10k ohm ±1% 1206 SMD	569-0111-401
R 121	20k ohm ±1% 1206 SMD	569-0111-430
R 122	10k ohm ±1% 1206 SMD	569-0111-401
R 123	20k ohm ±1% 1206 SMD	569-0111-430
R 124	10k ohm ±1% 1206 SMD	569-0111-401
R 125	20k ohm ±1% 1206 SMD	569-0111-430
R 126	10k ohm ±1% 1206 SMD	569-0111-401
R 127	20k ohm ±1% 1206 SMD	569-0111-430
R 128	10k ohm ±1% 1206 SMD	569-0111-401
R 129	20k ohm ±1% 1206 SMD	569-0111-430
R 130	10k ohm ±1% 1206 SMD	569-0111-401
R 131	20k ohm ±1% 1206 SMD	569-0111-430
R 132	10k ohm ±1% 1206 SMD	569-0111-401
R 133	20k ohm ±1% 1206 SMD	569-0111-430
R 134	20k ohm ±1% 1206 SMD	569-0111-430
R 135	22k ohm ±5% 1206 SMD	569-0115-223
R 136	22k ohm ±5% 1206 SMD	569-0115-223
R 137	22k ohm ±5% 1206 SMD	569-0115-223
R 138	22k ohm ±5% 1206 SMD	569-0115-223
R 139	10k ohm ±5% 1206 SMD	569-0115-103
R 140	10k ohm ±5% 1206 SMD	569-0115-103
R 141	10k ohm ±5% 1206 SMD	569-0115-103
R 142	10k ohm ±5% 1206 SMD	569-0115-103
R 143	22k ohm ±5% 1206 SMD	569-0115-223
R 144	22k ohm ±5% 1206 SMD	569-0115-223
R 145	22k ohm ±5% 1206 SMD	569-0115-223
R 146	22k ohm ±5% 1206 SMD	569-0115-223
R 147	22k ohm ±5% 1206 SMD	569-0115-223
R 148	22k ohm ±5% 1206 SMD	569-0115-223
R 149	22k ohm ±5% 1206 SMD	569-0115-223
R 151	10k ohm ±5% 1206 SMD	569-0115-103
R 152	10k ohm ±5% 1206 SMD	569-0115-103
R 153	22k ohm ±5% 1206 SMD	569-0115-223
R 154	22k ohm ±5% 1206 SMD	569-0115-223
R 155	22k ohm ±5% 1206 SMD	569-0115-223
R 156	22k ohm ±5% 1206 SMD	569-0115-223
R 157	10k ohm ±5% 1206 SMD	569-0115-103
R 158	10k ohm ±5% 1206 SMD	569-0115-103
R 159	10k ohm ±5% 1206 SMD	569-0115-103
R 160	22k ohm ±5% 1206 SMD	569-0115-223
R 161	22k ohm ±5% 1206 SMD	569-0115-223
R 162	22k ohm ±5% 1206 SMD	569-0115-223
R 163	22k ohm ±5% 1206 SMD	569-0115-223
R 164	22k ohm ±5% 1206 SMD	569-0115-223
R 165	22k ohm ±5% 1206 SMD	569-0115-223
R 166	22k ohm ±5% 1206 SMD	569-0115-223
R 167	1k ohm ±1% 1206 SMD	569-0111-301
R 168	10k ohm ±5% 1206 SMD	569-0115-103
R 169	270k ohm ±5% 1206 SMD	569-0115-274
R 170	1k ohm ±1% 1206 SMD	569-0111-301
R 171	511 ohm ±1% 1206 SMD	569-0111-269
R 172	1k ohm ±5% 1206 SMD	569-0115-102
R 173	3.3k ohm ±5% 1206 SMD	569-0115-332
R 174	8.2k ohm ±5% 1206 SMD	569-0115-822
R 175	8.2k ohm ±5% 1206 SMD	569-0115-822
R 176	8.2k ohm ±5% 1206 SMD	569-0115-822
R 177	8.2k ohm ±5% 1206 SMD	569-0115-822
R 178	8.2k ohm ±5% 1206 SMD	569-0115-822
R 179	10k ohm ±5% 1206 SMD	569-0115-103
R 180	10k ohm ±5% 1206 SMD	569-0115-103
R 181	22 ohm ±5% 1206 SMD	569-0115-220
R 182	22 ohm ±5% 1206 SMD	569-0115-220
R 183	22 ohm ±5% 1206 SMD	569-0115-220
R 184	22 ohm ±5% 1206 SMD	569-0115-220
R 185	22k ohm ±5% 1206 SMD	569-0115-223
R 186	10k ohm ±5% 1206 SMD	569-0115-103
R 187	15k ohm ±5% 1206 SMD	569-0115-153
R 188	22 ohm ±5% 1206 SMD	569-0115-220
R 189	22 ohm ±5% 1206 SMD	569-0115-220
R 190	22 ohm ±5% 1206 SMD	569-0115-220
R 191	22 ohm ±5% 1206 SMD	569-0115-220
R 192	22k ohm ±5% 1206 SMD	569-0115-223
R 193	10k ohm ±5% 1206 SMD	569-0115-103
R 194	15k ohm ±5% 1206 SMD	569-0115-153
R 197	10k ohm ±5% 1206 SMD	569-0115-103
R 198	10k ohm ±5% 1206 SMD	569-0115-103
R 199	10k ohm ±5% 1206 SMD	569-0115-103
U 101	+5V regulator 78L05	544-2603-039
U 102	Dual op amp SOIC LM2904	544-2019-004
U 103	8-bit shift register MC14094	544-3016-094
U 104	8-chan mux 4051	544-3016-051
U 105	8-chan mux 4051	544-3016-051
U 106	8-chan mux 4051	544-3016-051
U 107	Dual op amp SOIC LM2904	544-2019-004
U 108	Dual op amp SOIC LM2904	544-2019-004
U 109	Quad op amp SOIC LM224	544-2020-014
U 110	Hex non-inv buffer 4050B	544-3016-050
U 111	Dual op amp SO-8 LM2904	544-2019-004
U 112	Quad op amp SOIC LM224	544-2020-014

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	REPEATER RX/EX MODULE PART NO. 023-2034-836	
HW001	5/8-24 x 0.094 hex nut	560-9079-028
HW002	5/8 x 0.02 int lockwasher CPS	596-9119-028
HW249	10-32 machine panhead ZPS	575-1610-020
HW250	#10 flat washer ZPS	596-1410-016
MP200	Transceiver pad	017-2210-105
PA002	Transceiver mechanical	023-2000-205
PA004	Receiver 400-430 MHz	023-2034-270
PA004	Receiver 430-470 MHz	023-2044-270
PA004	Receiver 470-512 MHz	023-2034-270
PA005	Exciter 400-430 MHz	023-2054-400
PA005	Exciter 430-470 MHz	023-2044-400
PA005	Exciter 470-512 MHz	023-2054-400
	RECEIVE VCO 403-470 MHz PART NO. 023-2044-800	
C 803	0.6-4.5 pF vertical SMT	512-0006-011
C 804	1.5 pF ±5% NPO 0805 chip (400-470 MHz)	510-3601-159
C 804	1.2 pF ±5% NPO 0805 chip (470-512 MHz)	510-3601-129
C 805	68 pF ±5% NPO 0805 chip	510-3601-680
C 806	0.5 pF ±0.1 pF high Q	510-3710-508
C 807	7.5 pF ±5% NPO 0805 chip	510-3601-759
C 808	7.5 pF ±5% NPO 0805 chip	510-3601-759
C 809	68 pF ±5% NPO 0805 chip	510-3601-680
C 810	68 pF ±5% NPO 0805 chip	510-3601-680
C 811	68 pF ±5% NPO 0805 chip	510-3601-680
C 812	15 µF 20V tantalum SMD	510-2626-150
C 813	68 pF ±5% NPO 0805 chip	510-3601-680
C 814	68 pF ±5% NPO 0805 chip	510-3601-680
CR801	Varactor SOD-323 BB535	523-5005-022
CR802	Varactor SOD-323 BB535	523-5005-022
J 001	2-pin PC mount wafer	515-9031-101
J 002	2-pin PC mount wafer	515-9031-101
J 003	4-pin PC mount wafer	515-9031-103
L 801	180 nH ±10% 0805 SMD (400-430 MHz)	542-9003-188
L 801	150 nH ±10% 0805 SMD (430-512 MHz)	542-9003-158
L 802	180 nH ±10% 0805 SMD (400-430 MHz)	542-9003-188
L 802	150 nH ±10% 0805 SMD (430-512 MHz)	542-9003-158
L 803	150 nH ±10% 0805 SMD	542-9003-158
L 804	150 nH ±10% 0805 SMD	542-9003-158
L 805	12mm resonator SMD	542-9006-004
MP400	UHF VCO shield	017-2226-044
PC800	PC board	035-2044-800
Q 801	Si NPN gen purp switch/amp	576-0001-300
Q 802	NPN UHF low noise SOT-23	576-0003-636
R 803	10 ohm ±5% 0805 chip	569-0105-100
R 804	3.6k ohm ±5% 0805 chip	569-0105-362
R 805	10 ohm ±5% 0805 chip	569-0105-100
R 806	5.1k ohm ±5% 0805 chip	569-0105-512
R 807	6.2k ohm ±5% 0805 SMD	569-0105-622
R 808	200 ohm ±5% 1206 SMD	569-0115-201
	12.5/25 kHz RECEIVER PART NO. 023-2034-270 (400-430 MHz) PART NO. 023-2044-270 (430-470 MHz) PART NO. 023-2054-270 (470-512 MHz)	
A 201	RF input coax	023-2000-161
A 203	Top Shield	023-2000-199
A 401	VCO 400-430 MHz	023-2034-800
	VCO 430-470 MHz	023-2044-800
	VCO 470-512 MHz	023-2054-800
C 101	5.6 pF ±5% NPO 1206 chip (400-430 MHz)	510-3602-569
	7.5 pF ±5% NPO 1206 chip (403-470 MHz)	510-3602-759
	6.8 pF ±5% NPO 1206 chip (470-512 MHz)	510-3602-689
C 103	12 pF ±5% NPO 1206 chip	510-3602-120
C 104	7.5 pF ±5% NPO 1206 chip (400-430 MHz)	510-3602-759
	6.2 pF ±5% NPO 1206 chip (403-470 MHz)	510-3602-629
	4.7 pF ±5% NPO 1206 chip (470-512 MHz)	510-3602-479

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 105	4.7 µF 16V tantalum SMD	510-2625-479
C 106	150 pF ±5% NPO 1206 chip	510-3602-151
C 107	4.7 µF 16V tantalum SMD	510-2625-479
C 108	150 pF ±5% NPO 1206 chip	510-3602-151
C 109	.001 µF ±5% NPO 1206 chip	510-3602-102
C 110	.001 µF ±5% NPO 1206 chip	510-3602-102
C 111	4.7 µF 16V tantalum SMD	510-2625-479
C 112	150 pF ±5% NPO 1206 chip	510-3602-151
C 113	150 pF ±5% NPO 1206 chip	510-3602-151
C 114	6.2 pF ±5% NPO 1206 chip (400-430 MHz)	510-3602-629
	6.8 pF ±5% NPO 1206 chip (403-512 MHz)	510-3602-689
C 115	6.8 pF ±5% NPO 1206 chip (400-430 MHz)	510-3602-689
	7.5 pF ±5% NPO 1206 chip (403-512 MHz)	510-3602-759
C 131	3.9 pF ±5% NPO 1206 chip	510-3602-399
C 132	10 pF ±5% NPO 1206 chip	510-3602-100
C 133	68 pF ±5% NPO 1206 chip	510-3602-680
C 134	.018 µF ±10% X7R 0805 chip	510-3605-183
C 135	68 pF ±5% NPO 1206 chip	510-3602-680
C 136	.018 µF ±10% X7R 0805 chip	510-3605-183
C 137	68 pF ±5% NPO 1206 chip	510-3602-680
C 138	68 pF ±5% NPO 1206 chip	510-3602-680
C 139	68 pF ±5% NPO 1206 chip	510-3602-680
C 140	68 pF ±5% NPO 1206 chip	510-3602-680
C 141	.001 µF ±5% NPO 1206 chip	510-3602-102
C 142	68 pF ±5% NPO 1206 chip	510-3602-680
C 143	.1 µF ±10% X7R 1210	510-3607-104
C 144	.018 µF ±10% X7R 0805 chip	510-3605-183
C 145	.018 µF ±10% X7R 0805 chip	510-3605-183
C 146	7.5 pF ±5% NPO 1206 chip	510-3602-759
C 147	22 pF ±5% NPO 1206 chip	510-3602-220
C 148	4.7 µF 16V tantalum SMD	510-2625-479
C 149	68 pF ±5% NPO 1206 chip	510-3602-680
C 150	.001 µF ±5% NPO 1206 chip	510-3602-102
C 151	68 pF ±5% NPO 1206 chip	510-3602-680
C 152	3.9 pF ±5% NPO 1206 chip	510-3602-399
C 153	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 154	.018 µF ±10% X7R 0805 chip	510-3605-183
C 155	.018 µF ±10% X7R 0805 chip	510-3605-183
C 156	10 pF ±5% NPO 1206 chip	510-3602-100
C 157	68 pF ±5% NPO 1206 chip	510-3602-680
C 158	1.5 µF 25V tantalum SMD	510-2627-159
C 159	.001 µF ±5% NPO 1206 chip	510-3602-102
C 160	68 pF ±5% NPO 1206 chip	510-3602-680
C 161	4.7 µF 16V tantalum SMD	510-2625-479
C 162	5.6 pF ±5% NPO 1206	510-3602-569
C 163	8.2 pF ±5% NPO 1206 chip	510-3602-829
C 164	.018 µF ±10% X7R 0805 chip	510-3605-183
C 165	1 pF ±5% NPO 1206 chip	510-3602-109
C 166	.001 µF ±5% NPO 1206 chip	510-3602-102
C 167	.001 µF ±5% NPO 1206 chip	510-3602-102
C 169	6.8 pF ±5% NPO 1206	510-3602-689
C 201	10 pF ±5% NPO 1206 chip	510-3602-100
C 202	39 pF ±5% NPO 1206	510-3602-390
C 203	4.7 pF ±5% NPO 1206	510-3602-479
C 204	1.5-5 pF ceramic SMD	510-1602-001
C 205	39 pF ±5% NPO 1206	510-3602-390
C 206	10 pF ±5% NPO 1206 chip	510-3602-100
C 207	.01 µF ±10% X7R chip	510-3606-103
C 208	4.7 pF ±5% NPO 1206	510-3602-479
C 209	.001 µF ±5% NPO 1206 chip	510-3602-102
C 210	10 pF ±5% NPO 1206 chip	510-3602-100
C 211	.01 µF ±10% X7R chip	510-3606-103
C 212	39 pF ±5% NPO 1206	510-3602-390
C 213	4.7 pF ±5% NPO 1206	510-3602-479
C 214	1.5-5 pF ceramic SMD	510-1602-001
C 215	6.8 pF ±5% NPO 1206	510-3602-689
C 216	39 pF ±5% NPO 1206	510-3602-390
C 217	3.9 pF ±5% NPO 1206 chip	510-3602-399
C 218	.01 µF ±10% X7R 1206 chip	510-3606-103
C 219	.001 µF ±5% NPO 1206 chip	510-3602-102
C 220	.1 µF ±10% X7R chip	510-3606-104
C 221	.1 µF ±10% X7R chip	510-3606-104
C 222	.1 µF ±10% X7R chip	510-3606-104
C 223	.001 µF ±5% NPO 1206 chip	510-3602-102
C 225	.001 µF ±5% NPO 1206 chip	510-3602-102
C 226	.001 µF ±5% NPO 1206 chip	510-3602-102
C 227	4.7 pF ±5% NPO 1206	510-3602-479
C 228	27 pF ±5% NPO 1206 chip	510-3602-270
C 236	8.2 pF ±5% NPO 1206	510-3602-829
C 237	39 pF ±5% NPO 1206	510-3602-390
C 238	4.7 pF ±5% NPO 1206	510-3602-479
C 239	1.5-5 pF ceramic SMD	510-1602-001
C 240	100 pF ±5% NPO 1206 chip	510-3602-101
C 241	6.8 pF ±5% NPO 1206	510-3602-689
C 242	.001 µF ±5% NPO 1206 chip	510-3602-102
C 243	.01 µF ±10% X7R 1206 chip	510-3606-103
C 244	4.7 pF ±5% NPO 1206	510-3602-479
C 245	7.5 pF ±5% NPO 1206 chip	510-3602-759
C 246	.01 µF ±10% X7R 1206 chip	510-3606-103
C 247	39 pF ±5% NPO 1206 chip	510-3602-390

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 248	4.7 pF ±5% NPO 1206	510-3602-479
C 249	1.5-5 pF ceramic SMD	510-1602-001
C 250	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 251	39 pF ±5% NPO 1206	510-3602-390
C 252	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 253	.01 µF ±10% X7R 1206 chip	510-3606-103
C 254	.001 µF ±5% NPO 1206 chip	510-3602-102
C 255	.1 µF ±10% X7R	510-3606-104
C 256	.1 µF ±10% X7R	510-3606-104
C 257	.1 µF ±10% X7R	510-3606-104
C 258	.001 µF ±10% X7R 1206	510-3606-102
C 260	.001 µF ±10% X7R 1206	510-3606-102
C 261	.001 µF ±10% X7R 1206	510-3606-102
C 262	4.7 µF 16V tantalum SMD	510-2625-479
C 263	27 pF ±5% NPO 1206 chip	510-3602-270
C 265	100 pF ±5% NPO 1206	510-3602-101
C 266	.01 µF ±10% X7R 1206 chip	510-3606-103
C 267	4.7 µF 16V tantalum SMD	510-2625-479
C 268	.01 µF ±10% X7R 1206 chip	510-3606-103
C 269	.001 µF ±10% X7R 1206	510-3606-102
C 270	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 271	220 pF ±5% NPO 1206 chip	510-3602-221
C 275	100 pF ±5% NPO 1206 chip	510-3602-101
C 276	.01 µF ±10% X7R 1206 chip	510-3606-103
C 277	4.7 µF 16V tantalum SMD	510-2625-479
C 278	.01 µF ±10% X7R 1206 chip	510-3606-103
C 279	.001 µF ±10% X7R 1206	510-3606-102
C 280	220 pF ±5% NPO 1206 chip	510-3602-221
C 281	220 pF ±5% NPO 1206 chip	510-3602-221
C 282	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 283	120 pF ±5% NPO 1206 chip	510-3602-121
C 284	390 pF ±5% NPO 1206 chip	510-3602-391
C 301	.001 µF ±10% X7R 1206	510-3606-102
C 302	1.5 µF 25V tantalum SMD	510-2627-159
C 303	4.7 µF 16V tantalum SMD	510-2625-479
C 304	4.7 µF 16V tantalum SMD	510-2625-479
C 305	.001 µF ±5% NPO 1206 chip	510-3602-102
C 306	56 pF ±5% NPO 1206 chip	510-3602-560
C 307	.001 µF ±5% NPO 1206 chip	510-3602-102
C 308	1.5 µF 25V tantalum SMD	510-2627-159
C 309	4.7 µF 16V tantalum SMD	510-2625-479
C 310	.001 µF ±5% NPO 1206 chip	510-3602-102
C 311	.001 µF ±5% NPO 1206 chip	510-3602-102
C 312	1.5 µF 25V tantalum SMD	510-2627-159
C 313	.001 µF ±5% NPO 1206 chip	510-3602-102
C 314	4.7 µF 16V tantalum SMD	510-2625-479
C 315	.001 µF ±5% NPO 1206 chip	510-3602-102

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 316	1.5 µF 25V tantalum SMD	510-2627-159
C 317	4.7 µF 16V tantalum SMD	510-2625-479
C 318	.001 µF ±5% NPO 1206 chip	510-3602-102
C 401	.01 µF ±10% X7R 1206	510-3606-103
C 402	4.7 µF 16V tantalum SMD	510-2625-479
C 403	.01 µF ±10% X7R 1206	510-3606-103
C 404	820 pF ±5% NPO 1206 chip	510-3602-821
C 405	100 pF ±5% NPO 1206 chip	510-3602-101
C 406	.01 µF ±10% X7R 1206	510-3606-103
C 407	.001 µF ±5% NPO 1206 chip	510-3602-102
C 408	.01 µF ±5% NPO 1206 chip	510-3602-103
C 409	.01 µF ±5% NPO 1206 chip	510-3602-103
C 410	.001 µF ±5% NPO 1206 chip	510-3602-102
C 411	.1 µF ±10% X7R	510-3606-104
C 412	.1 µF ±10% X7R	510-3606-104
C 413	.01 µF ±10% X7R 1206	510-3606-103
C 414	6.8 µF 35V tantalum SMD	510-2628-689
C 415	.1 µF ±10% X7R	510-3606-104
C 416	.1 µF ±10% X7R	510-3606-104
C 431	100 pF ±5% NPO 1206 chip	510-3602-101
C 432	100 pF ±5% NPO 1206 chip	510-3602-101
C 433	68 pF ±5% NPO 1206 chip	510-3602-680
C 434	.1 µF ±10% X7R	510-3606-104
C 435	68 pF ±5% NPO 1206 chip	510-3602-680
C 436	.1 µF ±10% X7R	510-3606-104
C 437	.1 µF ±10% X7R	510-3606-104
C 438	4.7 µF 16V tantalum SMD	510-2625-479
C 439	68 pF ±5% NPO 1206 chip	510-3602-680
C 440	.018 µF ±10% X7R 0805 chip	510-3605-183
C 441	68 pF ±5% NPO 1206 chip	510-3602-680
C 442	.018 µF ±10% X7R 0805 chip	510-3605-183
C 443	68 pF ±5% NPO 1206 chip	510-3602-680
C 444	10 pF ±5% NPO 1206 chip	510-3602-100
C 445	.1 µF ±5% X7R 1206	510-3609-104
C 446	5.1 pF ±5% NPO 1206 chip	510-3602-519
C 447	1 µF 16V tantalum SMD	510-2625-109
C 448	1 µF 16V tantalum SMD	510-2625-109
C 449	.1 µF ±10% X7R	510-3606-104
C 450	1.5 µF 25V tantalum SMD	510-2627-159
C 451	.1 µF ±10% X7R	510-3606-104
C 452	10 pF ±5% NPO 1206 chip	510-3602-100
C 454	.001 µF ±5% NPO 1206 chip	510-3602-102
C 455	68 pF ±5% NPO 1206 chip	510-3602-680
C 456	3.3 pF ±5% NPO 1206 chip	510-3602-339
C 457	.018 µF ±10% X7R 0805 chip	510-3605-183
C 458	68 pF ±5% NPO 1206 chip	510-3602-680
C 459	68 pF ±5% NPO 1206 chip	510-3602-680

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 460	68 pF ±5% NPO 1206 chip	510-3602-680
C 461	68 pF ±5% NPO 1206 chip	510-3602-680
C 462	68 pF ±5% NPO 1206 chip	510-3602-680
C 463	68 pF ±5% NPO 1206 chip	510-3602-680
C 464	15 µF 20V tantalum SMD	510-2626-150
CH200	3-cavity helical front end	015-0901-038
CH201	3-cavity helical front end	015-0901-038
CH202	2-cavity helical front end	015-0901-028
CR101	Switching diode SOT-23	523-1504-002
CR131	5.6V zener SOT-23	523-2016-569
CR132	5.6V zener SOT-23	523-2016-569
CR133	Hot carrier diode SOT-23	523-1504-016
CR401	Si 9.1V zener SOT-23	523-2016-919
CR402	Dual switching diode SOT-23	523-1504-023
EP200	Crystal pin cer insulator mini	010-0345-280
HW201	Helical screw	013-1563-001
HW202	Tension lock nut CPS	560-1810-022
HW203	6-32 panhead 1/4" taptite	575-0606-008
HW205	Polarizing key box cnt	515-7109-010
J 201	20-pin right angle header	515-9031-375
J 203	3-pin single inline header	515-7100-003
J 204	3-pin single inline header	515-7100-003
J 205	3-pin single inline header	515-7100-003
L 101	2T 22 AWG 0.05 ID SMD (400-470 MHz)	542-0015-002
	3T 22 AWG 0.05 ID SMD (470-512 MHz)	542-0015-003
L 102	5.125T helical coil (400-430 MHz)	016-1929-161
	4.8125T helical coil (430-470 MHz)	016-1929-159
	4.4375T helical coil (470-512 MHz)	016-1929-155
L 103	5.125T helical coil (400-430 MHz)	016-1929-162
	4.8125T helical coil (430-470 MHz)	016-1929-159
	4.4375T helical coil (470-512 MHz)	016-1929-156
L 104	5.125T helical coil (400-430 MHz)	016-1929-161
	4.8125T helical coil (430-470 MHz)	016-1929-158
	4.4375T helical coil (470-512 MHz)	016-1929-155
L 105	3T 22 AWG 0.05 ID SMD (470-512 MHz)	542-0015-003
L 106	6T 22 AWG 0.05 ID SMD	542-0015-006
L 107	6T 22 AWG 0.05 ID SMD	542-0015-006
L 108	5.125T helical coil (400-430 MHz)	016-1929-161
	4.8125T helical coil (430-470 MHz)	016-1929-158
	4.4375T helical coil (470-512 MHz)	016-1929-155
L 109	5.125T helical coil (400-430 MHz)	016-1929-162
	4.8125T helical coil (430-470 MHz)	016-1929-159
	4.4375T helical coil (470-512 MHz)	016-1929-156
L 110	5.125T helical coil (400-430 MHz)	016-1929-161
	4.8125T helical coil (430-470 MHz)	016-1929-158
	4.4375T helical coil (470-512 MHz)	016-1929-155
L 111	4T 22 AWG 0.05 ID SMD (400-470 MHz)	542-0015-004
	3T 22 AWG 0.05 ID SMD (470-512 MHz)	542-0015-003
L 131	.1 µH SMD inductor	542-9001-108
L 132	.1 µH SMD inductor	542-9001-108
L 133	5.6 nH ceramic inductor	542-9003-566
L 134	.068 µH SMD inductor	542-9001-687
L 135	15 nH inductor LL2012 F15N	542-9003-157
L 136	18 nH inductor LL2012 F18N	542-9003-187
L 137	6.8 nH inductor LL2012 F6N8	542-9003-686
L 138	.068 µH SMD inductor	542-9001-687
L 139	12 nH inductor LL2012 F12N	542-9003-127
L 140	4.625T helical coil (400-430 MHz)	016-1929-157
	4.375T helical coil (430-470 MHz)	016-1929-153
	4.0625T helical coil (470-512 MHz)	016-1929-151

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 141	4.625T helical coil (400-430 MHz)	016-1929-157
	4.375T helical coil (430-470 MHz)	016-1929-153
	4.0625T helical coil (470-512 MHz)	016-1929-151
L 201	1 µH ±6% variable inductor	542-1012-015
L 202	.82 µH SMD inductor	542-9001-828
L 203	1 µH ±6% variable inductor	542-1012-015
L 204	1 µH ±6% variable inductor	542-1012-015
L 205	.82 µH SMD inductor	542-9001-828
L 206	1 µH ±6% variable inductor	542-1012-015
L 211	1 µH ±6% variable inductor	542-1012-015
L 212	.82 µH SMD inductor	542-9001-828
L 213	1 µH ±6% variable inductor	542-1012-015
L 214	1 µH ±6% variable inductor	542-1012-015
L 215	.82 µH SMD inductor	542-9001-828
L 216	1 µH ±6% variable inductor	542-1012-015
L 222	.1 µH inductor SMD	542-9001-108
L 223	.1 µH inductor SMD	542-9001-108
L 224	.1 µH inductor SMD	542-9001-108
L 401	.1 µH inductor SMD	542-9001-108
L 402	.1 µH inductor SMD	542-9001-108
L 403	.1 µH inductor SMD	542-9001-108
L 404	.1 µH inductor SMD	542-9001-108
L 405	.1 µH inductor SMD	542-9001-108
MP204	Bottom shield	017-2210-101
P 203	2-pos shorting socket	515-5010-001
P 204	2-pos shorting socket	515-5010-001
P 205	2-pos shorting socket	515-5010-001
PC200	PC board	035-2004-200
Q 101	NPN .2-2 GHz SO-8 amp	576-0003-604
Q 102	Si PNP low noise SOT-23	576-0003-657
Q 131	NPN UHF low noise SOT-23	576-0003-636
Q 132	NPN UHF low noise SOT-23	576-0003-636
Q 133	NPN .2-2 GHz SO-8 amp	576-0003-604
Q 134	NPN 750 mW UHF/800 MHz	576-0004-098
Q 201	Si NPN RF amp SOT-23	576-0003-602
Q 202	Si NPN RF amp SOT-23	576-0003-602
Q 203	Si NPN amp	576-0003-658
Q 204	Si NPN amp	576-0003-658
Q 401	Si NPN amp	576-0003-658
Q 402	Si NPN amp	576-0003-658

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Q 403	Si NPN amp	576-0003-658
Q 404	Si NPN amp	576-0003-658
Q 405	Si PNP low noise SOT-23	576-0003-657
Q 406	Si NPN GP sw/amp SOT-23	576-0001-300
Q 407	Si PNP low noise SOT-23	576-0003-650
Q 408	Si PNP low noise SOT-23	576-0003-650
Q 409	Si NPN GP sw/amp SOT-23	576-0001-300
Q 410	NPN UHF low noise SOT-23	576-0003-636
Q 411	NPN UHF low noise SOT-23	576-0003-636
R 101	24 ohm ±5% 1206 SMD	569-0115-240
R 102	10k ohm ±5% 1206 SMD	569-0115-103
R 103	1.8k ohm ±5% 1206 SMD	569-0115-182
R 104	10k ohm ±5% 1206 SMD	569-0115-103
R 106	1k ohm ±5% 1206 SMD	569-0115-102
R 107	43 ohm ±5% 1206 SMD	569-0115-430
R 108	43 ohm ±5% 1206 SMD	569-0115-430
R 131	1.3k ohm ±5% 1206 SMD	569-0115-132
R 132	1.5k ohm ±5% 1206 SMD	569-0115-152
R 133	1.3k ohm ±5% 1206 SMD	569-0115-132
R 134	3k ohm ±5% 1206 SMD	569-0115-302
R 135	51 ohm ±5% 1206 SMD	569-0115-510
R 136	10 ohm ±5% 1206 SMD	569-0115-100
R 137	36 ohm ±5% 1206 SMD	569-0115-360
R 138	75 ohm ±5% 1206 SMD	569-0115-750
R 139	300 ohm ±5% 1206 SMD	569-0115-101
R 140	18 ohm ±5% 1206 SMD	569-0115-180
R 141	300 ohm ±5% 1206 SMD	569-0115-101
R 142	270 ohm ±5% 1206 SMD	569-0115-271
R 143	1k ohm ±5% 1206 SMD	569-0115-102
R 144	390 ohm ±5% 1206 SMD	569-0115-391
R 145	240 ohm ±5% 1206 SMD	569-0115-241
R 146	240 ohm ±5% 1206 SMD	569-0115-241
R 147	300 ohm ±5% 1206 SMD	569-0115-101
R 148	18 ohm ±5% 1206 SMD	569-0115-180
R 149	300 ohm ±5% 1206 SMD	569-0115-101
R 150	270 ohm ±5% 1206 SMD	569-0115-271
R 151	1.2k ohm ±5% 1206 SMD	569-0115-122
R 152	270 ohm ±5% 1206 SMD	569-0115-271
R 153	68 ohm ±5% 1206 SMD	569-0115-680
R 154	68 ohm ±5% 1206 SMD	569-0115-680
R 157	1k ohm ±5% 1206 SMD	569-0115-102
R 158	51k ohm ±5% 1206 SMD	569-0115-513
R 159	100k ohm ±5% 1206 SMD	569-0115-104
R 160	10k ohm ±5% 1206 SMD	569-0115-103
R 161	100k ohm ±5% 1206 SMD	569-0115-104
R 201	1.8k ohm ±5% 1206 SMD	569-0115-182

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 202	680 ohm ±5% 1206 SMD	569-0115-681
R 203	51 ohm ±5% 1206 SMD	569-0115-510
R 204	220 ohm ±5% 1206 SMD	569-0115-221
R 205	560 ohm ±5% 1206 SMD	569-0115-561
R 206	1.8k ohm ±5% 1206 SMD	569-0115-182
R 207	51k ohm ±5% 1206 SMD	569-0115-513
R 208	100k ohm ±5% 1206 SMD	569-0115-104
R 211	5.1k ohm ±5% 1206 SMD	569-0115-512
R 212	100k ohm ±5% 1206 SMD	569-0115-104
R 213	10k ohm ±5% 1206 SMD	569-0115-103
R 214	100k ohm ±5% 1206 SMD	569-0115-104
R 215	20k ohm ±5% 1206 SMD	569-0115-203
R 216	5k ohm SMD top adjust	562-0135-502
R 217	10k ohm ±5% 1206 SMD	569-0115-103
R 218	10k ohm ±5% 1206 SMD	569-0115-103
R 219	5k ohm SMD top adjust	562-0135-502
R 220	5k ohm SMD top adjust	562-0135-502
R 221	5k ohm SMD top adjust	562-0135-502
R 233	1.8k ohm ±5% 1206 SMD	569-0115-182
R 234	680 ohm ±5% 1206 SMD	569-0115-681
R 235	51 ohm ±5% 1206 SMD	569-0115-510
R 236	220 ohm ±5% 1206 SMD	569-0115-221
R 237	560 ohm ±5% 1206 SMD	569-0115-561
R 238	1.8k ohm ±5% 1206 SMD	569-0115-182
R 239	51k ohm ±5% 1206 SMD	569-0115-513
R 240	100k ohm ±5% 1206 SMD	569-0115-104
R 243	5.1k ohm ±5% 1206 SMD	569-0115-512
R 244	100k ohm ±5% 1206 SMD	569-0115-104
R 245	100k ohm ±5% 1206 SMD	569-0115-104
R 246	100k ohm ±5% 1206 SMD	569-0115-104
R 247	20k ohm ±5% 1206 SMD	569-0115-203
R 248	5k ohm SMD top adjust	562-0135-502
R 249	1k ohm ±5% 1206 SMD	569-0115-102
R 250	10k ohm ±5% 1206 SMD	569-0115-103
R 253	5k ohm SMD top adjust	562-0135-502
R 254	1.8k ohm ±5% 1206 SMD	569-0115-182
R 255	680 ohm ±5% 1206 SMD	569-0115-681
R 256	51 ohm ±5% 1206 SMD	569-0115-510
R 257	220 ohm ±5% 1206 SMD	569-0115-221
R 258	10k ohm ±5% 1206 SMD	569-0115-103
R 259	1k ohm ±5% 1206 SMD	569-0115-102
R 260	270 ohm ±5% 1206 SMD	569-0115-271
R 261	10 ohm ±5% 1206 SMD	569-0115-100
R 262	1k ohm ±5% 1206 SMD	569-0115-102
R 301	220 ohm ±5% 1206 SMD	569-0115-221
R 302	220 ohm ±5% 1206 SMD	569-0115-221
R 303	220 ohm ±5% 1206 SMD	569-0115-221
R 304	240 ohm ±5% 1206 SMD	569-0115-241
R 305	43 ohm ±5% 1206 SMD	569-0115-430
R 311	Zero ohm ±10% 1206 SMD	569-0115-001
R 312	Zero ohm ±10% 1206 SMD	569-0115-001
R 315	Zero ohm ±10% 1206 SMD	569-0115-001
R 401	270 ohm ±5% 1206 SMD	569-0115-271
R 402	12.1k ohm ±1% 1206 SMD	569-0111-409
R 403	4.99k ohm ±1% 1206 SMD	569-0111-368
R 404	10 ohm ±5% 1206 SMD	569-0115-100
R 406	2.7k ohm ±5% 1206 SMD	569-0115-272
R 407	3.3k ohm ±5% 1206 SMD	569-0115-332
R 408	3.3k ohm ±5% 1206 SMD	569-0115-332
R 409	270 ohm ±5% 1206 SMD	569-0115-271
R 410	68k ohm ±5% 1206 SMD	569-0115-683
R 411	240 ohm ±5% 1206 SMD	569-0115-241
R 412	4.3k ohm ±5% 1206 SMD	569-0115-432
R 413	1k ohm ±5% 1206 SMD	569-0115-102
R 414	51 ohm ±5% 1206 SMD	569-0115-510
R 421	10k ohm ±5% 1206 SMD	569-0115-103
R 423	100 ohm ±5% 1206 SMD	569-0115-101
R 424	100 ohm ±5% 1206 SMD	569-0115-101
R 426	10k ohm ±5% 1206 SMD	569-0115-103
R 427	1k ohm ±5% 1206 SMD	569-0115-102
R 428	1k ohm ±5% 1206 SMD	569-0115-102
R 429	910 ohm ±5% 1206 SMD	569-0115-911
R 430	240 ohm ±5% 1206 SMD	569-0115-241
R 431	51 ohm ±5% 1206 SMD	569-0115-510
R 432	47k ohm ±5% 1206 SMD	569-0115-473
R 433	100k ohm ±5% 1206 SMD	569-0115-104
R 434	30k ohm ±5% 1206 SMD	569-0115-303
R 435	3k ohm ±5% 1206 SMD	569-0115-302
R 436	1k ohm ±5% 1206 SMD	569-0115-102
R 437	100k ohm ±5% 1206 SMD	569-0115-104
R 438	9.1k ohm ±5% 1206 SMD	569-0115-912
R 439	3.6k ohm ±5% 1206 SMD	569-0115-362
R 440	1k ohm ±5% 1206 SMD	569-0115-102
R 441	15k ohm ±5% 1206 SMD	569-0115-153
R 442	10 ohm ±5% 1206 SMD	569-0115-100
R 443	51 ohm ±5% 1206 SMD	569-0115-510
R 444	4.3k ohm ±5% 1206 SMD	569-0115-432
R 445	1.5k ohm ±5% 1206 SMD	569-0115-152
R 446	1.3k ohm ±5% 1206 SMD	569-0115-132
R 447	150 ohm ±5% 1206 SMD	569-0115-151
R 448	36 ohm ±5% 1206 SMD	569-0115-360
RT202	1k ohm ±5% chip thermistor	569-3013-002
RT204	1k ohm ±5% chip thermistor	569-3013-002

*** DANGER** Beryllium Product. Inhalation of dust or fumes may cause serious chronic lung disease

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
TP101	Red vertical tip jack 0.08	105-2202-211
TP201	Red vertical tip jack 0.08	105-2202-211
TP202	Red vertical tip jack 0.08	105-2202-211
TP203	Red vertical tip jack 0.08	105-2202-211
U 101	Mixer LRMS-2H	544-0007-013
U 102	Op amp SO-8 MC33172D	544-2019-017
U 201	FM IF MC3371D SO-16	544-2002-031
U 202	Dual op amp SO-8	544-2019-004
U 203	FM IF MC3371D SO-16	544-2002-031
U 204	Dual op amp SO-8	544-2019-004
U 301	+5V regulator 78L05 SO-8	544-2603-039
U 302	+12V regulator 78L12 SO-8	544-2603-032
U 303	+12V regulator 78L12 SO-8	544-2603-032
U 304	+12V regulator 78L12 SO-8	544-2603-032
U 401	Synthesizer MC145190F SOIC	544-3954-026
Y 401	17.5 MHz crystal 1 PPM	518-7117-500
Z 201	52.95 MHz 4-pole 15 kHz BW	532-0009-009
Z 202	52.95 MHz 4-pole 15 kHz BW	532-0009-009
Z 203	450 kHz cer filter 20 kHz BW	532-2004-013
Z 204	450 kHz cer filter 20 kHz BW	532-2004-013
Z 205	680 µH quad coil	542-5102-001
Z 211	52.95 MHz 4-pole 8 kHz BW	532-0009-011
Z 212	52.95 MHz 4-pole 8 kHz BW	532-0009-011
Z 213	450 kHz cer filter 9 kHz BW	532-2004-015
Z 214	450 kHz cer filter 9 kHz BW	532-2004-015
Z 215	680 µH quad coil	542-5102-001

TRANSMIT VCO 403-470 MHz
PART NO. 023-20X4-850

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 801	68 pF ±5% NPO 0805 SMD	510-3601-680
C 803	0.6-4.5 pF vertical SMT	512-0006-011
C 804	3.9 pF ±5% NPO 0805 chip (400-470 MHz)	510-3601-399
C 804	3.6 pF ±5% NPO 0805 chip (470-512 MHz)	510-3601-369
C 805	68 pF ±5% NPO 0805 chip	510-3601-680
C 806	0.7 pF ±0.1 pF high Q	510-3710-708
C 807	7.5 pF ±5% NPO 0805 chip	510-3601-759
C 808	7.5 pF ±5% NPO 0805 chip	510-3601-759
C 809	68 pF ±5% NPO 0805 chip	510-3601-680
C 810	68 pF ±5% NPO 0805 chip	510-3601-680
C 811	68 pF ±5% NPO 0805 chip	510-3601-680
C 812	15 µF 20V tantalum SMD	510-2626-150
C 813	68 pF ±5% NPO 0805 chip	510-3601-680
C 814	68 pF ±5% NPO 0805 chip	510-3601-680
C 815	1.2 pF ±5% NPO 0805 chip	510-3601-129
C 816	1 pF ±5% NPO 0805 chip	510-3601-109
CR801	Varactor SOD-323 BB535	523-5005-022
CR802	Varactor SOD-323 BB535	523-5005-022
CR803	Varactor SOD-323 BB535	523-5005-022
J 001	2-pin PC mount wafer	515-9031-101
J 002	2-pin PC mount wafer	515-9031-101
J 003	4-pin PC mount wafer	515-9031-103
L 801	150 nH ±10% 0805 SMD	542-9003-158
L 802	150 nH ±10% 0805 SMD	542-9003-158
L 803	150 nH ±10% 0805 SMD	542-9003-158
L 804	150 nH ±10% 0805 SMD	542-9003-158
L 805	12mm resonator SMD	542-9006-004
MP400	UHF VCO shield	017-2226-044
PC800	PC board	035-2044-850
Q 801	Si NPN gen purp switch/amp	576-0001-300
Q 802	NPN UHF low noise SOT-23	576-0003-636
R 803	10 ohm ±5% 0805 chip	569-0105-100
R 804	3.6k ohm ±5% 0805 chip	569-0105-362
R 805	10 ohm ±5% 0805 chip	569-0105-100
R 806	5.1k ohm ±5% 0805 chip	569-0105-512
R 807	6.2k ohm ±5% 0805 SMD	569-0105-622
R 808	200 ohm ±5% 1206 SMD	569-0115-201
R 809	47k ohm ±5% 0805 SMD	569-0105-473

EXCITER 403-470 MHz
PART NO. 023-2044-400

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 007	430-470 MHz VCO	023-2044-850
C 409	.01 µF ±10% X7R chip	510-3606-103
C 410	.01 µF ±10% X7R chip	510-3606-103
C 416	.1 µF ±10% X7R 1210	510-3607-104
C 417	.01 µF ±10% X7R 1206 chip	510-3606-103
C 418	.001 µF ±5% NPO 1206 chip	510-3602-102

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 419	.01 µF ±10% X7R chip	510-3606-103
C 420	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 421	4.7 µF 16V tantalum SMD	510-2625-479
C 422	.1 µF ±10% X7R 1210	510-3607-104
C 423	100 pF ±5% NPO 1206 chip	510-3602-101
C 424	.1 µF ±10% X7R 1210	510-3607-104
C 425	.1 µF ±10% X7R 1210	510-3607-104
C 426	4.7 µF 16V tantalum SMD	510-2625-479
C 427	68 pF ±5% NPO 1206 chip	510-3602-680
C 428	4.7 µF 16V tantalum SMD	510-2625-479
C 429	68 pF ±5% NPO 1206 chip	510-3602-680
C 430	68 pF ±5% NPO 1206 chip	510-3602-680
C 431	68 pF ±5% NPO 1206 chip	510-3602-680
C 432	.01 µF ±10% X7R chip	510-3606-103
C 433	6.8 pF ±5% NPO 1206 chip	510-3602-689
C 434	68 pF ±5% NPO 1206 chip	510-3602-680
C 441	100 pF ±5% NPO 1206 chip	510-3602-101
C 442	68 pF ±5% NPO 1206 chip	510-3602-680
C 443	68 pF ±5% NPO 1206 chip	510-3602-680
C 444	68 pF ±5% NPO 1206 chip	510-3602-680
C 446	.018 µF ±10% X7R 0805 chip	510-3605-183
C 447	4.7 µF 16V tantalum SMD	510-2625-479
C 448	68 pF ±5% NPO 1206 chip	510-3602-680
C 449	2.7 pF ±5% NPO 1206 chip	510-3602-279
C 450	7.5 pF ±5% NPO 1206 chip	510-3602-759
C 451	4.3 pF ±5% NPO 1206 chip	510-3602-439
C 452	6.2 pF ±5% NPO 1206 chip	510-3602-629
C 453	820 pF ±5% NPO 1206 chip	510-3602-821
C 454	68 pF ±5% NPO 1206 chip	510-3602-680
C 455	68 pF ±5% NPO 1206 chip	510-3602-680
C 456	68 pF ±5% NPO 1206 chip	510-3602-680
C 457	.018 µF ±10% X7R 0805 chip	510-3605-183
C 461	68 pF ±5% NPO 1206 chip	510-3602-680
C 462	.001 µF ±5% NPO 1206 chip	510-3602-102
C 463	15 µF 20V tantalum SMD	510-2626-150
C 464	.01 µF ±10% X7R chip	510-3606-103
C 465	.018 µF ±10% X7R 0805 chip	510-3605-183
C 466	.001 µF ±5% NPO 1206 chip	510-3602-102
C 467	1.5 µF 25V tantalum SMD	510-2627-159
C 468	4.7 µF 16V tantalum SMD	510-2625-479
C 469	4.7 µF 16V tantalum SMD	510-2625-479
C 470	.001 µF ±5% NPO 1206 chip	510-3602-102
C 471	.001 µF ±5% NPO 1206 chip	510-3602-102
C 472	1.5 µF 25V tantalum SMD	510-2627-159
C 474	4.7 µF 16V tantalum SMD	510-2625-479
C 475	.001 µF ±5% NPO 1206 chip	510-3602-102
C 476	4.7 µF 16V tantalum SMD	510-2625-479

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 479	.01 µF ±10% X7R 1206 chip	510-3606-103
C 480	68 pF ±5% NPO 1206 chip	510-3602-680
C 481	1 µF 16V tantalum SMD	510-2625-109
C 482	68 pF ±5% NPO 1206 chip	510-3602-680
C 483	68 pF ±5% NPO 1206 chip	510-3602-680
C 484	68 pF ±5% NPO 1206 chip	510-3602-680
C 485	68 pF ±5% NPO 1206 chip	510-3602-680
C 496	15 µF 20V tantalum SMD	510-2626-150
C 498	.018 µF ±10% X7R 0805 chip	510-3605-183
C 499	68 pF ±5% NPO 1206 chip	510-3602-680
C 500	22 pF ±5% NPO 1206 chip	510-3602-220
C 501	68 pF ±5% NPO 1206 chip	510-3602-680
C 502	.001 µF ±5% NPO 1206 chip	510-3602-102
C 503	.018 µF ±10% X7R 0805 chip	510-3605-183
C 504	.018 µF ±10% X7R 0805 chip	510-3605-183
C 505	8.2 pF ±5% NPO 1206 chip	510-3602-829
C 506	75 pF ±5% NPO 1206 chip	510-3602-750
C 507	4.7 µF 16V tantalum SMD	510-2625-479
C 508	68 pF ±5% NPO 1206 chip	510-3602-680
C 509	3.3 pF ±5% NPO 1206 chip	510-3602-339
C 510	6.2 pF ±5% NPO 1206 chip	510-3602-629
C 511	3.3 µF 16V tantalum SMD	510-2625-339
C 512	.33 µF 35V tantalum SMD	510-2628-338
C 513	.018 µF ±10% X7R 0805 chip	510-3605-183
C 514	68 pF ±5% NPO 1206 chip	510-3602-680
CR401	Si 9.1V zener SOT-23	523-2016-919
CR402	Si 5.6V zener SOT-23	523-2016-569
CR403	Si 5.6V zener SOT-23	523-2016-569
HW404	Polarized key box connector	515-7109-010
J 401	20-pin right angle header	515-9031-375
J 402	Right angle PC JCM-B	131-3701-301
L 402	.1 µH inductor SMD	542-9001-108
L 403	.1 µH inductor SMD	542-9001-108
L 405	.1 µH inductor SMD	542-9001-108
L 406	.1 µH inductor SMD	542-9001-108
L 407	.1 µH inductor SMD	542-9001-108
L 408	10 nH ±10% 0805 SMD	542-9003-107
L 409	.068 µH inductor SMD	542-9001-687
L 410	15 nH inductor LL2012 F15N	542-9003-157
L 411	.068 µH inductor SMD	542-9001-687
L 412	18 nH inductor LL2012 F18N	542-9003-187
PC401	PC board	035-2044-400

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Q 403	Si NPN amp	576-0003-658
Q 404	Si NPN amp	576-0003-658
Q 405	Si PNP switching	576-0003-612
Q 406	Si NPN low noise SOT-23	576-0003-636
Q 407	Si NPN low noise SOT-23	576-0003-636
Q 410	Si NPN amp	576-0003-658
Q 411	Si NPN low noise SOT-23	576-0003-636
Q 412	NPN 0.2-2 GHz SO-8	576-0003-604
Q 413	NPN 750 mW UHF/800 MHz	576-0004-098
R 402	10k ohm ±5% SMD 1206	569-0115-103
R 403	10k ohm ±5% SMD 1206	569-0115-103
R 404	100 ohm ±5% SMD 1206	569-0115-101
R 405	1k ohm ±5% SMD 1206	569-0115-102
R 414	12.1k ohm ±1% SMD 1206	569-0111-409
R 415	4.99k ohm ±1% SMD 1206	569-0111-368
R 416	270 ohm ±5% SMD 1206	569-0115-271
R 417	10k ohm ±5% SMD 1206	569-0115-103
R 419	12.1k ohm ±1% SMD 1206	569-0111-409
R 424	10k ohm ±5% SMD 1206	569-0115-103
R 425	50k ohm single turn trimmer	562-0112-503
R 426	10k ohm ±5% SMD 1206	569-0115-103
R 427	10k ohm ±5% SMD 1206	569-0115-103
R 428	10 ohm ±5% SMD 1206	569-0115-100
R 429	4.99k ohm ±1% SMD 1206	569-0111-368
R 430	2.7k ohm ±5% SMD 1206	569-0115-272
R 431	3.3k ohm ±5% SMD 1206	569-0115-332
R 432	3.3k ohm ±5% SMD 1206	569-0115-332
R 433	270 ohm ±5% SMD 1206	569-0115-271
R 434	150 ohm ±5% SMD 1206	569-0115-151
R 435	470 ohm ±5% SMD 1206	569-0115-471
R 436	100 ohm ±5% SMD 1206	569-0115-101
R 437	100 ohm ±5% SMD 1206	569-0115-101
R 438	10k ohm ±5% SMD 1206	569-0115-103
R 439	1k ohm ±5% SMD 1206	569-0115-102
R 440	1k ohm ±5% SMD 1206	569-0115-102
R 441	47k ohm ±5% SMD 1206	569-0115-473
R 442	100 ohm ±5% SMD 1206	569-0115-101
R 444	10k ohm ±5% SMD 1206	569-0115-103
R 445	82k ohm ±5% SMD 1206	569-0115-823
R 446	50k ohm single turn trimmer	562-0112-503
R 447	1k ohm ±5% SMD 1206	569-0115-102
R 448	10k ohm ±5% SMD 1206	569-0115-103
R 449	10k ohm ±5% SMD 1206	569-0115-103
R 450	10 ohm ±5% SMD 1206	569-0115-100
R 451	4.3k ohm ±5% SMD 1206	569-0115-432
R 452	110 ohm ±5% SMD 1206	569-0115-111

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 453	1.5k ohm ±5% SMD 1206	569-0115-152
R 454	1.3k ohm ±5% SMD 1206	569-0115-132
R 455	150 ohm ±5% SMD 1206	569-0115-151
R 456	470 ohm ±5% SMD 1206	569-0115-471
R 457	36 ohm ±5% SMD 1206	569-0115-360
R 458	3k ohm ±5% SMD 1206	569-0115-302
R 459	150 ohm ±5% SMD 1206	569-0115-151
R 460	36 ohm ±5% SMD 1206	569-0115-360
R 461	150 ohm ±5% SMD 1206	569-0115-151
R 462	10 ohm ±5% SMD 1206	569-0115-100
R 463	51 ohm ±5% SMD 1206	569-0115-510
R 464	330 ohm ±5% SMD 1206	569-0115-331
R 465	1.3k ohm ±5% SMD 1206	569-0115-132
R 466	1.5k ohm ±5% SMD 1206	569-0115-152
R 467	1.3k ohm ±5% SMD 1206	569-0115-132
R 468	75 ohm ±5% SMD 1206	569-0115-750
R 469	2k ohm ±5% SMD 1206	569-0115-202
R 470	270 ohm ±5% SMD 1206	569-0115-271
R 471	300 ohm ±5% SMD 1206	569-0115-301
R 472	300 ohm ±5% SMD 1206	569-0115-301
R 473	150 ohm ±5% SMD 1206	569-0115-151
R 474	36 ohm ±5% SMD 1206	569-0115-360
R 475	150 ohm ±5% SMD 1206	569-0115-151
R 476	150 ohm ±5% SMD 1206	569-0115-151
R 477	1.5k ohm ±5% SMD 1206	569-0115-152
R 478	200 ohm ±5% SMD 1206	569-0115-201
R 479	150 ohm ±5% SMD 1206	569-0115-151
R 480	7.5k ohm ±5% SMD 1206	569-0115-752
R 481	1.3k ohm ±5% SMD 1206	569-0115-132
R 482	Zero ohm ±5% SMD 1206	569-0115-001
R 486	12.1k ohm ±1% SMD 1206	569-0111-409
R 487	4.99k ohm ±1% SMD 1206	569-0111-368
R 488	10k ohm ±5% SMD 1206	569-0115-103
R 489	150 ohm ±5% SMD 1206	569-0115-151
R 491	Zero ohm ±5% SMD 1206	569-0115-001
R 493	6.8k ohm ±5% SMD 1206	569-0115-682
U 402	Dual op amp SO-8 2904	544-2019-004
U 403	Synthesizer SOIC MC145190	544-3954-026
U 404	Dual op amp SO-8	544-2019-004
U 405	+5V regulator 78L05 SO-8	544-2603-039
U 406	+12V regulator 78L12 SO-8	544-2603-032
U 407	Dual op amp SO-8	544-2019-004
Y 401	17.5 MHz, 1 PPM TCXO	518-7117-500

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	UHF FEEDBACK LOOP PART NO. 023-2004-530	
C 001	.1 µF µ% X7R 1206	510-3609-104
L 001	.082 µH inductor SMD	542-9001-827
P 001	Edge clip 48 mil	515-9034-004
P 002	Edge clip 48 mil	515-9034-004
PC502	PC board	035-2004-530
R 001	100 ohm ±5% X7R 1206	569-0175-101
	110 WATT POWER AMPLIFIER PART NO. 023-2044-500	
C 501	.018 µF ±10% X7R 0805 chip	510-3605-183
C 502	2.2 µF 20v tantalum SMD	510-2626-229
C 503	.1 µF ±10% X7R chip	510-3606-104
C 504	100 pF ±10% high Q cube	510-3663-101
C 505	100 pF ±10% high Q cube	510-3663-101
C 506	.018 µF ±10% X7R 0805 chip	510-3605-183
C 507	4.7 µF 16V tantalum SMD	510-2626-479
C 508	100 pF ±10% high Q cube	510-3663-101
C 509	.018 µF ±10% X7R 0805 chip	510-3605-183
C 510	1 µF 35V tantalum SMD	510-2628-109
C 511	.018 µF ±10% X7R 0805 chip	510-3605-183
C 512	100 pF ±10% high Q cube	510-3663-101
C 513	6.8 µF 35V tantalum SMD	510-2635-689
C 514	.018 µF ±10% X7R 0805 chip	510-3605-183
C 515	100 pF ±10% high Q cube	510-3663-101
C 516	.018 µF ±10% X7R 0805 chip	510-3605-183
C 517	100 pF ±10% high Q cube	510-3663-101
C 518	.1 µF ±10% X7R chip	510-3606-104
C 519	100 pF ±10% high Q cube	510-3663-101
C 520	.018 µF ±10% X7R 0805 chip	510-3605-183
C 521	.1 µF ±10% X7R chip	510-3606-104
C 522	6.8 µF 35V tantalum SMD	510-2635-689
C 523	100 pF ±10% high Q cube	510-3663-101
C 524	.018 µF ±10% X7R 0805 chip	510-3605-183
C 525	.018 µF ±10% X7R 0805 chip	510-3605-183
C 526	62 pF ±5% NPO 1206 chip	510-3602-620
C 527	12 pF ±5% NPO 1206 chip (403-430 MHz)	510-3602-120
	8.2 pF ±5% NPO 1206 chip (430-470 MHz)	510-3602-829
	9.1 pF ±5% NPO 1206 chip (470-512 MHz)	510-3602-919
C 528	30 pF ±5% NPO 1206 chip (403-430 MHz)	510-3602-300
	27 pF ±5% 250V mica (430-470 MHz)	510-0220-270
	22 pF ±5% 250V mica (470-512 MHz)	510-0220-220
C 529	27 pF ±5% 250V mica (400-470 MHz)	510-0220-270
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 530	.018 µF ±10% X7R 0805 chip	510-3605-183
C 531	.018 µF ±10% X7R 0805 chip	510-3605-183
C 532	100 pF ±10% high Q cube	510-3663-101
C 533	.018 µF ±10% X7R 0805 chip	510-3605-183
C 534	6.8 µF 35V tantalum SMD	510-2635-689
C 535	100 pF ±10% high Q cube	510-3663-101
C 536	.018 µF ±10% X7R 0805 chip	510-3605-183
C 537	6.8 µF 35V tantalum SMD	510-2635-689
C 538	100 pF ±10% high Q cube	510-3663-101
C 539	.018 µF ±10% X7R 0805 chip	510-3605-183
C 540	.018 µF ±10% X7R 0805 chip	510-3605-183
C 541	27 pF ±5% 250V mica (400-470 MHz)	510-0220-270
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 542	22 pF ±5% 250V mica (400-470 MHz)	510-0220-220
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 543	18 pF ±5% 250V mica (400-430 MHz)	510-0220-180
	15 pF ±5% 250V mica (430-470 MHz)	510-0220-150
	10 pF ±5% 250V mica (470-512 MHz)	510-0220-100
C 545	27 pF ±5% 250V mica (400-430 MHz)	510-0220-270
	56 pF ±10% high Q cube (430-470 MHz)	510-3663-560
	27 pF ±5% 250V mica (470-512 MHz)	510-0220-270
C 546	12 pF ±5% 250V mica (400-430 MHz)	510-0220-120
	8.2 pF ±10% high Q cube (430-470 MHz)	510-3663-829
	12 pF ±5% 250V mica (470-512 MHz)	510-0220-120

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 547	30 pF ±5% 250V mica (400-430 MHz)	510-0220-300
	22 pF ±5% 250V mica (430-512 MHz)	510-0220-220
C 548	27 pF ±5% 250V mica (400-470 MHz)	510-0220-270
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 549	.018 µF ±10% X7R 0805 chip	510-3605-183
C 550	.018 µF ±10% X7R 0805 chip	510-3605-183
C 551	100 pF ±10% high Q cube	510-3663-101
C 552	.018 µF ±10% X7R 0805 chip	510-3605-183
C 553	6.8 µF 35V tantalum SMD	510-2635-689
C 554	100 pF ±10% high Q cube	510-3663-101
C 555	.018 µF ±10% X7R 0805 chip	510-3605-183
C 556	6.8 µF 35V tantalum SMD	510-2635-689
C 557	100 pF ±10% high Q cube	510-3663-101
C 558	.018 µF ±10% X7R 0805 chip	510-3605-183
C 559	.018 µF ±10% X7R 0805 chip	510-3605-183
C 560	27 pF ±5% 250V mica (400-470 MHz)	510-0220-270
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 561	27 pF ±5% 250V mica (400-430 MHz)	510-0220-270
	30 pF ±5% 250V mica (430-470 MHz)	510-0220-300
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 562	22 pF ±5% 250V mica (400-430 MHz)	510-0220-220
	12 pF ±5% 250V mica (430-512 MHz)	510-0220-120
C 563	100 pF ±10% high Q cube	510-3663-101
C 564	27 pF ±5% 250V mica (400-430 MHz)	510-0220-270
	56 pF ±10% high Q cube (430-470 MHz)	510-3663-560
	27 pF ±5% 250V mica (470-512 MHz)	510-0220-270
C 565	12 pF ±5% 250V mica (400-430 MHz)	510-0220-120
	8.2 pF ±10% high Q cube (430-470 MHz)	510-3663-829
	12 pF ±5% 250V mica (470-512 MHz)	510-0220-120
C 566	.018 µF ±10% X7R 0805 chip	510-3605-183
C 567	.018 µF ±10% X7R 0805 chip	510-3605-183
C 568	30 pF ±5% 250V mica (400-430 MHz)	510-0220-300
	22 pF ±5% 250V mica (430-512 MHz)	510-0220-220
C 569	27 pF ±5% 250V mica (400-470 MHz)	510-0220-270
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 570	100 pF ±10% high Q cube	510-3663-101
C 571	.018 µF ±10% X7R 0805 chip	510-3605-183
C 572	6.8 µF 35V tantalum SMD	510-2635-689
C 573	100 pF ±10% high Q cube	510-3663-101
C 574	.018 µF ±10% X7R 0805 chip	510-3605-183
C 575	6.8 µF 35V tantalum SMD	510-2635-689
C 576	100 pF ±10% high Q cube	510-3663-101
C 577	.018 µF ±10% X7R 0805 chip	510-3605-183
C 578	.018 µF ±10% X7R 0805 chip	510-3605-183
C 579	27 pF ±5% 250V mica (400-470 MHz)	510-0220-270
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 580	27 pF ±5% 250V mica (400-430 MHz)	510-0220-270
	30 pF ±5% 250V mica (430-470 MHz)	510-0220-300
	39 pF ±5% 250V mica (470-512 MHz)	510-0220-390
C 581	22 pF ±5% 250V mica (400-430 MHz)	510-0220-220
	12 pF ±5% 250V mica (430-512 MHz)	510-0220-120
C 582	100 pF ±10% high Q cube	510-3663-101
C 583	.018 µF ±10% X7R 0805 chip	510-3605-183
C 584	.001 µF ±5% NPO 1206 chip	510-3602-102
C 585	39 pF ±5% NPO 1206 chip	510-3602-390
C 586	1 µF 16V tantalum SMD	510-2625-109
C 587	.018 µF ±10% X7R 0805 chip	510-3605-183
C 588	100 pF ±10% high Q cube	510-3663-101
C 589	1 µF 35V tantalum SMD	510-2628-109
C 590	4.7 µF 16V tantalum SMD	510-2625-479
C 591	4.7 µF 16V tantalum SMD	510-2625-479
C 592	.018 µF ±10% X7R 0805 chip	510-3605-183
C 593	.001 µF ±5% NPO 1206 chip	510-3602-102
C 594	100 pF ±10% high Q cube	510-3663-101
C 595	1 µF 35V tantalum SMD	510-2628-109
C 596	4.7 µF 16V tantalum SMD	510-2625-479

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 597	.018 µF ±10% X7R 0805 chip	510-3605-183
C 598	.001 µF ±5% NPO 1206 chip	510-3602-102
C 600	1.7-11 pF vert mt T-cap (430-512 MHz)	187-0106-175
C 601	.1 µF ±10% X7R chip	510-3606-104
C 602	.1 µF ±10% X7R chip	510-3606-104
C 603	.018 µF ±10% X7R 0805 chip	510-3605-183
C 604	10 pF ±5% 250V mica (400-430 MHz)	510-0220-100
CR501	Si 6.2V ±5% zener SOT-23	523-2016-629
CR502	Si 6.2V ±5% zener SOT-23	523-2016-629
CR503	Si 6.2V ±5% zener SOT-23	523-2016-629
EP501	Ferrite bead SMD 1233	517-2503-010
EP502	Ferrite bead SMD 1233	517-2503-010
EP503	Ferrite bead SMD 1233	517-2503-010
EP504	Ferrite bead SMD 1233	517-2503-010
EP505	Ferrite bead SMD 1233	517-2503-010
EP506	Ferrite bead SMD 1233	517-2503-010
EP507	Ferrite bead SMD 1233	517-2503-010
EP508	Ferrite bead SMD 1233	517-2503-010
EP509	Ferrite bead SMD 1233	517-2503-010
EP510	Ferrite bead SMD 1233	517-2503-010
EP511	Ferrite bead SMD 1233	517-2503-010
EP520	Ferrite bead SMD 1233	517-2503-010
L 504	.1 µH inductor SMD	542-9001-108
L 505	.1 µH inductor SMD	542-9001-108
L 506	.1 µH inductor SMD	542-9001-108
PC500	PC board	035-2044-500
Q 501*	100W UHF RF power amp	576-0006-119
Q 502*	100W UHF RF power amp	576-0006-119
Q 503*	100W UHF RF power amp	576-0006-119
Q 504	Si NPN GP sw/amp SOT-23	576-0001-300
Q 505	Si NPN GP sw/amp SOT-23	576-0001-300
R 501	150 ohm ±5% 1206 SMD	569-0115-151
R 502	36 ohm ±5% 1206 SMD	569-0115-360
R 503	150 ohm ±5% 1206 SMD	569-0115-151
R 504	.03 ohm ±5% SMD 2W	569-2019-307
R 505	200 ohm ±5% 1206 SMD	569-0115-201
R 506	200 ohm ±5% 1206 SMD	569-0115-201
R 508	2k ohm ±5% 1206 SMD	569-0115-202
R 509	4.7k ohm SMD top adjust	569-0115-472
R 510	5k ohm ±5% 1206 SMD	569-0135-502
R 511	2.2k ohm ±5% 1206 SMD	569-0115-222
R 512	10k ohm ±5% 1206 SMD	569-0115-103
R 513	4.7k ohm ±5% 1206 SMD	569-0115-472
R 514	.03 ohm ±5% SMD 2W	569-2019-307
R 515	200 ohm ±5% 1206 SMD	569-0115-201
R 516	200 ohm ±5% 1206 SMD	569-0115-201
R 517	Zero ohm ±5% 1206 SMD	569-0115-001
R 518	2k ohm ±5% 1206 SMD	569-0115-202
R 519*	100 ohm 20W flange mount	569-5001-001
R 520	4.7k ohm ±5% 1206 SMD	569-0115-472
R 521	5k ohm SMD top adjust	569-0115-502
R 522	2.2k ohm ±5% 1206 SMD	569-0115-222
R 523	10k ohm ±5% 1206 SMD	569-0115-103
R 524	4.7k ohm ±5% 1206 SMD	569-0115-472
R 525	.03 ohm ±5% SMD 2W	569-2019-307
R 526	200 ohm ±5% 1206 SMD	569-0115-201
R 527	200 ohm ±5% 1206 SMD	569-0115-201
R 528	2k ohm ±5% 1206 SMD	569-0115-202
R 529	4.7k ohm ±5% 1206 SMD	569-0115-472
R 530	5k ohm SMD top adjust	569-0115-502
R 531	2.2k ohm ±5% 1206 SMD	569-0115-222
R 532	10k ohm ±5% 1206 SMD	569-0115-103
R 533	4.7k ohm ±5% 1206 SMD	569-0115-472
R 534	.03 ohm ±5% SMD 2W	569-2019-307
R 535	200 ohm ±5% 1206 SMD	569-0115-201
R 536	200 ohm ±5% 1206 SMD	569-0115-201
R 537	2k ohm ±5% 1206 SMD	569-0115-202
R 538*	100 ohm 100W flange mount	569-5001-002
R 539	470 ohm ±5% 1206 SMD	569-0115-471
R 540	301k ohm ±1% 1206 SMD	569-0111-547
R 541	100k ohm ±1% 1206 SMD	569-0111-501
R 542	75 ohm ±5% 1206 SMD	569-0115-750
R 543	56 ohm ±5% 1206 SMD	569-0115-560
R 544	240 ohm ±5% 1206 SMD	569-0115-241
R 545	Zero ohm ±5% 1206 SMD	569-0115-001
R 547	51 ohm ±5% 2512 SMD	569-0175-510
R 548	51 ohm ±5% 2512 SMD	569-0175-510
R 549	51 ohm ±5% 2512 SMD	569-0175-510
R 550	10k ohm ±5% 1206 SMD	569-0115-103
R 551	100k ohm ±5% 1206 SMD	569-0115-104
R 552	10k ohm ±5% 1206 SMD	569-0115-103
RT501	80k ±5% chip thermistor	569-3006-803
RT502	80k ±5% chip thermistor	569-3006-803
RT503	80k ±5% chip thermistor	569-3006-803
U 501	5W power module (400-430 MHz)	544-4001-063
	5W power module (430-512 MHz)	544-4001-064

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 502	High side current sense	544-2039-002
U 503	High side current sense	544-2039-002
U 504	High side current sense	544-2039-002
U 505	High side current sense	544-2039-002
U 506	Dual op amp 532 SO-8	544-2019-004
U 507	Temp sensor LM35 SO-8	544-2032-003
U 508	+5V regulator 78L05 SO-8	544-2603-039
U 509	+5V regulator 78L05 SO-8	544-2603-039

LOW-PASS FILTER
PART NO. 023-2004-600

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 620	Low pass filter assembly	023-2004-620
MP600	LPF mounting plate	017-2222-264

FORWARD/REVERSE POWER DETECTOR
PART NO. 023-2004-660

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 601	68 pF ±5% NPO 1206 chip	510-3602-680
C 602	68 pF ±5% NPO 1206 chip	510-3602-680
C 603	68 pF ±5% NPO 1206 chip	510-3602-680
C 604	68 pF ±5% NPO 1206 chip	510-3602-680
C 605	68 pF ±5% NPO 1206 chip	510-3602-680
C 606	68 pF ±5% NPO 1206 chip	510-3602-680
C 607	.001 µF ±5% NPO 1206 chip	510-3602-102
C 608	68 pF ±5% NPO 1206 chip	510-3602-680
C 609	.001 µF ±5% NPO 1206 chip	510-3602-102
C 610	68 pF ±5% NPO 1206 chip	510-3602-680
C 611	4.7 µF 10V tantalum SMD	510-2624-479
C 612	.001 µF ±5% NPO 1206 chip	510-3602-102
C 613	68 pF ±5% NPO 1206 chip	510-3602-680
C 614	4.7 µF 10V tantalum SMD	510-2624-479
C 651	68 pF ±5% NPO 1206 chip	510-3602-680
C 652	68 pF ±5% NPO 1206 chip	510-3602-680
C 653	68 pF ±5% NPO 1206 chip	510-3602-680
C 654	68 pF ±5% NPO 1206 chip	510-3602-680
C 655	68 pF ±5% NPO 1206 chip	510-3602-680
C 656	68 pF ±5% NPO 1206 chip	510-3602-680
C 657	68 pF ±5% NPO 1206 chip	510-3602-680
C 658	.001 µF ±5% NPO 1206 chip	510-3602-102
C 659	.001 µF ±5% NPO 1206 chip	510-3602-102
C 660	68 pF ±5% NPO 1206 chip	510-3602-680
C 661	.001 µF ±5% NPO 1206 chip	510-3602-102
C 662	2.2 µF 20V tantalum SMD	510-2626-229
C 663	4.7 µF 10V tantalum SMD	510-2624-479
C 664	.001 µF ±5% NPO 1206 chip	510-3602-102
C 665	4.7 µF 10V tantalum SMD	510-2624-479
C 666	68 pF ±5% NPO 1206 chip	510-3602-680
C 667	4.7 µF 10V tantalum SMD	510-2624-479
CR601	Dual Schottky SOT-143	523-1504-033
CR651	Dual Schottky SOT-143	523-1504-033
L 602	9T 35.5 nH SMD air core	542-0030-009
L 603	.1 µH SMD inductor	542-9001-108
L 652	.1 µH SMD inductor	542-9001-108
L 653	9T 35.5 nH SMD air core	542-0030-009
L 654	9T 35.5 nH SMD air core	542-0030-009
MP601	PC board shield	017-2210-211
MP651	PC board shield	017-2210-211
MP653	Power detector board	017-2210-212
PC601	PC board	035-2004-660
R 601	51 ohm ±5% 1206 SMD	569-0115-510
R 603	51 ohm ±5% 1206 SMD	569-0115-510
R 604	51 ohm ±5% 1206 SMD	569-0115-510
R 605	10k ohm ±1% 1206 SMD	569-0111-401
R 606	10k ohm ±1% 1206 SMD	569-0111-401
R 607	20k ohm ±1% 1206 SMD	569-0111-430
R 608	10k ohm ±1% 1206 SMD	569-0111-401
R 609	10k ohm ±1% 1206 SMD	569-0111-401
R 610	160 ohm ±5% 1206 SMD	569-0115-161
R 611	5k ohm SMD top adjust	569-0135-502
R 612	10k ohm ±1% 1206 SMD	569-0111-401
R 613	10k ohm ±1% 1206 SMD	569-0111-401
R 614	10k ohm ±1% 1206 SMD	569-0111-401
R 615	470 ohm ±5% 1206 SMD	569-0115-471
R 616	2k ohm ±5% 1206 SMD	569-0115-202
R 651	51 ohm ±5% 1206 SMD	569-0115-510
R 653	51 ohm ±5% 1206 SMD	569-0115-510
R 654	51 ohm ±5% 1206 SMD	569-0115-510
R 655	10k ohm ±1% 1206 SMD	569-0111-401
R 656	20k ohm ±1% 1206 SMD	569-0111-430
R 657	10k ohm ±1% 1206 SMD	569-0111-401
R 658	10k ohm ±1% 1206 SMD	569-0111-401
R 659	10k ohm ±1% 1206 SMD	569-0111-401
R 660	150 ohm ±5% 1206 SMD	569-0115-151
R 661	5k ohm SMD top adjust	569-0135-502
R 662	10k ohm ±1% 1206 SMD	569-0111-401
R 663	7.5k ohm ±5% 1206 SMD	569-0115-752
R 664	12k ohm ±5% 1206 SMD	569-0115-123
R 665	470 ohm ±5% 1206 SMD	569-0115-471
R 666	240 ohm ±5% 1206 SMD	569-0115-241
R 667	47 ohm ±5% 1206 SMD	569-0115-470
R 669	2k ohm ±5% 1206 SMD	569-0115-202

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 601	Dual op amp SO-8	544-2019-004
U 651	Dual op amp SO-8	544-2019-004
U 652	5V regulator 78L05	544-2603-039

POWER AMPLIFIER MECHANICAL
PART NO. 023-2004-732

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
B 252	24V DC fan 3.14" sq x 1.26"	529-2002-027
EP200	6-14 ground lug	586-0007-070
HW251	6-32 panhead philips ZPS	575-1606-008
HW253	6-32 panhead philips ZPS	575-1606-012
HW254	1/8" cable clamp	572-0001-001
HW255	6-32 pan torx ZPS	575-0006-010
HW256	4-40 panhead philips ZPS	575-1604-010
HW257	6-32 panhead philips ZPS	575-1606-010
HW258	6-32 panhead philips ZPS	575-1606-016
HW259	6-19 panhead philips ZPS	575-5606-008
HW260	6 x 0.018 lockwasher int ZPS	596-1206-010
HW261	0.26 x 0.54 grafoil flgres	018-1007-030
HW262	0.42 x 0.995 grafoil mrf	018-1007-032
HW265	Grafoil M67709	018-1007-105
HW266	Grafoil isolator	018-1007-041
HW268	10-32 HHSL Sems scr ZPS	575-9810-012
HW269	0.062 x 0.85 x 5.65 poron stp	574-3002-110
HW270	8-32 panhead CPS philips	575-0608-008
HW300	Solder ground terminal	017-2210-213
HW777	Self mount wire tie	574-9008-025
MP240	PA coax ground tab	017-2210-038
MP254	M PA plate align dowel pin	013-1723-216
MP256	PA shield, left	017-2210-121
MP257	PA shield, top	017-2210-022
MP258	PA shield, right, 1 fan	017-2210-023
MP262	Low-pass filter shield	017-2210-209
MP268	M PA stop	013-1723-222
MP270	PA shield	017-2210-207

2000 SERIES REPEATER POWER SUPPLY
PART NO. 023-2000-800

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 801	Main board assembly	023-2000-810
A 803	AC filter board assembly	023-2000-820
B 800	24V DC fan 3.14” square	529-2002-012
HW800	Speed nut	537-0001-002
HW801	10-32 x 0.375 CPS nut	560-1110-012
HW802	6-32 x 0.094 nut	560-1106-010
HW803	4-40 machine panhead ZPS	575-1604-010
HW804	6-32 machine panhead ZPS	575-1606-010
HW805	6-32 machine panhead ZPS	575-1606-016
HW806	Washer	596-2406-012
HW809	6 x 0.018 lockwasher int.	596-1106-009
HW810	3/8” cable clamp	572-0001-005
HW811	#10 split lock washer	596-1310-010
HW812	Snap rivet 0.157 dia. x 0.29	574-9015-052
HW813	Connector mounting screw	515-7141-215
J 800	2-pos lock receptacle #22 wire	515-9032-262
MP801	Main enclosure	017-2210-165
MP802	Top cover	017-2210-166
MP803	Handle	017-2139-202
MP804	Strain releif	016-2187-270
MP805	Fan finger guard	578-1000-001
NP800	Nameplate holder	015-0900-406
NP801	Nameplate label	559-5861-161

WIREHARNESS
PART NO. 023-2000-803

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
EP001	Power socket	515-9012-284
EP002	Signal socket	515-9012-291
MP001	15-pos plug	515-9012-272

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	800W POWER SUPPLY MAIN BOARD PART NO. 023-2000-810	
A 002	Pin feed EPROM blank label	559-1154-004
A 802	Wireharness	023-2000-803
A 803	Thermal sensor board assem	023-2000-840
C 101	220 µF 25V aluminum radial	510-4225-221
C 102	.01 µF ±5% X7R 1206	510-3609-103
C 103	220 nF ±10% X7R 1210	510-3606-224
C 104	1 µF 35V tantalum SMD	510-2628-109
C 105	1 µF 35V tantalum SMD	510-2628-109
C 106	1500 µF 35Valuminum elect	510-4075-152
C 107	1500 µF 35Valuminum elect	510-4075-152
C 108	470 pF ±5% NPO 1206	510-3602-471
C 109	.1 µF ±10% X7R 1206	510-3609-104
C 110	330 µF 450V aluminum	510-4574-331
C 111	330 µF 450V aluminum	510-4574-331
C 113	.0047 µF ±10% X7R 1206	510-3609-472
C 114	.1 µF ±10% X7R 1206	510-3609-104
C 115	.1 µF ±10% X7R 1206	510-3609-104
C 116	.1 µF ±10% X7R 1206	510-3609-104
C 117	.47 µF 16V tantalum SMD	510-2625-478
C 118	270 pF ±5% NPO 1206	510-3602-271
C 119	1 µF 35V tantalum SMD	510-2628-109
C 120	270 pF ±5% NPO 1206	510-3602-271
C 121	.0027 µF ±5% X7R 1206	510-3609-272
C 122	470 pF ±5% NPO 1206	510-3602-471
C 123	1 µF 35V tantalum SMD	510-2628-109
C 124	.1 µF ±10% X7R 1206	510-3609-104
C 125	.0022 µF ±5% X7R 1206	510-3609-222
C 126	.1 µF ±5% X7R 1206	510-3609-104
C 127	.01 µF ±10% X7R 1206	510-3609-103
C 128	6.8 µF 35V tantalum SMD	510-2635-689
C 129	.1 µF ±10% X7R 1206	510-3609-104
C 131	.1 µF ±10% X7R 1206	510-3609-104
C 132	1 µF 35V tantalum SMD	510-2628-109
C 133	1 µF 35V tantalum SMD	510-2628-109
C 134	.1 µF ±5% X7R 1206	510-3609-104
C 135	.1 µF ±5% X7R 1206	510-3609-104
C 136	2.2 µF 16V tantalum SMD	510-2625-229
C 137	2.2 µF 16V tantalum SMD	510-2625-229
C 138	.001 µF ±5% NPO 1206	510-3602-102
C 139	6.8 µF 35V tantalum SMD	510-2635-689
C 140	6.8 µF 35V tantalum SMD	510-2635-689
C 141	.1 µF ±5% X7R 1206	510-3609-104
C 142	1 nF 600V AC double m	510-1023-102
C 143	2700 µF 35V aluminum	510-4075-272
C 144	2700 µF 35V aluminum	510-4075-272
C 145	2700 µF 35V aluminum	510-4075-272
C 146	.1 µF ±5% X7R 1206	510-3609-104
C 147	.1 µF ±5% X7R 1206	510-3609-104
C 148	.1 µF ±5% X7R 1206	510-3609-104
C 149	.1 µF ±5% X7R 1206	510-3609-104
C 150	.01 µF ±5% X7R 1206	510-3609-103
C 152	.1 µF ±5% X7R 1206	510-3609-104
C 153	1 µF 35V tantalum SMD	510-2628-109
C 154	.1 µF ±5% X7R chip	510-3609-104
C 156	.01 µF ±5% X7R 1206	510-3609-103
C 159	6.8 µF 35V tantalum SMD	510-2635-689
C 160	15 µF 20V tantalum SMD	510-2633-150
C 161	.01 µF ±5% X7R 1206	510-3609-103
C 162	.1 µF ±5% X7R 1206	510-3609-104
C 163	2700 µF 35V aluminum	510-4075-272
C 164	.001 µF ±5% NPO 1206	510-3602-102
C 165	1500 µF 35V aluminum	510-4075-152
C 166	1500 µF 35V aluminum	510-4075-152
C 167	.01 µF ±5% X7R 1206	510-3609-103
C 168	.01 µF ±5% X7R 1206	510-3609-103
C 169	1500 µF 35V aluminum	510-4075-152
C 170	.01 µF ±5% X7R 1206	510-3609-103
C 172	.01 µF ±5% X7R 1206	510-3609-103
C 173	.1 µF ±5% X7R 1206	510-3609-104
C 174	2200 pF ±5% NPO 1206	510-3602-222
C 175	.22 µF ±10% X7R 1210	510-3606-224
C 176	.001 µF ±5% NPO 1206	510-3602-102
C 178	1 µF 35V tantalum SMD	510-2628-109
C 180	6.8 µF 35V tantalum SMD	510-2635-689
C 181	.01 µF ±5% X7R 1206	510-3609-103
C 182	470 pF ±5% NPO 1206	510-3602-471
C 183	270 pF ±5% NPO 1206	510-3602-271
C 184	.1 µF ±5% X7R 1206	510-3609-104
C 185	.001 µF ±5% NPO 1206	510-3602-102
C 186	1500 µF 35V aluminum	510-4075-152
C 187	1500 µF 35V aluminum	510-4075-152
C 188	1500 µF 35V aluminum	510-4075-152
C 189	.01 µF ±5% X7R 1206	510-3609-103
C 190	.01 µF ±5% X7R 1206	510-3609-103
C 192	.1 µF ±5% X7R 1206	510-3609-104
C 193	2200 pF ±5% NPO 1206	510-3602-222
C 194	.22 µF ±10% X7R 1210	510-3606-224
C 195	.01 µF ±5% X7R 1206	510-3609-103
C 196	.001 µF ±5% NPO 1206	510-3602-102
C 197	2.2 µF 16V tantalum SMD	510-2625-229

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 198	1 µF 35V tantalum SMD	510-2628-109
C 199	6.8 µF 35V tantalum SMD	510-2635-689
C 200	6.8 µF 35V tantalum SMD	510-2635-689
C 201	.01 µF ±5% X7R 1206	510-3609-103
C 202	470 pF ±5% NPO 1206	510-3602-471
C 203	470 pF ±5% NPO 1206	510-3602-471
C 204	.047 µF ±5% X7R 1206	510-3609-473
C 205	1500 µF 35V aluminum	510-4075-152
C 207	2200 pF ±5% NPO 1206	510-3602-222
C 208	.1 µF ±5% X7R 1206	510-3609-104
C 209	1500 µF 35V aluminum	510-4075-152
C 210	2200 pF ±5% NPO 1206	510-3602-222
C 211	.01 µF ±5% X7R 1206	510-3609-103
C 212	.01 µF ±5% X7R 1206	510-3609-103
C 213	.1 µF ±5% X7R 1206	510-3609-104
C 214	.01 µF ±5% X7R 1206	510-3609-103
C 215	.1 µF ±5% X7R 1206	510-3609-104
C 216	.01 µF ±5% X7R 1206	510-3609-103
C 217	.1 µF ±5% X7R 1206	510-3609-104
C 218	.01 µF ±5% X7R 1206	510-3609-103
C 219	.1 µF ±5% X7R 1206	510-3609-104
C 220	.1 µF ±5% X7R 1206	510-3609-104
C 221	.01 µF ±5% X7R 1206	510-3609-103
C 222	.1 µF ±5% X7R 1206	510-3609-104
C 223	.1 µF ±5% X7R 1206	510-3609-104
C 224	.01 µF ±5% X7R 1206	510-3609-103
C 225	.01 µF ±5% X7R 1206	510-3609-103
C 227	.1 µF ±5% X7R 1206	510-3609-104
C 228	2.2 µF 16V tantalum SMD	510-2625-229
C 229	.1 µF ±5% X7R 1206	510-3609-104
C 230	1 µF 35V tantalum SMD	510-2628-109
C 232	6.8 µF 35V tantalum SMD	510-2635-689
C 233	.1 µF ±5% X7R 1206	510-3609-104
C 234	.001 µF ±5% NPO 1206	510-3602-102
C 235	.1 µF ±5% X7R 1206	510-3609-104
C 236	.1 µF ±5% X7R 1206	510-3609-104
CR101	Switching diode SOT-23	523-1504-002
CR102	Switching diode SOT-23	523-1504-002
CR103	3A ultra-fast diode	523-1507-004
CR104	18V zener ±5% SMD	523-2026-180
CR105	1A Schottky diode	523-0519-031
CR106	1A Schottky diode	523-0519-031
CR107	Switching diode SOT-23	523-1504-017
CR108	Switching diode SOT-23	523-1504-017
CR110	Switching diode SOT-23	523-1504-002
CR111	Switching diode SOT-23	523-1504-002
CR112	Switch diode SOT-23	523-1504-017
CR113	5.1V zener SOT-23	523-2016-519
CR114	1A Schottky diode	523-0519-031
CR115	1A Schottky diode	523-0519-031
CR116	1A Schottky diode	523-0519-031
CR117	18V zener SOT-23	523-2016-180
CR118	3A ultra-fast diode	523-1507-004
CR119	3A ultra-fast diode	523-1507-004
CR120	18V zener SOT-23	523-2016-180
CR121	Ultra-fast rectifier	523-0019-024
CR122	Switch diode SOT-23	523-1504-017
CR123	1A Schottky diode	523-0519-031
CR124	1A Schottky diode	523-0519-031
CR125	1A Schottky diode	523-0519-031
CR126	Schottkey diode 20A	523-0519-030
CR127	Switch diode SOT-23	523-1504-017
CR128	Ultra-fast rectifier	523-0019-024
CR129	25A 400V SCR TO-220	523-3021-001
CR130	1A Schottky diode	523-0519-031
CR131	1A Schottky diode	523-0519-031
CR132	Schottkey diode 20A	523-0519-030
CR133	Switch diode SOT-23	523-1504-017
CR134	1A Schottky diode	523-0519-031
CR135	25A 400V SCR TO-220	523-3021-001
CR136	3A ultra-fast diode	523-1507-004
CR137	Switching diode SOT-23	523-1504-002
CR138	Switching diode SOT-23	523-1504-002
CR139	Dual switching common cath	523-1504-022
CR140	4.7V zener SOT-23	523-2016-479
CR141	25A 400V SCR TO-220	523-3021-001
CR142	Switch diode SOT-23	523-1504-017
CR143	Switch diode SOT-23	523-1504-017
CR145	8A 600V ultrafast diode	523-0019-026
CR148	13V 1W zener SMT	523-2026-130
EP100	Ferrite bead	517-2002-008
EP101	0.25” spade lug	586-3502-021
EP103	0.25” spade lug	586-3502-021
EP104	0.25” spade lug	586-3502-021
EP105	0.25” spade lug	586-3502-021
EP106	0.25” spade lug	586-3502-021
EP110	0.25” spade lug	586-3502-021
EP111	0.25” spade lug	586-3502-021
EP112	0.25” spade lug	586-3502-021
F 102	10A 250V fastblow AGC fuse	534-0003-036

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
FH102	Fuse clip	534-1007-001
HW100	Cam5 x 3.795 sil-pad	018-1007-051
HW101	0.89 x 1.37 sil-pad	018-1007-052
HW102	1.06 x 4.73 sil-pad	018-1007-053
HW104	0.83 x 5 Teflon spacer	018-1007-056
HW105	0.83” Teflon spacer	018-1007-057
HW106	1.28” Teflon spacer	018-1007-058
HW107	4-40 3/8” hex socket CPS	575-9076-122
HW108	6-32 3/8” socket hoodcap	575-9076-112
HW109	6-32 machine panhead ZPS	575-1606-012
HW110	#4 x 0.046 shoulder washer	596-4504-008
HW111	#4 x 0.040 flat washer NPB	596-2404-008
HW112	#6 x 0.028 flat washer NPB	596-2406-010
HW113	#4 shakeproof washer	596-1104-008
HW114	#6 x 0.018 int lockwasher	596-1106-009
HW115	#4 spring washer	596-9604-009
HW120	TO-220 clamp	537-9055-051
J 101	2-pin friction header	515-9031-201
J 102	2-pin friction header	515-9031-201
L 101	15 µH 30A DC inductor	542-5010-005
L 102	20 µH 8A DC inductor	542-5010-006
L 103	7.5 µH 8A DC inductor	542-5010-008
L 104	10 µH 5A DC inductor	542-5010-007
L 105	100 µH 1A DC inductor	542-5010-012
L 107	300 µH 17A DC inductor	542-5010-004
MP100	5.7” heat sink	014-0771-130
MP101	2.9” heat sink	014-0771-131
MP102	5.7” heat sink	014-0771-133
MP105	TO-202 spacer	017-2210-162
PC001	PC board	035-2000-810
Q 101	30A 500V N-chnl pwr module	576-0006-354
Q 102	PNP switching	576-0003-612
Q 103	Si NPN amp/sw SOT-23	576-0003-600
Q 104	PNP high current SOT-223	576-0006-026
Q 105	PNP switching	576-0003-612
Q 106	Si NPN amp/sw SOT-23	576-0003-600
Q 107	PNP high current SOT-223	576-0006-026
Q 108	NPN high current SOT-223	576-0006-027
Q 110	Si NPN amp/sw SOT-23	576-0003-600
Q 111	Si NPN amp/sw SOT-23	576-0003-600
Q 112	Si NPN amp/sw SOT-23	576-0003-600
Q 114	PNP switching	576-0003-612
Q 115	PNP high current SOT-223	576-0006-026
Q 116	14A 500V N-MOSFET	576-0006-351
Q 117	PNP high current SOT-223	576-0006-026
Q 118	14A 500V N-MOSFET	576-0006-351
Q 120	Si NPN amp/sw SOT-23	576-0003-600
Q 121	PNP 6A SMD MJD42C	576-0002-603
Q 122	PNP high current SOT-223	576-0006-026
Q 123	N-Chnl E-MOSFET SOT-23	576-0006-110
Q 124	PNP high current SOT-223	576-0006-026
Q 125	20A 200V N-MOSFET	576-0006-352
Q 126	PNP switching	576-0003-612
Q 127	Si NPN amp/sw SOT-23	576-0003-600
Q 128	PNP switching	576-0003-612
Q 129	PNP high current SOT-223	576-0006-026
Q 130	N-Chnl E-MOSFET SOT-23	576-0006-110
Q 131	PNP high current SOT-223	576-0006-026
Q 132	20A 200V N-MOSFET	576-0006-352
Q 133	PNP switching	576-0003-612
Q 138	PNP switching	576-0003-612
R 101	330k ohm ±5% 1206 SMD	569-0115-334
R 102	330k ohm ±5% 1206 SMD	569-0115-334
R 103	240k ohm ±5% 1206 SMD	569-0115-244
R 104	100k ohm ±5% 1206 SMD	569-0115-104
R 105	330k ohm ±5% 1206 SMD	569-0115-334
R 106	330k ohm ±5% 1206 SMD	569-0115-334
R 107	330k ohm ±5% 1206 SMD	569-0115-334
R 108	20k ohm ±5% 2512 SMD	569-0175-203
R 109	20k ohm ±5% 2512 SMD	569-0175-203
R 110	20k ohm ±5% 2512 SMD	569-0175-203
R 111	220 ohm ±5% 1206 SMD	569-0115-221
R 112	10 ohm ±5% 1206 SMD	569-0115-100
R 113	0.03 ohm 55W low ind wire	569-4151-307
R 114	0.03 ohm 55W low ind wire	569-4151-307
R 115	4.7k ohm ±5% 1206 SMD	569-0115-472
R 116	36k ohm ±5% 1206 SMD	569-0115-363
R 117	330 ohm ±5% 1206 SMD	569-0115-331
R 118	18.2k ohm ±1% 1206 SMD	569-0111-426
R 119	24.3k ohm ±1% 1206 SMD	569-0111-438
R 120	20k ohm ±5% 2512 SMD	569-0175-203
R 121	100k ohm ±1% 1206 SMD	569-0111-501
R 122	100k ohm ±1% 1206 SMD	569-0111-501
R 123	100k ohm ±1% 1206 SMD	569-0111-501
R 124	100k ohm ±1% 1206 SMD	569-0111-501
R 125	13 ohm ±5% 1206 SMD	569-0115-130

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 126	10 ohm ±5% 1206 SMD	562-0115-100
R 127	1.27k ohm ±1% 1206 SMD	569-0111-311
R 128	51 ohm ±5% 2512 SMD	569-0175-510
R 129	36k ohm ±5% 1206 SMD	569-0115-363
R 130	100k ohm ±5% 1206 SMD	569-0115-104
R 131	36k ohm ±5% 1206 SMD	569-0115-363
R 132	10k ohm ±5% 1206 SMD	569-0115-103
R 133	100k ohm ±5% 1206 SMD	569-0115-104
R 134	20k ohm ±5% 1206 SMD	569-0115-203
R 135	13k ohm ±1% 1206 SMD	569-0111-412
R 136	100k ohm ±5% 1206 SMD	569-0115-104
R 137	1M ohm ±5% 1206 SMD	569-0115-105
R 138	2.26k ohm ±1% 1206 SMD	569-0111-335
R 139	2.26k ohm ±1% 1206 SMD	569-0111-335
R 140	15k ohm ±1% 1206 SMD	569-0111-418
R 141	10k ohm ±5% 1206 SMD	569-0115-103
R 142	560k ohm ±5% 1206 SMD	569-0115-564
R 143	3k ohm ±5% 1206 SMD	569-0115-302
R 144	25.5k ohm ±1% 1206 SMD	569-0111-440
R 146	100 ohm ±5% 1206 SMD	569-0115-101
R 148	4.7k ohm ±5% 1206 SMD	569-0115-472
R 149	1k ohm ±5% 1206 SMD	569-0115-102
R 150	2k ohm ±5% 1206 SMD	569-0115-202
R 151	20k ohm ±5% 2512 SMD	569-0175-203
R 152	4.7k ohm ±5% 1206 SMD	569-0115-472
R 153	100 ohm ±5% 1206 SMD	569-0115-101
R 154	10k ohm ±5% 1206 SMD	569-0115-103
R 155	36k ohm ±5% 1206 SMD	569-0115-363
R 156	1k ohm ±5% 1206 SMD	569-0115-102
R 157	20k ohm ±5% 1206 SMD	569-0115-203
R 158	15k ohm ±5% 1206 SMD	569-0115-153
R 159	20 ohm ±5% 1206 SMD	569-0115-200
R 160	470 ohm ±5% 1206 SMD	569-0115-471
R 161	20 ohm ±5% 1206 SMD	569-0115-200
R 162	Zero ohm ±5% 1206 SMD	569-0115-001
R 163	20 ohm ±5% 1206 SMD	569-0115-200
R 164	470 ohm ±5% 1206 SMD	569-0115-471
R 165	20 ohm ±5% 1206 SMD	569-0115-200
R 166	10 ohm ±5% 2512 SMD	569-0175-100
R 167	10 ohm ±5% 2512 SMD	569-0175-100
R 168	10 ohm ±5% 2512 SMD	569-0175-100
R 169	1k ohm ±5% 1206 SMD	569-0115-102
R 170	820 ohm ±5% 1206 SMD	569-0115-821
R 171	820 ohm ±5% 1206 SMD	569-0115-821
R 172	100k ohm ±5% 1206 SMD	569-0115-104
R 173	16.9k ohm ±1% 1206 SMD	569-0111-423
R 174	1k ohm trim pot	562-0110-102
R 175	1.8k ohm ±5% 1206 SMD	569-0115-182
R 176	100 ohm ±5% 1206 SMD	569-0115-101
R 178	2k ohm ±5% 1206 SMD	569-0115-202
R 179	4.7k ohm ±5% 1206 SMD	569-0115-472
R 180	7.5k ohm ±5% 1206 SMD	569-0115-752
R 181	1k ohm ±5% 1206 SMD	569-0115-102
R 182	75 ohm ±5% 1206 SMD	569-0115-750
R 183	95.3k ohm ±1% 1206 SMD	569-0111-495
R 184	357k ohm ±1% 1206 SMD	569-0111-554
R 185	1k ohm ±5% 1206 SMD	569-0115-102
R 186	10k ohm ±5% 1206 SMD	569-0115-103
R 187	95.3k ohm ±1% 1206 SMD	569-0111-495
R 188	10k ohm ±1% 1206 SMD	569-0111-401
R 189	6.81k ohm ±1% 1206 SMD	569-0111-381
R 190	1k ohm ±5% 1206 SMD	569-0115-102
R 191	3.3k ohm ±5% 1206 SMD	569-0115-332
R 192	8.2k ohm ±5% 1206 SMD	569-0115-822
R 193	8.2k ohm ±5% 1206 SMD	569-0115-822
R 194	8.2k ohm ±5% 1206 SMD	569-0115-822
R 195	8.2k ohm ±5% 1206 SMD	569-0115-822
R 196	8.2k ohm ±5% 1206 SMD	569-0115-822
R 197	10k ohm ±5% 1206 SMD	569-0115-103
R 198	18 ohm ±5% 1206 SMD	569-0115-180
R 199	18 ohm ±5% 1206 SMD	569-0115-180
R 200	18 ohm ±5% 1206 SMD	569-0115-180
R 201	180 ohm ±5% 1206 SMD	569-0115-181
R 202	20k ohm ±5% 1206 SMD	569-0115-203
R 203	2k ohm ±5% 1206 SMD	569-0115-202
R 204	2k ohm ±5% 2512 SMD	569-0175-202
R 205	10 ohm ±5% 1206 SMD	569-0115-100
R 206	10 ohm ±5% 1206 SMD	569-0115-100
R 207	180 ohm ±5% 1206 SMD	569-0115-181
R 208	51 ohm ±5% 1206 SMD	569-0115-510
R 209	820 ohm ±5% 1206 SMD	569-0115-821
R 210	820 ohm ±5% 1206 SMD	569-0115-821
R 211	12.4k ohm ±1% 1206 SMD	569-0111-410
R 212	2.26k ohm ±1% 1206 SMD	569-0111-335
R 213	200 ohm ±5% 1206 SMD	569-0115-201
R 214	1k ohm ±5% 1206 SMD	569-0115-102
R 215	6.2k ohm ±5% 1206 SMD	569-0115-622
R 216	1k ohm single turn trimmer	562-0112-102
R 217	1.2k ohm ±5% 1206 SMD	569-0115-122
R 218	4.7k ohm ±5% 1206 SMD	569-0115-472
R 219	470 ohm ±5% 1206 SMD	569-0115-471
R 220	2k ohm ±1% 1206 SMD	569-0111-330
R 221	36k ohm ±5% 1206 SMD	569-0115-363
R 222	Zero ohm ±5% 1206 SMD	569-0115-001

SYMBOL NUMBER	DESCRIPTION	PART NUMBER	SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 223	13k ohm ±5% 1206 SMD	569-0115-133	R 272	51 ohm ±5% 2512 SMD	569-0175-510
R 224	Zero ohm ±5% 1206 SMD	569-0115-001	R 273	1k ohm ±5% 1206 SMD	569-0115-102
R 225	68 ohm ±5% 1206 SMD	569-0115-680	R 274	1k ohm ±5% 1206 SMD	569-0115-102
R 226	24 ohm ±5% 1206 SMD	569-0115-240	R 275	20k ohm ±5% 1206 SMD	569-0115-203
R 227	180 ohm ±5% 1206 SMD	569-0115-181	R 276	10k ohm ±5% 1206 SMD	569-0115-103
R 228	2k ohm ±1% 1206 SMD	569-0111-330	R 277	10k ohm ±5% 1206 SMD	569-0115-103
R 229	820 ohm ±5% 1206 SMD	569-0115-821	R 278	10k ohm ±5% 1206 SMD	569-0115-103
R 230	100 ohm ±5% 1206 SMD	569-0115-101	R 279	10k ohm ±5% 1206 SMD	569-0115-103
R 231	51 ohm ±5% 2512 SMD	569-0175-510	R 280	75 ohm ±5% 1206 SMD	569-0115-750
R 232	820 ohm ±5% 1206 SMD	569-0115-821	R 281	470 ohm ±5% 1206 SMD	569-0115-471
R 233	3.3k ohm ±5% 1206 SMD	569-0115-332	R 284	3.4k ohm ±1% 1206 SMD	569-0111-352
R 234	1k ohm ±5% 1206 SMD	569-0115-102	R 285	2.49k ohm ±1% 1206 SMD	569-0111-339
R 235	18 ohm ±5% 1206 SMD	569-0115-180	R 286	1k ohm ±5% 1206 SMD	569-0115-102
R 236	18 ohm ±5% 1206 SMD	569-0115-180	R 287	200 ohm ±5% 1206 SMD	569-0115-201
R 237	18 ohm ±5% 1206 SMD	569-0115-180	R 302	20k ohm ±5% 1206 SMD	569-0115-203
R 238	180 ohm ±5% 1206 SMD	569-0115-181	R 303	200 ohm ±5% 1206 SMD	569-0115-201
R 240	2k ohm ±5% 1206 SMD	569-0115-202	R 306	20k ohm ±5% 1206 SMD	569-0115-203
R 241	2k ohm ±5% 2512 SMD	569-0175-202	R 307	Zero ohm ±5% 1206 SMD	569-0115-001
R 242	10 ohm ±5% 1206 SMD	569-0115-100	R 308	Zero ohm ±5% 1206 SMD	569-0115-001
R 243	10 ohm ±5% 1206 SMD	569-0115-100	R 309	Zero ohm ±5% 1206 SMD	569-0115-001
R 244	180 ohm ±5% 1206 SMD	569-0115-181	R 311	100k ohm ±1% 1206 SMD	569-0111-501
R 245	51 ohm ±5% 1206 SMD	569-0115-510	R 312	100k ohm ±1% 1206 SMD	569-0111-501
R 246	200 ohm ±5% 1206 SMD	569-0115-201	R 313	100k ohm ±1% 1206 SMD	569-0111-501
R 247	36 ohm ±5% 1206 SMD	569-0115-360	R 314	100k ohm ±1% 1206 SMD	569-0111-501
R 249	3.4k ohm ±1% 1206 SMD	569-0111-352	R 315	820 ohm ±5% 1206 SMD	569-0115-821
R 250	2.49k ohm ±1% 1206 SMD	569-0111-339			
R 251	200 ohm ±5% 1206 SMD	569-0115-201	RT101	8A 2.5 ohm NTC thermistor	569-3014-001
R 252	1k ohm ±5% 1206 SMD	569-0115-102	RT102	8A 2.5 ohm NTC thermistor	569-3014-001
R 253	4.7k ohm ±5% 1206 SMD	569-0115-472			
R 254	1k ohm single turn trimmer	562-0112-102			
R 255	4.3k ohm ±5% 1206 SMD	569-0115-432	T 101	0.5 line freq. bias transformer	592-3041-004
R 256	2k ohm ±1% 1206 SMD	569-0111-330	T 103	1:200 current transformer	592-3041-002
R 257	10k ohm ±5% 1206 SMD	569-0115-103	T 104	1:200 current transformer	592-3041-002
R 258	36k ohm ±5% 1206 SMD	569-0115-363	T 105	100:1 current transformer	592-3041-005
R 259	13k ohm ±5% 1206 SMD	569-0115-133	T 106	1:1 transformer	592-3041-003
R 260	68 ohm ±5% 1206 SMD	569-0115-680	T 107	4.5:1 switch mode transformer	592-3041-001
R 261	24 ohm ±5% 1206 SMD	569-0115-240			
R 262	29.4k ohm ±1% 1206 SMD	569-0111-446			
R 263	2.49k ohm ±1% 1206 SMD	569-0111-339	U 102	PFC/PWN combo SOIC	544-2002-035
R 264	2k ohm ±1% 1206 SMD	569-0111-330	U 104	Quad 2-in AND SOIC HC08	544-3766-008
R 265	3.3k ohm ±5% 1206 SMD	569-0115-332	U 105	5V regulator LM78L05ABD	544-2603-039
R 266	1k ohm ±5% 1206 SMD	569-0115-102	U 106	5V regulator LM78L05ABD	544-2603-039
R 267	430 ohm ±5% 1206 SMD	569-0115-431	U 107	Opto-isolator surface mt	544-9022-001
R 268	4.7k ohm ±5% 1206 SMD	569-0115-472	U 108	Opto-isolator	544-2010-005
R 269	360 ohm ±5% 1206 SMD	569-0115-361	U 109	Programmable TL431AID	544-2003-097
R 270	33k ohm ±5% 1206 SMD	569-0115-333	U 110	Quad op amp LMC660 SOIC	544-2020-020
R 271	3.3k ohm ±5% 1206 SMD	569-0115-332	U 111	Adj volt reg full temp LM317T	544-2003-094

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 112	PWM current mode ML4823	544-2002-034
U 113	PWM current mode ML4823	544-2002-034
U 114	5V 3A regulator power supply	544-2003-098
U 115	Programmable TL431AID	544-2003-097
U 116	Programmable TL431AID	544-2003-097
U 117	Programmable TL431AID	544-2003-097
U 118	Programmable TL431AID	544-2003-097
U 119	Opto-isolator SOIC-8	544-2010-006
U 120	Opto-isolator SOIC-8	544-2010-006
U 121	Programmable volt TL431AID	544-2003-097
U 122	Opto-isolator SOIC-8	544-2010-006

AC FILTER BOARD
PART NO. 023-2000-820

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 001	.22 µF 275V AC ±2%	510-1024-224
C 003	.0022 µF ±2% Y2	510-1022-222
C 004	.0022 µF ±2% Y2	510-1022-222
C 005	1 µF 275V X2 class capacitor	510-1024-105
CR001	600V 35A rectifier bridge	523-4004-025
EP006	1/2” tubing	042-0241-557
F 001	15A 250V ceramic body	534-0003-045
FH001	Fuse clip	534-1007-001
HW001	#10 shakeproof washer	596-1110-012
HW002	4-40 machine panhead ZPS	575-1604-016
HW003	9/16” ID rubber grommet	574-0002-004
HW004	10-32 machine panhead ZPS	575-1610-016
HW005	#4 whakeproof washer	596-1104-008
HW007	Heatsink Grafoil TO-15	018-1007-055
J 001	AC power cord connector	515-0028-008
L 001	1 µH 10A coil	542-5010-010
L 002	4.2 µH 10A coil	542-5010-009
MP001	Filter bracket	017-2210-167
PC001	PC board	035-2000-820
R 001	1M ohm ±5% 1/4W CF	569-0513-105
RV001	Metal oxide varistor	569-3503-001
RV002	Metal oxide varistor	569-3503-001
W 001	Wire 1 assembly	023-2000-825
W 002	Wire 2 assembly	023-2000-826
W 003	Wire 3 assembly	023-2000-827
W 004	Wire 4 assembly	023-2000-828
W 005	Wire 5 assembly	023-2000-829

BATTERY BACK-UP
PART NO. 023-2000-830

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 101	.01 µF ±10% X7R chip	510-3606-103
C 103	6.8 µF 35V tantalum SMD	510-2635-689
C 104	.1 µF ±5% X7R 1206	510-3609-104
C 105	1000 µF 50Valuminum elect	510-4076-102
C 106	.1 µF ±5% X7R 1206	510-3609-104
C 107	.1 µF ±5% X7R 1206	510-3609-104
C 109	.1 µF ±5% X7R 1206	510-3609-104
C 110	6.8 µF 35V tantalum SMD	510-2635-689
C 111	1000 µF 50Valuminum elect	510-4076-102
C 112	.1 µF ±5% X7R 1206	510-3609-104
C 113	1 µF 35V tantalum SMD	510-2628-109
C 114	.1 µF ±5% X7R 1206	510-3609-104
C 115	.1 µF ±5% X7R 1206	510-3609-104
C 118	1 µF ±10% 100V polyester	510-1031-105
C 119	220 µF 25V aluminum radial	510-4225-221
C 124	1 µF 35V tantalum SMD	510-2628-109
C 125	.1 µF ±5% X7R 1206	510-3609-104
C 126	.1 µF ±5% X7R 1206	510-3609-104
C 127	.1 µF ±5% X7R 1206	510-3606-104
C 128	.01 µF ±10% X7R 1206	510-3606-103
C 129	.1 µF ±10% X7R 1206	510-3606-104
C 130	.01 µF ±10% X7R 1206	510-3606-103
C 131	.1 µF ±10% X7R 1206	510-3606-104
C 132	.01 µF ±10% X7R 1206	510-3606-103
C 133	.1 µF ±10% X7R 1206	510-3606-104
C 134	.01 µF ±10% X7R 1206	510-3606-103
CR101	Red LED right angle PC mt	549-4001-035
CR102	3A ultra-fast diode	523-1507-004
CR103	12V zener diode	523-2016-120
CR104	18V ±5% zener SMT	523-2026-180
CR105	Red LED right angle PC mt	549-4001-035
CR109	8A 600V ultra-fast diode	523-0019-026
CR111	Green LED rt angle PC mt	549-4001-037
CR113	Switching diode SOT-23	523-1504-002
CR114	3A ultra-fast diode	523-1507-004

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
CR115	Switching diode SOT-23	523-1504-002
CR116	3A ultra-fast diode	523-1507-004
CR117	13V 1W zener SMT	523-2026-130
CR118	18V ±5% zener SMT	523-2026-180
EP100	Heat sink insulator TO-220	574-5005-060
EP101	Copper terminal lug	586-0007-072
EP102	Copper terminal lug	586-0007-072
EP103	Copper terminal lug	586-0007-071
F 101	4A resettable polyfuse	534-0020-001
HW100	4-40 machine panhead ZPS	575-1604-012
HW101	6-32 machine panhead ZPS	575-1606-008
HW102	4 x 0.04 flat washer	596-2404-008
HW103	6 x 0.018 int lockwasher	596-1106-009
HW104	#4 shakeproof washer	596-1104-008
HW105	10-32 machine panhead ZPS	575-1610-012
HW106	#10 shakeproof washer	596-1110-012
HW107	4 x 0.46 shoulder washer	596-4504-008
HW108	10-32 x 0.375 CPS	560-1110-012
HW800	Speed nut	537-0001-002
J 100	2-pin lock receptacle	515-9032-232
K 101	Single pole 24V relay	567-0031-001
L 101	70 µH 3A Toroid inductor	542-5010-014
MP100	Bracket	017-2210-169
MP101	Terminal cover	032-0758-050
NP100	Max input 28.5V Bat/Backup	559-5861-166
NP800	Nameplate holder	015-0900-406
NP801	Nameplate	559-5861-161
PC001	PC board	035-2000-830
Q 101	PNP high current SOT-223	576-0006-026
Q 102	PNP high current SOT-223	576-0006-026
Q 103	N-channel E-MOSFET	576-0006-110
Q 104	PNP TO-220 ISO	576-0002-057
Q 105	PNP high current SOT-223	576-0006-026
R 101	4.7k ohm ±5% 1206 SMD	569-0115-472
R 102	330 ohm ±5% 1206 SMD	569-0115-331
R 103	2k ohm ±5% 1206 SMD	569-0115-202

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 104	2k ohm ±5% 1206 SMD	569-0115-202
R 105	2k ohm ±5% 1206 SMD	569-0115-202
R 106	2k ohm ±5% 2512 SMD	569-0175-202
R 107	1k ohm ±5% 1206 SMD	569-0115-102
R 108	2k ohm ±5% 1206 SMD	569-0115-202
R 109	2k ohm ±5% 1206 SMD	569-0115-202
R 110	2k ohm ±5% 1206 SMD	569-0115-202
R 111	51 ohm ±5% 1W 2512 SMD	569-0175-510
R 112	7.5k ohm ±1% 1206 SMD	569-0111-385
R 112	1k ohm ±1% 1206 SMD	569-0111-301
R 115	470 ohm ±5% 1W 2512 SMD	569-0175-471
R 116	47 ohm ±5% 1206 SMD	569-0115-470
R 117	3.3k ohm ±5% 1206 SMD	569-0115-332
R 118	10.5k ohm ±1% 1206 SMD	569-0111-403
R 119	1k ohm ±1% 1206 SMD	569-0111-301
R 120	1k ohm ±1% 1206 SMD	569-0111-301
R 121	62k ohm ±5% 1206 SMD	569-0115-623
R 122	4.7k ohm ±5% 1206 SMD	569-0115-472
R 123	10k ohm ±5% 1206 SMD	569-0115-103
R 124	10k ohm ±5% 1206 SMD	569-0115-103
R 125	1k ohm ±1% 1206 SMD	569-0111-301
R 126	42.2k ohm ±1% 1206 SMD	569-0111-461
R 127	82.5k ohm ±1% 1206 SMD	569-0111-489
R 128	10k ohm ±5% 1206 SMD	569-0115-103
R 129	20k ohm ±5% 1206 SMD	569-0115-203
R 130	33k ohm ±5% 1206 SMD	569-0115-333
R 136	3.3k ohm ±5% 2512 SMD	569-0175-332
R 137	3.3k ohm ±5% 2512 SMD	569-0175-332
R 138	240 ohm ±5% 2512 SMD	569-0115-241
R 139	3.3k ohm ±5% 2512 SMD	569-0175-332
R 140	1k ohm single turn trimmer	562-0112-102
R 141	Zero ohm ±5% 1206 SMD	569-0115-001
R 142	10k ohm ±5% 1206 SMD	569-0115-103
R 143	2k ohm ±5% 2512 SMD	569-0175-202
R 144	15k ohm ±5% 1206 SMD	569-0115-153
R 145	15k ohm ±5% 1206 SMD	569-0115-153
R 146	3.9k ohm ±5% 1206 SMD	569-0115-392
R 147	10k ohm ±5% 1206 SMD	569-0115-103
R 148	15k ohm ±5% 1206 SMD	569-0115-153
R 149	82k ohm ±5% 1206 SMD	569-0115-823
R 150	10k ohm ±5% 1206 SMD	569-0115-103
R 151	100 ohm ±5% 1206 SMD	569-0115-101
R 152	75 ohm ±5% 1206 SMD	569-0115-750
R 153	100k ohm ±5% 1206 SMD	569-0115-104
R 154	300k ohm ±5% 1206 SMD	569-0115-304
R 155	1k ohm ±5% 1206 SMD	569-0115-102
R 156	10k ohm ±5% 1206 SMD	569-0115-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 157	15k ohm ±1% 1206 SMD	569-0111-301
R 158	1k ohm ±1% 1206 SMD	569-0111-301
R 159	180k ohm ±5% 1206 SMD	569-0115-184
R 160	10k ohm ±5% 1206 SMD	569-0115-103
R 165	2k ohm ±5% 2512 SMD	569-0175-202
S 101	Toggle switch on/on rt angle	583-0006-014
U 101	Quad comparator 2901	544-2025-011
U 102	Programmable voltage reg	544-2003-097
U 103	Programmable voltage reg	544-2003-097
U 104	Dual op amp SO-8	544-2019-004
U 105	Dual op amp SO-8	544-2019-004
U 106	Temp sensor LM-35 SO-8	544-2032-003
U 107	Full temp adjustable LM317T	544-2003-094
W 101	Green wire assembly	023-2000-836
W 102	Red wire assembly	023-2000-837
W 103	Black wire assembly	023-2000-838
W 104	Orange wire assembly	023-2000-839

THERMAL SENSOR BOARD
PART NO. 023-2000-840

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 001	Thermal sensor board assem	023-2000-841
C 001	.1 µF 10% X7R chip	510-3606-104
J 001	48 mil edge clip, short	515-9034-004
J 002	48 mil edge clip, short	515-9034-004
J 003	48 mil edge clip, short	515-9034-004
PC001	Thermal sensor board	035-2000-840
U 001	Temp sensor LM-35 SO-8	544-2032-003

MAIN PROCESSOR CARD
PART NO. 023-2000-310

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 001	10 pF ±5% NPO 1206 chip	510-3602-100
C 002	20 pF ±5% NPO 1206 chip	510-3602-200
C 004	.01 µF ±10% X7R chip	510-3606-103
C 005	.01 µF ±10% X7R chip	510-3606-103
C 006	.01 µF ±10% X7R chip	510-3606-103
C 007	.01 µF ±10% X7R chip	510-3606-103
C 008	10 pF ±5% NPO 1206 chip	510-3602-100
C 009	.01 µF ±10% X7R chip	510-3606-103
C 010	.01 µF ±10% X7R chip	510-3606-103
C 011	.01 µF ±10% X7R chip	510-3606-103
C 012	.01 µF ±10% X7R chip	510-3606-103
C 013	20 pF ±5% NPO 1206 chip	510-3602-200
C 015	.01 µF ±10% X7R chip	510-3606-103
C 016	.01 µF ±10% X7R chip	510-3606-103
C 017	47 µF 25V electrolytic radial	510-4425-470
C 018	47 µF 25V electrolytic radial	510-4425-470
C 019	62 pF ±5% NPO 1206 chip	510-3602-620
C 020	.1 µF ±10% X7R chip	510-3606-104
C 021	.1 µF ±10% X7R chip	510-3606-104
C 022	.1 µF ±10% X7R chip	510-3606-104
C 023	.1 µF ±10% X7R chip	510-3606-104
C 024	10 µF 16V tantalum SMD	510-2625-100
C 025	10 µF 16V tantalum SMD	510-2625-100
C 026	.01 µF ±10% X7R chip	510-3606-103
C 027	10 µF 16V tantalum SMD	510-2625-100
C 028	10 µF 16V tantalum SMD	510-2625-100
C 029	62 pF ±5% NPO 1206 chip	510-3602-620
C 030	.01 µF ±10% X7R chip	510-3606-103
C 031	.01 µF ±10% X7R chip	510-3606-103
C 032	.01 µF ±10% X7R chip	510-3606-103
CR001	Green LED submin radial	549-4001-122
CR002	Yellow LED submin radial	549-4001-121
CR003	Red LED subminiature radial	549-4001-120
CR004	Red LED subminiature radial	549-4001-120
CR005	Yellow LED submin radial	549-4001-121
DS001	7-segment display .3" green	549-4002-020
EP001	Crystal pin insulator	018-1080-001
EP002	Crystal pin insulator	018-1080-001
EP003	Crystal pin insulator	018-1080-001
EP004	Crystal pin insulator	018-1080-001
HW001	Panel fastener	537-0011-031
J 001	8-cond modular jack PC mt	515-2006-040
J 002	3-pin single inline header	515-7100-003
J 003	14-pin double row header	515-7101-407
J 004	6-pin double row header	515-7101-403
J 005	3-pin single inline header	515-7100-003
J 006	3-pin single inline header	515-7100-003

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
P 001	64-pin DIN male right angle	515-7082-101
P 002	2-pos shorting socket	515-5010-001
P 003	2-pos shorting socket	515-5010-001
P 004	2-pos shorting socket	515-5010-001
P 005	2-pos shorting socket	515-5010-001
P 006	2-pos shorting socket	515-5010-001
PC310	PC board	035-2000-310
Q 002	PNP switching SOT-23	576-0003-612
Q 003	NPN gen purp SOT-23	576-0001-300
R 001	10M ohm ±5% 1206 SMD	569-0115-106
R 002	2.2k ohm ±5% 1206 SMD	569-0115-222
R 003	Zero ohm ±5% 1206 SMD	569-0115-001
R 004	2k ohm ±5% 1206 SMD	569-0115-202
R 005	150 ohm ±5% 1206 SMD	569-0115-151
R 006	200 ohm ±5% 1206 SMD	569-0115-201
R 007	1.2k ohm ±5% 1/4W CF	569-0115-122
R 008	1.2k ohm ±5% 1/4W CF	569-0115-122
R 009	1.2k ohm ±5% 1/4W CF	569-0115-122
R 010	200 ohm ±5% 1206 SMD	569-0115-201
R 011	1.2k ohm ±5% 1/4W CF	569-0115-122
R 012	10k ohm ±5% 1206 SMD	569-0115-103
R 013	150 ohm ±5% 1206 SMD	569-0115-151
R 014	10k ohm ±5% 1206 SMD	569-0115-103
R 015	10k ohm ±5% 1206 SMD	569-0115-103
R 016	10k ohm ±5% 1206 SMD	569-0115-103
R 017	2.2k ohm ±5% 1206 SMD	569-0115-222
R 018	2.2k ohm ±5% 1206 SMD	569-0115-222
R 019	2.2k ohm ±5% 1206 SMD	569-0115-222
R 020	2.2k ohm ±5% 1206 SMD	569-0115-222
R 021	100k ohm ±5% 1206 SMD	569-0115-104
R 022	10k ohm ±5% 1206 SMD	569-0115-103
R 023	4.7k ohm ±5% 1206 SMD	569-0115-472
R 024	4.7k ohm ±5% 1206 SMD	569-0115-472
R 025	10k ohm ±5% 1206 SMD	569-0115-103
R 026	10k ohm ±5% 1206 SMD	569-0115-103
R 027	10k ohm ±5% 1206 SMD	569-0115-103
R 028	4.7k ohm ±5% 1206 SMD	569-0115-472
R 029	10k ohm ±5% 1206 SMD	569-0115-103
R 030	10k ohm ±5% 1206 SMD	569-0115-103
R 031	10k ohm ±5% 1206 SMD	569-0115-103
R 032	1k ohm ±5% 1206 SMD	569-0115-102
R 033	1k ohm ±5% 1206 SMD	569-0115-102
R 034	10k ohm ±5% 1206 SMD	569-0115-103
R 035	3.9k ohm ±5% 1206 SMD	569-0115-392

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 038	20k ohm ±5% 1206 SMD	569-0115-203
R 039	270k ohm ±5% 1206 SMD	569-0115-274
R 040	15 ohm 1W SMD	569-0175-150
S 001	Push-button momentary sw	583-4005-002
S 002	8-pos DIP switch	583-5002-008
S 003	4-pos DIP switch	583-5002-004
U 001	8k x 8 CMOS static RAM	544-5001-109
U 002	Hex inverter SOIC 74HC04	544-3766-004
U 003	1 of 8 demux 74HC138	544-3766-138
U 004	1 of 8 demux 74HC138	544-3766-138
U 005	1 of 16 demux SOIC 74HC154	544-3766-154
U 006	Quad 2-input OR 74HC32	544-3766-032
U 007	Quad 2-input OR 74HC32	544-3766-032
U 008	D-latch non-inv 74HC573	544-3766-573
U 009	9 bit x 64 word FIFO DIP-28	544-3764-703
U 010	9 bit x 64 word FIFO DIP-28	544-3764-703
U 011	12V regulator TO-92 78L12	544-2003-032
U 012	12V regulator TO-92 78L12	544-2003-032
U 013	87C52 CMOS	544-5011-948
U 014	HSDB Multi-Net software	023-9998-289
U 015	Hex open drain buffer SO-14	544-3716-906
U 016	Driver/receiver RS232C/v28	544-2023-014
U 017	Micro monitor SO-8 DS1232	544-2003-085
U 018	32 x 8 SCRAM SO-28 CMOS	544-5001-412
U 020	Quad 2-input NAND 74HC00	544-3766-000
U 021	7-stage binary cntr SOIC 4024	544-3016-024
U 022	Prog comm intfc 82C51	544-5001-319
U 023	Differential bus xcvr 65176	544-2023-025
U 024	Differential bus xcvr 65176	544-2023-025
U 025	MPC boot code	023-9998-277
U 026	BCD 7-latch DIP-16 14495	544-3014-495
U 027	CPU v25 PLCC-84 7032	544-5002-016
U 028	EEPROM PLCC32R 28C64	544-5002-412
U 030	Hex inverter Schmitt trigger	544-3014-092
U 031	Quad 2-input NOR	544-3014-002
U 032	Octal buffer/line driver	544-3542-243
X 001	10-pos right angle IC socket	515-5008-270
X 014	28-pin IC socket	515-5008-018
X 013	40-pin IC socket	515-5008-019
X 024	8-pin DIP socket	515-5008-011
X 025	32-pin IC socket	515-5008-108
X 027	84-pos PLCC socket	515-5020-100

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Y 001	10 MHz crystal HC-18	521-0010-000
Y 002	11.059 MHz crystal	521-0011-059
Y 003	2.4576 MHz HC-18U	521-0002-458
Y 004	12 MHz µP crystal	521-0012-000
Z 001	EMI suppression filter	532-3003-002
Z 002	EMI suppression filter	532-3003-002

MAIN AUDIO CARD
PART NO. 023-2000-320

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 301	Compandor option	023-2000-940
C 100	470 pF ±5% NPO 1206 chip	510-3602-471
C 101	.0022 µF ±10% X7R 1206 chip	510-3606-222
C 102	.001 µF ±2% NPO 1206	510-3616-102
C 103	.1 µF ±10% X7R chip	510-3606-104
C 104	100 pF ±2% NPO 1206	510-3616-101
C 105	.033 µF ±5% X7R 1210	510-3610-333
C 106	.068 µF ±5% X7R 1206	510-3609-683
C 107	.022 µF ±5% X7R 1206	510-3609-223
C 108	.1 µF ±5% X7R 1206	510-3609-104
C 109	.1 µF ±5% X7R 1206	510-3609-104
C 110	.022 µF ±5% X7R 1206	510-3609-223
C 111	.022 µF ±5% X7R 1206	510-3609-223
C 112	.01 µF ±5% X7R 1206	510-3609-103
C 113	100 pF ±5% NPO 1206 chip	510-3602-101
C 114	100 pF ±5% NPO 1206 chip	510-3602-101
C 115	100 pF ±5% NPO 1206 chip	510-3602-101
C 116	.001 µF ±5% NPO 1206	510-3602-102
C 117	.01 µF ±5% X7R 1206	510-3609-103
C 118	.01 µF ±5% X7R 1206	510-3609-103
C 119	.1 µF ±5% X7R 1206	510-3609-104
C 120	.1 µF ±5% X7R 1206	510-3609-104
C 121	.01 µF ±5% X7R 1206	510-3609-103
C 122	.022 µF ±5% X7R 1206	510-3609-223
C 123	.047 µF ±5% X7R 1206	510-3609-473
C 124	.0068 µF ±10% X7R chip	510-3606-682
C 125	680 pF ±2% NPO 1206	510-3616-681
C 126	.01 µF ±2% NPO 1206	510-3617-103
C 127	680 pF ±2% NPO 1206	510-3616-681
C 128	.0033 µF ±2% NPO 1206	510-3616-332
C 129	470 pF ±2% NPO 1206	510-3616-471
C 130	470 pF ±2% NPO 1206	510-3616-471
C 131	.0047 µF ±5% X7R 1206	510-3609-472
C 132	.0056 µF ±2% NPO 1206	510-3617-562
C 133	.0047 µF ±2% NPO 1206	510-3616-472
C 134	20 pF ±5% NPO 1206 chip	510-3602-200
C 136	100 pF ±5% NPO 1206	510-3602-101
C 137	100 pF ±5% NPO 1206	510-3602-101
C 138	.1 µF ±10% X7R chip	510-3606-104
C 139	.1 µF ±10% X7R chip	510-3606-104
C 140	.1 µF ±10% X7R chip	510-3606-104
C 141	.1 µF ±10% X7R chip	510-3606-104
C 142	.01 µF ±5% X7R 1206	510-3609-103
C 143	.022 µF ±5% X7R 1206	510-3609-223
C 144	.047 µF ±10% X7R 1206	510-3606-473
C 145	.0068 µF ±5% X7R 1206	510-3609-682
C 146	390 pF ±5% NPO 1206	510-3602-391
C 147	4700 pF ±2% NPO 1206	510-3616-681
C 148	.01 µF ±2% NPO 1206	510-3617-103
C 149	4700 pF ±2% NPO 1206	510-3616-472
C 150	.022 µF ±5% X7R 1206	510-3609-223
C 151	.1 µF ±10% X7R chip	510-3606-104
C 152	.1 µF ±10% X7R chip	510-3606-104
C 153	.1 µF ±10% X7R chip	510-3606-104
C 154	.1 µF ±10% X7R chip	510-3606-104
C 155	15 pF ±5% NPO 1206 chip	510-3602-150
C 156	.1 µF ±10% X7R chip	510-3606-104
C 157	.1 µF ±10% X7R chip	510-3606-104
C 158	10 µF 16V tantalum SMD	510-2625-100
C 159	.1 µF ±10% X7R chip	510-3606-104
C 160	.1 µF ±10% X7R chip	510-3606-104
C 161	.1 µF ±10% X7R chip	510-3606-104
C 162	20 pF ±5% NPO 1206 chip	510-3602-200
C 163	20 pF ±5% NPO 1206 chip	510-3602-200
C 164	.001 µF ±2% NPO 1206	510-3616-102
C 165	360 pF ±5% NPO 1206	510-3602-361
C 166	15 pF ±5% NPO 1206 chip	510-3602-150
C 169	.1 µF ±10% X7R chip	510-3606-104
C 170	.01 µF ±10% X7R chip	510-3606-103
C 171	.01 µF ±10% X7R chip	510-3606-103
C 172	.01 µF ±10% X7R chip	510-3606-103
C 173	.01 µF ±10% X7R chip	510-3606-103
C 174	.01 µF ±10% X7R chip	510-3606-103
C 175	.01 µF ±10% X7R chip	510-3606-103
C 176	.01 µF ±10% X7R chip	510-3606-103
C 177	.01 µF ±10% X7R chip	510-3606-103
C 178	.01 µF ±10% X7R chip	510-3606-103
C 179	.01 µF ±10% X7R chip	510-3606-103
C 180	.01 µF ±10% X7R chip	510-3606-103
C 181	.01 µF ±10% X7R chip	510-3606-103
C 182	.01 µF ±10% X7R chip	510-3606-103
C 183	.01 µF ±10% X7R chip	510-3606-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER	SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 184	.01 µF ±10% X7R chip	510-3606-103	C 231	.01 µF ±10% X7R chip	510-3606-103
C 185	.01 µF ±10% X7R chip	510-3606-103	C 232	.01 µF ±10% X7R chip	510-3606-103
C 186	.01 µF ±10% X7R chip	510-3606-103	C 233	.01 µF ±10% X7R chip	510-3606-103
C 187	.01 µF ±10% X7R chip	510-3606-103	C 234	.01 µF ±10% X7R chip	510-3606-103
C 188	.01 µF ±10% X7R chip	510-3606-103	C 235	1 µF tantalum SMD	510-2625-109
C 189	.01 µF ±10% X7R chip	510-3606-103	C 236	.001 pF ±2% NPO 1206	510-3616-102
C 190	.01 µF ±10% X7R chip	510-3606-103	C 237	.033 µF ±5% X7R 1210	510-3610-333
C 191	.01 µF ±10% X7R chip	510-3606-103	C 238	.047 µF ±5% X7R 1206	510-3609-473
C 192	.01 µF ±10% X7R chip	510-3606-103	C 239	.068 µF ±5% X7R 1206	510-3609-683
C 193	.01 µF ±10% X7R chip	510-3606-103	C 240	1 µF tantalum SMD	510-2625-109
C 194	.01 µF ±10% X7R chip	510-3606-103	C 241	15 µF 20V tantalum SMD	510-2626-150
C 195	.01 µF ±10% X7R chip	510-3606-103	C 242	15 µF 20V tantalum SMD	510-2626-150
C 196	.01 µF ±10% X7R chip	510-3606-103	C 243	10 µF 35V axial low temp	510-4235-100
C 197	.01 µF ±10% X7R chip	510-3606-103	C 244	10 µF 35V axial low temp	510-4235-100
C 198	.01 µF ±10% X7R chip	510-3606-103	C 245	10 µF 35V axial low temp	510-4235-100
C 199	.01 µF ±10% X7R chip	510-3606-103	C 246	10 µF 35V axial low temp	510-4235-100
C 200	.01 µF ±10% X7R chip	510-3606-103	C 247	.1 µF ±10% X7R 1206	510-3606-104
C 201	.01 µF ±10% X7R chip	510-3606-103	C 249	.1 µF ±10% X7R chip	510-3606-104
C 202	.01 µF ±10% X7R chip	510-3606-103	C 251	15 µF 20V tantalum SMD	510-2626-150
C 203	.01 µF ±10% X7R chip	510-3606-103	C 254	.1 µF ±10% X7R 1206	510-3606-104
C 204	.01 µF ±10% X7R chip	510-3606-103	C 255	47 µF 10V tantalum SMD	510-2624-470
C 205	.01 µF ±10% X7R chip	510-3606-103	C 256	15 µF 20V tantalum SMD	510-2626-150
C 206	.01 µF ±10% X7R chip	510-3606-103	C 257	47 µF 10V tantalum SMD	510-2624-470
C 207	1 µF tantalum SMD	510-2625-109	C 258	47 µF 10V tantalum SMD	510-2624-470
C 208	.01 µF ±10% X7R chip	510-3606-103	C 262	.01 µF ±10% X7R chip	510-3606-103
C 209	.01 µF ±10% X7R chip	510-3606-103	C 263	.01 µF ±10% X7R chip	510-3606-103
C 210	.01 µF ±10% X7R chip	510-3606-103	C 264	.01 µF ±10% X7R chip	510-3606-103
C 211	.01 µF ±10% X7R chip	510-3606-103	C 265	.01 µF ±10% X7R chip	510-3606-103
C 212	.01 µF ±10% X7R chip	510-3606-103	C 266	.01 µF ±10% X7R chip	510-3606-103
C 213	.01 µF ±10% X7R chip	510-3606-103	C 267	47 µF 10V tantalum SMD	510-2624-470
C 214	.01 µF ±10% X7R chip	510-3606-103	C 268	47 µF 10V tantalum SMD	510-2624-470
C 215	.01 µF ±10% X7R chip	510-3606-103	C 269	47 µF 10V tantalum SMD	510-2624-470
C 216	.01 µF ±10% X7R chip	510-3606-103	C 270	47 µF 10V tantalum SMD	510-2624-470
C 217	.01 µF ±10% X7R chip	510-3606-103	C 271	.01 µF ±10% X7R chip	510-3606-103
C 218	.01 µF ±10% X7R chip	510-3606-103	C 272	.01 µF ±10% X7R chip	510-3606-103
C 219	.01 µF ±10% X7R chip	510-3606-103	C 273	.01 µF ±10% X7R chip	510-3606-103
C 220	.01 µF ±10% X7R chip	510-3606-103	C 276	.0022 µF ±2% NPO 1206	510-3616-222
C 221	.01 µF ±10% X7R chip	510-3606-103	C 277	.0047 µF ±2% NPO 1206	510-3616-472
C 222	.01 µF ±10% X7R chip	510-3606-103	C 278	.0068 µF ±2% NPO 1206	510-3617-682
C 223	.01 µF ±10% X7R chip	510-3606-103	C 279	.22 µF ±5% X7R 1210	510-3610-224
C 224	.01 µF ±10% X7R chip	510-3606-103	C 280	.022 µF ±5% X7R 1206	510-3609-223
C 225	.01 µF ±10% X7R chip	510-3606-103	C 281	820 pF ±2% NPO 1206	510-3616-821
C 226	.01 µF ±10% X7R chip	510-3606-103	C 282	.1 µF ±10% X7R 1206	510-3606-104
C 227	.01 µF ±10% X7R chip	510-3606-103	C 283	.1 µF ±10% X7R 1206	510-3606-104
C 228	.01 µF ±10% X7R chip	510-3606-103	C 284	220 µF 25V aluminum radial	510-4225-221
C 229	.01 µF ±10% X7R chip	510-3606-103	C 285	470 µF 25V radial low profile	510-4064-471
C 230	.01 µF ±10% X7R chip	510-3606-103	C 286	10 µF tantalum SMD	510-2625-100

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 287	300 pF ±5% NPO 1206	510-3602-301
C 288	300 pF ±5% NPO 1206	510-3602-301
C 289	300 pF ±5% NPO 1206	510-3602-301
C 290	300 pF ±5% NPO 1206	510-3602-301
C 291	.1 µF ±5% X7R 1206	510-3609-104
C 292	360 pF ±5% NPO 1206	510-3602-361
C 293	68 pF ±5% NPO 1206	510-3602-680
C 294	.1 µF ±5% X7R 1206	510-3609-104
C 295	220 µF 25V aluminum radial	510-4225-221
C 296	10 µF 16V tantalum SMD	510-2625-100
C 297	.0039 µF ±2% NPO 1206	510-3616-392
C 298	.0033 µF ±2% NPO 1206	510-3616-332
C 299	.01 µF ±10% X7R chip	510-3606-103
C 300	.0056 µF ±2% NPO 1210	510-3617-562
C 301	.0047 µF ±2% NPO 1206	510-3616-472
C 302	.0033 µF ±2% NPO 1206	510-3616-332
C 303	.0039 µF ±2% NPO 1206	510-3616-392
C 304	.1 µF ±10% X7R 1206 chip	510-3606-104
C 305	10 µF tantalum SMD	510-2625-100
C 306	.1 µF ±10% X7R 1206 chip	510-3606-104
C 307	100 pF ±5% NPO 1206	510-3602-101
CR100	Switching diode SOT-23	523-1504-002
CR101	Dual switching diode SOT-23	523-1504-023
CR102	Dual switching diode SOT-23	523-1504-023
CR103	Dual switching diode SOT-23	523-1504-023
CR104	Dual switching diode SOT-23	523-1504-023
CR105	Dual switching diode SOT-23	523-1504-023
CR106	Switching diode SOT-23	523-1504-002
CR107	4.3V zener SOT-23	523-2016-439
CR108	UHF/VHF band switch SOT	523-1504-012
CR109	UHF/VHF band switch SOT	523-1504-012
CR110	UHF/VHF band switch SOT	523-1504-012
CR111	2.4V 1W zener	523-2505-249
CR112	2.4V 1W zener	523-2505-249
CR113	15V zener SOT-23	523-2016-150
CR114	15V zener SOT-23	523-2016-150
CR117	15V zener SOT-23	523-2016-150
CR118	15V zener SOT-23	523-2016-150
CR119	5.1V zener SOT-23	523-2016-519
CR120	5.1V zener SOT-23	523-2016-519
EP100	Crystal pin insulator	018-1080-001
HW001	Panel fastener	537-0011-031
HW101	Card inj/ext nylon pull	537-9057-020
HW102	Rivet snap 0.142 dia	574-9015-050

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
J 100	Green horizontal tip jack .080	105-2204-105
J 101	Speaker jack mini enclosed	515-2002-011
J 102	3.6mm jack enclosed	515-2001-011
J 103	Black horiz tip jack .080	105-2203-101
J 104	3.6mm jack enclosed	515-2001-011
J 105	3-pin single inline header	515-7100-003
J 106	5-pin single inline header	515-7100-005
J 301	Miniset CL bottom socket	515-5006-041
MP101	Control knob	032-0792-010
P 100	32-pin DIN male right angle	515-7082-102
P 101	64-pin DIN male right angle	515-7082-101
P 102	2-pos shorting socket	515-5010-001
P 106	2-pos shorting socket	515-5010-001
P 107	2-pos shorting socket	515-5010-001
PC200	PC board	035-2000-320
Q 101	Si PNP SOT-23 2N3906	576-0003-657
Q 102	Si NPN SOT-23 2N3904	576-0003-658
R 101	29.4k ohm ±1% 1206 SMD	569-0111-446
R 102	147k ohm ±1% 1206 SMD	569-0111-517
R 103	69.8k ohm ±1% 1206 SMD	569-0111-482
R 104	15k ohm ±1% 1206 SMD	569-0111-418
R 105	100 ohm ±1% 1206 SMD	569-0111-201
R 106	1.07M ohm ±1% 1206 SMD	569-0111-604
R 107	1.07M ohm ±1% 1206 SMD	569-0111-604
R 108	110 ohm ±1% 1206 SMD	569-0111-205
R 109	1.07M ohm ±1% 1206 SMD	569-0111-604
R 110	110 ohm ±1% 1206 SMD	569-0111-205
R 111	18.2k ohm ±1% 1206 SMD	569-0111-426
R 112	47k ohm ±5% 1206 SMD	569-0115-473
R 113	150k ohm ±5% 1206 SMD	569-0115-154
R 114	18k ohm ±5% 1206 SMD	569-0115-183
R 115	47k ohm ±5% 1206 SMD	569-0115-473
R 116	1.5k ohm ±5% 1206 SMD	569-0115-152
R 117	6.2k ohm ±5% 1206 SMD	569-0115-622
R 118	12k ohm ±5% 1206 SMD	569-0115-123
R 119	47k ohm ±5% 1206 SMD	569-0115-473
R 120	10k ohm ±5% 1206 SMD	569-0115-103
R 121	47k ohm ±5% 1206 SMD	569-0115-473
R 122	10k ohm ±5% 1206 SMD	569-0115-103
R 123	330k ohm ±5% 1206 SMD	569-0115-334
R 124	1M ohm ±5% 1206 SMD	569-0115-105
R 125	100k ohm ±5% 1206 SMD	569-0115-104

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 126	100k ohm ±5% 1206 SMD	569-0115-104
R 127	470k ohm ±5% 1206 SMD	569-0115-474
R 128	100k ohm ±5% 1206 SMD	569-0115-104
R 129	47k ohm ±5% 1206 SMD	569-0115-473
R 130	100k ohm ±5% 1206 SMD	569-0115-104
R 131	56k ohm ±5% 1206 SMD	569-0115-563
R 132	56k ohm ±5% 1206 SMD	569-0115-563
R 133	100k ohm ±5% 1206 SMD	569-0115-104
R 134	100k ohm ±5% 1206 SMD	569-0115-104
R 135	47k ohm ±5% 1206 SMD	569-0115-473
R 136	10k ohm ±5% 1206 SMD	569-0115-103
R 137	121k ohm ±1% 1206 SMD	569-0111-509
R 138	121k ohm ±1% 1206 SMD	569-0111-509
R 139	35.7k ohm ±1% 1206 SMD	569-0111-454
R 140	27.4k ohm ±1% 1206 SMD	569-0111-443
R 141	22.6k ohm ±1% 1206 SMD	569-0111-435
R 142	17.4k ohm ±1% 1206 SMD	569-0111-424
R 143	3.3k ohm ±5% 1206 SMD	569-0115-332
R 144	1k ohm ±5% 1206 SMD	569-0115-102
R 145	150k ohm ±5% 1206 SMD	569-0115-154
R 150	86.6k ohm ±1% 1206 SMD	569-0111-491
R 151	43.2k ohm ±1% 1206 SMD	569-0111-462
R 152	22k ohm ±5% 1206 SMD	569-0115-223
R 153	43k ohm ±5% 1206 SMD	569-0115-433
R 154	43k ohm ±5% 1206 SMD	569-0115-433
R 155	82k ohm ±5% 1206 SMD	569-0115-823
R 156	82k ohm ±5% 1206 SMD	569-0115-823
R 157	82k ohm ±5% 1206 SMD	569-0115-823
R 158	82k ohm ±5% 1206 SMD	569-0115-823
R 159	2.74k ohm ±1% 1206 SMD	569-0111-343
R 160	1.1k ohm ±1% 1206 SMD	569-0111-305
R 161	3.01k ohm ±1% 1206 SMD	569-0111-347
R 162	18.2k ohm ±1% 1206 SMD	569-0111-426
R 163	100k ohm ±5% 1206 SMD	569-0115-104
R 164	100k ohm ±5% 1206 SMD	569-0115-104
R 165	47k ohm ±5% 1206 SMD	569-0115-473
R 166	56k ohm ±5% 1206 SMD	569-0115-563
R 167	56k ohm ±5% 1206 SMD	569-0115-563
R 168	2.2k ohm ±5% 1206 SMD	569-0115-222
R 169	54.9k ohm ±1% 1206 SMD	569-0111-472
R 170	1M ohm ±5% 1206 SMD	569-0115-105
R 171	10k ohm ±5% 1206 SMD	569-0115-103
R 172	10k ohm ±5% 1206 SMD	569-0115-103
R 173	430k ohm ±5% 1206 SMD	569-0115-434
R 174	160k ohm ±5% 1206 SMD	569-0115-164
R 175	4.3k ohm ±5% 1206 SMD	569-0115-432
R 176	6.8k ohm ±5% 1206 SMD	569-0115-682
R 177	100k ohm ±5% 1206 SMD	569-0115-104
R 178	100k ohm ±5% 1206 SMD	569-0115-104
R 179	300 ohm ±5% 1206 SMD	569-0115-301
R 180	300 ohm ±5% 1206 SMD	569-0115-301
R 181	100k ohm ±5% 1206 SMD	569-0115-104
R 182	100k ohm ±5% 1206 SMD	569-0115-104
R 183	300 ohm ±5% 1206 SMD	569-0115-301
R 184	300 ohm ±5% 1206 SMD	569-0115-301
R 185	75k ohm ±1% 1206 SMD	569-0111-485
R 186	75k ohm ±1% 1206 SMD	569-0111-485
R 187	75k ohm ±1% 1206 SMD	569-0111-485
R 188	75k ohm ±1% 1206 SMD	569-0111-485
R 189	300 ohm ±5% 1206 SMD	569-0115-301
R 190	300 ohm ±5% 1206 SMD	569-0115-301
R 191	75k ohm ±1% 1206 SMD	569-0111-485
R 192	75k ohm ±1% 1206 SMD	569-0111-485
R 193	75k ohm ±1% 1206 SMD	569-0111-485
R 194	75k ohm ±1% 1206 SMD	569-0111-485
R 195	300 ohm ±5% 1206 SMD	569-0115-301
R 196	300 ohm ±5% 1206 SMD	569-0115-301
R 197	1M ohm ±5% 1206 SMD	569-0115-105
R 198	10k ohm ±5% 1206 SMD	569-0115-103
R 199	100k ohm ±5% 1206 SMD	569-0115-104
R 200	2.2k ohm ±5% 1206 SMD	569-0115-222
R 201	270k ohm ±5% 1206 SMD	569-0115-274
R 202	1M ohm ±5% 1206 SMD	569-0115-105
R 203	10k ohm ±5% 1206 SMD	569-0115-103
R 204	47k ohm ±5% 1206 SMD	569-0115-473
R 205	7.5k ohm ±5% 1206 SMD	569-0115-752
R 206	10k ohm ±5% 1206 SMD	569-0115-103
R 207	10k ohm ±5% 1206 SMD	569-0115-103
R 208	10k ohm ±5% 1206 SMD	569-0115-103
R 209	10k ohm ±5% 1206 SMD	569-0115-103
R 210	10k ohm ±5% 1206 SMD	569-0115-103
R 211	100 ohm ±5% 1206 SMD	569-0115-101
R 212	1k ohm ±5% 1206 SMD	569-0115-102
R 213	5.1k ohm ±5% 1206 SMD	569-0115-512
R 214	3.9k ohm ±5% 1206 SMD	569-0115-392
R 215	1k ohm ±5% 1206 SMD	569-0115-102
R 216	10k ohm ±5% 1206 SMD	569-0115-103
R 217	100 ohm ±5% 1206 SMD	569-0115-101
R 218	82k ohm ±5% 1206 SMD	569-0115-823
R 219	180k ohm ±5% 1206 SMD	569-0115-184
R 220	16k ohm ±5% 1206 SMD	569-0115-163
R 222	100k ohm ±5% 1206 SMD	569-0115-104
R 223	6.8k ohm ±5% 1206 SMD	569-0115-682
R 225	10k ohm ±5% 1206 SMD	569-0115-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 226	10k ohm ±5% 1206 SMD	569-0115-103
R 227	10k ohm ±5% 1206 SMD	569-0115-103
R 228	5.1k ohm ±1% 1206 SMD	569-0111-512
R 229	1k ohm ±5% 1206 SMD	569-0115-102
R 230	7.5k ohm ±5% 1206 SMD	569-0115-752
R 231	10k ohm ±5% 1206 SMD	569-0115-103
R 232	51 ohm ±5% 2512 SMD	569-0175-510
R 233	100k ohm multi-turn pot	562-0110-104
R 234	100k ohm multi-turn pot	562-0110-104
R 235	100k ohm multi-turn pot	562-0110-104
R 236	10k ohm Vol/Audio switch	562-0018-044
R 237	100k ohm multi-turn pot	562-0110-104
R 238	100k ohm multi-turn pot	562-0110-104
R 239	100k ohm multi-turn pot	562-0110-104
R 240	100k ohm multi-turn pot	562-0110-104
R 241	100k ohm multi-turn pot	562-0110-104
R 242	100k ohm multi-turn pot	562-0110-104
R 243	100k ohm multi-turn pot	562-0110-104
R 244	100k ohm multi-turn pot	562-0110-104
R 247	54.9k ohm ±1% 1206 SMD	569-0111-472
R 248	120k ohm ±5% 1206 SMD	569-0115-124
R 249	36k ohm ±5% 1206 SMD	569-0115-363
R 250	150k ohm ±5% 1206 SMD	569-0115-154
R 251	51k ohm ±5% 1206 SMD	569-0115-513
R 252	43k ohm ±5% 1206 SMD	569-0115-433
R 253	390k ohm ±5% 1206 SMD	569-0115-394
R 254	47k ohm ±5% 1206 SMD	569-0115-473
R 256	36k ohm ±5% 1206 SMD	569-0115-363
R 257	36k ohm ±5% 1206 SMD	569-0115-363
R 258	2.2k ohm ±5% 1206 SMD	569-0115-222
R 259	10k ohm ±5% 1206 SMD	569-0115-103
R 260	47k ohm ±5% 1206 SMD	569-0115-473
R 261	270k ohm ±5% 1206 SMD	569-0115-274
R 262	2.2k ohm ±5% 1206 SMD	569-0115-222
R 263	10k ohm ±5% 1206 SMD	569-0115-103
R 264	10k ohm ±5% 1206 SMD	569-0115-103
R 265	2.2k ohm ±5% 1206 SMD	569-0115-222
R 266	10k ohm ±5% 1206 SMD	569-0115-103
R 267	2.2k ohm ±5% 1206 SMD	569-0115-222
R 268	36k ohm ±5% 1206 SMD	569-0115-363
R 269	36k ohm ±5% 1206 SMD	569-0115-363
R 270	39k ohm ±5% 1206 SMD	569-0115-393
R 271	180k ohm ±5% 1206 SMD	569-0115-184
R 274	36k ohm ±5% 1206 SMD	569-0115-363
R 275	36k ohm ±5% 1206 SMD	569-0115-363
R 276	18k ohm ±5% 1206 SMD	569-0115-183
R 277	5.1k ohm ±5% 1206 SMD	569-0115-512
R 279	150k ohm ±5% 1206 SMD	569-0115-154
R 280	150k ohm ±5% 1206 SMD	569-0115-154
R 281	1M ohm ±5% 1206 SMD	569-0115-105
R 282	10k ohm ±5% 1206 SMD	569-0115-103
R 283	Zero ohm ±5% 1206 SMD	569-0115-001
R 284	10k ohm ±5% 1206 SMD	569-0115-103
R 285	2.2k ohm ±5% 1206 SMD	569-0115-222
R 286	75k ohm ±5% 1206 SMD	569-0115-753
R 288	220 ohm ±5% 1206 SMD	569-0115-221
R 289	2.2 ohm ±10% 1206 SMD	569-0115-229
R 290	1 ohm ±10% 1206 SMD	569-0115-109
R 291	1k ohm ±5% 1206 SMD	569-0115-102
R 292	39 ohm ±5% 1206 SMD	569-0115-390
R 293	6.2k ohm ±5% 1206 SMD	569-0115-622
R 294	1k ohm ±5% 1206 SMD	569-0115-102
R 295	10k ohm ±5% 1206 SMD	569-0115-103
R 296	10k ohm ±5% 1206 SMD	569-0115-103
R 297	10k ohm ±5% 1206 SMD	569-0115-103
R 298	10k ohm ±5% 1206 SMD	569-0115-103
R 299	10k ohm ±5% 1206 SMD	569-0115-103
R 300	36k ohm ±5% 1206 SMD	569-0115-363
R 301	100k ohm multi-turn pot	562-0110-104
R 302	36k ohm ±5% 1206 SMD	569-0115-363
R 303	240 ohm ±5% 1206 SMD	569-0115-241
R 304	27 ohm ±5% 1206 SMD	569-0115-270
R 305	100k ohm multi-turn pot	562-0110-104
R 306	36k ohm ±5% 1206 SMD	569-0115-363
R 307	36k ohm ±5% 1206 SMD	569-0115-363
R 308	909k ohm ±1% 1206 SMD	569-0111-593
R 309	25.5k ohm ±1% 1206 SMD	569-0111-440
R 310	Zero ohm ±10% 1206 SMD	569-0115-001
R 311	Zero ohm ±10% 1206 SMD	569-0115-001
R 312	Zero ohm ±10% 1206 SMD	569-0115-001
R 313	Zero ohm ±10% 1206 SMD	569-0115-001
R 314	43.2k ohm ±1% 1206 SMD	569-0111-462
R 315	86.6k ohm ±1% 1206 SMD	569-0111-491
R 316	25.5k ohm ±1% 1206 SMD	569-0111-440
R 317	909k ohm ±1% 1206 SMD	569-0111-593
R 318	10k ohm ±5% 1206 SMD	569-0115-103
R 319	10k ohm ±5% 1206 SMD	569-0115-103
R 320	180k ohm ±5% 1206 SMD	569-0115-184
R 321	100 ohm ±5% 1206 SMD	569-0115-101
R 322	Zero ohm ±5% 1206 SMD	569-0115-001
R 323	Zero ohm ±5% 1206 SMD	569-0115-001
RT100	10k ohm chip thermistor	569-3013-007

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
S 100	8-pos DIP switch	583-5002-008
S 101	4-pos DIP switch	583-5002-004
U 100	Quad 2-input NOR	544-3766-002
U 101	Hex inverter SOIC 74HC04	544-3766-004
U 102	1 of 8 demux 74HC138	544-3766-138
U 103	1 of 16 demux SOIC 74HC154	544-3766-154
U 104	D-latch non-inverting SOIC	544-3766-573
U 105	D-latch non-inverting SOIC	544-3766-573
U 106	D flip flop SOIC 74HC574	544-3766-574
U 107	D flip flop SOIC 74HC574	544-3766-574
U 108	D flip flop SOIC 74HC574	544-3766-574
U 109	Bell-202 compatible modem	544-3988-014
U 110	Bell-202 compatible modem	544-3988-014
U 111	87C52 CMOS	544-5011-948
U 112	Main Audio Card/LTR	023-9998-291
U 113	Quad analog sw SPST SO-16	544-3003-001
U 114	Quad analog sw SPST SO-16	544-3003-001
U 115	Quad analog sw SPST SO-16	544-3003-001
U 116	Quad analog sw SPST SO-16	544-3003-001
U 117	Quad analog sw SPST SO-16	544-3003-001
U 118	Quad analog sw SPST SO-16	544-3003-001
U 119	Micro monitor SO-8 DS1232	544-2003-085
U 120	Dual op amp SOIC LM2904	544-2019-004
U 121	Dual op amp SOIC LM2904	544-2019-004
U 122	Quad op amp SOIC MC3403	544-2020-008
U 123	Quad op amp SOIC MC3403	544-2020-008
U 124	Dual op amp SOIC LM2904	544-2019-004
U 125	Quad op amp SOIC MC3404	544-2020-008
U 126	Quad op amp SOIC MC3404	544-2020-008
U 127	Quad op amp SOIC MC3404	544-2020-008
U 128	Quad op amp SOIC MC3404	544-2020-008
U 129	Quad op amp SOIC MC3404	544-2020-008
U 130	Dual op amp SOIC LM2904	544-2019-004
U 131	Quad op amp SOIC MC3404	544-2020-008
U 132	Audio amp 10W TO-220	544-2006-013
U 133	1 of 16 demux SOIC 74HC154	544-3766-154
U 135	Dual op amp SO-8	544-2019-018
U 136	+5V regulator SOIC 78L08	544-2603-042
U 149	EEPOT 100k SOIC 9C104	544-0004-209
U 151	EEPOT 100k SOIC 9C104	544-0004-209
U 153	Quad analog sw SPST SO-16	544-3003-001
U 154	Quad 2-in OR SOIC 74HC32	544-3766-032
U 155	D flip flop SOIC 74HC574	544-3766-574
U 156	D flip flop SOIC 74HC574	544-3766-574
U 157	D flip flop SOIC 74HC574	544-3766-574
U 158	Quad analog sw SOIC DG202	544-3003-001
U 159	Quad analog sw SOIC DG202	544-3003-001
U 160	9 bit x 64 word FIFO DIP-28	544-3764-703
U 161	9 bit x 64 word FIFO DIP-28	544-3764-703
U 162	Dr/Rcvr RS232C V.28 145406	544-2023-014
U 163	Dual op amp SOIC LM2904	544-2019-004
U 164	Dual op amp SOIC LM2904	544-2019-004
U 165	Dual op amp SOIC LM2904	544-2019-004
U 166	Dual op amp SO-8 MC33178	544-2019-018
U 167	Quad op amp SOIC MC3404	544-2020-008
X 110	28-pin IC socket	515-5008-018
X 111	40-pin IC socket	515-5008-019
X 112	28-pin IC socket	515-5008-018
Y 100	3.5795 MHz crystal	521-0003-579
Y 101	11.059 MHz crystal	521-0011-059
Z 100	EMI suppression filter	532-3003-002
Z 101	EMI suppression filter	532-3003-002
Z 102	EMI suppression filter	532-3003-002

INTERFACE ALARM CARD
PART NO. 023-2000-350

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 500	.01 µF ±10% X7R chip	510-3606-103
C 502	.1 µF ±10% X7R 1210	510-3607-104
C 503	150 pF ±5% NPO 1206 chip	510-3602-151
C 511	.01 µF ±10% X7R chip	510-3606-103
C 512	.01 µF ±10% X7R chip	510-3606-103
C 513	.01 µF ±10% X7R chip	510-3606-103
C 514	.01 µF ±10% X7R chip	510-3606-103
C 515	.01 µF ±10% X7R chip	510-3606-103
C 516	.01 µF ±10% X7R chip	510-3606-103
C 517	.01 µF ±10% X7R chip	510-3606-103
C 518	.01 µF ±10% X7R chip	510-3606-103
C 519	.01 µF ±10% X7R chip	510-3606-103
C 521	.01 µF ±10% X7R chip	510-3606-103
C 522	47 µF 25V electrolytic radial	510-4425-470
C 523	47 µF 25V electrolytic radial	510-4425-470
C 525	10 µFD 16V tantalum SMD	510-2625-100
C 526	1 µF 16V tantalum SMD	510-2625-109
C 527	.1 µF 35V tantalum SMD	510-2628-108
C 529	.01 µF ±10% X7R chip	510-3606-103
C 530	220 µF electrolytic axial	510-4325-221
C 531	.01 µF ±10% X7R chip	510-3606-103
C 532	1000 µF electrolytic	510-4350-102
C 533	.01 µF ±10% X7R chip	510-3606-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 534	100 pF ±5% NPO 1206	510-3602-101
C 535	100 pF ±5% NPO 1206	510-3602-101
C 536	.1 µF ±10% X7R 1210	510-3607-104
C 537	.1 µF ±10% X7R 1210	510-3607-104
C 538	.01 µF ±10% X7R chip	510-3606-103
C 539	.01 µF ±10% X7R chip	510-3606-103
CR500	Red LED submin radial	549-4001-120
CR501	Green LED submin radial	549-4001-122
CR502	Yellow LED submin radial	549-4001-121
CR503	Green LED submin radial	549-4001-122
CR504	Green LED submin radial	549-4001-122
CR505	Yellow LED submin radial	549-4001-121
CR506	Dual switch diode SOT-23	523-1504-023
CR507	Dual switch diode SOT-23	523-1504-023
CR508	Dual switch diode SOT-23	523-1504-023
CR509	Dual switch diode SOT-23	523-1504-023
CR510	Dual switch diode SOT-23	523-1504-023
CR511	Dual switch diode SOT-23	523-1504-023
CR512	Dual switch diode SOT-23	523-1504-023
CR513	Dual switch diode SOT-23	523-1504-023
CR523	Green LED submin radial	549-4001-122
CR524	Green LED submin radial	549-4001-122
CR525	Green LED submin radial	549-4001-122
CR526	200V 1.5A rectifier 1N4818	523-0013-201
CR527	5.1V zener SOT-23	523-2016-519
CR528	5.1V zener SOT-23	523-2016-519
CR529	15V zener SOT-23	523-2016-150
CR530	15V zener SOT-23	523-2016-150
CR531	15V zener SOT-23	523-2016-150
CR532	15V zener SOT-23	523-2016-150
CR533	15V zener SOT-23	523-2016-150
CR534	15V zener SOT-23	523-2016-150
CR535	4.3V zener SOT-23	523-2016-439
CR536	15V zener SOT-23	523-2016-150
CR537	15V zener SOT-23	523-2016-150
F 501	1A 250V submin fuse	534-0017-014
FH501	Fuse holder	534-1017-001
HW001	Panel fastener 0.475 long	537-0011-031
HW500	Card inj/ext nylon pull	537-9057-020
J 500	Horizontal green tip jack .080	105-2204-105
J 501	Horizontal black tip jack .080	105-2203-101
J 502	Horizontal red tip jack .080	105-2202-101
J 503	3-pin single inline header	515-7100-003
J 504	3-pin single inline header	515-7100-003
J 505	4-pin single inline header	515-7100-004
K 500	12V SPDT 1A relay submin	567-2002-021
K 501	12V SPDT 1A relay submin	567-2002-021
K 502	12V SPDT 1A relay submin	567-2002-021
K 503	12V SPDT 1A relay submin	567-2002-021
L 501	3 µH filter choke PC mount	542-5007-031
P 500	64-pin DIN male right angle	515-7082-101
P 501	32-pin DIN male right angle	515-7082-102
P 503	2-pos shorting socket	515-5010-001
P 504	2-pos shorting socket	515-5010-001
P 505	2-pos shorting socket	515-5010-001
PC350	PC board	035-2000-350
Q 500	Si NPN SOT-23 2N3904	576-0003-658
Q 501	Si NPN SOT-23 2N3904	576-0003-658
Q 502	Si NPN SOT-23 2N3904	576-0003-658
Q 503	Si NPN SOT-23 2N3904	576-0003-658
Q 504	NPN dig SOT-23F RN1404	576-0003-616
Q 505	NPN dig SOT-23F RN1404	576-0003-616
R 500	4.7k ohm ±5% 1206 SMD	569-0115-472
R 501	4.7k ohm ±5% 1206 SMD	569-0115-472
R 502	430 ohm ±5% 1/4W CF	569-0513-431
R 504	1k ohm ±5% 1206 SMD	569-0115-102
R 506	1k ohm ±5% 1206 SMD	569-0115-102
R 507	100k ohm ±5% 1206 SMD	569-0115-104
R 508	10k ohm ±1% 1206 SMD	569-0111-401
R 509	10k ohm ±1% 1206 SMD	569-0111-401
R 510	10k ohm ±5% 1206 SMD	569-0115-103
R 511	20k ohm ±5% 1206 SMD	569-0115-203
R 512	10k ohm ±5% 1206 SMD	569-0115-103
R 513	10k ohm ±5% 1206 SMD	569-0115-103
R 514	10k ohm ±5% 1206 SMD	569-0115-103
R 515	1k ohm ±5% 1206 SMD	569-0115-102
R 516	2.7k ohm ±5% 1/4W CF	569-0115-272
R 517	2.7k ohm ±5% 1/4W CF	569-0115-272
R 518	2.7k ohm ±5% 1/4W CF	569-0115-272
R 519	2.7k ohm ±5% 1/4W CF	569-0115-272
R 520	2.7k ohm ±5% 1/4W CF	569-0115-272
R 521	4.7k ohm ±5% 1206 SMD	569-0115-472
R 522	10k ohm ±1% 1206 SMD	569-0111-401

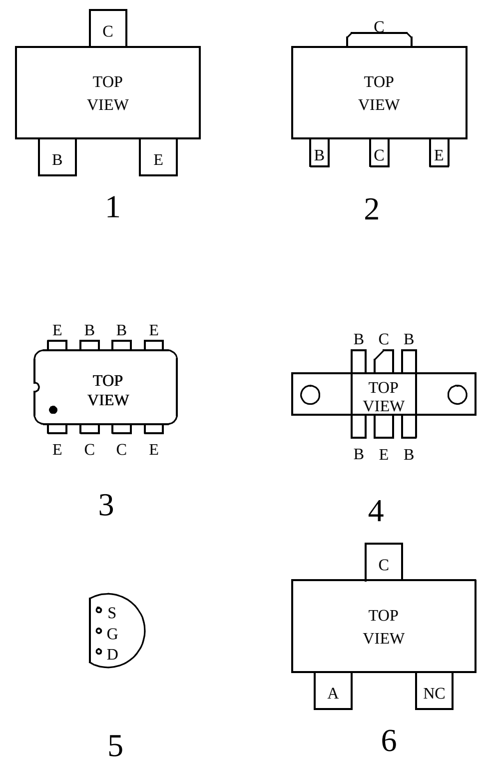
SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 523	10k ohm ±1% 1206 SMD	569-0111-401
R 524	4.7k ohm ±5% 1206 SMD	569-0115-472
R 525	10k ohm ±1% 1206 SMD	569-0111-401
R 526	10k ohm ±1% 1206 SMD	569-0111-401
R 527	4.7k ohm ±5% 1206 SMD	569-0115-472
R 528	1.2k ohm ±5% 1206 SMD	569-0115-122
R 529	4.7k ohm ±5% 1206 SMD	569-0115-472
R 530	10k ohm ±1% 1206 SMD	569-0111-401
R 531	4.32k ohm ±1% 1206 SMD	569-0111-362
R 532	4.7k ohm ±5% 1206 SMD	569-0115-472
R 533	1k ohm ±5% 1206 SMD	569-0115-102
R 534	1M ohm ±5% 1206 SMD	569-0115-105
R 535	4.7k ohm ±5% 1206 SMD	569-0115-472
R 536	10k ohm ±5% 1206 SMD	569-0115-103
R 537	1k ohm ±5% 1206 SMD	569-0115-102
R 538	100k ohm ±5% 1206 SMD	569-0115-104
R 539	100k ohm ±5% 1206 SMD	569-0115-104
R 541	200 ohm ±5% 1206 SMD	569-0115-201
R 543	10k ohm ±5% 1206 SMD	569-0115-103
R 544	1k ohm ±5% 1206 SMD	569-0115-102
R 545	10k ohm ±5% 1206 SMD	569-0115-103
R 546	430 ohm ±5% 1/4W CF	569-0513-431
R 547	430 ohm ±5% 1/4W CF	569-0513-431
R 548	430 ohm ±5% 1/4W CF	569-0513-431
R 549	10k ohm ±5% 1206 SMD	569-0115-103
R 550	10k ohm ±5% 1206 SMD	569-0115-103
R 551	10k ohm ±5% 1206 SMD	569-0115-103
R 552	10k ohm ±5% 1206 SMD	569-0115-103
R 553	1.2k ohm ±5% 1206 SMD	569-0115-122
R 554	1.2k ohm ±5% 1206 SMD	569-0115-122
R 555	1.2k ohm ±5% 1206 SMD	569-0115-122
R 556	10k ohm ±5% 1206 SMD	569-0115-103
R 557	10k ohm ±5% 1206 SMD	569-0115-103
R 558	10k ohm ±5% 1206 SMD	569-0115-103
R 559	10k ohm ±5% 1206 SMD	569-0115-103
R 560	10k ohm ±5% 1206 SMD	569-0115-103
R 561	10k ohm ±5% 1206 SMD	569-0115-103
R 562	10k ohm ±5% 1206 SMD	569-0115-103
R 563	3.9k ohm ±5% 1206 SMD	569-0115-392
R 564	1k ohm ±5% 1206 SMD	569-0115-102
R 567	200 ohm ±5% 1206 SMD	569-0115-201
R 568	200 ohm ±5% 1206 SMD	569-0115-201
R 569	200 ohm ±5% 1206 SMD	569-0115-201
R 576	2.7k ohm ±5% 1206 SMD	569-0115-272
R 577	1k ohm ±5% 1206 SMD	569-0115-102
R 578	2.7k ohm ±5% 1206 SMD	569-0115-272

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
S 500	4-pos recessed DIP switch	583-5002-104
S 501	4-pos recessed DIP switch	583-5002-104
S 502	4-pos recessed DIP switch	583-5002-104
S 503	4-pos recessed DIP switch	583-5002-104
S 508	Toggle switch on/on rt angle	583-0006-014
U 500	1 of 16 demux SOIC 74HC154	544-3766-154
U 501	1 of 16 demux SOIC 74HC154	544-3766-154
U 503	D flip flop SOIC 74HC574	544-3766-574
U 504	D flip flop SOIC 74HC574	544-3766-574
U 505	D flip flop SOIC 74HC574	544-3766-574
U 506	8-bit A/D converter	544-2031-001
U 507	Bilateral switch SOIC 4066B	544-3016-066
U 508	Hex open drain buffer SO-14	544-3716-906
U 510	NPN out opto isolator 4N35	544-2010-001
U 511	NPN out opto isolator 4N35	544-2010-001
U 512	NPN out opto isolator 4N35	544-2010-001
U 513	Bilateral switch SOIC 4066B	544-3016-066
U 514	Dual op amp SOIC LM2904	544-2019-004
U 517	Transparent latch SOIC	544-3766-573
U 518	D flip flop SOIC 74HC574	544-3766-574
U 520	NPN out opto isolator 4N35	544-2010-001
U 521	Transparent latch SOIC	544-3766-573
U 523	+8V regulator 78M08	544-2003-081
Z 500	EMI suppression filter	532-3003-002
Z 501	EMI suppression filter	532-3003-002

SECTION 10 SCHEMATICS AND COMPONENT LAYOUTS

TRANSISTORS

TRANSISTORS		
Part Number	Basing Diagram	Identification
576-0001-300	1	1R
576-0002-603	2	
576-0003-600	1	2X
576-0003-602	1	R2/R3
576-0003-604	3	3604
576-0003-612	1	2T
576-0003-636	1	R25
576-0003-657	1	2A
576-0003-658	1	1A
576-0004-098	3	
576-0004-820	4	
576-0004-821	4	
576-0006-109	5	
DIODES		
523-1504-002	6	5A
523-1504-012	6	2A
523-1504-015	6	4E
523-1504-016	6	5H
523-1504-023	-	A7
523-2016-180	6	Y7
523-2016-479	6	8E/Z1
523-2016-519	6	8F/Z2
523-2016-629	6	8J/Z4
523-2016-919	6	8P/Z8
523-5004-002		



INTEGRATED CIRCUITS

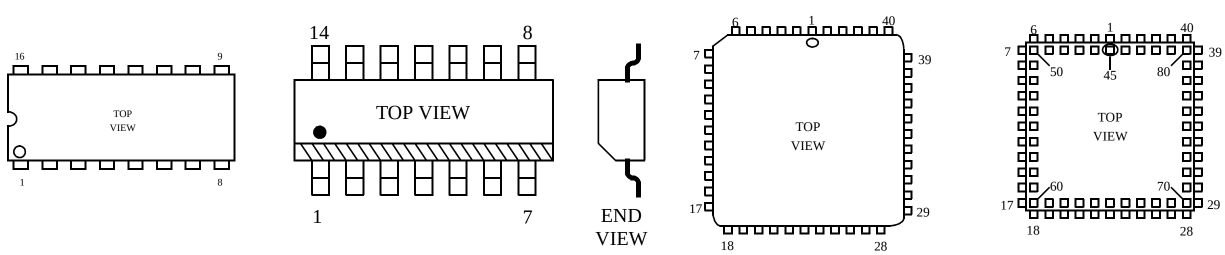


Figure 10-1 RF MODULE INTERFACE CONNECTOR
Figure 10-2 BACKPLANE CABLE CONNECTIONS

Figure 10-3 REPEATER REAR VIEW

Figure 10-4 REPEATER FRONT VIEW

Figure 10-5 REPEATER CABINET EXPLODED VIEW

Figure 10-6 INPUT/OUTPUT ALARM INTERCONNECT

Figure 10-7 RF INTERCONNECT

Figure 10-8 BACKPLANE INTERCONNECT

Figure 10-9 RECEIVE VCO

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Figure 10-12   RF INTERFACE BOARD SCHEMATIC

Figure 10-13 RECEIVER COMPONENT LAYOUT (COMP SIDE)

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Figure 10-16   EXCITER SCHEMATIC

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Figure 10-18 110W POWER AMPLIFIER SCHEMATIC

Figure 10-19 FORWARD/REVERSE POWER COMPONENT LAYOUT

Figure 10-20   FORWARD/REVERSE POWER SCHEMATIC

Figure 10-21 MAIN PROCESSOR CARD COMPONENT LAYOUT

Figure 10-22 MAIN PROCESSOR CARD SCHEMATIC (1 OF 2)

Figure 10-23 MAIN PROCESSOR CARD SCHEMATIC (2 OF 2)

Figure 10-24   MAIN AUDIO CARD COMPONENT LAYOUT (OPP COMP SIDE)

Figure 10-25 MAIN AUDIO CARD COMPONENT LAYOUT (COMPONENT SIDE)

Figure 10-26 MAIN AUDIO CARD SCHEMATIC (1 OF 3)

Figure 10-27 MAIN AUDIO CARD SCHEMATIC (2 OF 3)

Figure 10-28 MAIN AUDIO CARD SCHEMATIC (3 OF 3)

Figure 10-29 INTERFACE ALARM CARD COMPONENT LAYOUT

Figure 10-30 INTERFACE ALARM CARD SCHEMATIC

Figure 10-31 BACKPLANE COMPONENT LAYOUT (CARD SIDE)

Figure 10-32   BACKPLANE COMPONENT LAYOUT (CABLE SIDE)

Figure 10-33   BACKPLANE SCHEMATIC

Figure 10-34 800W POWER SUPPLY COMPONENT LAYOUT (OPP COMP SIDE)

Figure 10-35 800W POWER SUPPLY COMPONENT LAYOUT (COMPONENT SIDE)

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Figure 10-39 AC SUPPLY FILTER BOARD SCHEMATIC

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Figure 10-41 BATTERY BACK-UP SCHEMATIC

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Figure 10-44 POWER CABLE CONNECTOR AND SCHEMATIC

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