VIKING® VX
VHF LTR
25W-110W Repeater

Part No. 242-20X1-213

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PRELIMINARY

VIKING® VX
VHF LTR REPEATER
PART NO. 242-20X1-213

The E.F. Johnson Company designs and manufactures two-way radio equipment to serve a wide variety of communications needs. Johnson 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

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 could void the user's authority to operate this equipment (FCC rules, 47CFR Part 15.19).

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.

To comply with FCC RF exposure limits, DO NOT operate the transmitter of a stationary radio (base station or marine radio) when a person is within four (4) meters 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 transmitter equipped radio equipment.

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

SAFETY INFORMATION

The FCC has adopted a safety standard for human exposure to RF energy. Proper operation of this radio under normal conditions results in user exposure to RF energy 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.

FCC EXPOSURE LIMITS

This fixed station radio transceiver was tested by the manufacturer with an appropriate antenna in order to verify compliance with Maximum Permissible Exposure (MPE) limits set under Section 2.1091 of the FCC Rules and Regulations. The guidelines used in the evaluation are derived from Table 1 (B) titled “Limits For General Population/Uncontrolled Exposure” which is from FCC report OET bulletin #65.

Table 1 (B)
FCC Limits for Maximum Permissible Exposure (MPE)

(B) Limits For General Population/Uncontrolled Exposure			
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/cm^2)**
0.3 - 1.34	614	1.63	(100)*
1.34 - 30	824/f	2.19/f	($180/f^2$)*
30 - 300	27.5	0.073	0.2
300 - 1500	--	--	f/1500
1500 - 100,000	--	--	1.0
f = Frequency in MHz *Plane-wave equivalent power density.			

Table 2 lists the antennas recommended for use in the VHF frequency range. Each model of this radio was tested with the appropriate antenna listed. The antenna shall be mounted to a tower and be a minimum of 10 meters above the ground at the lowest point on the antenna. The radio manufacturer has determined that the user and service personnel should remain four (4) meters in distance away from the antenna when transmitting. By maintaining this distance, these individuals are not exposed to radio frequency energy or magnetic fields in excess of the guidelines set forth in Table 1 (B).

NOTE: Other antennas or installation configurations that have not been tested may not comply with FCC RF exposure limits and therefore are not recommended.

Table 2
Recommended Antennas
(Antenna Manufacturer - Decibel Products)

Frequency	Antenna Model No.
132-144 MHz	DB205E
144-178 MHz	DB205F

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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® Repeater, Part No. 242-20X1-213.

1.2 REPEATER DESCRIPTION

The VIKING VX repeater is designed for operation in a Johnson LTR system. It operates on the VHF channels from 132-178 MHz. Channel spacing is 12.5/25 kHz and RF power output is adjustable from 25 to 125 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 2000 Series Programmer software, Part No. 023-9998-390.

The VIKING VX repeater interfaces with a MPC (Main Processor Card) and MAC (Main Audio Card) to provide LTR operation. All signal ports used to interface to the Repeater are on J2 located at the back of the cabinet.

1.3 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:

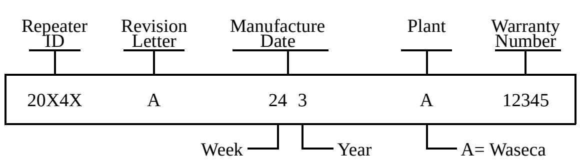


Figure 1-1 REPEATER IDENTIFICATION

1.4 MODEL NUMBER BREAKDOWN

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

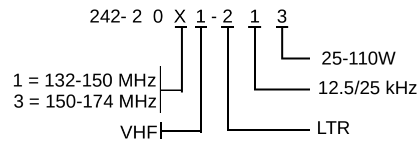


Figure 1-2 PART NUMBER BREAKDOWN

1.5 ACCESSORIES

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

2-Wire Telephone Interconnect Card (TIC) - This card provides an interface between the Repeater and a phone line to permit telephone calls to be placed to and from mobile transceivers.

LTR System ID Validator - If an invalid ID is detected on the repeater data bus, the audio of the mobile receiving the call is disabled.

2000 Series Service Kit - This kit contains an alarm wire harness, extender power cable, programming kit, extender card, extender harness, and a TIC bias cable. These items are used when tuning the repeater and while troubleshooting.

Battery Backup and Cable Option - This option can be factory or field installed (refer to installation instructions 004-2000-830). It includes the 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).

RJ-11 to 6-BNC Adapter - This adapter box provides connections for the high speed data bus at the rear of the repeater and the data bus from the logic drawers in existing repeater systems.

Table 1-1 REPEATER ACCESSORIES

Accessory	Part No.
2-Wire Telephone Interconnect Card	023-2000-370
LTR System ID Validator	023-4408-500
2000 Series Service Kit[1]	250-2000-230
Battery Backup option and cable	023-2000-835
RJ-11 to 6-BNC Adapter[2]	023-2000-194
3’ RG-58 coax w/male BNC for HSDB	023-4406-505
6’ RG-58 coax w/male BNC for HSDB	597-3001-214
Custom Frequency Programming & Setup	023-2000-100
PC programmer PGMR 2000 software	023-9998-390
Service Microphonee	589-0015-011
50 ohm Termination HSDB	023-4406-504
Programming cable kit[3]	023-2000-195
Extender Card	023-2000-230
Extender cable kit, 7 ft.	250-2000-010

[1] Includes: extender card, extender cables, TIC bias cable and programming cable kit (PN 023-2000-195).
[2] Required when using Viking Networking products, one per station.
3 Included in 2000 Series Service Kit (PN250-2000-230).

PC Programmer PGMR Software - 3.5" programming disk used to program the repeater.

Programming Cable Kit - This kit connects the MPC and a computer during programming and for monitoring repeater activity at the site.

Extender Card - Used to extend the cards plugged into the backplane beyond the card rack enclosure when tuning the repeater and while troubleshooting.

Extender Cable Kit - These are seven foot extension cables for the RF Transceiver power and data, when the transceiver is removed from the cabinet.

1.6 PRODUCT WARRANTY

The warranty statement 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 with warranties or warranty service by dialing (507) 835-6970.

1.7 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. Customer Service hours are 7:30 a.m. - 4:30 p.m. Central Time, Monday - Friday. There is also a 24-hour emergency technical support telephone number. From within the continental United States, the Customer Service Department can be reached toll-free at:

1-800-328-3911

When your call is answered at the 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 a first number of "1" or "2", another number is requested to further categorize the type of information. You may also enter the 4-digit extension number of the person that you want to reach.

FAX Machine - Sales (507) 835-6485
FAX Machine - Cust Serv (507) 835-6969

If you are calling from outside the continental United States, the Customer Service telephone numbers are as follows:

Customer Service Department - (507) 835-6911
Customer Service FAX Machine - (507) 835-6969

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

1.8 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.

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 1.7) 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.

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.

1.9 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 1.7. 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 1.4).

You may also send your order by mail or FAX. The mailing address is as follows and the FAX number is shown in Section 1.7.

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

1.10 SOFTWARE UPDATES/REVISIONS

All inquiries concerning updated software, its installation and revisions should be directed to the Customer Service Department (see Section 1.7).

1.11 REPEATER OPERATION

1.11.1 MAIN PROCESSOR CARD (MPC)

Refer to Figure 1-3.

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.

RF Thermal Sense Alarm Condition Exists

NOTE: Safety measures are disabled

Ok

Alarms

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. Refer to Figure 1-3 for an example of this type of alarm.

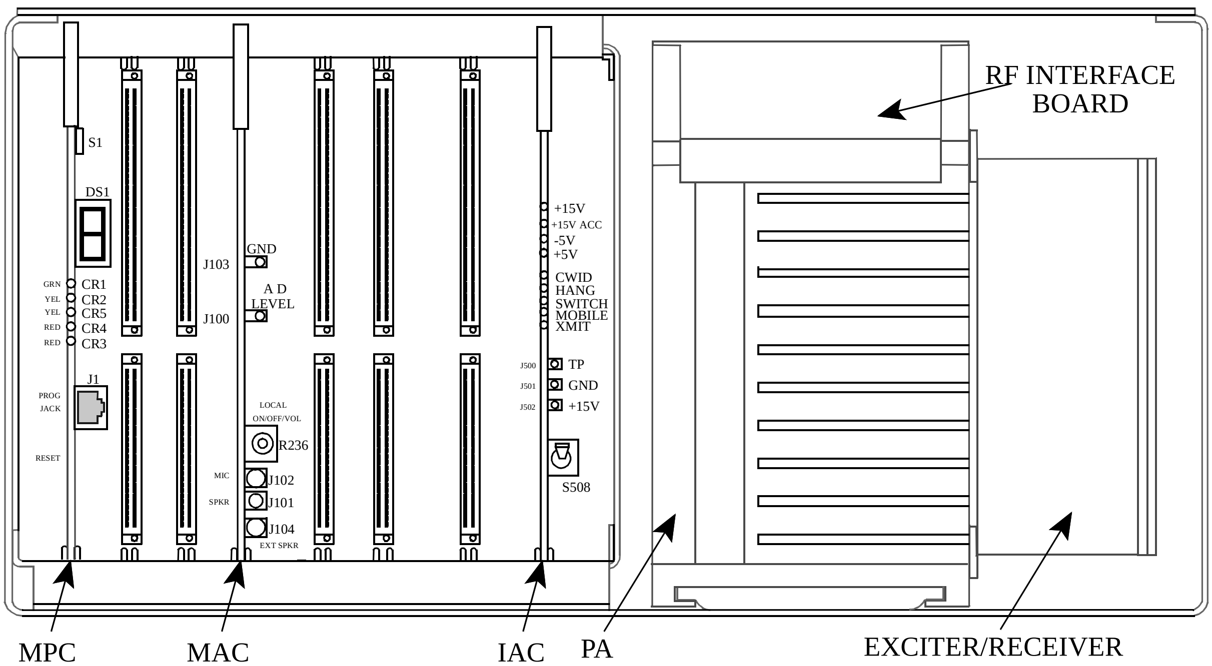


Figure 1-3 REPEATER CARDS

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
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	Switch (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

1.11.2 MAIN AUDIO CARD (MAC)

Refer to Figure 1-3.

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.

1.11.3 INTERFACE ALARM CARD (IAC)

Refer to Figure 1-3.

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

Not used in the LTR repeater.

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.

1.11.4 POWER SUPPLY

The power supply is sealed and the line and supply fuses are inside. If a supply fuse opens, the power supply must be removed and opened for repair (see Section 2.4 and 8.5). Refer to the power supply service manual 004-2000-810.

Standby Battery Jack

This provides a connection point for a +24V DC standby battery. Current is drawn from the battery only when the power supply output voltage is lower than the battery voltage. A trickle charge switch on the supply ensures that the battery is fully charged. Disable this switch when a separate battery charger is used (see Section 2.5).

1.12 REPEATER INFORMATION

1.12.1 INTRODUCTION

NOTE: The VIKING VX does not require a separate LTR logic drawer.

The repeater model used in an LTR system is determined by frequency range. 800 MHz systems use the VIKING VX (2008-232/-234) or LTR 8000s, UHF use 20x4-232/-234 or 1010s, and VHF use 2011/2031-213 or 1100s. Repeaters operate on a single frequency (one repeater is required for each channel). The MPC in each repeater performs all control and signaling functions on that channel. Information is exchanged between repeaters via a high-speed data bus (modular cable). No system controller is required.

Optional accessories, such as the Telephone Interconnect Card (TIC) can be installed in the repeater and the ID Validator drawer can be installed in the repeater rack. Refer to Johnson LTR ID Validator Manual, Part No. 001-4408-501 and Johnson Telephone Interconnect Card Manual, Part No. 004-2000-370 for detailed information.

1.12.2 HOME REPEATERS

All mobiles have one of the site repeaters assigned as its "Home" repeater. This is the repeater from which it receives most of its control information. When a mobile is not placing or receiving a call, it is always monitoring its Home repeater to determine which channel is free and if it is being called by another mobile.

The Home repeater is always used to make a call unless it is busy. When the Home repeater is busy, any other repeater in the site may then be used. Up to 250 ID codes are assigned to each repeater. An ID code and Home repeater number are the "address" of the mobiles in the system. Therefore, up to 1250 separate addresses can be assigned in a 5-repeater system and up to 5000 can be assigned in a 20-repeater system. An ID code may be assigned to an individual mobile or a group of mobiles as required.

1.12.3 INTER-REPEATER DATA COMMUNICATION

Data communication between VIKING VX and LTR repeaters at a site is via a high-speed data bus. This bus cable is installed in a daisy-chain manner between repeaters. If both VIKING VX and LTR repeaters are located at a site, 20 repeaters can be interconnected. Refer to Section 2.8 for information on connecting the data bus.

1.12.4 MOBILE TRANSCEIVERS

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

1.13 REPEATER DATA BUS SIGNALING

1.13.1 GENERAL

A single-line serial data bus interconnects the logic units of all the LTR repeaters at the site. The first repeater powered on generates the synchronization pulse that is used by all other repeaters to determine their time slot on the data bus. If all repeaters are powered on at the same time, the lowest numbered repeater generates the synchronization pulse. There are 21 slots with 1-20 used for repeater reporting and 21 used by the ID Validator (see Section 1.13.3). The time slot used by a repeater is determined by the number assigned to that repeater by the programming in the MPC. Repeater 1 uses time slot 1, repeater 5 uses time slot 5, and so on. The data rate on the repeater data bus is 18,750 bits per second.

In its time slot, each repeater places information on the data bus indicating its status. If a repeater is not busy, only start bits appear in its slot. If a repeater is busy, it places in its slot the Home repeater and ID code of the mobile receiving the call on that repeater. If a repeater number is unassigned, nothing appears in that time slot.

1.13.2 MOBILE DATA MESSAGE ORDER

Each repeater monitors all the time slots on the repeater data bus. If it detects its number in another time slot, it begins transmitting an additional data message to its mobiles. This message tells mobiles programmed to detect that ID code to go to that repeater to receive a call. This additional message continues for as long as the mobile is transmitting on the other repeater.

The sequence of data messages transmitted on a home repeater is as follows: Every third message is to the mobile currently receiving a call on that repeater. Then alternating between these messages are messages to its mobiles that have been trunked to other repeaters. For example, assume that fivedifferent mobiles on a five-repeater system are making calls. If all have Repeater 1 as their home channel (not very likely in actual practice), the data message order on Repeater 1 is as follows: 1 2 3 1 4 5 1 2 3 and so on.

1.13.3 ID VALIDATOR OPERATION

If the ID Validator is used, it is programmed with the status of up to all 5000 home repeater/ID code combinations possible with a 20-channel system. Each combination is programmed as either valid or invalid. Information in the twenty time slots on the repeater data bus is monitored. If an invalid home repeater/ID code combination is detected, the ID Validator places in time slot 21 the number of the repeater being used by the invalid mobile and also the ID code. When a repeater detects its number in slot 21, it transmits the turn-off code (31) to the mobile receiving the call. That mobile then squelches and resumes monitoring its home channel. This effectively disables the invalid mobile because it cannot talk to anyone. When the turn-off code is sent, the repeater places "21" in the repeater position of its time slot to indicate to the ID validator that turn-off has occurred.

SPECIFICATIONS

GENERAL (Per TIA 603)[1]

Frequency Ranges	132-178 MHz Transmit/Receive (132-150 MHz and 150-178 MHz)
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 /15 /25 /30 kHz selectable
Channel Resolution	5 / 6.25 kHz
Temperature Range	-30°C to +60°C (-22°F to +140°F)
Duty Cycle	Continuous
FCC Type Acceptance	ATH2422001
FCC Compliance	Parts 15, 90

RECEIVER (Per TIA 603)

12 dB SINAD	0.35 µV
20 dB Quieting	0.50 µV
Signal Displacement Bandwidth	±1 kHz (12.5/15 kHz), ±2.0 kHz (25/30 kHz)
Adjacent Channel Rejection	-85 dB (12.5/15 kHz), -90 dB (25/30 kHz)
Intermodulation Rejection	-85 dB
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 (12.5/15 kHz), ±1.5 kHz (25/30 kHz)
Hum & Noise Ratio	-50 dB
Frequency Spread	2 MHz
Frequency Stability	±2.5 PPM -30°C to +60°C (-22°F to +140°F)
Modulation Acceptance Bandwidth	±3.5 kHz (12.5/15 kHz), ±7.0 kHz (25/30 kHz)

TRANSMITTER (Per TIA 603)

RF Power Out	132-178 MHz 110W (Default setting), 25-110W (Variable Set Point)
Spurious Emissions	-90 dBc
Harmonic Emissions	-90 dBc
Audio Deviation	±1.6 kHz (12.5/15 kHz), ±3.5 kHz (25/30 kHz)
LTR Data Deviation	±0.8 kHz (12.5/15 kHz), ±1 kHz (25/30 kHz)
CWID Deviation	±1 kHz (12.5/15 kHz), ±2 kHz (25/30 kHz)
Repeat Deviation	±0.8 kHz (12.5/15 kHz), ±1.5 kHz (25/30 kHz)
Audio Response	+1/-3 dB TIA
Audio Distortion	Less than 2%
Hum & Noise (TIA)	-50 dB (12.5/15 kHz), -55 dB (25/30 kHz)
Frequency Spread	6 MHz
Frequency Stability	±2.5 PPM -30°C to +60°C (-22°F to +140°F)
Emission Designators	11K0F3E, 16K0F3E

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 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 µg/m^3.

For equipment operating in an uncontrolled environment with the Repeaters rack mounted, the airborne particles must not exceed 100 µg/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 2-4). There are a few considerations when installing Repeaters to provide adequate air circulation.

1. The Repeaters should be mounted with a minimum of 6 inches clearance between the front or back of the cabinet for air flow. The power supply requires a minimum of 18 inches 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.

2. Cabinet enclosures must provide air vents for adequate air circulation.
3. 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.

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.

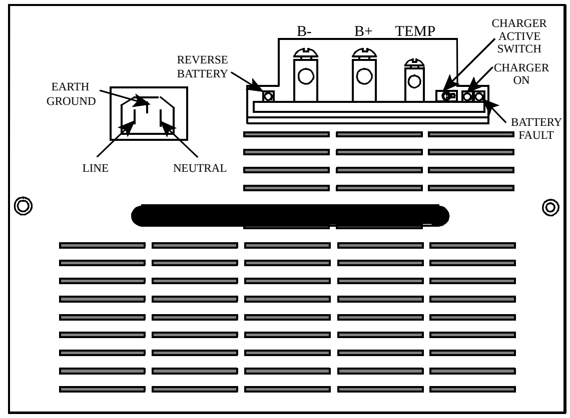


Figure 2-1 BATTERY BACKUP CONNECTOR

The temperature sensor is required to adjust the charging voltage over temperature.

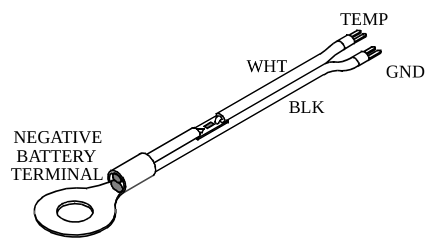


Figure 2-2 TEMPERATURE SENSOR CABLE

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.

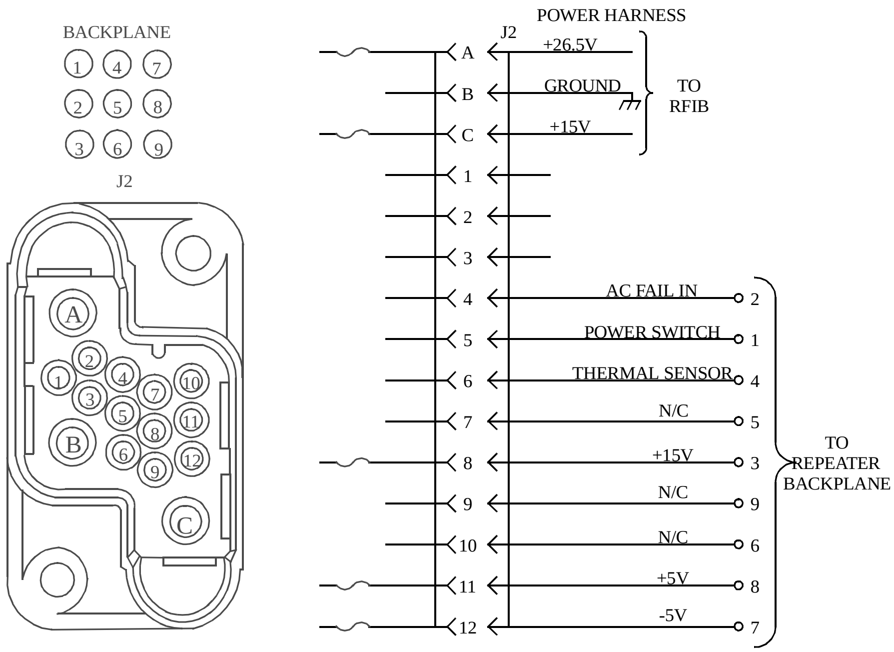


Figure 2-3 POWER CABLE CONNECTOR AND SCHEMATIC

Table 2-1 OUTPUT VOLTAGES

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

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 (dependant 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):

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

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.

1. 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.

2. With surge protectors, ensure that ground wires go directly to ground, and not through other equipment.

3. Run the ground wire for RF coax protectors directly to ground.

4. With coax protectors, ensure maximum instantaneous voltage does not exceed the rated voltage.

5. Do not run ground wires parallel to any other wiring (e.g. a ground wire parallel to a telephone line), except other ground wires.

6. 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 1.7).

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

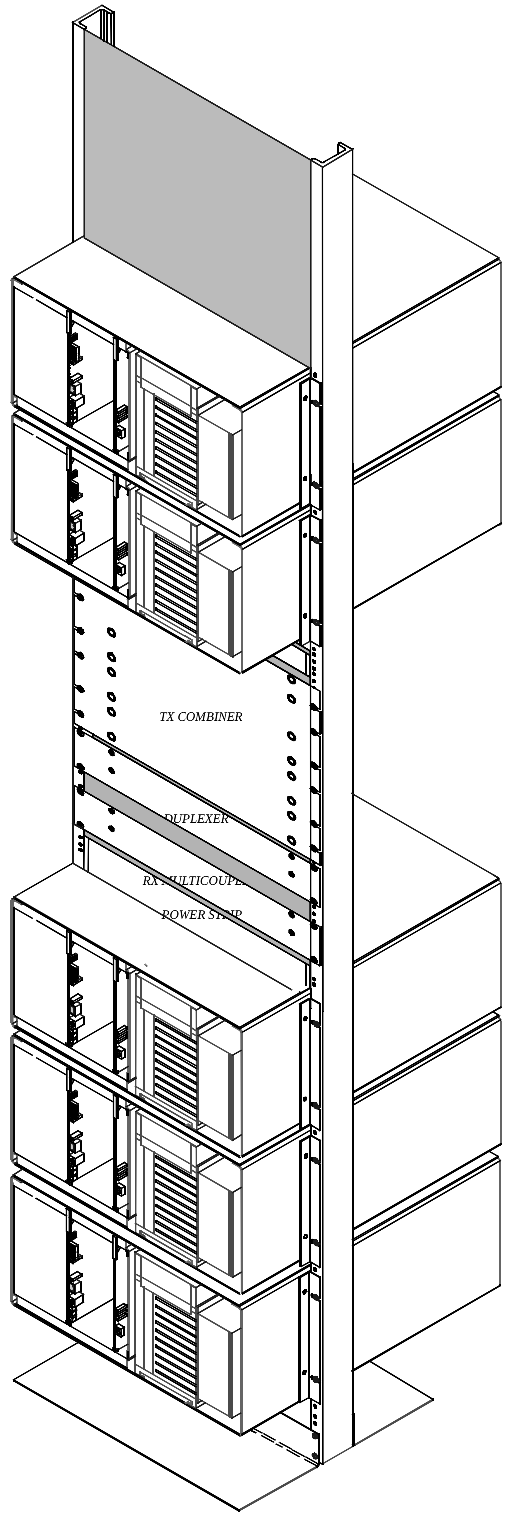


Figure 2-4 RACK MOUNTED REPEATERS

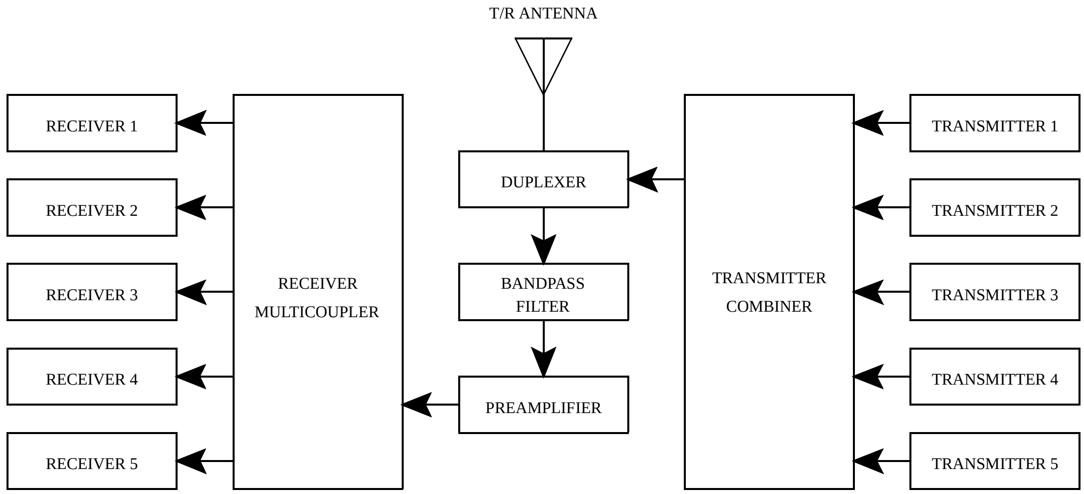


Figure 2-5 5-CHANNEL COMBINING SYSTEM

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 2-8).

2.9 REPEATER DATA BUS INSTALLATION

VIKING VX repeaters with High Speed Data Bus (HSDB) software Version 201 or earlier (reference U14 label) installed on the MPC board must use the optional RJ-11 to BNC Adapter Module (see Table 1-1 and Figure 2-9) to connect the HSDB. Any VIKING VX repeater (regardless of the HSDB software version) that connects to a HSDB that is also servicing LTR 1010 repeaters, other VIKING VX repeaters that use VIKING VNC cards, or an ID Validator must also use the adapter module. The BNC Adapter Module is installed on the back of the VIKING VX repeater cabinet (see Figure 2-13).

Systems constructed only with LTR VIKING VX repeaters that have Version 202 or later HSDB software and do not use VNC cards can be connected directly to the HSDB from the RJ-11 jack on the back of the repeater.

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 Figures 2-10 through 2-13.

2.9.2 MPC DATA BUS JUMPER SETTINGS

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

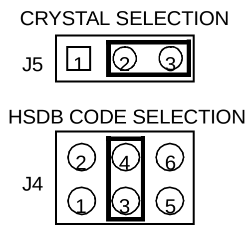


Figure 2-6 RJ-11 TO BNC MPC JUMPERS

Jumper J4 must be placed with the following guidelines (see Figure 2-6):

J4, pins 3-4 for operation with the RJ-11 to BNC adapter module and mixed systems (20x1 and 1100) with any version of HSDB software.

J4, pins 3-4 for operation with the RJ-11 to BNC adapter module with 2008 only systems with any version of HSDB software.

J4, pins 5-6 for operation with the RJ-11 to RJ-11 cable with 2008 only systems with Version 202 or later HSDB software.

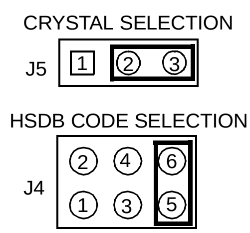


Figure 2-7 RJ-11 TO RJ-11 MPC JUMPERS

2.10 CONNECTING RECEIVE AND TRANSMIT ANTENNAS

Receive and Transmit antenna connector locations are shown in Figure 2-8. 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 2-5. 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.

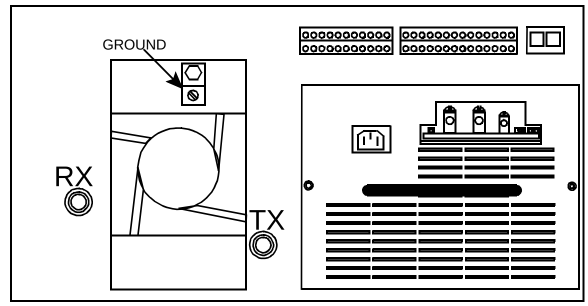


Figure 2-8 ANTENNA CONNECTIONS

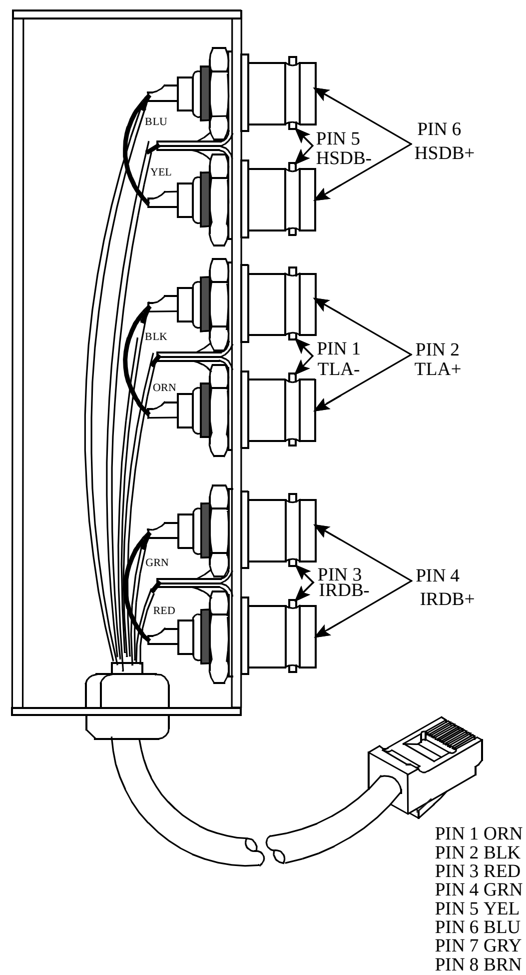


Figure 2-9 RJ-11 TO BNC ADAPTER MODULE

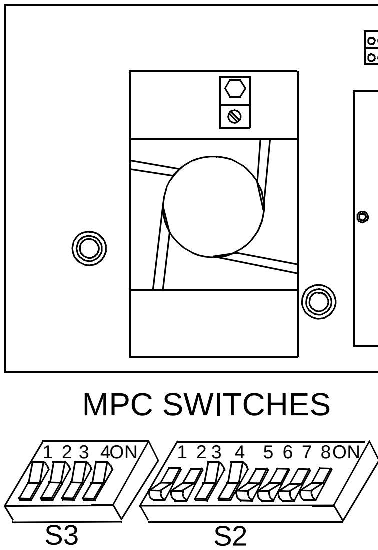


Figure 2-10 SINGLE REPEATER INSTALLATION

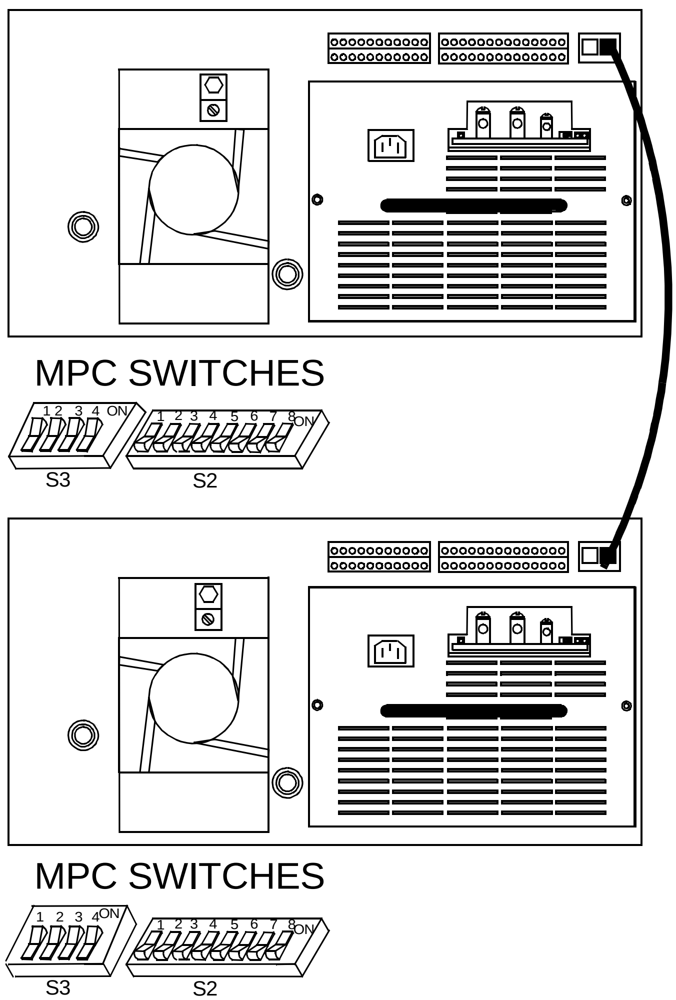


Figure 2-11 TWO REPEATER INSTALLATION

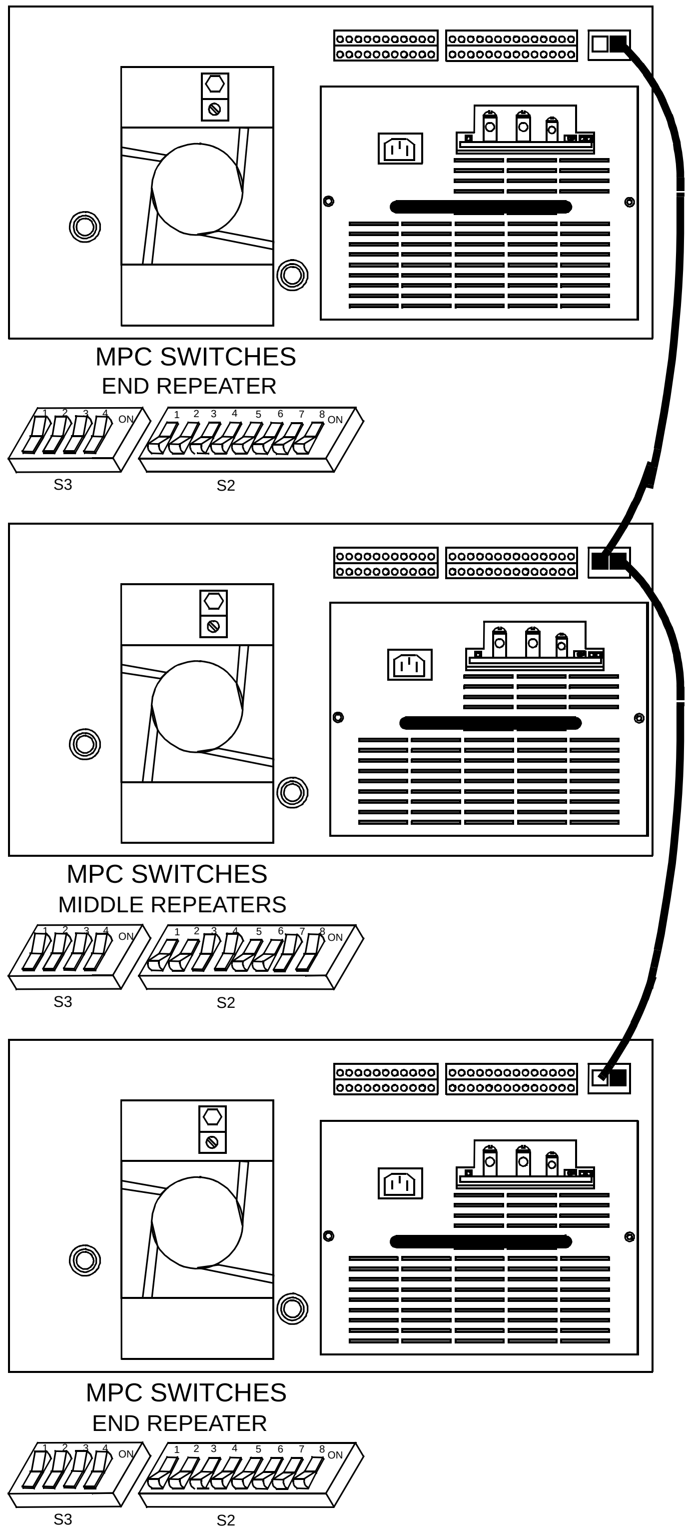


Figure 2-12 THREE OR MORE REPEATERS INSTALLATION

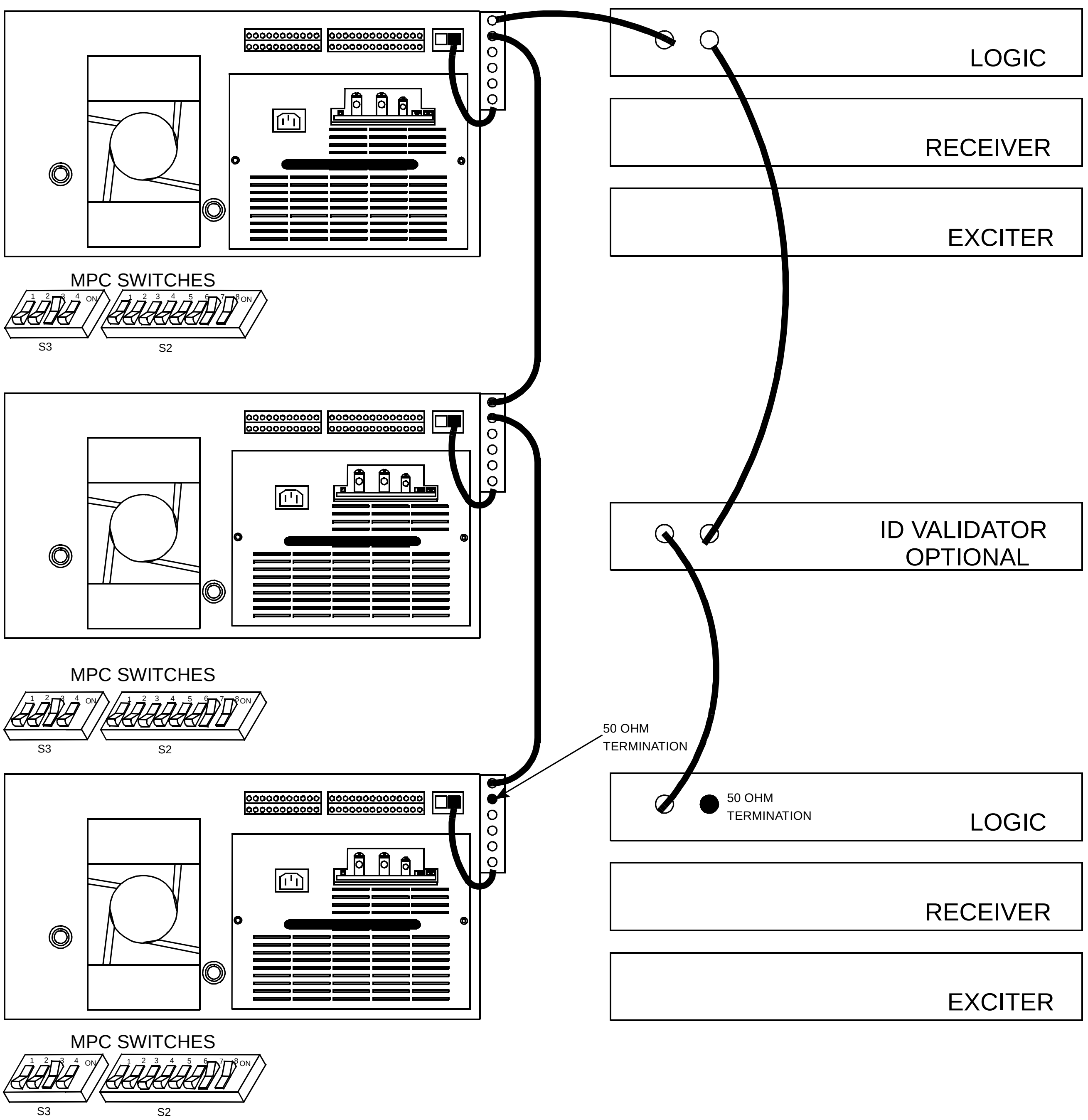


Figure 2-13 MIXED VIKING VX AND CR1100 REPEATER INSTALLATION

SECTION 3 SOFTWARE

3.1 INTRODUCTION

The Johnson 2000 Repeater Program on 3.5 inch disk, Part No. 023-9998-390, uses an IBM® personal computer to program the EEPROM Memory in the Main Processor Card (MPC). To lessen the chance of programming errors and simplify operation, the program uses yes/no questions or toggles through the available responses.

The computer is connected directly from the serial card to the MPC. The interconnect cables used are shown in Figure 4-29. 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.

3.1.1 HOW TO USE THIS MANUAL

This manual introduces the program and illustrates how to use the features. This manual is organized to easily find programming information with the Table of Contents, Index and Parameter Tables for the responses required for programming.

Graphic reproductions of the screens are shown for reference. Adjacent to the screens are tables to provide the parameters, available responses and a brief description of the parameter. It is not the intent of this manual to teach computer operation, but to allow the user to become familiar with the available screens and the responses without having to be at the computer.

3.1.2 GETTING STARTED

NOTE: Before starting you should already know how to start MS-DOS®, 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 MS-DOS manual for your computer for more information (see Section 5-1).

Follow the computer instructions for loading the disk. The MS-DOS Revision 2.0 or later operating system is needed to run the programs. The computer needs to have RS-232C capability, for example, the Serial Card in slot "COM1" or "COM2".

3.1.3 COMPUTER DESCRIPTION

The programming software is designed to run on an IBM PC or compatible computer that meet the following minimum requirements.

1. One 3.5" high density disk drive.
2. 640K of memory
3. MS-DOS version 2.0 or higher
4. One serial port
5. Monochrome or color monitor and video card

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 such as EGA and VGA are supported. A serial port is required to connect the Repeater to the computer. This port is standard with most computers.

The cables from the Repeater to the computer are not included. With most computers, the adapter-to-computer cable is a standard DB-25 M-F cable, PN 023-5800-017, (the male connector plugs into the adapter). If your computer requires a male connector, a male-to-male cable is also available, PN 023-5800-016. The cable from the adapter to the Repeater has a modular-type 8-pin connector (see Figure 4-29).

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 COMMAND LINE OPTIONS

HELP

To show all options available from the command line type: /h or /?. Either '/' or '-' can be used. For example: 2004pgmr /h

The options can be entered in any order.
For example: 2004pgmr /d /b /c

COM PORT

The Johnson programming software defaults to serial port COM1. However, if this port is already in use, the software can be reconfigured to use serial port COM2. To do this, use one of the following methods:

1. When running the compiled (.EXE) version, type /c2 on the command line after the program name. For example: 2004pgmr /c2 or -c2

2. Select COM port from Utilities heading.

BAUD RATE

The software defaults to 9600 baud, however this rate can be changed. To do this from the command line, type /bxxxx (xxxx = baud rate).
For example: 2004pgmr /b or -b

NOTE: When the baud rate is changed on the command line, the baud rate jumpers on J3 in the MPC must also be changed to the same baud rate (see Section 6.10.8).

DEMO MODE

To view the screens for Read Setup Parms and Write Setup Parms from the Transfer menu when a repeater is not connected to the computer this option is used. Normally these screens are not available without a repeater connected. To do this from the command line, type: /d or -d.
For example: 2004pgmr /d

3.1.6 COLOR OR MONOCHROME OPERATION

The programming software utilizes color for a color monitor and video card. However, with LCD-type displays, this may make some information hard to read because the contrast is poor. To improve contrast, a monochrome mode can be selected in the display mode from Utilities heading.

3.2 REPEATER PROGRAM SOFTWARE

3.2.1 INSTALLING THE SOFTWARE

When you receive the programming software, make a backup copy and store the master in a safe place. Copy the distribution disks using DOS DISKCOPY command. For example, type:

DISKCOPY A: A: (single floppy drive)

or

DISKCOPY A: B: or C: (multi-drive systems).

If you have a hard disk drive, you may want to create one or more separate directories for transceiver programming and then transfer the program disk files to those directories. To create a new directory, use the MKDIR command. For example, to create directory RADIOPRG, type:

MKDIR \RADIOPRG.

Then to make the new directory the current directory, use the CHDIR command. For example, to change to the \RADIOPRG directory, type

CHDIR \RADIOPRG.

To copy all files from a floppy disk in drive A: to this directory, type:

COPY A:*.*

If you have a single floppy drive and no hard disk drive, you need to create programming disks. The reason for this is that there is not adequate space on the backup disk(s) for storing radio files. If your computer has dual floppy disk drives, the backup disk can be placed in one drive and then the radio files stored on a disk in the second drive.

To make a programming disk, format a blank disk using FORMAT B: or FORMAT B: /S (use "/S" if it must be a bootable disk). Then copy the required program file or files to the programming disk. To do this, type COPY A:(filename.ext) B:(filename.ext). For example, to copy the file 2004pgm2.exe from drive A to drive B, type

COPY A:2004pgm2.exe B:2004pgm2.exe

This procedure works for either single or dual drive computers. Refer to your computer reference manual for more information on these DOS commands.

The programming software is shipped in a compressed format. The name of the compressed file is 2000pgm2.exe and it extracts the following files so the program can be used on a PC.

VHF_PGMR.EXE	488K
VHF_PGMR.HLP	46K
VHF12LMN.HLP	2K
VHF_PGMR.LNF	181K
VHF12HMN.LNF	11K
VHF12LMN.LNF	278K
VHF12LUS.LMF	59K
VHF25HMN.LNF	11K
VHF25LMN.LNF	270K
VHF25LUS.LMF	62K

The 2004PGM2.EXE file is self extracting which means that the files extract automatically when executed. To extract these files so the program can be used, first make the current directory the destination directory for these files. For example, to make it the \RADIOPRG directory on drive C: (if not the current directory), type C: (Return) and then CD \RADIOPRG as just described. To make it the disk in drive B:, simply type B:. Then insert the program disk in drive A: and type A:2004PGM2 (or B: 2004PRM2 if drive B: is being used). The program files are automatically extracted into the current directory or disk.

3.2.2 MINIMUM FREE MEMORY REQUIRED

Approximately 560K of free conventional memory is required to run this program (use the CHKSK or MEM command to display the amount of free memory). If you have at least 640K of memory and not enough is available, there may be other programs that are also being loaded into conventional memory. Contact Customer Service for information on how these programs can be moved or disabled to make more space available.

3.3 REPEATER PROGRAMMER

When the program is loaded into the computer and executed, the menu shows the files available from the directory. The program is used to create, edit, transfer and receive the repeater and channel parameters described in Section 5.

IMPORTANT

The commands and displays referred to in this manual are for the IBM PC and may differ from IBM compatible. Refer to the computer's operating system manual for command explanations.

3.3.1 PROGRAM FILES

The files in the software directory are needed to run the program.

3.4 ALIGNMENT SOFTWARE

File Edit Transfer Hardware Test Utilities

PA
Receiver
Exciter
Full Rptr/Station
RNT Interface
Telephone Interface
VNC Interface

Figure 3-1 REPEATER TEST MENU

The software for the VIKING VX 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 7.3), Receiver (see Section 7.1), Exciter (see Section 7.2) and overall Full Repeater (see Section 7.4) including the MAC card (see Figure 3-1).

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

3.5 HELP F1

Help screens are available for most parameters and options in this program. Whenever a parameter or options clarification is needed, press F1 and if a help screen is available it will pop-up on the screen. Press Escape <ESC> to exit the pop-up screen.

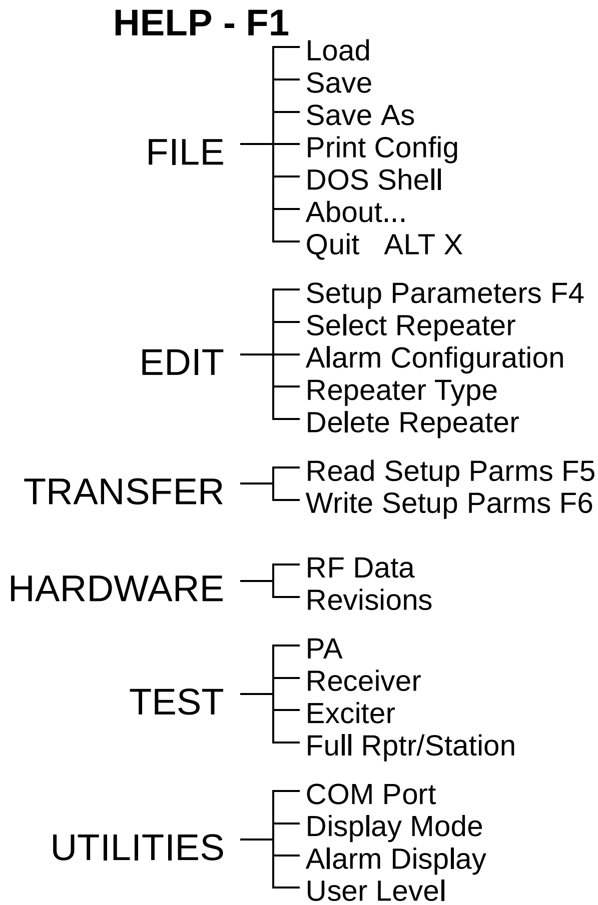


Figure 3-2 PROGRAMMING FLOWCHART

SECTION 4 PULL DOWN MENUS

4.1 MENU DISPLAYS

The menus available are listed at the top of the screen (see Figure 3-2). Move the cursor with the arrow keys to highlight the menu name. Press Enter to view the menu and the arrow keys to scroll through the menu. Call up the highlighted selection by pressing Enter.

4.2 FILE MENU

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

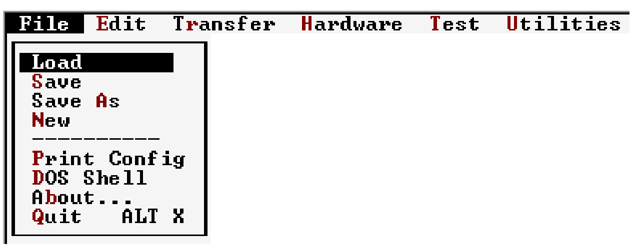


Figure 4-1 FILE MENU

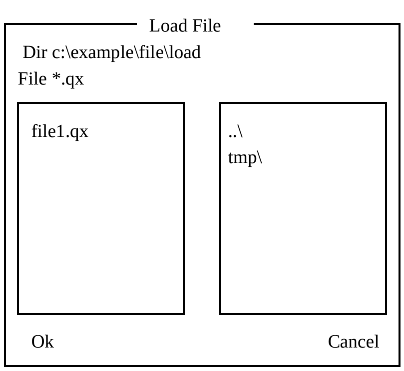


Figure 4-2 LOAD FILE

4.2.1 LOAD

Load reads information from a stored file. The program requests the filename to be loaded into the buffer. The filename from a disk can be entered in the highlighted area. Then move the cursor down with the arrow key and highlight "Ok" and press Enter. To select an existing file, use the arrow keys to move down the menu list and press Enter when the highlighted filename is the file to load.

4.2.2 SAVE

This saves the edited version of an existing file loaded in the buffer under the same filename in the directory and deletes the old file. It loads a new file created in the Edit menu into the directory.

4.2.3 SAVE AS

This 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.

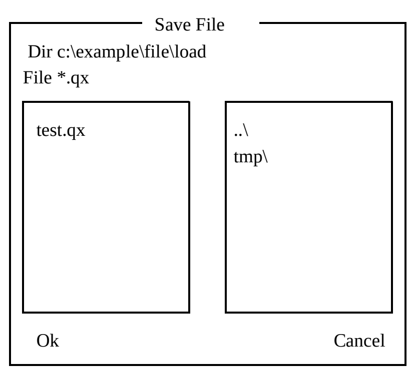


Figure 4-3 SAVE FILE

4.2.4 NEW

This menu selection erases all Site and Repeater information in the programmer and loads factory defaults. If the current data has been changed, selecting File -> New provides the opportunity to save the data before loading the defaults.

4.2.5 PRINT REPEATER CONFIGURATION

Select the destination for the configurations.
Printer - Prints to printer connected to PC.
File - Writes printable test to selected filename.

Select which repeater data will be printed.

All Repeaters - Prints the data for all valid repeaters.
Single Repeater - Prints the data for the entered repeater number.

NOTE: A list of valid repeaters can be seen under the Edit-Select Repeater menu selection.

4.2.6 DOS SHELL

DOS shell temporarily suspends the program and returns to DOS. Directories and other DOS commands can be performed. To return to the program from DOS, type EXIT and press Enter.

4.2.7 QUIT (ALT X)

Quit exits the repeater program and returns to DOS. Save all files before exiting the repeater program.

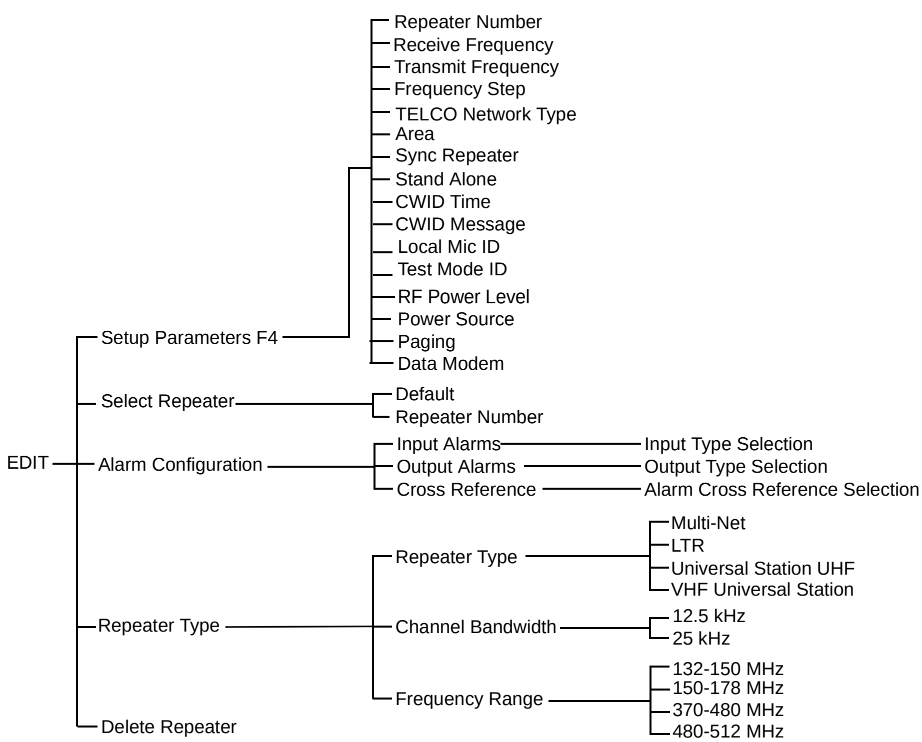


Figure 4-4 EDIT PROGRAMMING FLOWCHART

4.3 EDIT

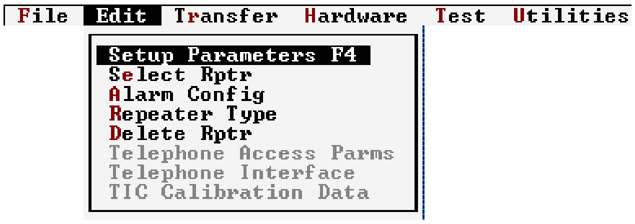


Figure 4-5 EDIT MENU

This menu is used to create new files and set or change the repeater operating parameters. The filename for the repeaters in this file is shown in the lower left corner of the screen.

4.3.1 SETUP PARAMETERS

First see Section 4.3.4 to select repeater type to setup LTR Parameters. This menu programs the repeater parameters and options of each repeater at a site. Table 5-1 lists the parameters that are set by this screen (see Figure 5-1) and gives a brief description of each.

NOTE: The parameters are shown in the lower left of the pop-up screen for reference.

Repeater Number

Each repeater is programmed with a repeater number from 1-20. Make sure that this number agrees with the Home repeater number programmed in the mobiles assigned to this repeater.

Receive/Transmit Frequency

Each Repeater is programmed with a Transmit and Receive frequency that it is operating on.

Frequency Step

Using the space bar, select either:
5000 Hz or 6250 Hz for allowable frequency spacing.

To eliminate the chance of incorrect synthesizer settings arising from ambiguous frequencies, make sure this setting is correct.

Telco Network Type

None is used for LTR system repeaters.

Area

This is the same as the area bit used when programming the mobiles. This bit is usually "0".

Sync Repeater

None is used for LTR system repeaters.

Stand Alone

Select if the repeater is not connected to additional repeaters via the high speed data bus.

ID Validator (Not applicable at this time.)

CWID Time

The time interval between transmission of the repeater's CWID message.

CWID Message

FCC regulations require that the station call letters be transmitted periodically on the lowest- frequency repeater in the system and disabled on all the others. Morse code is used to encode these letters/numbers for continuous-wave (CW) transmission (15 characters/numbers UPPER CASE).

Local MIC ID

The local microphone connected to the MAC jack is assigned a Group ID for transmitting when the local microphone PTT is active. This allows the Repeater to operate as a base station.

Test Mode ID

This Group ID is transmitted when the Repeater is in Test Mode. Mobiles with the same Group ID can communicate with the Repeater in Test Mode.

RF Power Level

This is the default power level. Enter the power level for transmit power.

NOTE: This is not the actual power out level. Other factors must be considered for true power out.

Power Source

This indicates the primary power source for the Repeater (AC/DC). If AC is selected and Battery Backup is installed, the transmitter goes to half rated power (max.) when AC fails. If DC is selected and AC fails, power output is unchanged.

Data Modem

This is selected if the Data Modem option is installed. This option is not compatible with Paging, TIC, or VNC.

4.3.2 SELECT REPEATER

Select the repeater number to be programmed or edited from the pop-up menu (see Figure 4-6). Move the cursor with the arrow keys to highlight the repeater number and press Enter.

```
Repeater List
default
Rptr 1
-------
-------
-------
Rptr 30
```

Figure 4-6 REPEATER LIST

4.3.3 ALARM CONFIGURATION

This programs the input alarm (see Figure 4-8) and output alarm (see Figure 4-9) configurations and provides a cross reference screen.

Use the arrow keys to move down the list. Use the Space bar to toggle through the parameters: Disabled, Active Low, Active High, for each alarm.

```
Select Which Alarms To Edit
Input Alarms
Output Alarms
Cross Reference
```

Figure 4-7 ALARM CONFIGURATION

Input Alarms

There are four input alarms that can be activated by external devices (see Section 6.12). These inputs can be disabled, energized or de-energized. Alarms 3 and 4 can also be analog input.

If the input is disabled, the input alarm line is inactive. When energized and current flow is detected, the alarm is activated. When de-energized and no current flow is detected, the alarm is activated. Analog inputs provide a detection of an analog input out of limit condition. Select the Low and High Limit pair 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).

```
Input Alarm Configuration

        Input Type Selection                          Description

Alarm 1 Input Type:  Energized                        Door 1 open
Alarm 2 Input Type:  De-Energized                     Door 2 open
Alarm 3 Input Type:  Analog                           Fuel Tank 1/2
Alarm 4 Input Type:  Analog                           Fuel Tank 1/4
Low  Limit Voltage (Input3):   1.6  Volts
High Limit Voltage (Input3):   2.5  Volts
Low  Limit Voltage (Input4):   0    Volts
High Limit Voltage (Input4):   1.5  Volts

Spacebar
```

Figure 4-8 INPUT ALARMS

Output Type Selection

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

Active Open - An active alarm opens (no contact) the output lines.

Active Closed - An active alarm closes (contact) the output lines.

Output Alarm Configuration

Output Type Selection		Description	Tx ID
Alarm 1 Output Type:	Active Open	DOOR OPEN	15
Alarm 2 Output Type:	Active Open	FUEL 1/2	120
Alarm 3 Output Type:	Active Open	FUEL 1/4	120
Alarm 4 Output Type:	Active Closed	RF HALF POWER	0

Alarm Tx Rate: 0

Press F2 to Accept

Spacebar

Figure 4-9 OUTPUT ALARMS

Alarm Cross Reference Selection

Select which Output Alarm is activated by each Input Alarm.

0. None	8. None	16. None	24. None	32. None	40. None
1. 1	9. None	17. None	25. None	33. 4	41. None
2. 1	10. None	18. None	26. None	34. None	42. None
3. 2	11. None	19. None	27. None	35. None	43. None
4. 3	12. None	20. None	28. None	36. None	44. None
5. None	13. None	21. None	29. None	37. None	45. None
6. None	14. None	22. None	30. None	38. None	46. None
7. None	15. None	23. None	31. None	39. None	47. None

Press F2 to Accept

Figure 4-10 ALARM CROSS REFERENCE

Alarm Description

This is a text string (up to 15 characters) to describe the alarm. This test 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 4-10).

Transmit ID

Each of the 8-alarm outputs can be assigned a Group ID from 1-225. The default setting is 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. 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), 8 external input alarms and 40 internal alarms (see Table 1-2). There are eight output alarms. An alarm condition on any input can cause an output alarm. This screen configures which input alarm activates an output alarm.

NOTE: More than one alarm condition can have the same output alarm (see Figure 4-10).

4.3.4 REPEATER TYPE

This screen (see Figure 4-11) selects the repeater type (LTR signaling protocol and features):

Repeater Type	VHF
Channel Bandwidth	12.5/25 kHz
Frequency Range	132-150/150-178 MHz

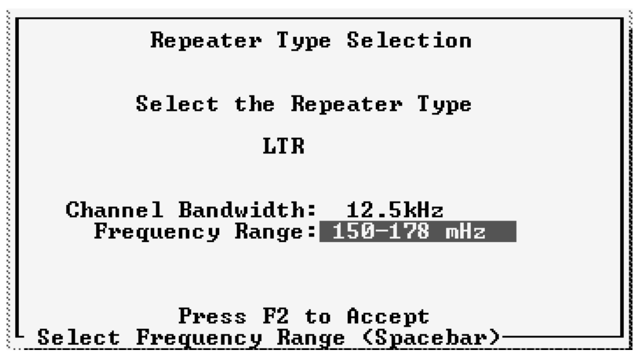


Figure 4-11 REPEATER TYPE

4.3.5 DELETE REPEATER

Select Rptr To Delete

Rptr 1

Figure 4-12 DELETE REPEATER

4.3.6 TELEPHONE PARAMETERS

Refer to the Telephone Interface Card manual, Part No. 004-2000-370, for information on the Telephone Access Parameters, Telephone Interface and TIC Calibration Data.

4.4 TRANSFER

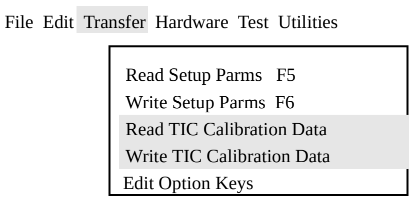


Figure 4-13 TRANSFER MENU

4.4.1 WRITE SETUP PARAMETERS

This command sends the contents of a file to the repeater and programs the EEPROM memory in the Main Processor Card (MPC).

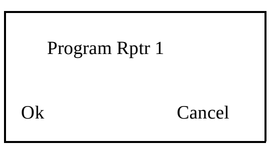


Figure 4-14 WRITE SETUP PARAMETERS

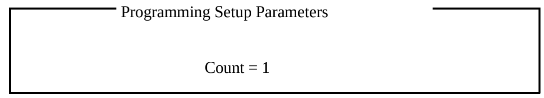


Figure 4-15 PROGRAM WRITE SETUP

4.4.2 READ SETUP PARAMETERS

This command reads the contents of the EEPROM memory of a repeater and loads it into a buffer. The contents of the buffer is then displayed to show the programming of the repeater.

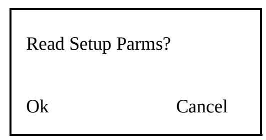


Figure 4-16 READ SETUP PARAMETERS

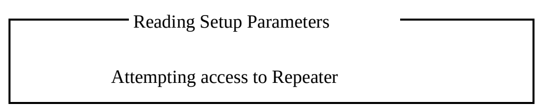


Figure 4-17 READING SETUP

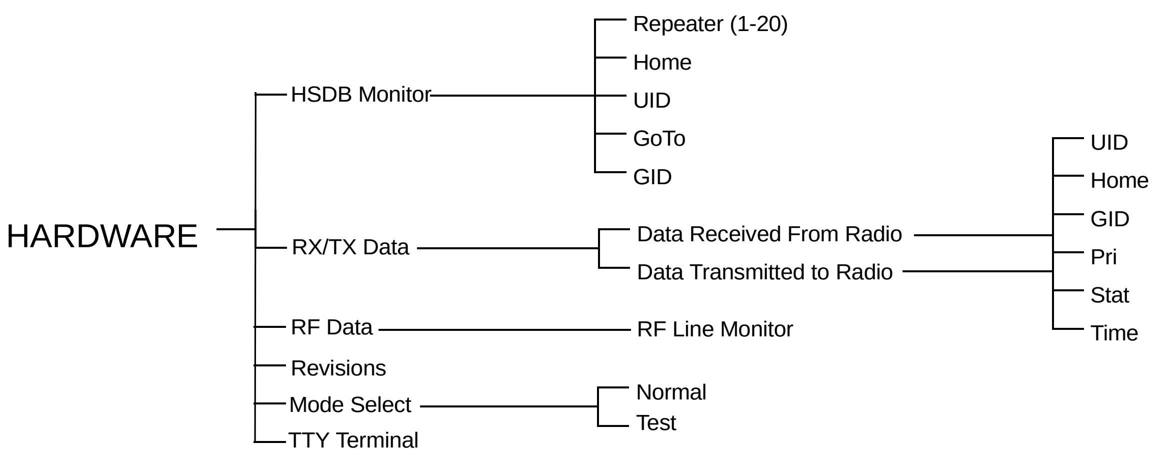


Figure 4-18 HARDWARE PROGRAMMING FLOWCHART

4.5 HARDWARE

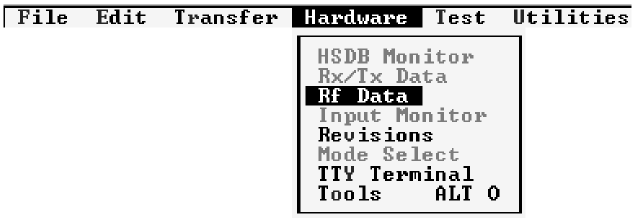


Figure 4-19   HARDWARE MENU

4.5.1 HSDB MONITOR

High Speed Data Bus (HSDB) connects all repeaters at a site and continually sends updates on the status of each repeater. This information screen provides a list of all repeaters at the site (1 to 20). 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 number and the Home number may not be the same number. The UID is the Unique ID used to identify the originator of special calls. The GID column refers to the Group ID of the talk group of the originator (236=UID Call, 237 Telco call). The GoTo column shows the repeater channel all destination users switch to so they receive the call.

Rptr	Home	UID	GoTo	GID

Figure 4-20   HSDB MONITOR

4.5.2 RECEIVE/TRANSMIT DATA

This is an information screen used at the repeater site while the computer (laptop) is connected to the MPC in the repeater being monitored. This information is contained in the receive data stream exchanged between the repeater and the destination user (mobile) and the data content of the repeater transmit data stream. The message contains data received from the destination and data sent to the mobile by the repeater.

The repeater receives the destination's: Unique ID, Home Repeater Number, Group ID, Priority, Status and Time Stamp. The information sent to the destination in the update message from the repeater includes: Unique ID of originator, Home Repeater Number, Group ID, GoTo Channel Number, Free Channel Number and Priority of the current repeater. The time stamp is included because messages are sent continually and this provides a reference for when a data exchange took place.

UID	Home	GID	Pri	Stat	Time

Figure 4-21   MOBILE TRAFFIC MONITOR

4.5.3 RF DATA

The A/D Monitor Screen shows the state of the lines (see Figure 4-22). These lines are monitored by the A to D converter in the IAC. The normal values for each line are defined as follows.

Synthesizer Lock Lines	Yes or No
Forward Power (LP)	25-110 Watts
Reflected Power	0-6 Watts
Final Out (ratio)	approx equal
Chassis Temp	27°C-55°C
Wideband Audio Output	approx 200
LO Injection	approx 200
RSSI	20-150
Fan Current	100-200, 0
Fan	On or Off
Power Supply Temp	22°C-45°C
Battery Voltage	21V-28V

Values with no label are the actual A to 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 on this screen are relative measurements only.

RF Line Monitor

Synthesizer Lock Lines		Receive Parameters	
Exciter Synthesizer:	Yes	Wideband Audio Output:	0
Receive Synthesizer:	Yes	LO Injection:	0
Exciter High Stability:	No	RSSI:	0
Receive High Stability:	No		

Transmit Parameters (Not Calibrated)		System Parameters	
		Fan 1 Current:	0
Forward Power:	0 Watts	Fan 2 Current:	0
Reflected Power:	0 Watts	Fan On:	Off
Final Output 1/2:	0/ 0 ratio	Chassis Temp:	0 C
Final Output 3/4:	0/ 0 ratio	Power Supply Temp:	0 C
		Battery Voltage:	0 Volts

Figure 4-22 RF LINE MONITOR

Repeater Version Display

Repeater Number: 1

HSDB: 2.1d MAC: 1.09 TIC: 0.00

MPC or TPI: 10.12 05/23/95 11
Serial Number: 1234567891234567

Figure 4-23 REVISION/VERSION

4.5.4 REVISION/VERSION

The Revision/Version is displayed for the repeater modules in this screen. 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 4-23 is for J4, pins 5/6 connected in the MPC and Figure 4-24 is the version for J4, pins 3/4 connected in the MPC.

Repeater Version Display

Repeater Number: 1

HSDB: 50.02 MAC: 1.09 TIC: 0.00

MPC or TPI: 10.12 05/23/95 11
Serial Number: 1234567891234567

Figure 4-24 REVISION/VERSION

4.5.5 MODE SELECT

The Mode Select screen places the repeater either in the Normal mode or the Test mode. In the Normal mode the repeater operates as a normal repeater.

In the Test mode the repeater transmits a test word. This test word is the Test Mode ID setup in the Setup Parameters (see Section 4.3.1).

C A U T I O N

While in the test mode the repeater is "busy", therefore it is important to place the repeater in Normal mode when the test mode is no longer required.

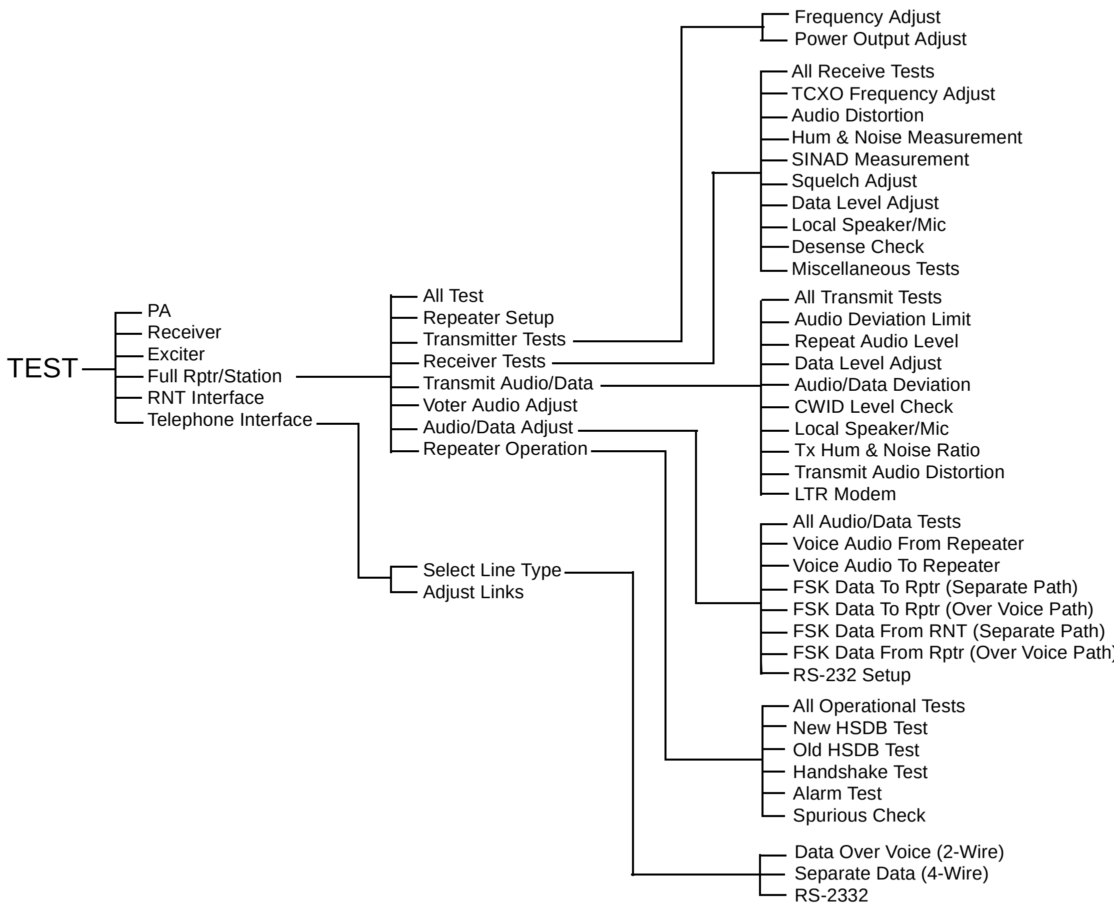


Figure 4-25 TEST PROGRAMMING FLOWCHART

4.6 TEST

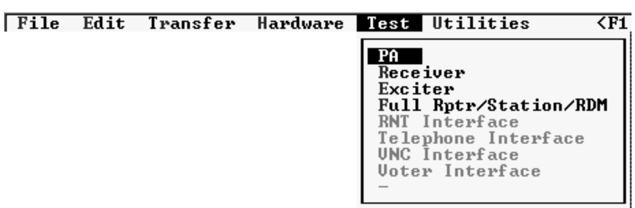


Figure 4-26 TEST MENU

4.6.1 POWER AMPLIFIER

This menu selection walks through the alignment of the Power Amplifier and RF Interface Board on the computer screen. Refer to Section 7.3 for the PA and RFIB alignment in this manual and Figures 7-3 and 7-8 for alignment points diagrams.

4.6.2 RECEIVER

This menu selection walks through the alignment of the receiver on the computer screen. Refer to Section 7.1 for the Receiver alignment in this manual and Figure 7-1 for an alignment points diagram and Figure 7-6 for a test setup of the Receiver.

4.6.3 EXCITER

This menu selection walks through the alignment of the Exciter on the computer screen. Refer to Section 7.2 for the Exciter alignment and Figure 7-2 for an alignment points diagram and Figure 7-7 for a test setup of the Exciter.

4.6.4 FULL REPEATER

This menu selection walks through the alignment of the entire repeater. 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 7-12 for an alignment points diagram for the MAC.

4.7 UTILITIES

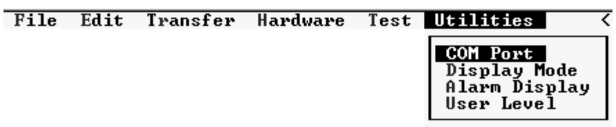


Figure 4-27 UTILITIES MENU

4.7.1 COM PORT

This is the COM port used to send and receive data from the Repeater MPC. An interface cable connects the Repeater to the computer (see Figure 4-29). This screen also selects the data baud rate.

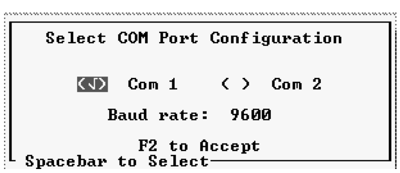


Figure 4-28 COM PORT SELECTION

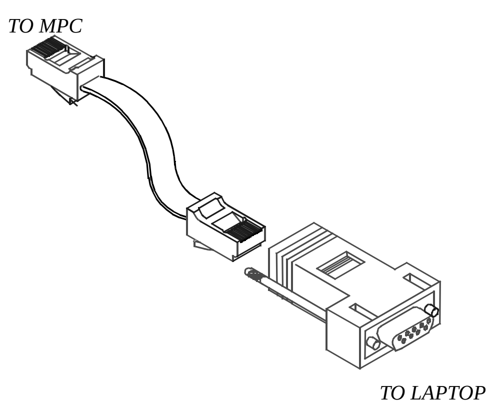


Figure 4-29 LAPTOP INTERCONNECT CABLE

4.7.2 DISPLAY MODE

This screen allows the color mode to be selected for color monitors. When using a laptop, monochrome is recommended for better resolution.

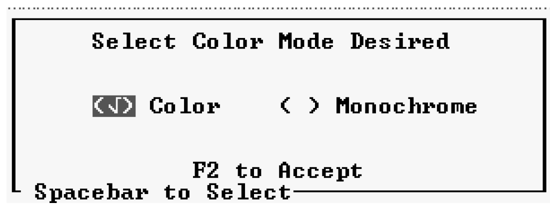
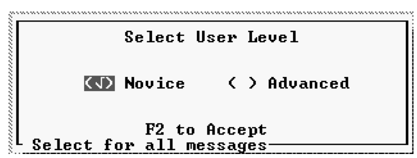


Figure 4-30 COLOR MODE SELECTION

4.7.3 USER LEVEL

There are two levels to choose from, Novice and Advanced. The Novice uses prompts in the Edit-Parameters screens when Escape or F2 keys are pressed that ask "are you sure" before the task is executed. The Advanced selection performs the task without asking the question.



SECTION 5 REPEATER PROGRAMMING

5.1 CREATING A NEW FILE

An example will be used to show the programming for a new file created for Site 1.

NOTE: At any point in the programming sequence, if F1 is selected, a help screen appears to explain the menu selection highlighted at that point.

5.1.1 SELECT REPEATER TO EDIT

A repeater is selected to program. When no file exists with programmed repeaters, the default is selected and edited.

1. Highlight EDIT, press Enter.
2. Highlight SELECT REPEATER, press Enter.
3. Default is the only repeater in this list, press Enter.
4. Highlight EDIT, press Enter.
5. Highlight SETUP PARAMETERS, press Enter.
6. The Setup Parameters screen appears (see Figure 5-1). Fill in the parameters for this repeater. A brief description of the parameters is in Table 5-1. Full descriptions are in Section 4.3.1.
7. Select parameters, press F2 to accept.
8. Highlight EDIT, press Enter.
9. Highlight ALARM CONFIGURATION and press Enter, if alarms are to be configured.
10. Program the Alarms to be configured (see Section 4.3.3), press F2 to accept.
11. Highlight FILES, press Enter.
12. Highlight SAVE, press Enter.
13. Type in a valid DOS filename. For this example site1.dat is used.
14. The file consists of default and repeater one under the filename of site1.dat.

5.2 ADDING A REPEATER TO A FILE

The example used for Site 1 will again be used to add repeaters to the filename site1.dat.

1. Highlight EDIT, press Enter.
2. Highlight SELECT REPEATER, press Enter.
3. The repeater list shown for this file includes default and repeater one. These contain the same parameters with the exception that when selected for edit the programmed repeater can be overwritten and the data lost.
4. Highlight DEFAULT, press Enter.
5. Highlight EDIT, press Enter.
6. Highlight SETUP PARAMETERS, press Enter.
7. Change the Repeater number and other parameters as required for this repeater, press F2.
8. Highlight EDIT, press Enter.
9. Highlight ALARM CONFIGURATION and press Enter, if alarms are to be configured.
10. Program the Alarms to be configured (see Section 4.3.3), press F2 to accept.
11. Highlight FILES, press Enter.
12. Highlight SAVE, press Enter.
13. Repeater 2 is added to the Repeater List in file site1.dat.

Table 5-1 REPEATER SETUP PARAMETERS

Parameter	Response	Description
Repeater Number	1-20	Each repeater is assigned a Home Repeater number from 1-20.
Channel Frequency	Rx: Tx:	Each repeater is programmed with the transmit and receive frequency that it is operating on.
Frequency Step	5 kHz or 6.25 kHz	Allowable frequency spacing.
Telco Network Type	None FSK RS232 FSK Blank & Burst TIC VNC	None=LTR dispatch only. Data signaling type for a Switch, FSK, RS232 or FSK B&B. TIC is for Telephone Interface Card w/o a Switch. VNC=network telephone interconnect w/o a Switch.
Area	0, 1	Same as value of the Area bit in the mobiles.
Sync Repeater	No	Not used.
Stand Alone	Yes, No	Select if the repeater is not connected to additional repeaters (via HSDB).
ID Validator	Yes, No	Not used.
CWID Time	0 = disabled 1-60 min	Time between CWID transmissions.
CWID Message	15 characters/numbers UPPER CASE	Station call letters.
Local MIC ID	0 = disabled (default) 1-250, 253	Group ID transmitted when the local microphone PTT is active.
Test Mode ID	0 = disabled 1-250, 254 (default)	Group ID transmitted when the Repeater is in the Test Mode.
RF Power Level	25-110	Power level in watts for transmit power.
Power Source	AC or DC	The type of primary power source for the Repeater.
Data Modem	Yes, No	Select if the Data Modem option is installed.

LTR Repeater Setup Parameters Edit

Repeater Number:	1	Telco Network Type:	None
Rcv Frequency:	158.145000	Area:	0
Xmit Frequency:	153.095000		
Frequency Step:	5000 Hz		
Sync Repeater:	No	CWID Time:	0
Stand Alone:	Yes	CWID Message:	REDHAWK
ID Validator:	N/A		
Local MIC ID:	0	RF Power Level:	110
Test Mode ID:	254	Power Source:	AC
Paging:	No	Data Modem:	No

Press F2 to Accept

Repeater Home (1-20)

Figure 5-1 SETUP PARAMETERS

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 ±2.5 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 L101, L102 and L103 is a three-pole bandpass filter tuned to pass only a narrow band of frequencies within the 132-178 MHz band. This filter also attenuates the image and other unwanted frequencies.

Impedance matching between the helical filter and RF amplifier U103A is provided by C102. U103A amplifies the receive signal to recover filter losses and increases receiver sensitivity. Biasing for U103A is provided by R105/R106/R107/R108 and C105, C106, C107 and C108 provide RF bypass. Additional filtering of the receive signal is provided by 3-pole helical filter L108-L110. C103/C104 match the output from U103A 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.

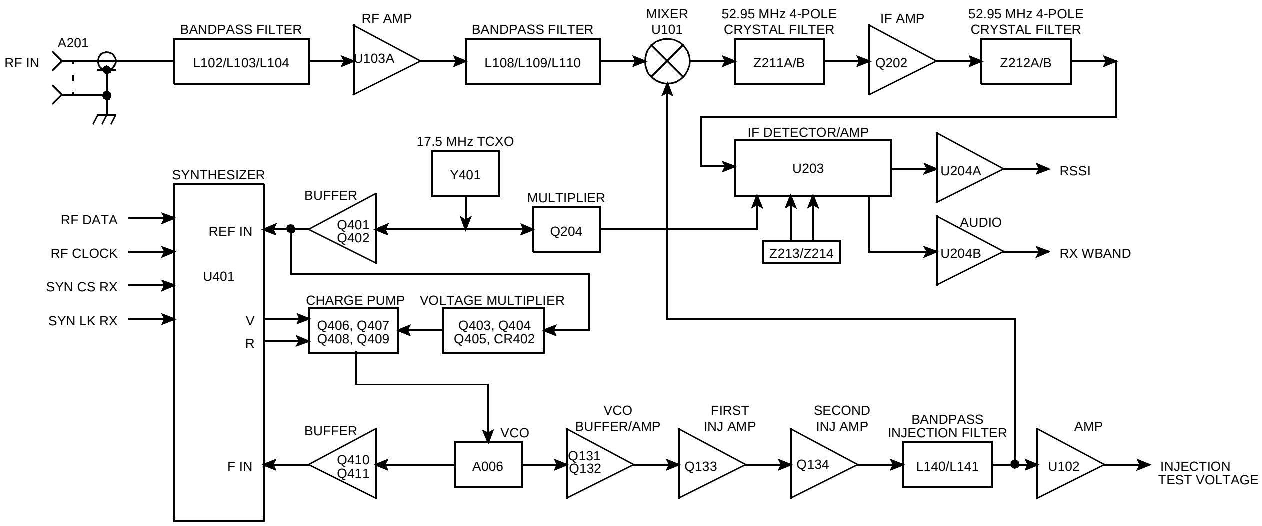


Figure 6-1   12.5 kHz IF RECEIVER BLOCK DIAGRAM

<u>Second Mixer/Detector</u>

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 (±2.5 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.

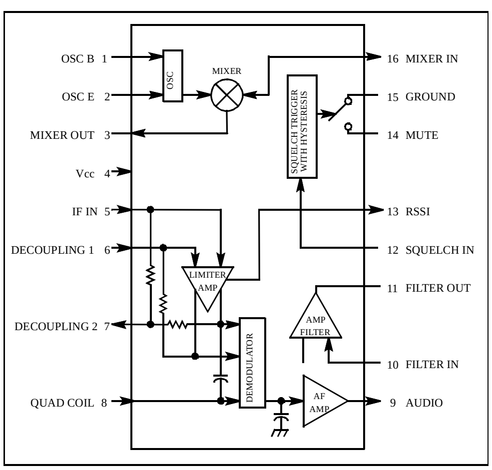


Figure 6-2   U201/U203 BLOCK DIAGRAM

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.

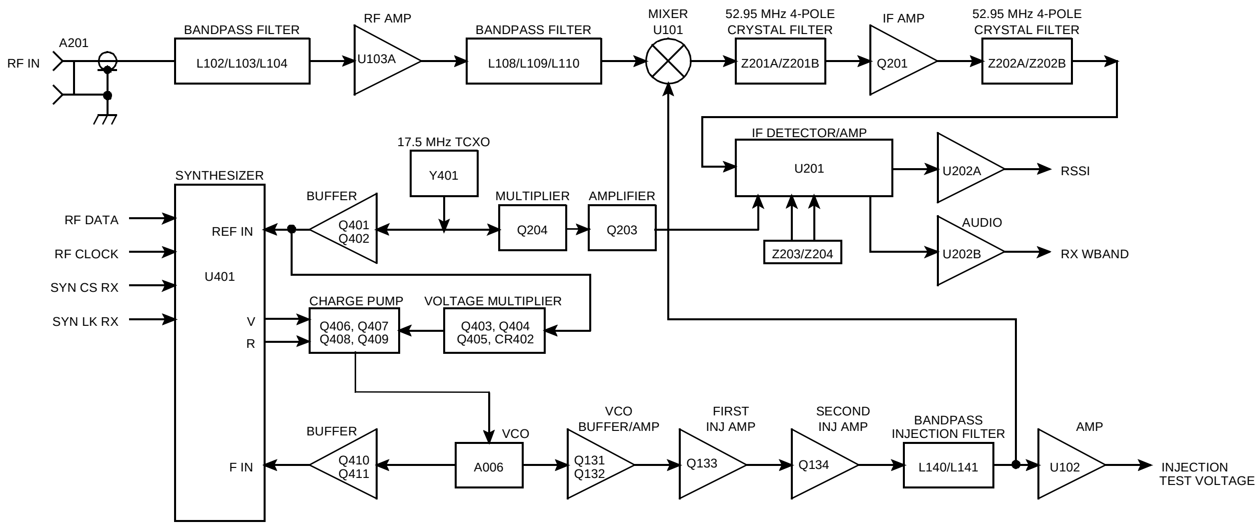


Figure 6-3 25 kHz IF RECEIVER BLOCK DIAGRAM

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 (±2.5 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

The Voltage-Controlled Oscillator (VCO) is formed by Q101 circuitry and high-Q inductor L102. The VCO oscillates in a frequency range from 184-231 MHz. Biasing of Q101 is provided by R102, R103, R104 and R105. AC voltage divider C104, C105 and C106 initiates and maintains oscillation and matches Q101 to the tank circuit. The high-Q inductor 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 D101. 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 L101. The amount of frequency change produced by D101 is controlled by series capacitor C102.

Q102 and Q103 form a cascade-connected buffer circuitry. DC bias is produced by R107, R108, R109 and R112. A signal oscillated at Q101 is DC cut and adjusted by C107, and fed into the buffer. An output from RF choke L104 passes through an adjustment circuit consisting of C114 and C119.

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.

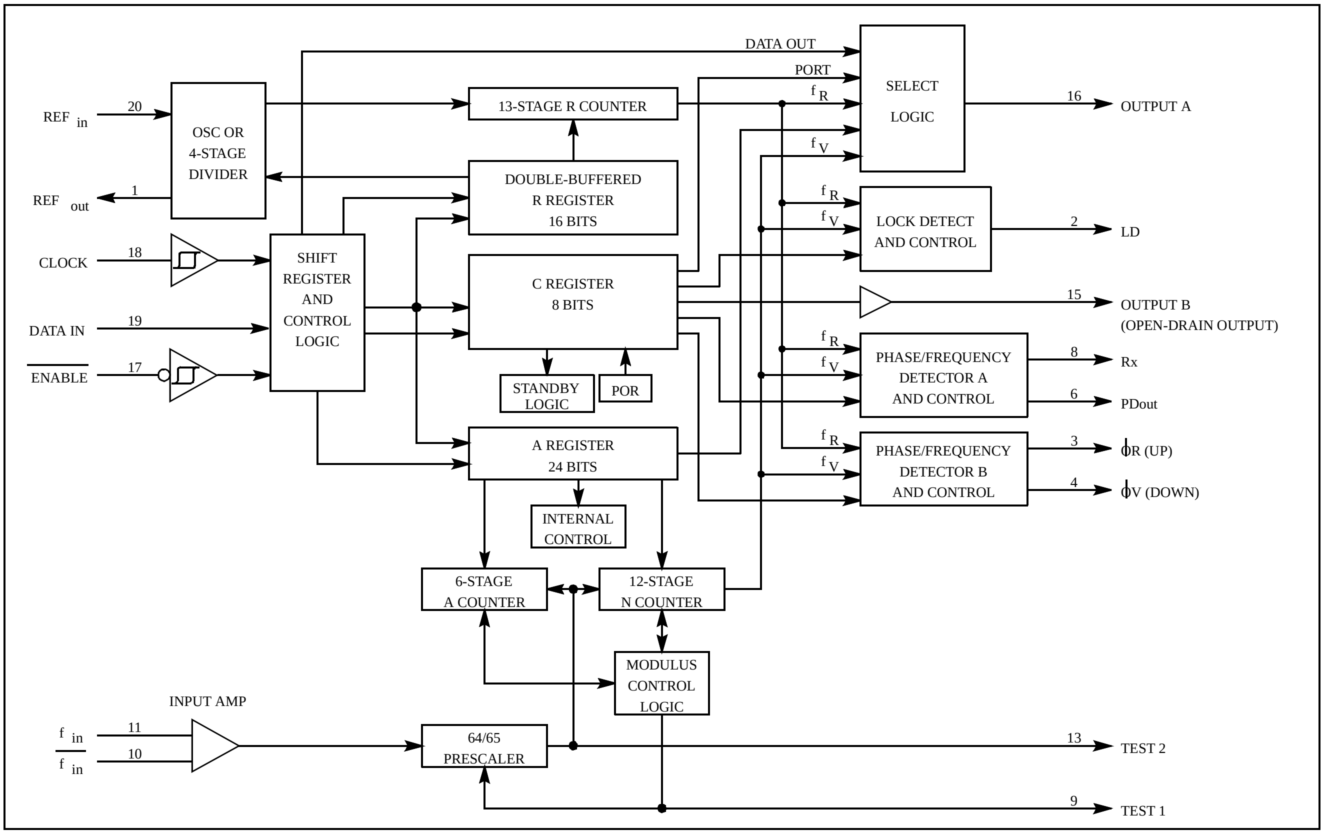


Figure 6-4 SYNTHESIZER BLOCK DIAGRAM

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 ±2.5 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 Third Party Interface Card (TPI), 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 150.025 MHz. Since the VCO is 52.95 MHz above the receive frequency it must be 202.975 MHz. To produce this frequency, the N and A counters are programmed as follows:
N = 507   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 (507 - 28) or 30,656 input pulses. The overall divide number K is therefore (30,656 + 1,820) or 32,476. The VCO frequency of 202.975 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 Q101, associated circuitry and High-Q indicator L102. The VCO oscillates in a frequency range from 132-178 MHz. Biasing of Q101 is provided by R102, R103 and R104. An AC voltage divider formed by C107 and C108 initiates and maintains oscillation. C106 couples Q101 to the High-Q inductor. RF choke L103 completes the DC bias path to ground.

The VCO frequency is controlled in part by DC voltage across varactor diode D101. 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 L101. The amount of frequency change produced by D101 is controlled by series capacitor C102.

The frequency is modulated in a similar manner. The transmit audio/data signal is applied across varactor diode D102 to vary the VCO frequency at an audio rate. C104/C105 in series with D102 determine the amount of modulation produced by the audio signal.

6.2.2 VCO BUFFER

Q102/Q103 form a cascade-connected buffer circuitry. DC bias is produced by R107, R108, R109 and R1212. A signal oscillated at Q101 is DC cut and adjusted by C107 and fed into the buffer. An output from RF choke L104 passes through an adjustment circuit consisting of C114/C119.

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.

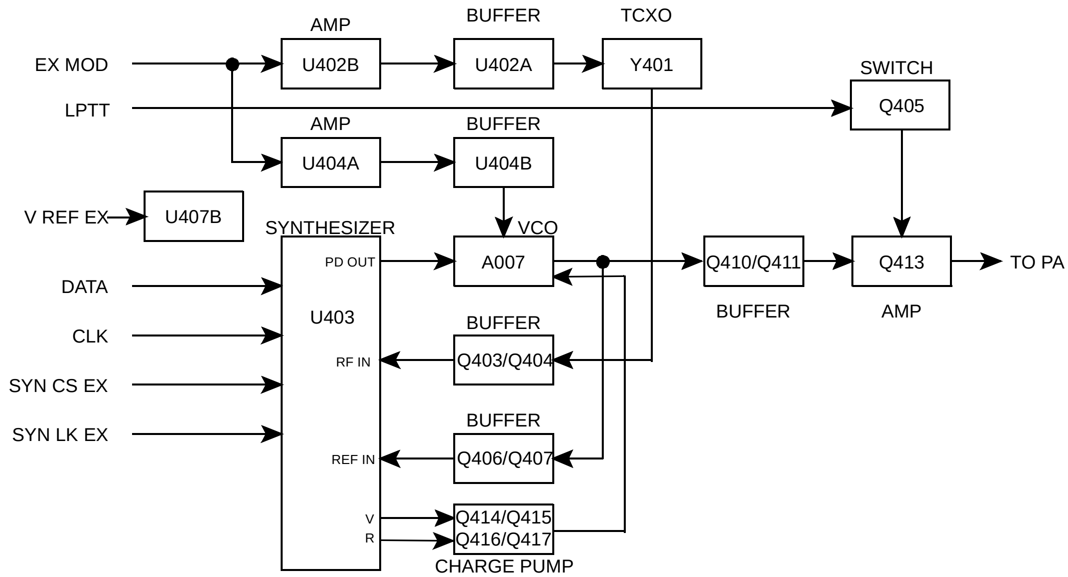


Figure 6-5   EXCITER BLOCK DIAGRAM

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 SYNTHESIZER

The synthesizer inputs/outputs are shown in Figure 6-5. 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 ±2.5 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 frequency step 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 Third Party Interface (TPI), 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 6.25 kHz steps. The reference frequency is 6.25 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 150.250 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 = 375 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 (375 - 40) or 21,440 input pulses. The overall divide number K is therefore (21,440 + 2,600) or 24,040. The VCO frequency of 150.250 MHz divided by 24,040 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.

6.2.5 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.

6.2.6 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.

6.2.7 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/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.

6.2.8 CHARGE PUMP, LOOP FILTER

The charge pump circuit charges and discharges C519, C520 and C521 in the loop filter to provide the 12V VCO control voltage (see Section 6.1.12). Pulses which control the charge pump are fed out of U403, 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.

Q414 and Q415 are drivers which make the 5V levels and polarity of U403 phase detector outputs compatible with the high voltage supply to Q416 and Q417. Capacitors C523 and C517 momentarily bypass R494 and R498 when negative-going pulses occur. This speeds up the turn-off time of Q414 and Q415 by minimizing the effect of the base charge.

When a negative-going pulse occurs on pin 4, Q414 turns on which turns on Q416. Q416 sources current to charge up the loop filter capacitors C519/C520, thereby increasing the VCO control line voltage. When a negative-going pulse occurs on pin 3, Q415 turns on which turns on Q417. Q417 sinks current to discharge the loop filter capacitors C519/C520 thereby decreasing the VCO control line voltage. The source current from Q416, when it is on, equals the sink current from Q417, when it is on.

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 Q413 is biased by CR403, R477, R478, R479 and R480. C508 provides RF bypass from the DC line and R479/R480 provide supply voltage isolation. L 411 is an RF choke to the supply line. Q413 is matched to 50 ohms by low pass filter C509/L412/C510 and C465 provides DC blocking. 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 0.3W pre-driver Q501. R504, R505 and R506 provide DC bias to the gate of Q501. C506, C507 and C508 provide RF bypass from the DC supply line. L503 is an RF choke. C510 and C522 provide RF bypass. C511/L504/C512/C513 match Q501 output impedance to U501 input impedance. U502 provides Q501 with DC voltage regulated at 8V.

6.3.2 DRIVER

U501 is a 12W amplifier operating in the 132-178 MHz range. The RF is applied to the input of the splitter and to the finals.

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 10W.

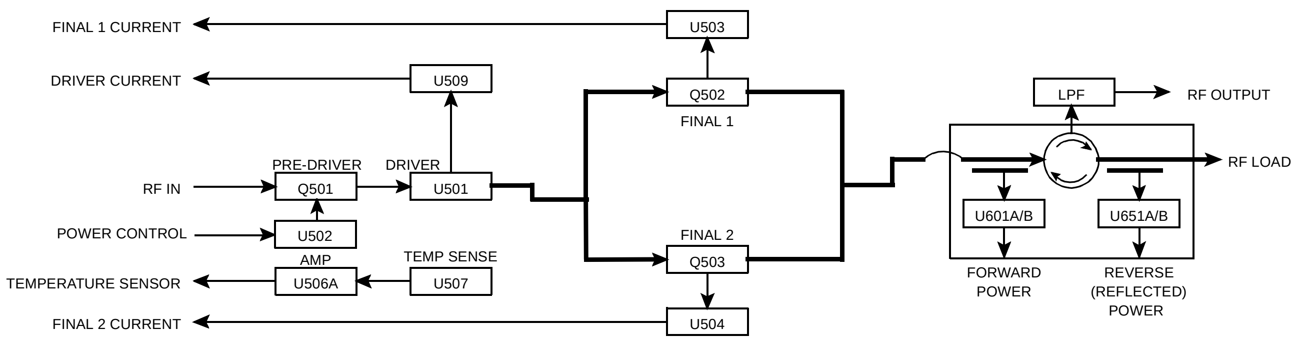


Figure 6-6 110W POWER AMPLIFIER BLOCK DIAGRAM

6.3.3 FINAL AMPLIFIERS

Q502 and Q503 are combined 60W amplifiers. The 10W RF input from the driver U501 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 transmissionline 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 Universal Station 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 RF Interface Board 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 station cabinet (see Figure 10-2). 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.

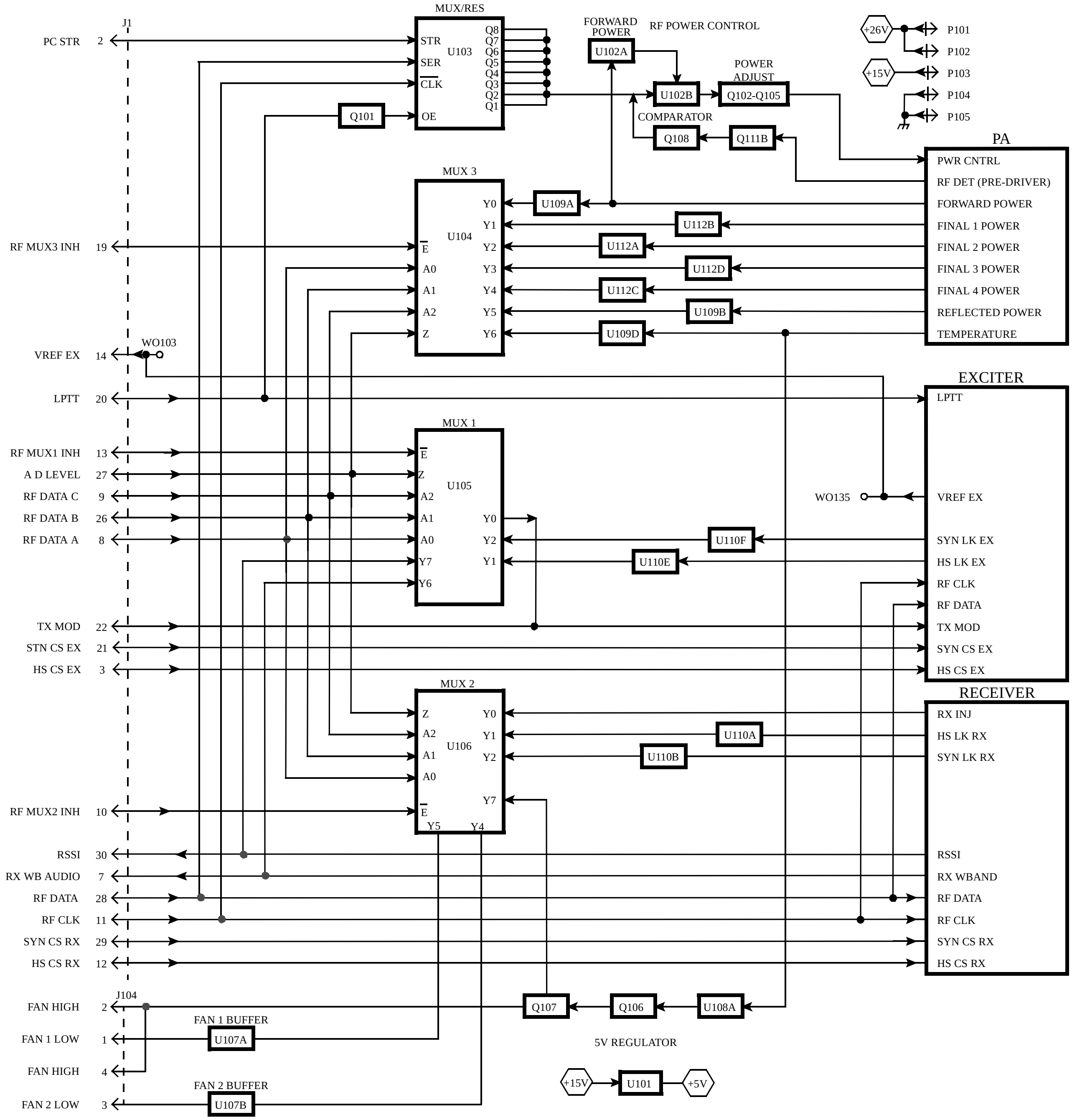


Figure 6-7 RF INTERFACE BOARD BLOCK DIAGRAM

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 1.7).

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 2-8). 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.

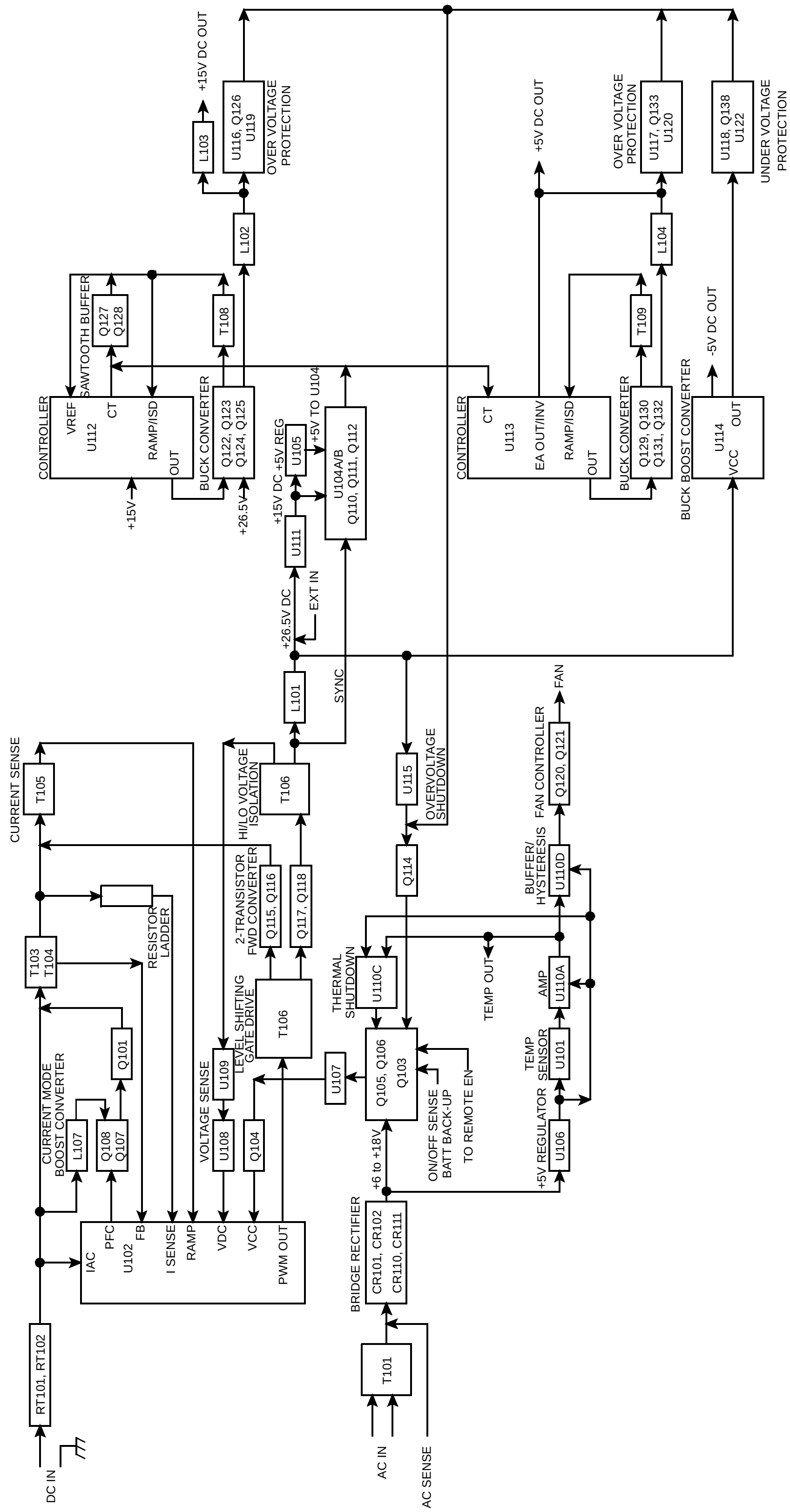


Figure 6-8 BLOCK DIAGRAM

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 dependant 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).

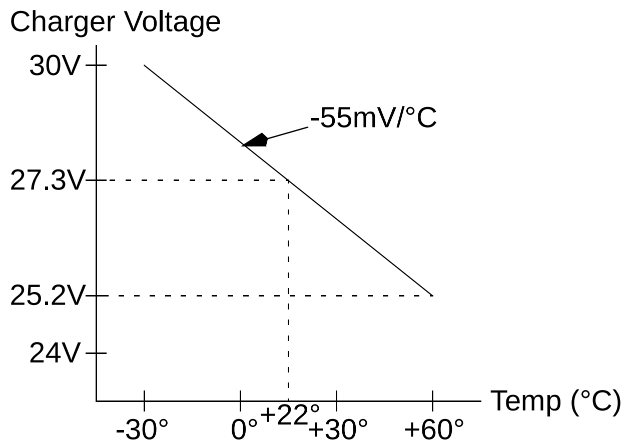


Figure 6-9 NO LOAD CHARGE VOLTAGE vs. TEMPERATURE

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.

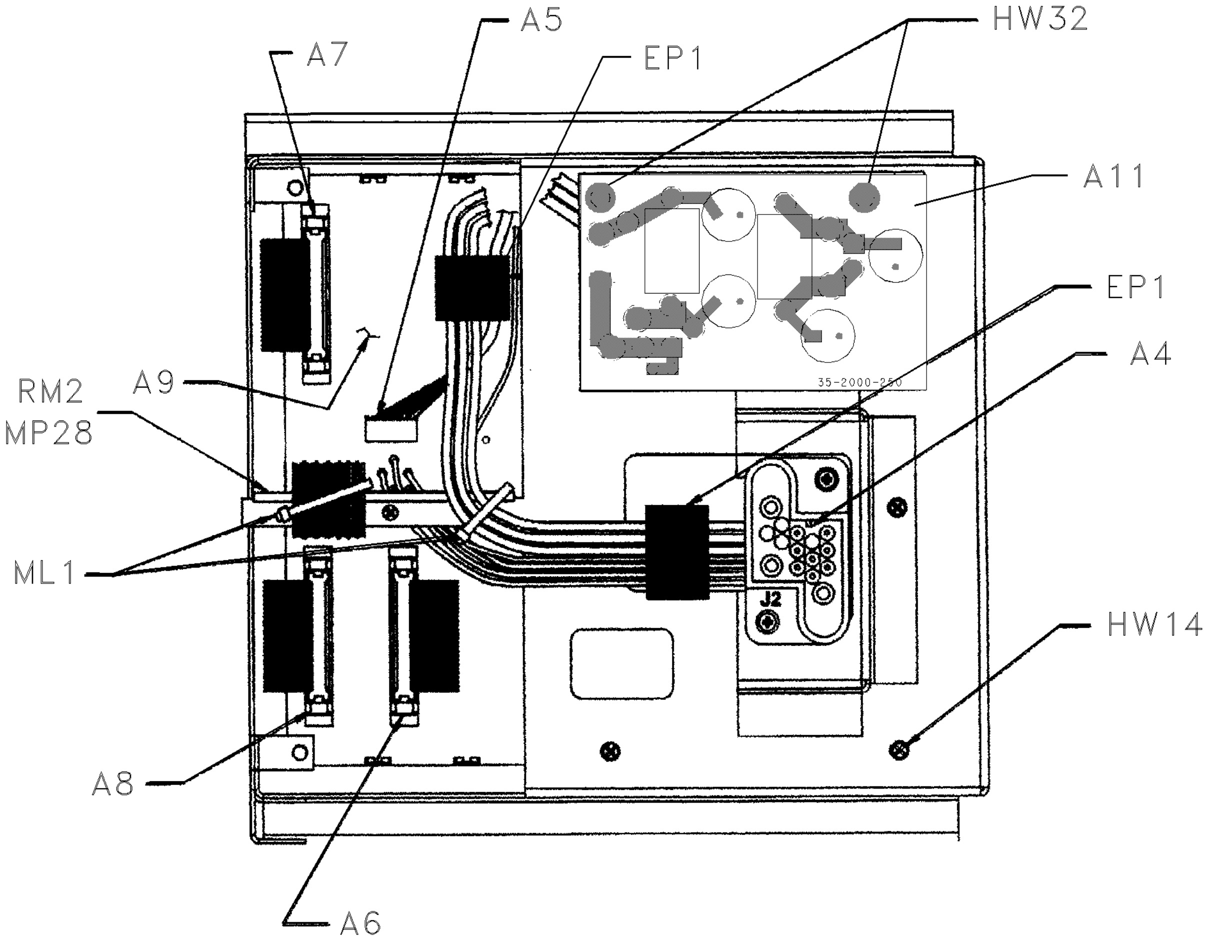


Figure 6-10 BACKPLANE CONNECTORS

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.

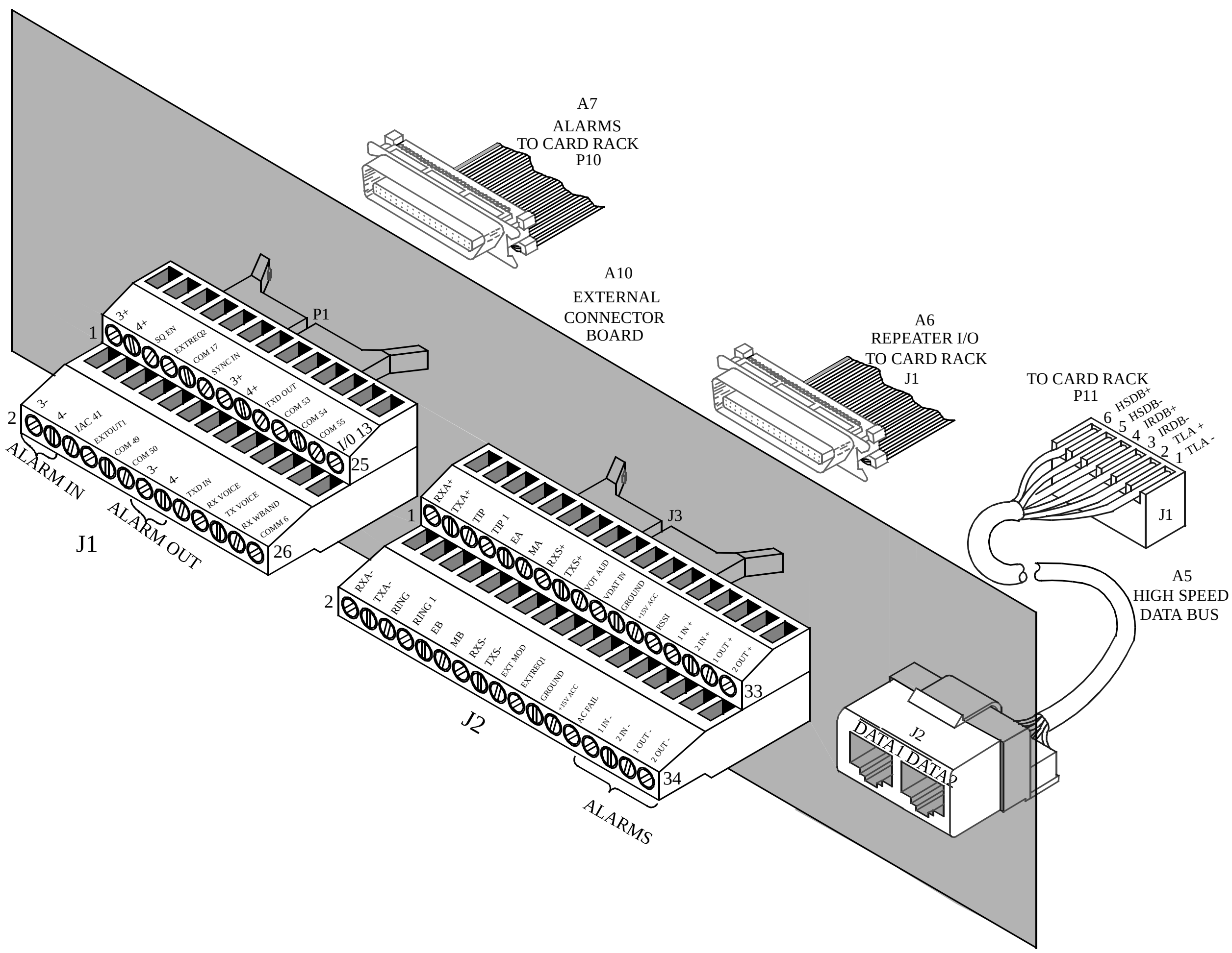


Figure 6-11   EXTERNAL CONNECTOR BOARD

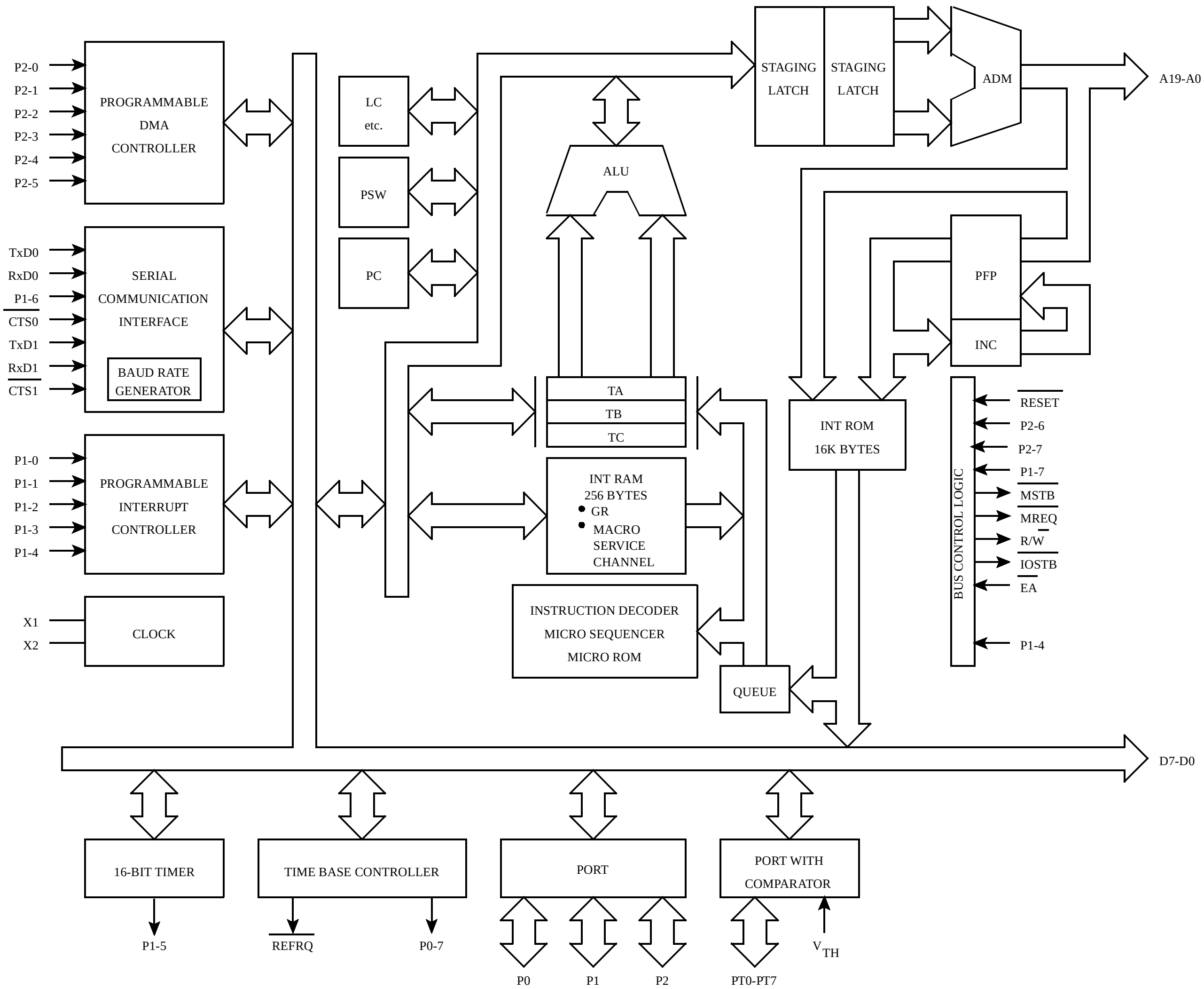


Figure 6-12 U27 BLOCK DIAGRAM

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 3.1.5). 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 Summit repeaters are connected to existing repeaters or only Summit 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 IRDB +/-

This data bus interconnects all repeaters to provide an exchange of programming information with the programming software and computer. This data bus allows all repeaters to be accessed without having to connect the computer to the MPC on each repeater individually.

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 4-10).

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.

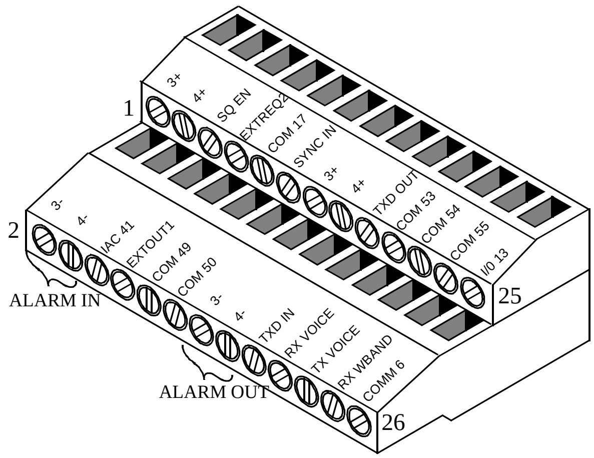


Figure 6-13 4 I/O J1 ALARM OUTPUTS

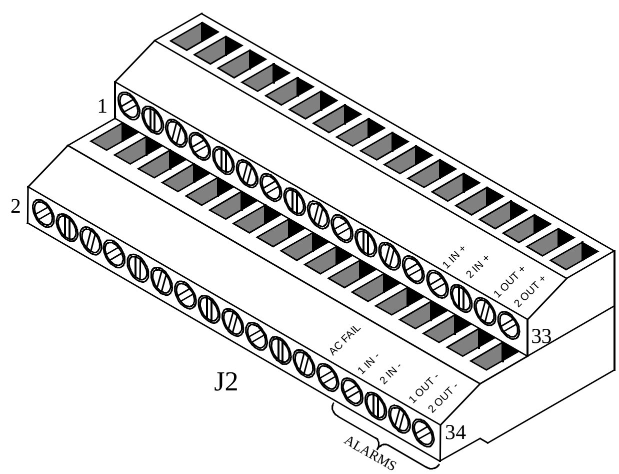


Figure 6-14 4 I/O J2 ALARM OUTPUTS

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.

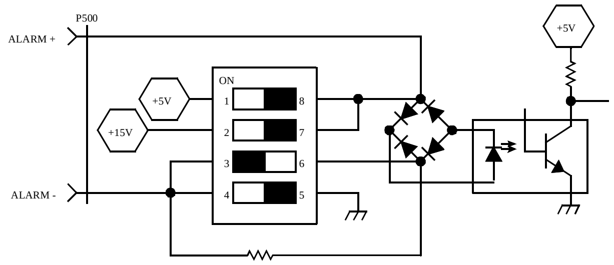


Figure 6-15 S500-S503

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 4-10) 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 4-10). 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.

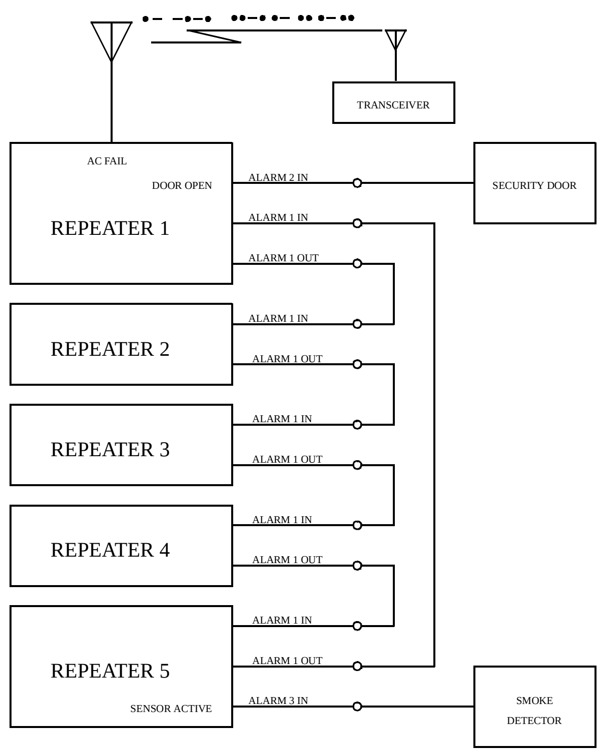


Figure 6-16 ALARM EXAMPLE

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

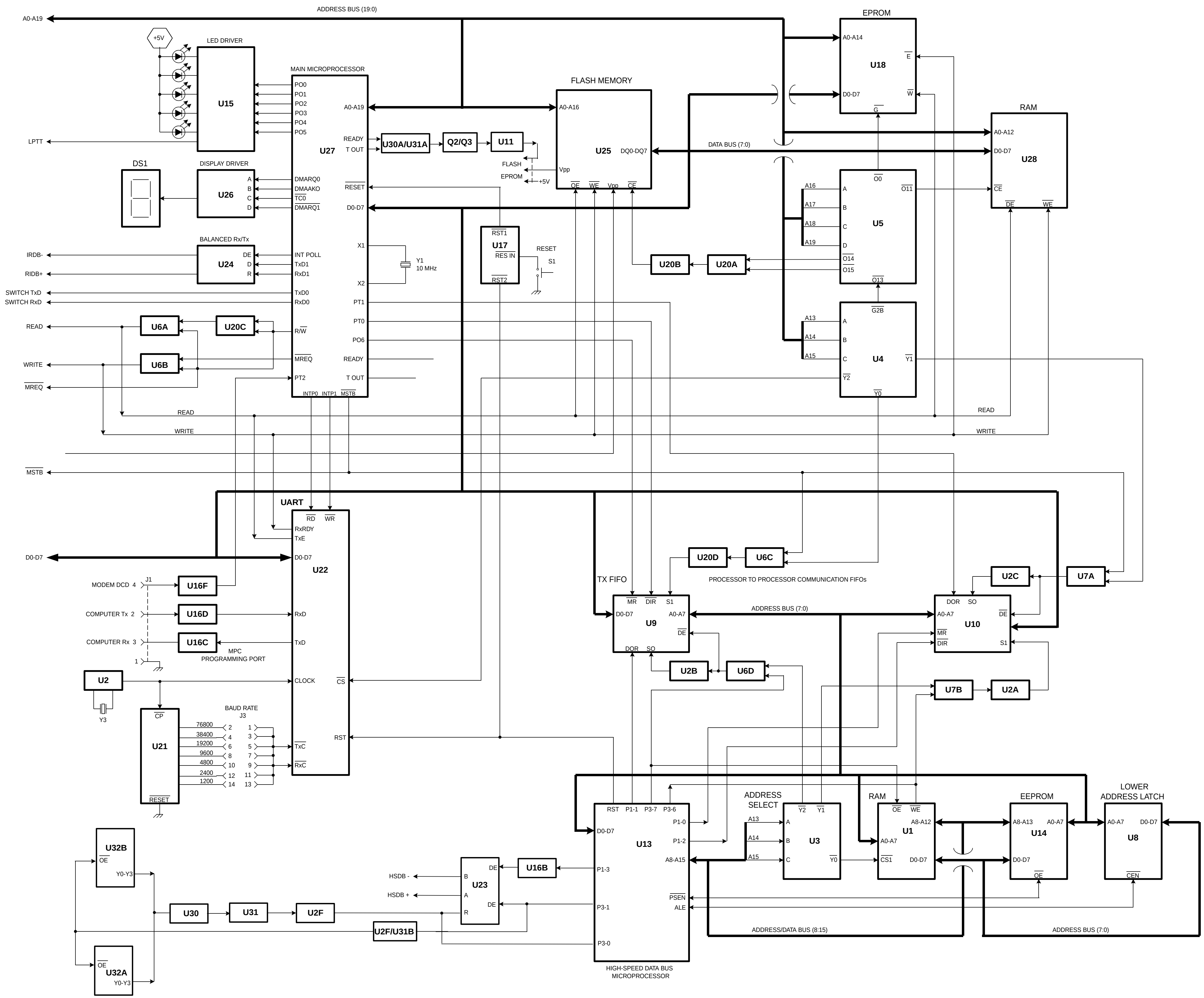
J502 is a voltage test point.

6.11.10 POWER SWITCH

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

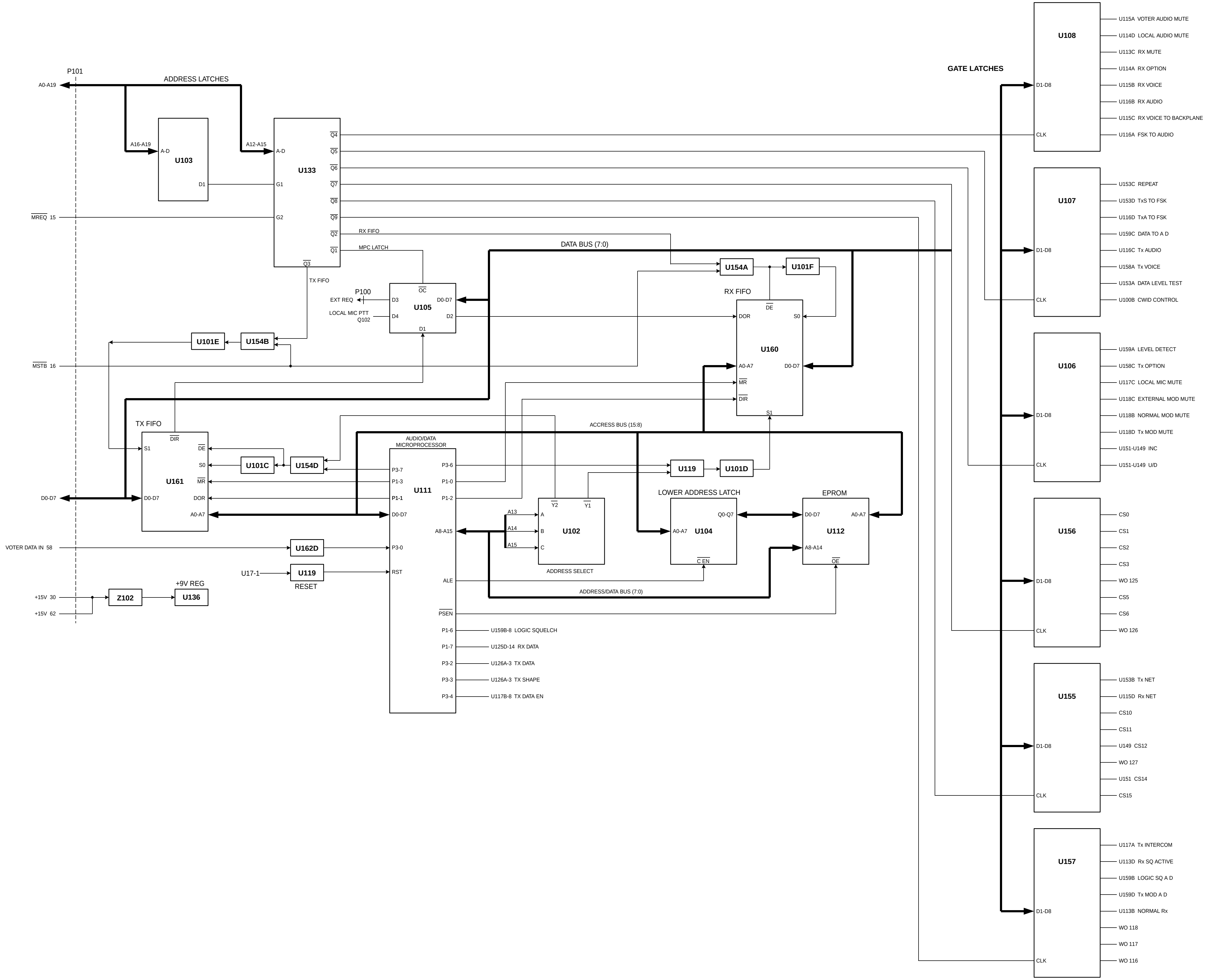
6.11.11 J505 SQUELCH ENABLE OUTPUT

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.

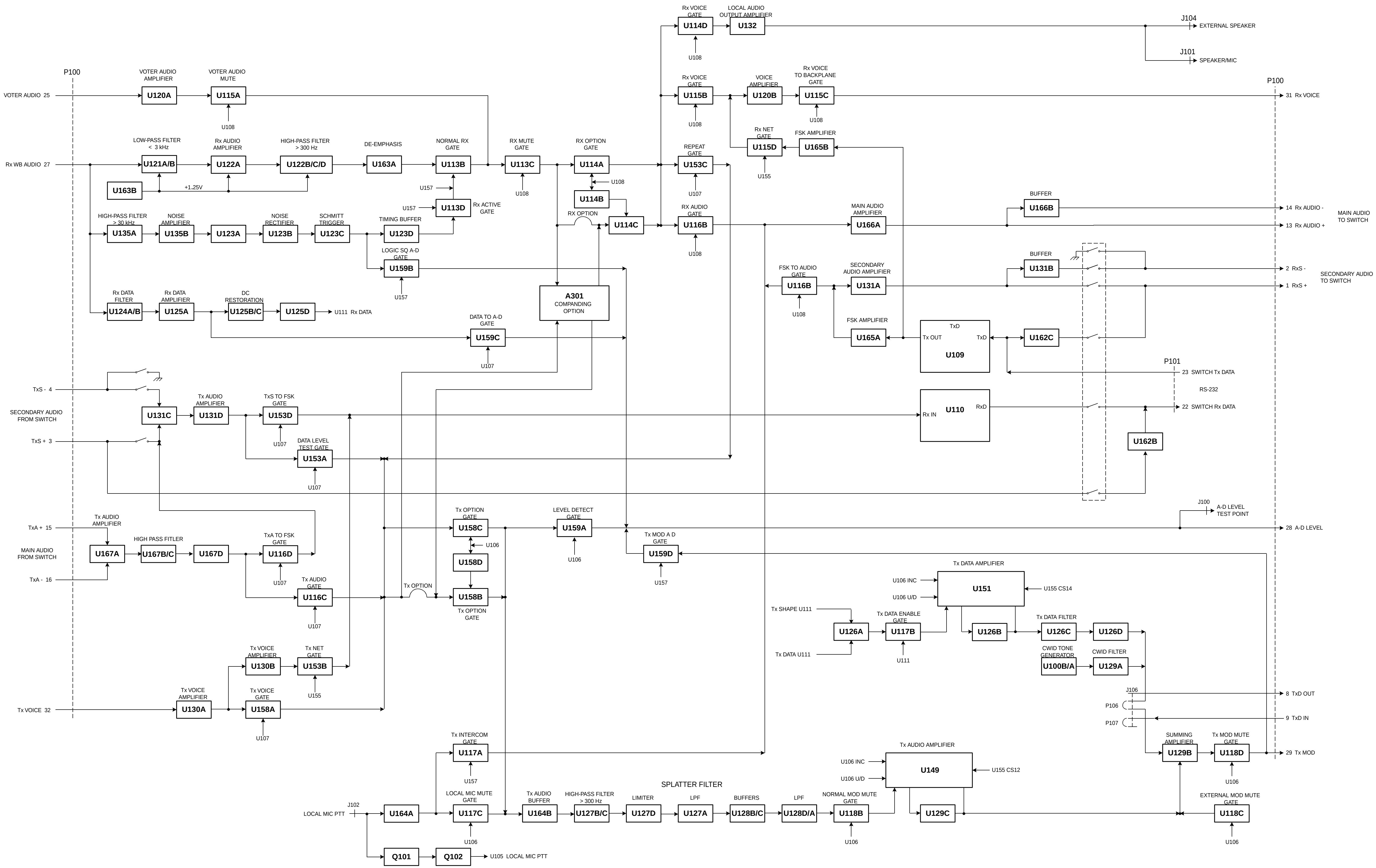


MAIN PROCESSOR CARD BLOCK DIAGRAM
FIGURE 6-17

FOLDOUT

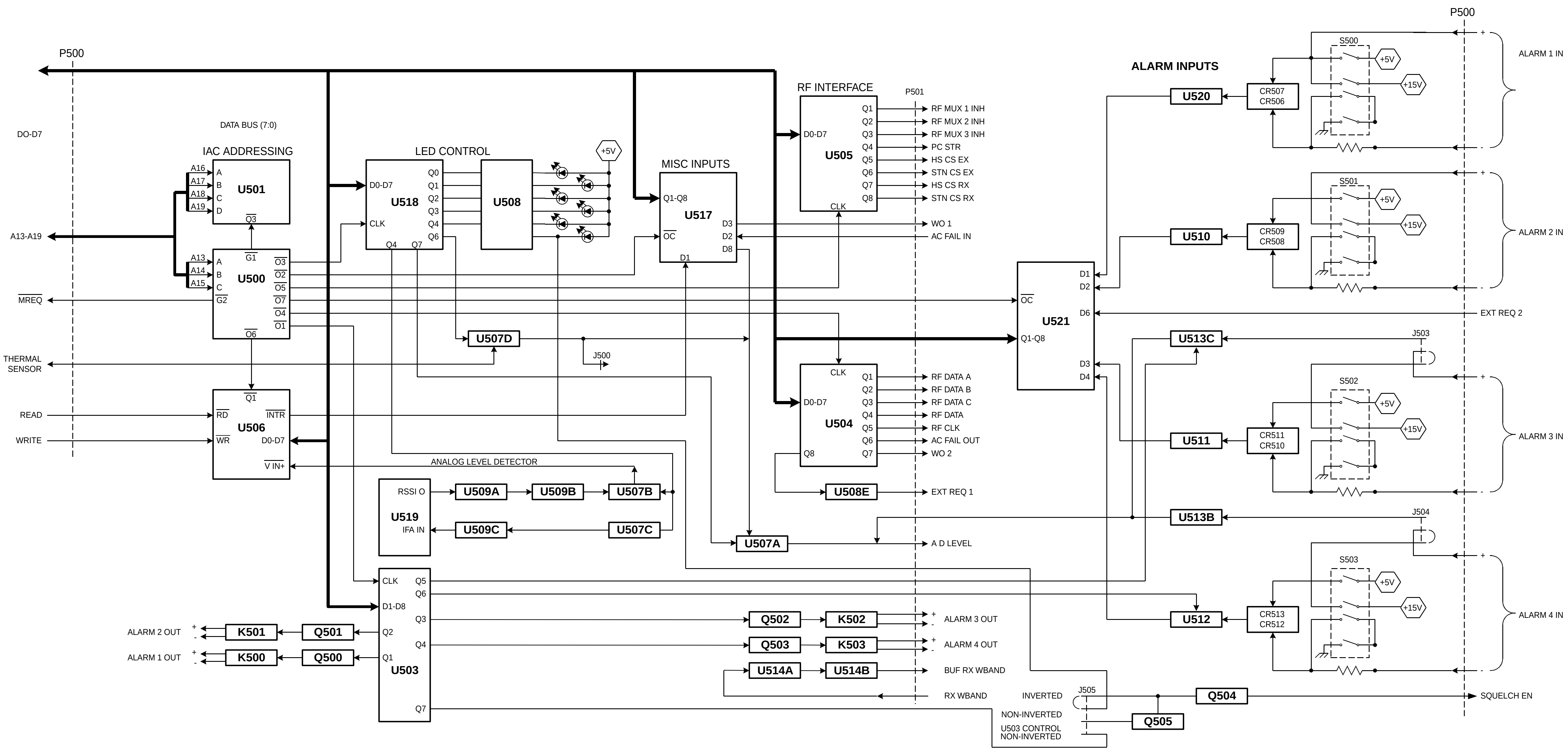


MAIN AUDIO CARD LOGIC BLOCK DIAGRAM
FIGURE 6-18



MAIN AUDIO CARD AUDIO BLOCK DIAGRAM
FIGURE 6-19

FOLDOUT



INTERFACE ALARM CARD BLOCK DIAGRAM
FIGURE 6-20

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 7-6 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 3	+6V DC ±0.3V
U302, pin 3	+12V DC ±0.4V
U303, pin 3	+12V DC ±0.4V
U304, pin 3	+12V DC ±0.4V
R402/R403 junction	+3.5V DC ±0.1V

7.1.3 PROGRAM TUNE-UP CHANNEL

For Receivers operating between:
132-150 MHz, 150-178 MHz.

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

2. Tune the VCO capacitor L102 for +7V DC ±0.05V at TP401.
   Increase the receive frequency by 1 MHz.
   The voltage on TP401 shall be less than 15V.
   Decrease the receive frequency by 1 MHz.
   The voltage on TP401 shall be greater than 2.5V.

3. Alternately tune CV151 and CV152 in 1/2-turn to 1-turn increments until a voltage is measured at TP401. At that time, tune CV151 for a peak, then CV152 for a peak.

4. Retune CV151/CV152 for a peak at TP401.

For Receivers operating within 2 MHz of the top of the receive band (148-150 or 176-178 MHz).

1. Program the Synthesizer for the *Highest* receive frequency (i.e. 150 or 178 MHz).

2. Set the control line voltage for 15V at TP401. Check 2 MHz *below* the programmed frequency (i.e. 148 or 176 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 2 MHz of the bottom of the receive band (132-134 or 150-152 MHz).

1. Program the Synthesizer for the *Lowest* receive frequency (i.e. 132 or 150 MHz).

2. Set the control line voltage for 2V at TP401. Check 2 MHz *above* the programmed frequency (i.e. 134 or 176 MHz) to verify that the control voltage at TP401 is *less than* 15V. 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.

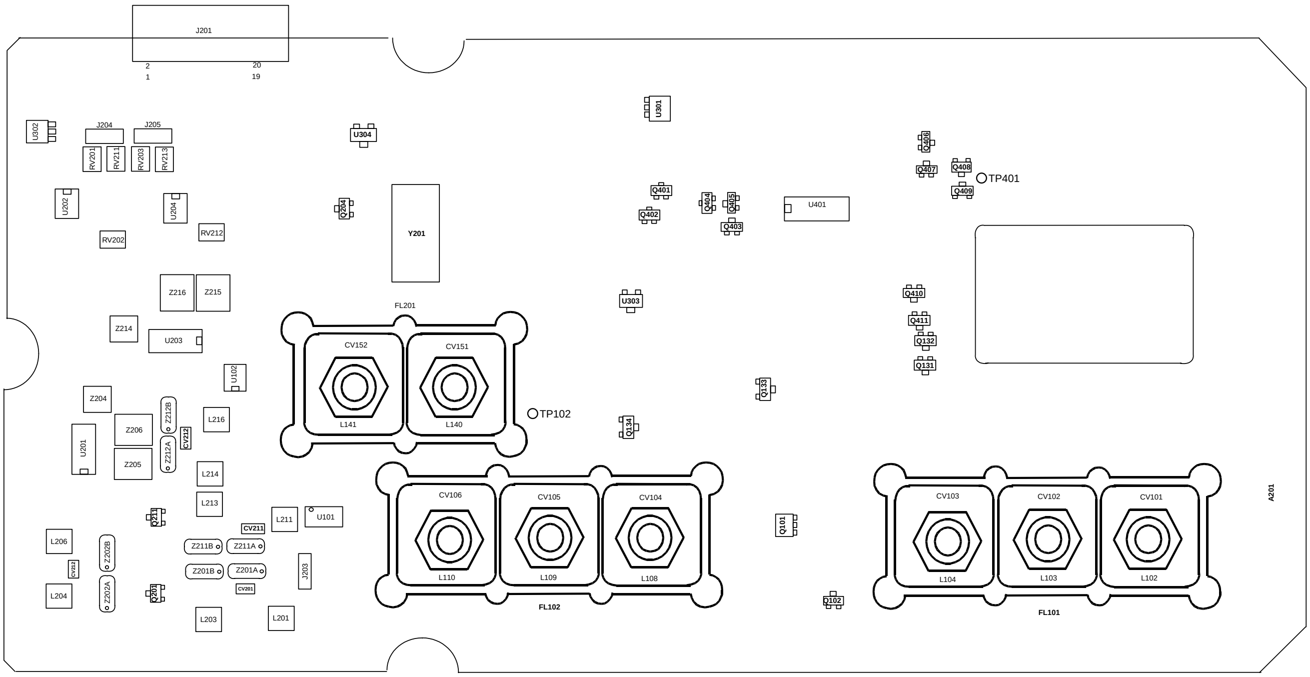


Figure 7-1   RECEIVER ALIGNMENT POINTS

7.1.4 RECEIVER FREQUENCY ADJUST

1. Place a pick-up loop (sniffer) or RF probe connected to a frequency counter near TP102.

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 TP401 __________.

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 TP401 __________.

7. If the voltages recorded in Steps 3 and 6 are not within ±0.2V, tune L102 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 CV101, CV102, CV103, CV104, CV105, and CV106, 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 CV211 and CV212 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 CV211 for peak DC voltage at TP201.

5. Adjust CV212 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 RV215 for 387 mV RMS, ±5 mV RMS, at TP202.

10. Adjust RV212 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.

FOR 25 kHz CHANNELS:

NOTE: Perform this test if CV201 and CV202 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 CV201 for peak DC voltage at TP201.

5. Adjust CV202 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 RV203 for 387 mV RMS, ±5 mV RMS, at TP202.

10. Adjust RV202 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.

7.1.7 AUDIO DISTORTION

1. Plug a 16 ohm load at J101 or J104 on the TPI (Third Party Interface 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 TPI 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 TPI.

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 RV201 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. Refer to Figure 7-7 for equipment needed and setup diagram.

NOTE: Some adjustments will be made using the cursor "Up"/"Dn" or "PgUp"/"PgDn" keys.

WARNING

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

7.2.1 PRETEST

1. Set TCXO modulation adjust RV101 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 ±0.3V
U402, pin 1	+3.5V DC ±0.1V
U404, pin 7	+3.5V DC ±0.1V

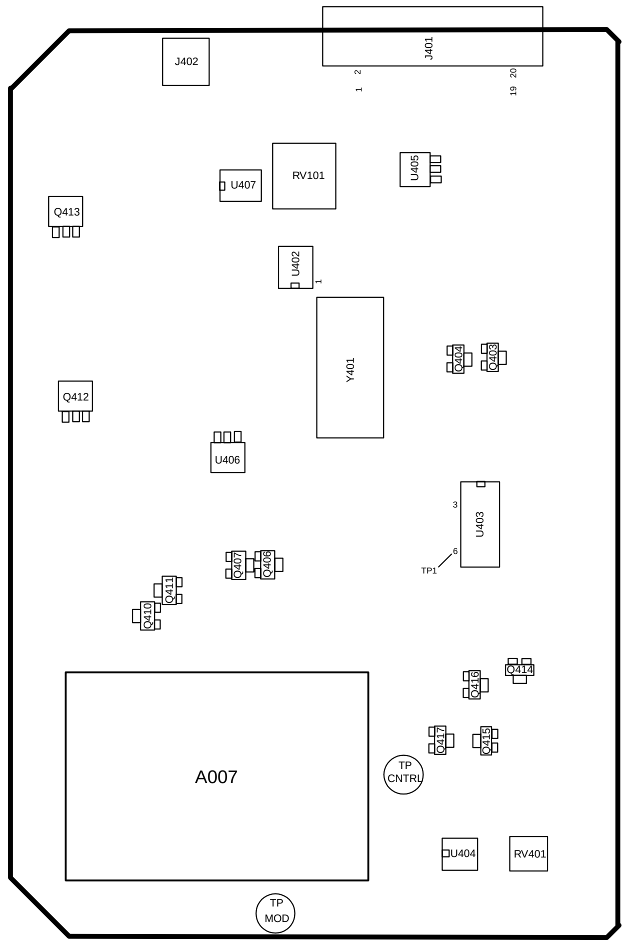


Figure 7-2 EXCITER ALIGNMENT POINTS

7.2.3 PROGRAM TUNE-UP CHANNEL

For Exciters operating between:
138-144 MHz or 154-172 MHz.

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

2. Press the space bar to key the Exciter.

3. Tune the VCO inductor L102 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 TP1 shall be greater than 2V.

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

5. Press the space bar to unkey the Exciter.

For Transmitters operating within 6 MHz of the top of the transmit band (144-150 or 172-178 MHz).

1. Program the Synthesizer for the *Highest* transmit frequency (i.e. 150 or 178 MHz).

2. Press the space bar to key the Exciter.

3. Set the control line voltage for 7.5V at TP1. Check 6 MHz *below* the programmed frequency (i.e. 144 or 172 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. Press the space bar to unkey the Exciter.

For Transmitters operating within 6 MHz of the bottom of the transmit band (132-138 or 150-156 MHz).

1. Program the Synthesizer for the *Lowest* transmit frequency (i.e. 132 or 150 MHz).

2. Set the control line voltage for 2V at TP1. Check 6 MHz *above* the programmed frequency (i.e. 138 or 156 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. Press the space bar to key the Exciter.

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

4. Press the space bar to unkey the Exciter.

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

6. Press the space bar to key the Exciter.

7. The voltage on TP1 (U403, pin 6) should be > 2.5V. Power output should be > +18 dBm.

8. Press the space bar 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. Press the space bar to key the Exciter.

3. Tune TCXO Y401 for the Transmit Channel Frequency, ± 50 Hz.

4. Press the space bar 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 J2, pin 5 on the back of the Station.

   NOTE: This test changes the Tx Audio Deviation Limit. To correct the limit, perform adjustment per Section 7.4.5.

4. Adjust U207 with "Up/Dn" and "PgUp/PgDn" keys for 707 mV RMS on P100, pin 29. This waveform should be a "clean" sine wave.

5. Press the space bar to key the Exciter.

6. Set RV401 for ±3 kHz deviation for 25 kHz channels (±1.5 kHz deviation for 12.5 kHz channels).

7. Press the space bar to unkey the Exciter.

8. Adjust R237 for a 2V P-P square wave on P100, pin 29 of the TPI.

   NOTE: This test changes the Tx Data Level. To correct the limit, perform adjustment per Section 7.4.5.

9. Press the space bar to key the Exciter.

10. Set RV101 for "best" square wave as observed on the modulation analyzer output to the oscilloscope.

NOTE: Ensure that the oscilloscope is "DC" coupled and turn off de-emphasis and HPF switches on the Modulation Analyzer.

11. Press the space bar to unkey the Exciter.

12. Repeat Steps 1-7. Very little adjustment of RV401 should be needed.

7.3 110W POWER AMPLIFIER ALIGNMENT

7.3.1 INTRODUCTION

Refer to Figures 7-3 and 7-4 for component locations. Refer to Figure 7-8 for equipment needed and setup diagram. Select "PA" from the "TEST" menu in the Repeater Software.

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. Press the space bar to key the PA.

5. Monitor the voltage on R45 on the RFIB and set R76 for 1.3V DC (see Figure 7-4).

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). Use the carrier frequency needed.

1. Set RV501 on the PA fully counterclockwise. Set RV502 on the PA fully clockwise, see Figure 7-3.

2. Set Forward Power Adjust RV601 and Reflected Power Adjust RV602 on the power detector board fully counterclockwise (see Figure 7-3).

3. Monitor the voltage on R45 on the RFIB and set R76 for 1.3V DC (see Figure 7-4). This sets the current limit point for driver Q501 at hot temperatures.

4. Set each of the quiescent currents for Q502 and Q503 for 10 mA (DC) each.

5. Program the power output for the correct frequency range as follows:

   132-150 MHz 110W
   150-178 MHz 110W

6. Press the space bar to key the PA. Output power will be approximetly 80W.

7. Monitor the output power and tune C601 and C602 for maximum output power (see Figure 7-3).

8. Set Forward Power Adjust RV601 for rated power (110W or 100W).

9. Press the space bar to unkey the PA.

10. Disconnect the antenna or dummy load from the RF port.

11. Press the space bar to key the PA.
    NOTE: This will not harm the PA.

12. Adjust Reverse Power Calibration Pot RV602 for equal voltages on W121 and W126 on the RFIB or for equal Forward and Reverse Power (see Figure 7-4).

13. Press the space bar to unkey the PA.

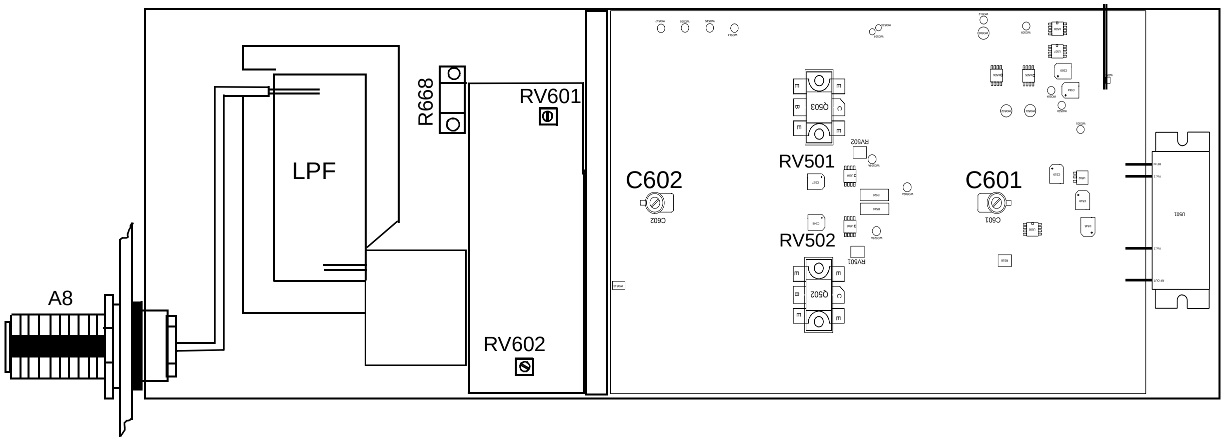


Figure 7-3 110W POWER AMPLIFIER ALIGNMENT POINTS

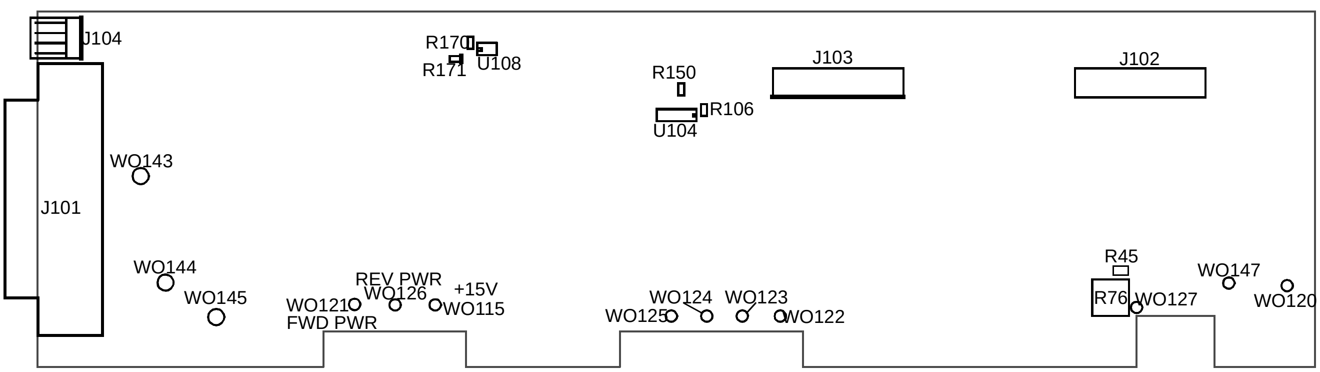
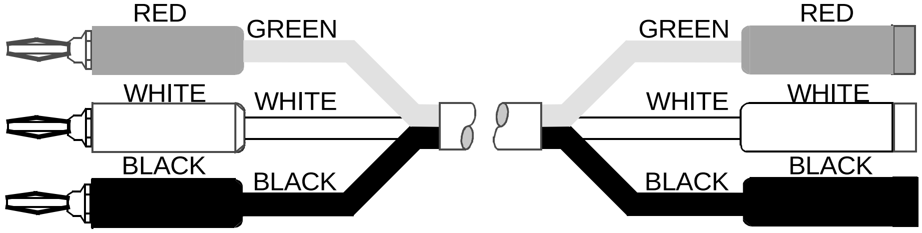


Figure 7-4 RF INTERFACE BOARD ALIGNMENT POINTS



(INCLUDED IN 2000 SERIES SERVICE KIT 250-2000-230)

Figure 7-5 POWER EXTENDER CABLES

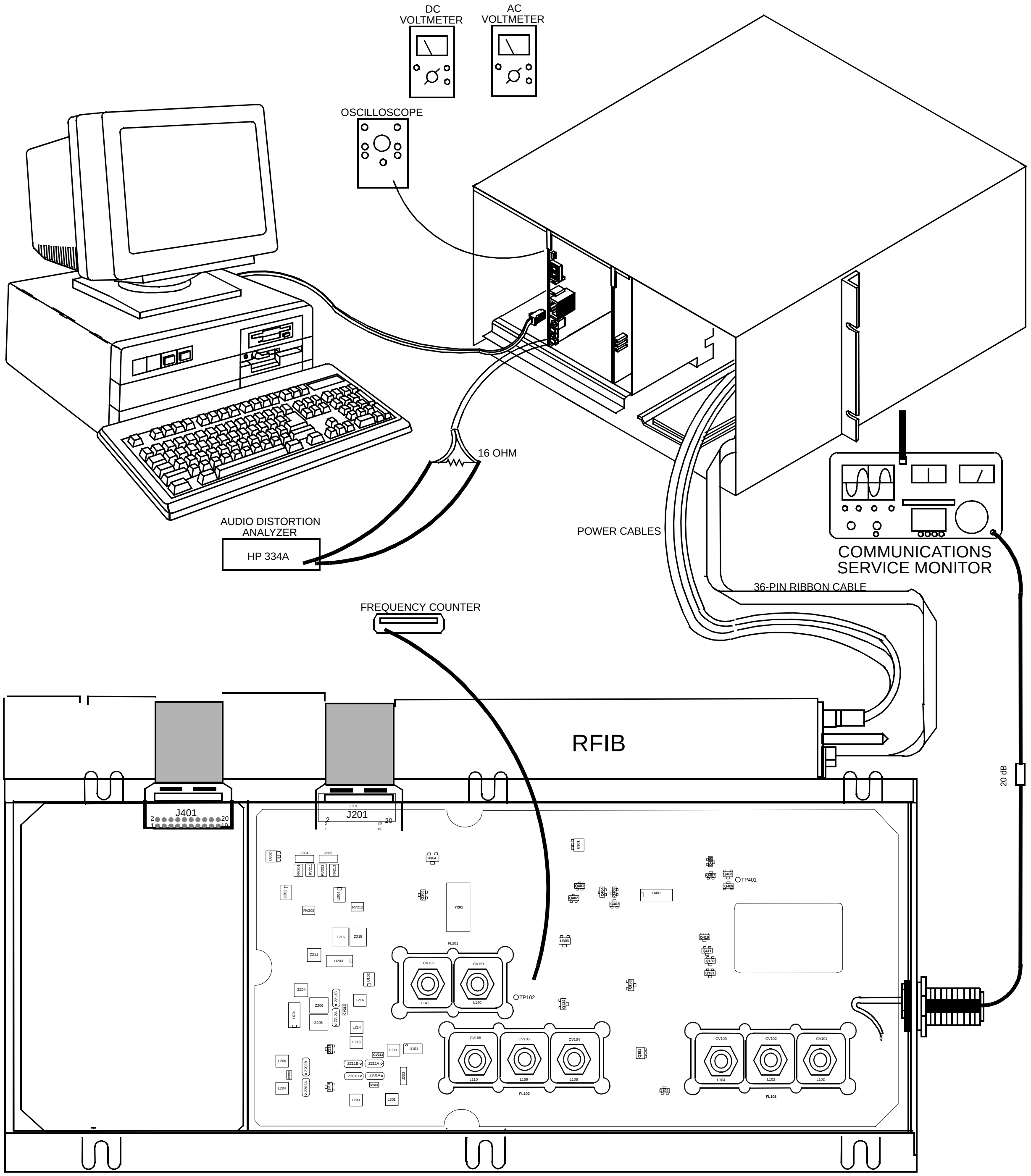


Figure 7-6   RECEIVER TEST SETUP

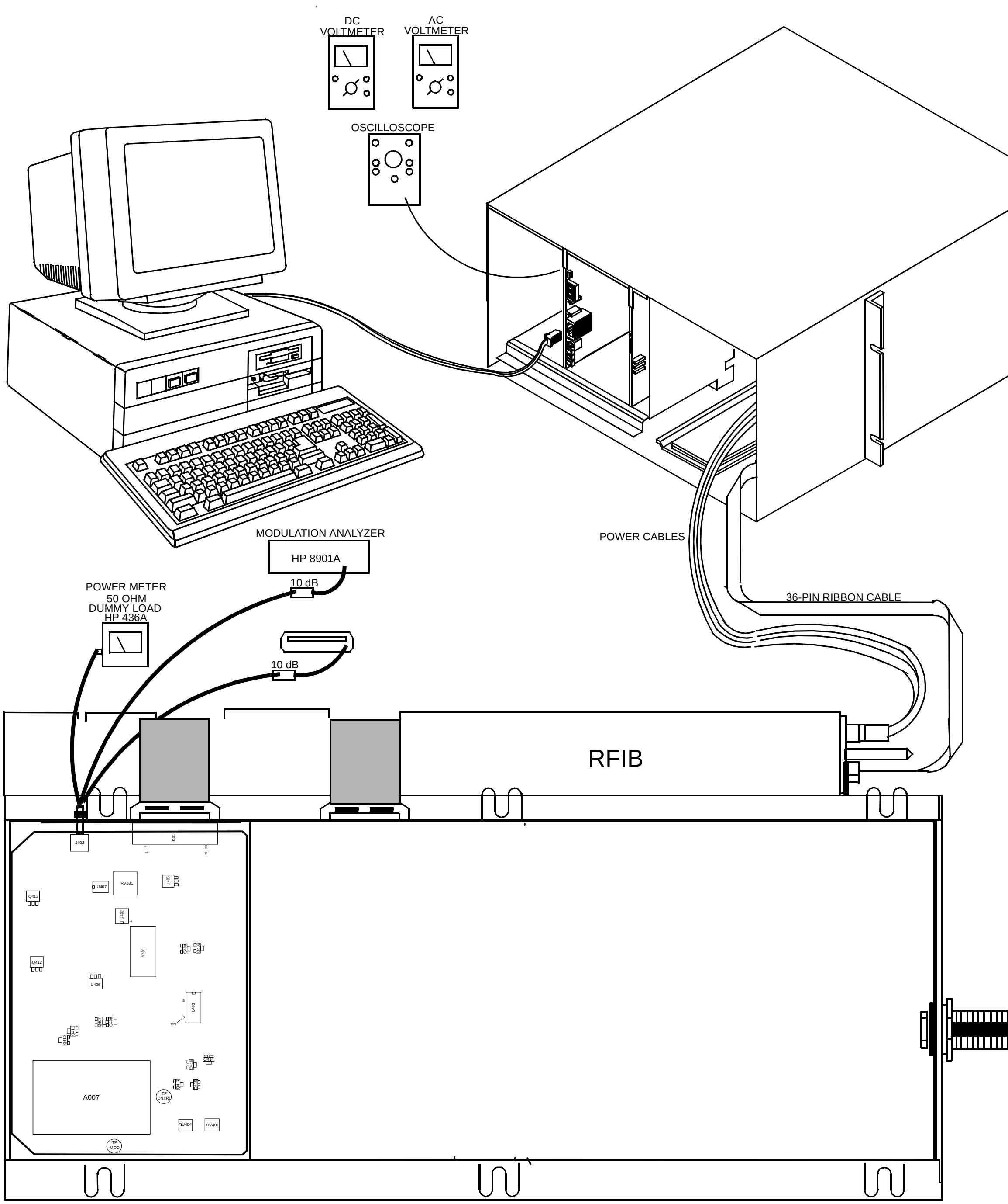


Figure 7-7 EXCITER TEST SETUP

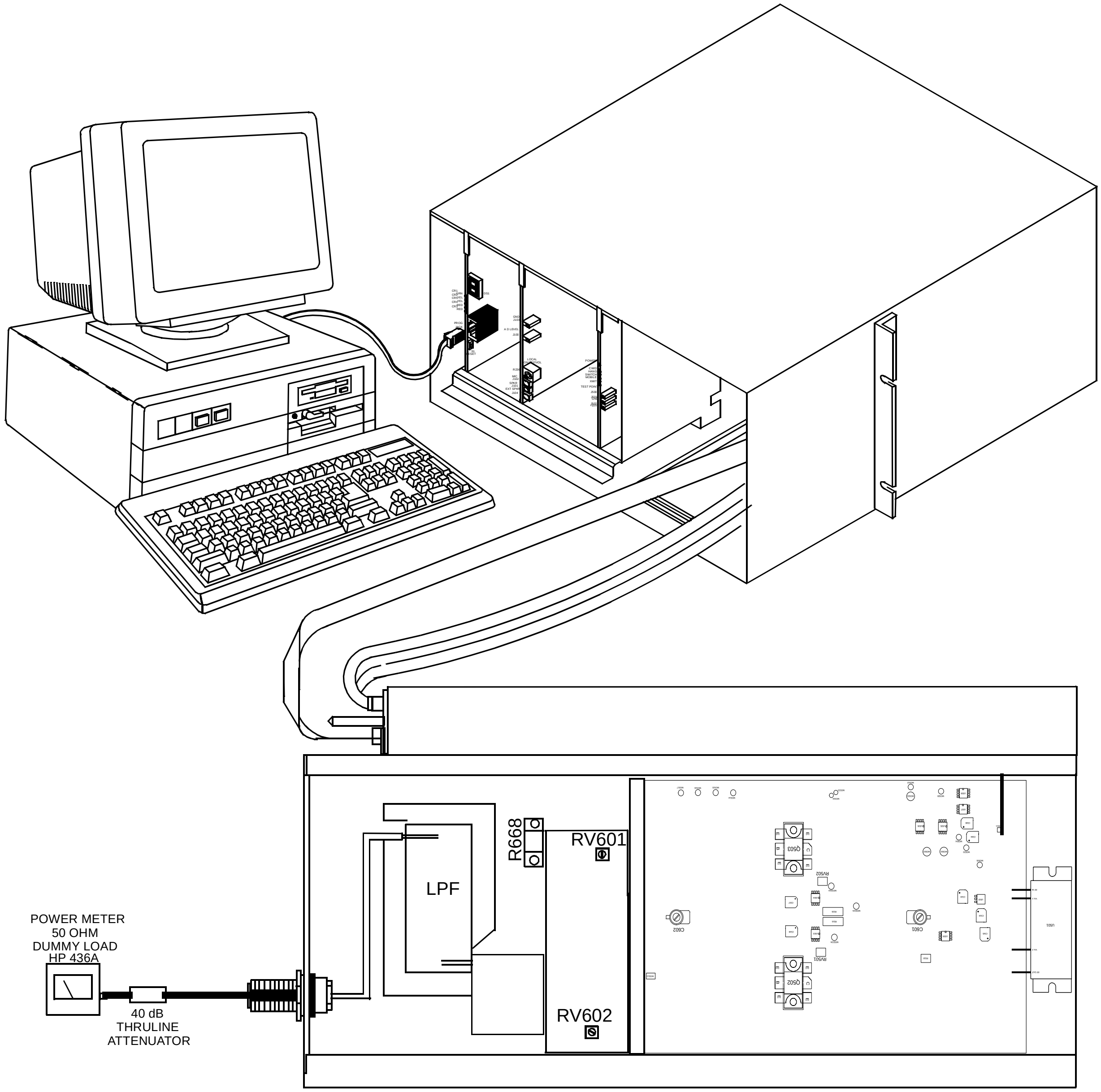


Figure 7-8   110W POWER AMPLIFIER TEST SETUP

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 7-14).

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.

7.4.3 TRANSMITTER TEST/ADJUSTMENTS

Transmit Mode

1. Press the space bar to key the repeater.

2. The IAC Transmit LED should turn on to indicate the repeater is transmitting (see Figure 7-14).

3. Press the space bar to unkey the repeater.

Transmit TCXO Frequency Adjustment

C R I T I C A L A D J U S T M E N T

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.

4. Press the space bar to key the repeater.

5. Check the frequency of the transmitted signal. The frequency should be ±50 Hz of the channel frequency.

6. Adjust the frequency with Y401 (TCXO) on the Exciter (see Section 7.2.5).

7. Press the space bar to unkey the repeater.

Transmitter Output Power Adjustment

1. Press the space bar to key the repeater.

2. Check the transmit output power. The power can be adjusted from the computer using the cursor Up/Dn and PgUp/PgDn keys. The test equipment should be calibrated for ±2W.

3. Press the space bar to unkey the repeater.

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

C R I T I C A L A D J U S T M E N T

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 TP102 in the Receiver (see Section 7.1.4).

2. Adjust Y401 (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) (±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 (±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 (±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 (±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 (±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 (±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 (±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. Press the space bar to key the transmitter.

6. SINAD should not degrade more than 1 dB or to no less than 11 dB SINAD.

7. Press the space bar 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 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 (578 mV RMS) to P100, pin 32.

2. Insert test cables into J100/J103 and connect to an AC voltmeter.

3. Press the space bar to key the transmitter.

4. Adjust R305 for 0 dBm (775 mV RMS).

5. Press the space bar 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. Press the space bar to key the transmitter.

8. Adjust U149 with the PgUp/PgDn and CurUp/CurDn keys to set the maximum allowed deviation at ±3.5 kHz deviation, 25 kHz channels (±1.6 kHz 12.5 kHz channels).

9. Press the space bar 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 (±800 Hz 12.5 kHz channels). Be sure the Modulation Analyzer LPF switch is set to 3 kHz.

2. Press the space bar to key the transmitter.

3. **On the MAC**, adjust R237 to achieve ±1.5 kHz (±100 Hz) transmit deviation, 25 kHz channels, (±800 Hz 12.5 kHz channels). Be sure the modulation analyzer LPF switch is set to 3 kHz.

4. Press the space bar 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.
   Press the space bar to key the transmitter.

2. Adjust U151 with the PgUp/PgDn and CurUp/Cur/Dn keys to achieve ±1 kHz (±100 Hz) transmit deviation, 25 kHz channels (±800 Hz 12.5 kHz channels).

3. Press the space bar 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. Press the space bar to key the transmitter.

3. Measured deviation should be ±4.5 kHz (±200 Hz), 25 kHz channels (±2.4 kHz (±100 Hz) 12.5 kHz channels).

4. Press the space bar to unkey the transmitter.
   Disconnect all cables.

CWID Level Check

1. Set modulation analyzer LPF switch to 3 kHz.
   Press the space bar to key the transmitter.

2. Deviation should be 1.5 kHz to 2.5 kHz, 25 kHz channels, (±0.750 kHz to 1.75 kHz, 12.5 kHz channels).

3. Press the space bar 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. Press the space bar 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, (±0.75 kHz to 1.6 kHz, 12.5 kHz channels).

5. Release the microphone PTT.

6. Press the space bar 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. Press the space bar 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. Press the space bar 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. Press the space bar 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. Press the space bar 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. Press the space bar to unkey the transmitter.

7.4.6 VOTER AUDIO LEVEL ADJUSTMENT

NOTE: Use an unbalanced audio voltmeter.

1. Inject a 1 kHz tone at -12 dBm (194 mV RMS) into J2, pin 17. This tone represents ±1.5 kHz deviation in the Voter Receiver.

2. **On the MAC**, adjust R233 to obtain a level of -6 dBm (387 mV RMS) at J100/J103.

7.4.7 AUDIO/DATA LEVEL ADJUSTMENTS

NOTE: Section 7.4.5 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. **On the MAC**, set S100 and S101, all Sections OFF (see Figure 7-9).

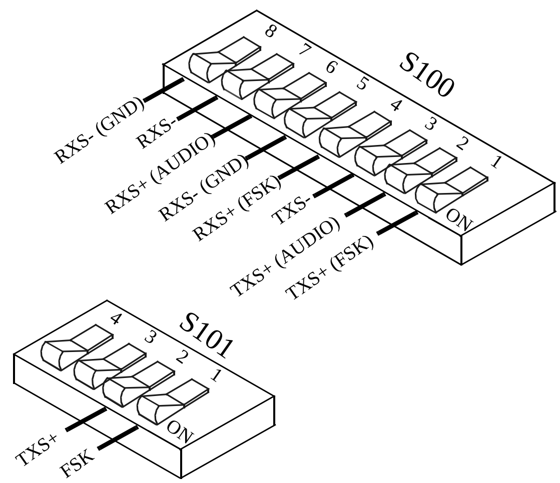


Figure 7-9 S100 SETTING

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 7-11).

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

3. **On the MAC**, adjust R243 to obtain -6 dBm (387 mV RMS) measured at J100/J103.

7.4.8 REPEATER OPERATION

New HSDB Test

1. **On the MPC**, switch settings for RS-485 operation are shown in Figure 7-10.

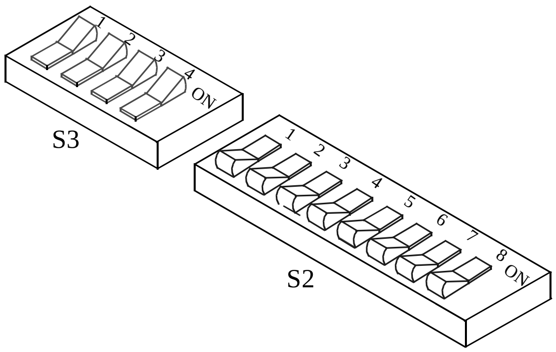


Figure 7-10 NEW HSDB SWITCH SETTINGS

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 -
   Sameas 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).

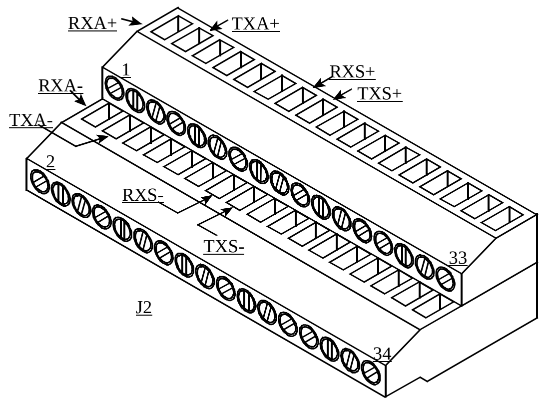


Figure 7-11 J2 TERMINAL BLOCK

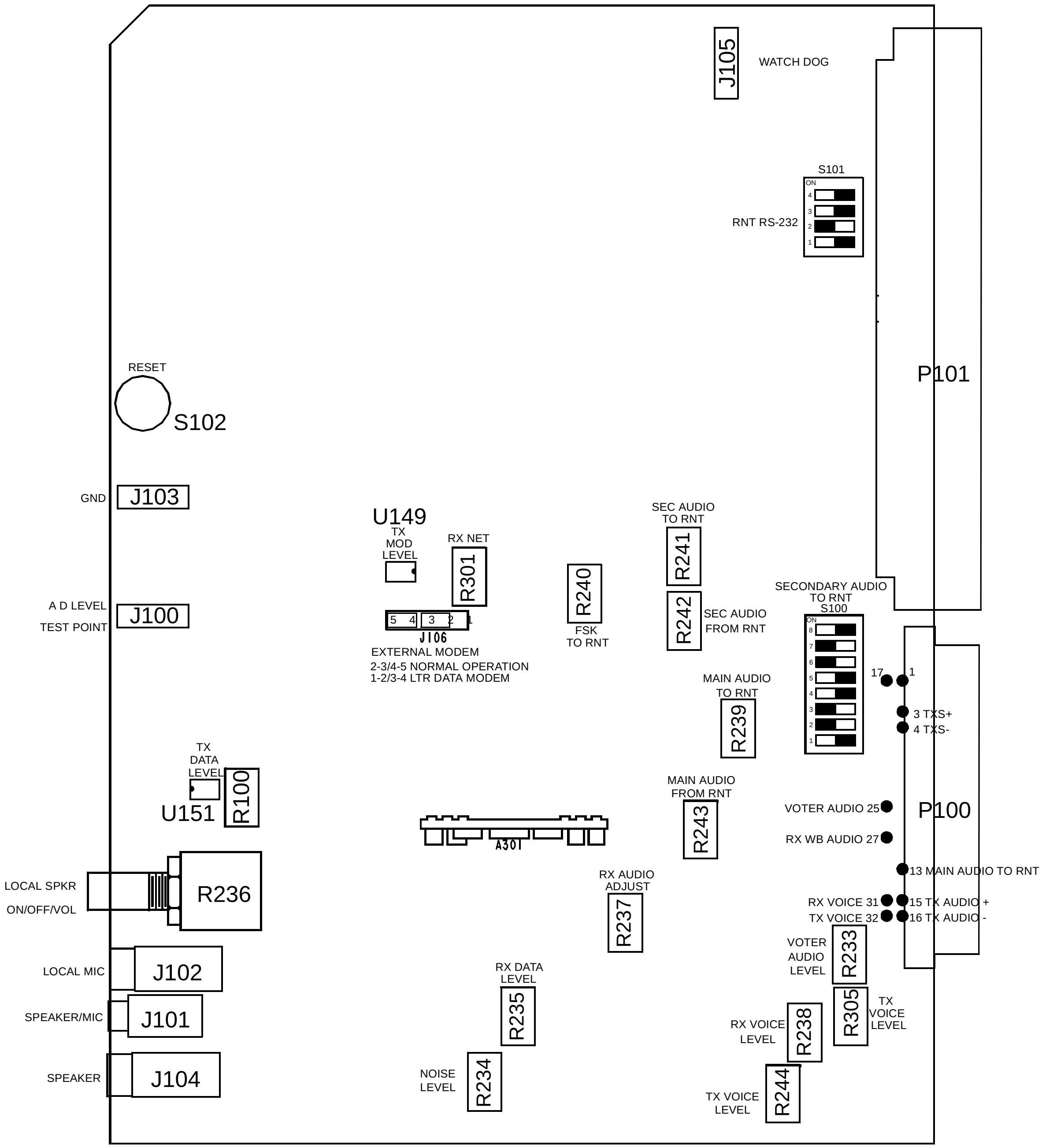


Figure 7-12   MAC ALIGNMENT POINTS

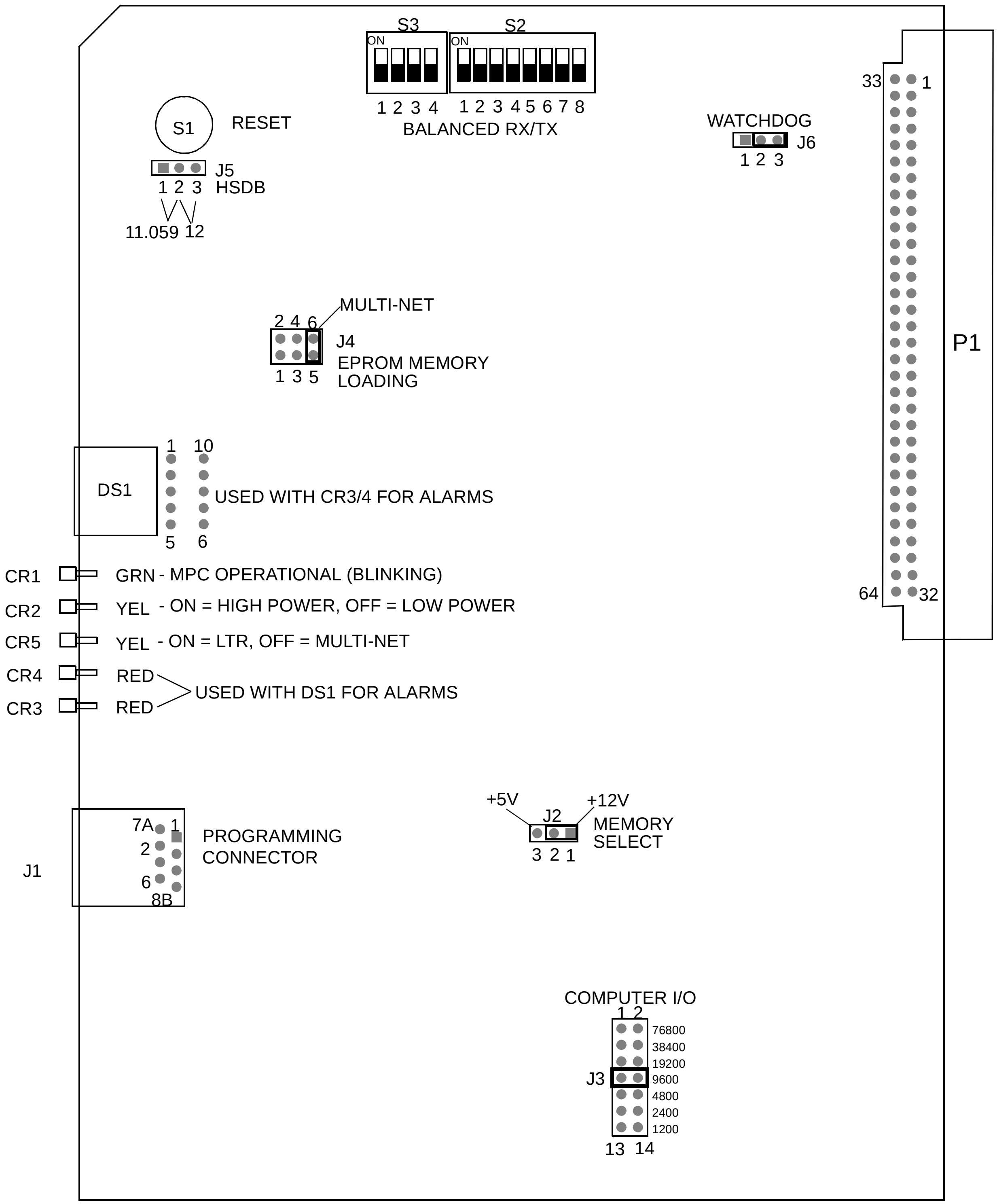


Figure 7-13   MAIN PROCESSOR CARD ALIGNMENT POINTS

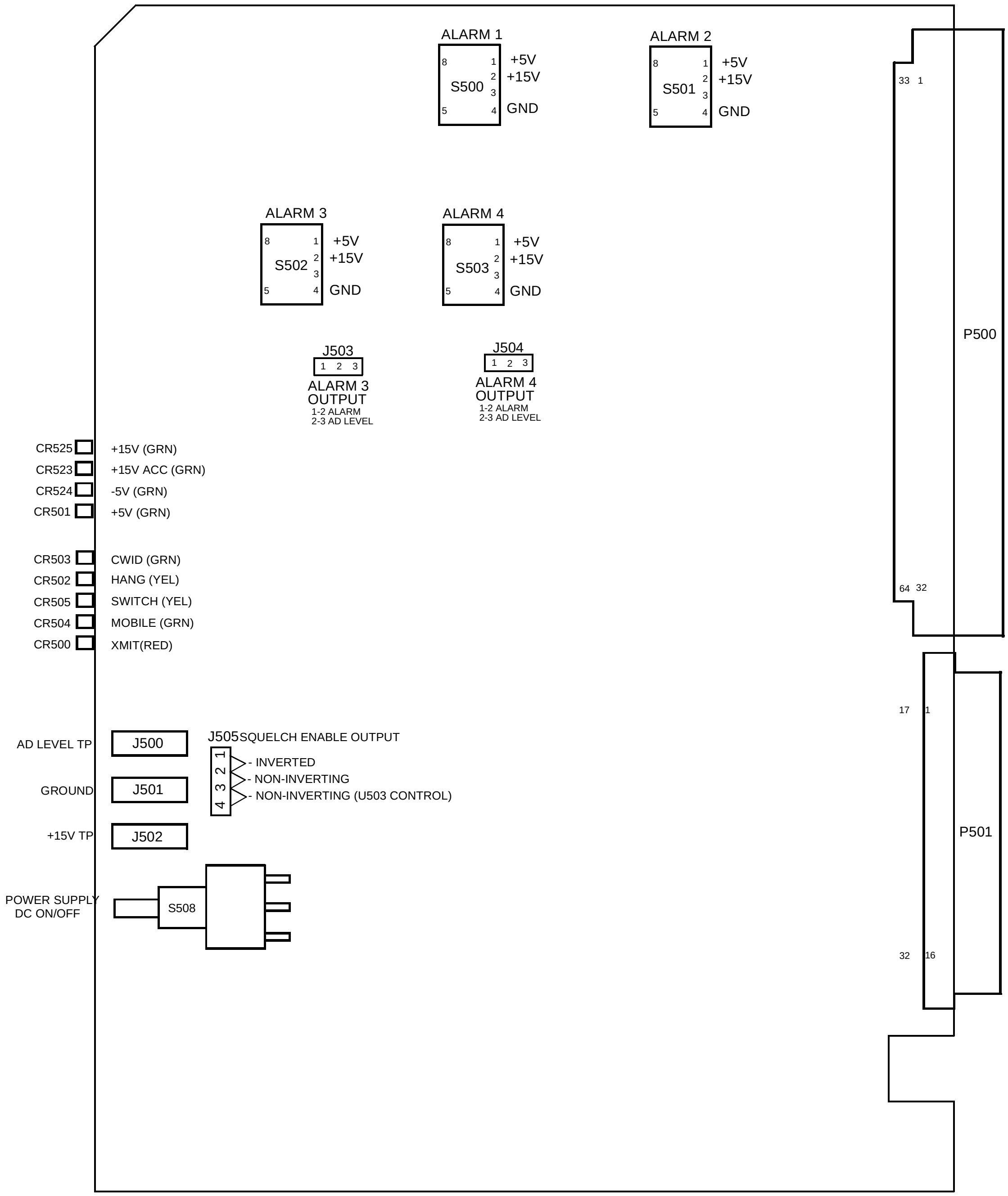


Figure 7-14 INTERFACE ALARM CARD ALIGNMENT POINTS

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 1.9.

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 ±2.5 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 ($\overline{\text{Enable}}$) 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 6.1.6 and 6.2.1). 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 6-2 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.

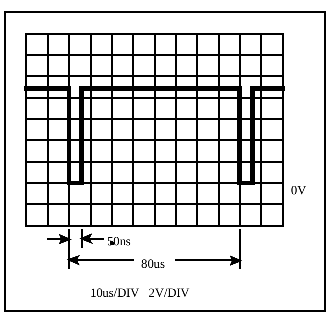


Figure 8-1 LOCK DETECT WAVEFORM

Modulus Control Signal

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.

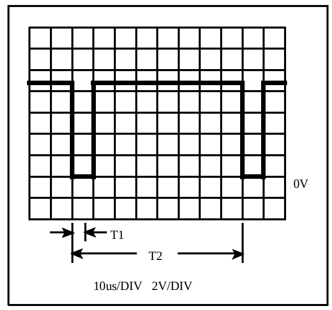


Figure 8-2 MODULUS CONTROL WAVEFORM

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

Checking Prescaler Divide Number

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: 150.250 MHz (receive)

Prescaler Div No = 64 + (40 ÷ 507) = 64.106666

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.

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: 150.025 MHz (receive)

VCO freq = 150.025 + 52.95 = 202.975 MHz
N Cntr Div No = 202.975 ÷ 0.4 = 507.4375
Integer (whole no.) of 507.4375 = **507**

EXAMPLE: 150.250 MHz (transmit)

N Cntr Div No = 150.250 ÷ 0.4 = 375.625
Integer (whole no.) of 375.625 = **375**

"A" Counter
A Counter Divide Number =
(VCO freq (MHz) ÷ .00625) - (N Cntr Div No x 64)

EXAMPLE: 150.025 MHz (receive)

A Cntr Div No = (202.975 ÷ .00625) - (507 x 64)
= 32,476 - 32,448
= **28**

EXAMPLE: 150.250 MHz (transmit)

A Cntr Div No = (150.250 ÷ .00625) - (375 x 64)
= 24,040 - 24,000
= **40**

8.3 RECEIVER SERVICING

To isolate a receiver problem to a defective section, start by checking the DC voltages shown in Section 6.1.2 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 7.2.2 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 recommended that the power supply be returned to the factory for servicing (see Section 1.8). Customers that desire to do their own repairs can obtain a service manual for the power supply, Part No. 004-2000-810.

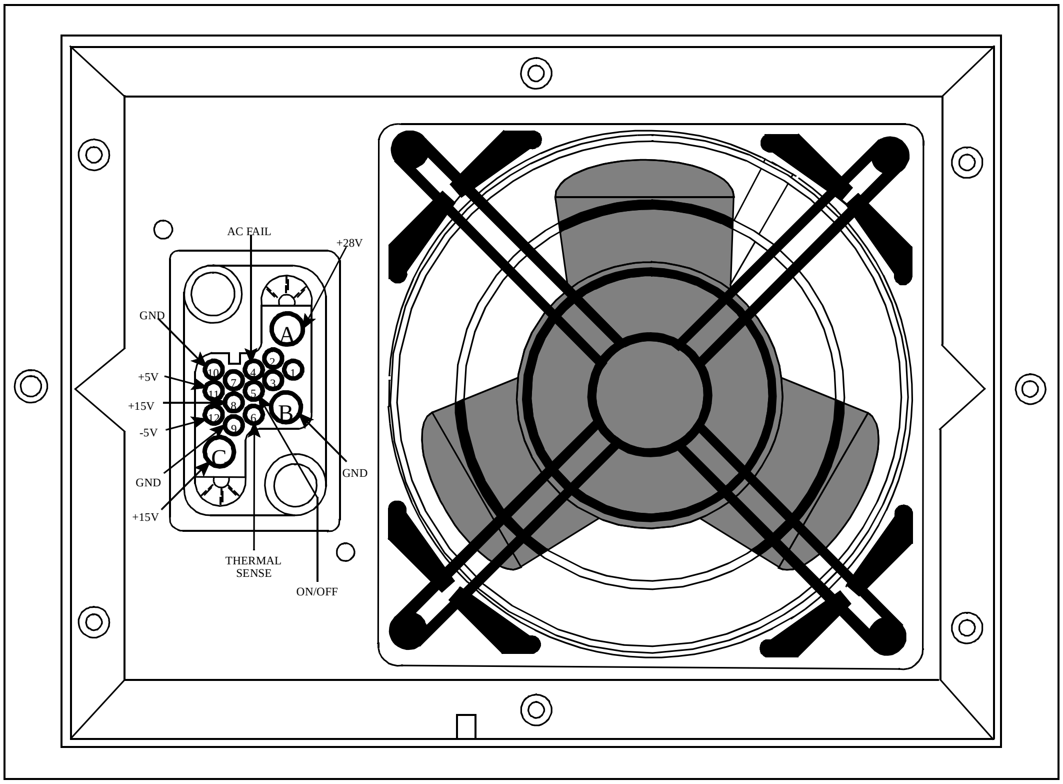


Figure 8-3 POWER SUPPLY REAR VIEW

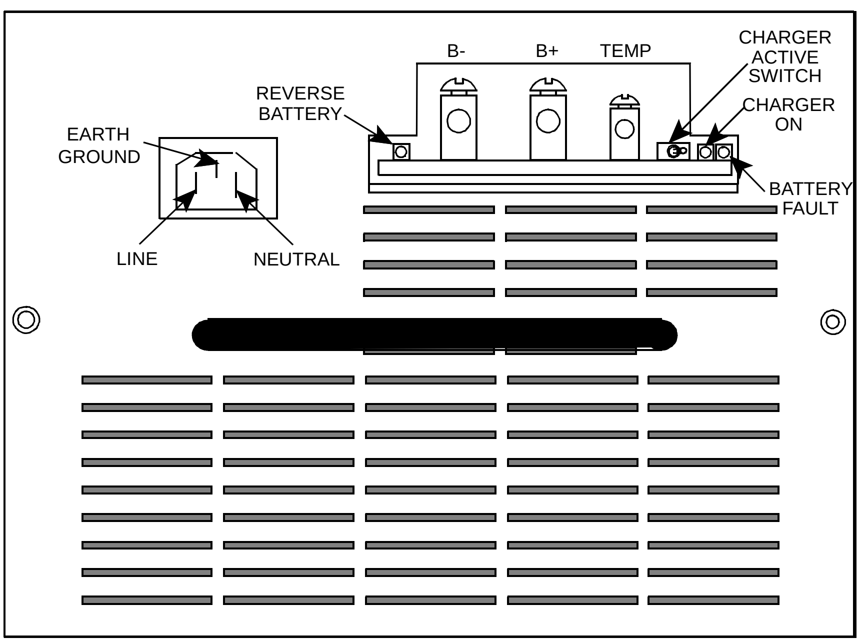


Figure 8-4 POWER SUPPLY FRONT VIEW

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 switched in to charge the battery when AC returns. The charger switch is removed when a separate battery charger is used (see Figure 8-4). The standby battery connection to the power supply is factory or field installable.

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 8-3). 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: $\overline{A2}$ - 100 pF NPO

XX = NPO	$\overline{X}X$ = N150	$X\overline{X}$ = N220
$\underline{XX}$ = N330	$\underline{X}X$ = N470	$X\underline{X}$ = N750
|XX = 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 nano-Henries, 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: 5761 5.76k ohm

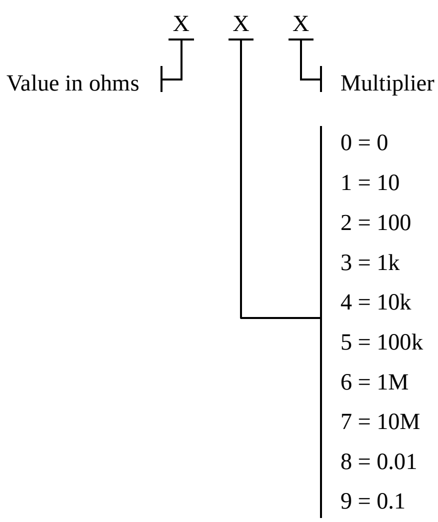
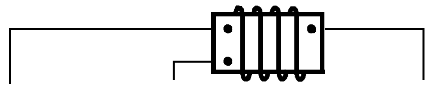


Figure 8-5 3-DIGIT RESISTOR

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 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 VHF LTR REPEATER PART NO. 242-2011-213 (132-150 MHz) PART NO. 242-2031-213(150-178 MHz)	
A 003	132-150 MHz 110W 12.5/25	023-2011-932
	150-178 MHz 110W 12.5/25	023-2031-932
A 006	132-150 MHz Rx/Tx module	023-2011-836
	150-178 MHz Rx/Tx module	023-2031-836
A 010	2000 series 800W power supply	023-2000-800
HW001	6-32 machine panhead philips	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
W 013	AC power cord 6'7" 16 AWG	597-1001-013

**Requires Application Engineering authorization to purchase.

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	110W VHF LTR REPEATER PART NO. 023-2011-932 (132-150 MHz) PART NO. 023-2031-932 (150-178 MHz)	
A 002	132-150 MHz circulator	585-0590-008
	150-178 MHz circulator	585-0590-009
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
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
EP500	Jumper/RF power detector	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
PA001	110W PA mechanical assem	023-2004-732
PA008	RF Interface board assembly	023-2008-110
PA009	110W 132-150 MHz PA	023-2061-520
	110W 150-178 MHz PA	023-2081-520
R 668	50 ohm 250W flange mount	569-5001-003

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	REPEATER ENCLOSURE ASSEMBLY PART NO. 023-2000-200	
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	EXTERNAL CONNECTOR BOARD PART NO. 023-2000-220	
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	
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	
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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

REPEATER RX/EX MODULE
PART NO. 023-2011-836 (132-150 MHz)
PART NO. 023-2031-836 (150-178 MHz)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 201	RF input coax for Rx	023-2000-161
A 203	Receiver board top shield	023-2000-199
HW001	5/8-24 x 0.094 hex nut	560-9079-028
HW002	5/8 x 0.02 int lockwasher CPS	596-9119-028
HW205	Polarizing key box connector	515-7109-010
HW249	10-32 machine panhead ZPS	575-1610-020
HW250	#10 flat washer ZPS	596-1410-016
HW404	Polarizing key box connector	515-7109-010
J 201	20-pin right angle header	515-9031-375
J 401	20-pin right angle header	515-9031-375
MP200	Transceiver pad	017-2210-105
MP204	Transceiver bottom shield	017-2210-101

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
PA002	Transceiver mechanical	023-2000-205
PA004	132-150 MHz Receiver	585-2061-270
	150-178 MHz Receiver	585-2081-270
PA005	132-150 MHz Exciter	585-2061-400
	150-178 MHz Exciter	585-2081-400

RECEIVE VCO 132-150 MHz
A401

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 101	100 pF 50V ceramic chip	GRM40CH101K50
C 102	2 pF 50V ceramic chip	GRM40CK020D50
C 103	5 pF 50V ceramic chip	GRM40CH050C50
C 104	7 pF 50V ceramic chip	GRM40CH070C50
C 105	56 pF 50V ceramic chip	GRM40CH560J50
C 106	56 pf 50V ceramic chip	GRM40CH560J50
C 107	10 pf 50V ceramic chip	GRM40CH100J50
C 108	1000 pf 50V ceramic chip	GRM40B102K50
C 109	.1 µF ceramic chip	GRM40F104Z50
C 110	1000 pf 50V ceramic chip	GRM40B102K50
C 111	47 pF 50V ceramic chip	GRM40CH470J50
C 112	10 pf 50V ceramic chip	GRM40CH100J50
C 113	1000 pf 50V ceramic chip	GRM40B102K50
C 114	15 pf 50V ceramic chip	GRM40CH150J50
C 115	1000 pf 50V ceramic chip	GRM40B102K50
C 116	1000 pf 50V ceramic chip	GRM40B102K50
C 118	22 µF 25V electrolytic	
D 101	Varactor	HVU202A
L 101	10 µH inductor	ELJ-FC100K
L 102	3.5 turn inductor	
L 103	1 µH inductor	ELJ-FC1ROM
L 104	.1 µH inductor	LQN21AR10K
Q 101	NPN SOT-23	2SC3356
Q 102	NPN SOT-23	2SC3356
Q 103	NPN SOT-23	2SC3356
Q 104	NPN SOT-23	2SC2712
R 101	10k ohm 1/8W chip	ERJ-6GMYJ103
R 102	22k ohm 1/8W chip	ERJ-6GMYJ223
R 103	470 ohm 1/8W chip	ERJ-6GMYJ471
R 104	47 ohm 1/8W chip	ERJ-6GMYJ470
R 105	100 ohm 1/8W chip	ERJ-6GMYJ101
R 106	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 107	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 108	4.7K ohm 1/8W chip	ERJ-6GMYJ472
R 109	560 ohm 1/8W chip	ERJ-6GMYJ561
R 110	100 ohm 1/8W chip	ERJ-6GMYJ101
R 112	3.3k ohm 1/8W chip	ERJ-6GMYJ332

12.5/25 kHz RECEIVER
PART NO. 585-2061-270 (132-150 MHz)
PART NO. 585-2081-270 (150-178 MHz)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 201	Cable assembly	
A 401	VCO Unit	
C 101	10 pF 50V ceramic chip	GRM40CH100C50
C 102	220 pF 50V ceramic chip	GRM40CH221K50
C 103	220 pF 50V ceramic chip	GRM40CH221K50
C 104	10 pF 50V ceramic chip	GRM40CH100C50
C 105	4.7 µF 20V tantalum chip	SVC1D475M
C 106	470 pF 50V ceramic chip	GRM40CH471K50
C 107	4.7 µF 20V tantalum chip	SVC1D475M
C 108	470 pF 50V ceramic chip	GRM40CH471K50
C 109	10 pF 50V ceramic chip	GRM40CH100C50
C 130	470 pF 50V ceramic chip	GRM40CH471K50
C 131	5 pF 50V ceramic chip	GRM40CH050C50
C 132	10 pF 50V ceramic chip	GRM40CH100C50
C 133	470 pF 50V ceramic chip	GRM40CH471K50
C 134	.01 µF 50V ceramic chip	GRM40B103K50
C 135	.01 µF 50V ceramic chip	GRM40B103K50
C 136	470 pF 50V ceramic chip	GRM40CH471K50
C 137	470 pF 50V ceramic chip	GRM40CH471K50
C 139	470 pF 50V ceramic chip	GRM40CH471K50
C 140	470 pF 50V ceramic chip	GRM40CH471K50
C 144	.01 µF 50V ceramic chip	GRM40B103K50
C 145	.01 µF 50V ceramic chip	GRM40B103K50
C 146	12 pF 50V ceramic chip	GRM40CH120J50
C 147	47 pF 50V ceramic chip	GRM40CH470J50
C 148	4.7 µF 20V tantalum chip	SVC1D475M
C 149	1000 pF 50V ceramic chip	GRM40B102K50
C 150	.01 µF 50V ceramic chip	GRM40B103K50
C 151	15 pF 50V ceramic chip	GRM40CH150J50
C 152	470 pF 50V ceramic chip	GRM40CH471K50
C 153	22 pF 50V ceramic chip	GRM40CH220J50
C 154	1000 pF 50V ceramic chip	GRM40B102K50
C 155	1000 pF 50V ceramic chip	GRM40B102K50
C 156	1000 pF 50V ceramic chip	GRM40B102K50
C 157	100 pF 50V ceramic chip	GRM40CH101K50
C 158	4.7 µF 20V tantalum chip	SVC1D475M
C 159	100 pF 50V ceramic chip	GRM40CH101K50
C 160	470 pF 50V ceramic chip	GRM40CH471K50

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 161	4.7 µF 20V tantalum chip	SVC1D475M
C 162	10 pF 50V ceramic chip	GRM40CH100C50
C 163	15 pF 50V ceramic chip	GRM40CH150J50
C 164	1000 pF 50V ceramic chip	GRM40B102K50
C 165	1 pF 50V ceramic chip	GRM40CK010D50
C 166	1000 pF 50V ceramic chip	GRM40B102K50
C 169	12 pF 50V ceramic chip	GRM40CH120J50
C 201	10 pF 50V ceramic chip	GRM40CH100C50
C 202	39 pF 50V ceramic chip	GRM40CH390J50
C 203	5 pF 50V ceramic chip	GRM40CH050C50
C 205	39 pF 50V ceramic chip	GRM40CH390J50
C 206	10 pF 50V ceramic chip	GRM40CH100C50
C 207	4.7 µF 20V tantalum chip	SVC1D475M
C 208	.01 µF 50V ceramic chip	GRM40B103K50
C 109	1000 pF 50V ceramic chip	GRM40B102K50
C 210	8 pF 50V ceramic chip	GRM40CH080C50
C 211	.1 µF 50V ceramic chip	GRM40F104Z50
C 212	39 pF 50V ceramic chip	GRM40CH390J50
C 213	5 pF 50V ceramic chip	GRM40CH050C50
C 214	8 pF 50V ceramic chip	GRM40CH080C50
C 215	39 pF 50V ceramic chip	GRM40CH390J50
C 216	4 pF 50V ceramic chip	GRM40CH040C50
C 217	.01 µF 50V ceramic chip	GRM40B103K50
C 218	.1 µF 50V ceramic chip	GRM40F104Z50
C 219	.1 µF 50V ceramic chip	GRM40F104Z50
C 220	1000 pF 50V ceramic chip	GRM40B102K50
C 221	1000 pF 50V ceramic chip	GRM40B102K50
C 222	.1 µF 50V ceramic chip	GRM40F104Z50
C 223	1000 pF 50V ceramic chip	GRM40B102K50
C 225	.1 µF 50V ceramic chip	GRM40F104Z50
C 226	1000 pF 50V ceramic chip	GRM40B102K50
C 227	4.7 µF 20V tantalum chip	SVC1D475M
C 228	27 pF 50V ceramic chip	GRM40CH270J50
C 236	10 pF 50V ceramic chip	GRM40CH100C50
C 237	39 pF 50V ceramic chip	GRM40CH390J50
C 238	5 pF 50V ceramic chip	GRM40CH050C50
C 240	39 pF 50V ceramic chip	GRM40CH390J50
C 241	10 pF 50V ceramic chip	GRM40CH100C50
C 242	1000 pF 50V ceramic chip	GRM40B102K50
C 243	.01 µF 50V ceramic chip	GRM40B103K50
C 244	4.7 µF 20V tantalum chip	SVC1D475M
C 245	8 pF 50V ceramic chip	GRM40CH080C50
C 246	.01 µF 50V ceramic chip	GRM40B103K50
C 247	39 pF 50V ceramic chip	GRM40CH390J50
C 248	5 pF 50V ceramic chip	GRM40CH050C50
C 250	6 pF 50V ceramic chip	GRM40CH060C50
C 251	39 pF 50V ceramic chip	GRM40CH390J50
C 252	4 pF 50V ceramic chip	GRM40CH040C50
C 253	.01 µF 50V ceramic chip	GRM40B103K50
C 254	1000 pF 50V ceramic chip	GRM40B102K50
C 255	.1 µF 50V ceramic chip	GRM40F104Z50
C 256	.1 µF 50V ceramic chip	GRM40F104Z50
C 257	.1 µF 50V ceramic chip	GRM40F104Z50
C 258	1000 pF 50V ceramic chip	GRM40B102K50
C 261	1000 pF 50V ceramic chip	GRM40B102K50
C 262	4.7 µF 20V tantalum chip	SVC1D475M
C 263	27 pF 50V ceramic chip	GRM40CH270J50
C 265	100 pF 50V ceramic chip	GRM40CH101K50
C 266	.01 µF 50V ceramic chip	GRM40B103K50
C 267	4.7 µF 20V tantalum chip	SVC1D475M
C 268	.01 µF 50V ceramic chip	GRM40B103K50
C 269	1000 pF 50V ceramic chip	GRM40B102K50
C 270	6 pF 50V ceramic chip	GRM40CH060C50
C 271	220 pF 50V ceramic chip	GRM40B221K50
C 275	100 pF 50V ceramic chip	GRM40CH101K50
C 276	.01 µF 50V ceramic chip	GRM40B103K50
C 277	4.7 µF 20V tantalum chip	SVC1D475M
C 278	.01 µF 50V ceramic chip	GRM40B103K50
C 280	220 pF 50V ceramic chip	GRM40B221K50
C 281	220 pF 50V ceramic chip	GRM40B221K50
C 282	5 pF 50V ceramic chip	GRM40CH050C50
C 283	120 pF 50V ceramic chip	GRM40B121K50
C 284	330 pF 50V ceramic chip	GRM40B331K50
C 301	1000 pF 50V ceramic chip	GRM40B102K50
C 302	4.7 µF 20V tantalum chip	SVC1D475M
C 303	4.7 µF 20V tantalum chip	SVC1D475M
C 304	1000 pF 50V ceramic chip	GRM40B102K50
C 306	100 pF 50V ceramic chip	GRM40CH101K50
C 307	1000 pF 50V ceramic chip	GRM40B102K50
C 308	4.7 µF 20V tantalum chip	SVC1D475M
C 309	4.7 µF 20V tantalum chip	SVC1D475M
C 310	1000 pF 50V ceramic chip	GRM40B102K50
C 311	1000 pF 50V ceramic chip	GRM40B102K50
C 312	4.7 µF 20V tantalum chip	SVC1D475M
C 313	1000 pF 50V ceramic chip	GRM40B102K50
C 314	4.7 µF 20V tantalum chip	SVC1D475M
C 315	1000 pF 50V ceramic chip	GRM40B102K50
C 316	4.7 µF 20V tantalum chip	SVC1D475M
C 317	4.7 µF 20V tantalum chip	SVC1D475M
C 318	1000 pF 50V ceramic chip	GRM40B102K50
C 351	1000 pF 50V ceramic chip	GRM40B102K50
C 401	.01 µF 50V ceramic chip	GRM40B103K50
C 402	4.7 µF 20V tantalum chip	SVC1D475M
C 403	.01 µF 50V ceramic chip	GRM40B103K50

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 404	820 pF 50V ceramic chip	GRM40B821K50
C 405	100 pF 50V ceramic chip	GRM40CH101K50
C 406	.01 µF 50V ceramic chip	GRM40B103K50
C 407	1000 pF 50V ceramic chip	GRM40B102K50
C 408	.01 µF 50V ceramic chip	GRM40B103K50
C 409	.01 µF 50V ceramic chip	GRM40B103K50
C 410	1000 pF 50V ceramic chip	GRM40B102K50
C 411	.1 µF 50V ceramic chip	GRM40F104Z50
C 412	.1 µF 50V ceramic chip	GRM40F104Z50
C 413	.01 µF 50V ceramic chip	GRM40B103K50
C 415	.1 µF 50V ceramic chip	GRM40F104Z50
C 432	100 pF 50V ceramic chip	GRM40CH101K50
C 433	.1 µF 50V ceramic chip	GRM40F104Z50
C 434	100 pF 50V ceramic chip	GRM40CH101K50
C 435	100 pF 50V ceramic chip	GRM40CH101K50
C 436	.1 µF 50V ceramic chip	GRM40F104Z50
C 437	.1 µF 50V ceramic chip	GRM40F104Z50
C 439	100 pF 50V ceramic chip	GRM40CH101K50
C 440	.01 µF 50V ceramic chip	GRM40B103K50
C 441	100 pF 50V ceramic chip	GRM40CH101K50
C 443	100 pF 50V ceramic chip	GRM40CH101K50
C 444	10 pF 50V ceramic chip	GRM40CH100C50
C 445	.1 µF 50V ceramic chip	GRM40F104Z50
C 446	12 pF 50V ceramic chip	GRM40CH120J50
C 447	1 µF 16V tantalum chip	SVA1C105M
C 450	1 µF 50V poly film	553M5002-105K
C 451	.1 µF 50V ceramic chip	GRM40F104Z50
C 452	10 pF 50V ceramic chip	GRM40CH100C50
C 454	1000 pF 50V ceramic chip	GRM40B102K50
C 455	100 pF 50V ceramic chip	GRM40CH101K50
C 456	5 pF 50V ceramic chip	GRM40CH050C50
C 457	.01 µF 50V ceramic chip	GRM40B103K50
C 458	470 pF 50V ceramic chip	GRM40CH471K50
C 459	470 pF 50V ceramic chip	GRM40CH471K50
C 460	470 pF 50V ceramic chip	GRM40CH471K50
C 461	470 pF 50V ceramic chip	GRM40CH471K50
C 462	470 pF 50V ceramic chip	GRM40CH471K50
C 463	470 pF 50V ceramic chip	GRM40CH471K50
C 464	4.7 µF 20V tantalum chip	SVC1D475M
CR131	5.1V zener	RD5.1ML B2
CR132	5.1V zener	RD5.1ML B2
CR133	Diode chip	HSM107S
CR401	5.1V zener	RD5.1ML B2
CR402	Si diode chip	HSM123
CV101	Variable capacitor	ECV-1ZW04X53T
CV102	Variable capacitor	ECV-1ZW04X53T
CV103	Variable capacitor	ECV-1ZW04X53T
CV104	Variable capacitor	ECV-1ZW04X53T
CV105	Variable capacitor	ECV-1ZW04X53T
CV106	Variable capacitor	ECV-1ZW04X53T
CV151	Variable capacitor	ECV-1ZW04X53T
CV152	Variable capacitor	ECV-1ZW04X53T
CV201	5 pF variable capacitor	
CV202	5 pF variable capacitor	
CV211	5 pF variable capacitor	
CV212	5 pF variable capacitor	
J 201	Connector	2520-5002UB
L 101	Helical coil	
L 102	Helical coil	
L 103	Helical coil	
L 108	Helical coil	
L 109	Helical coil	
L 110	Helical coil	
L 130	22 nH SMD	KQ1008TE22NK
L 131	.22 µH SMD	KQ1008TER22K
L 132	1 µH SMD	ELJ-FC1ROM
L 133	22 nH SMD	KQ1008TE22NK
L 134	.22 µH SMD	KQ1008TER22K
L 135	47 nH SMD	KQ1008TE47NK
L 136	47 nH SMD	KQ1008TE47NK
L 137	47 nH SMD	KQ1008TE47NK
L 138	.22 µH SMD	KQ1008TER22K
L 139	22 nH SMD	KQ1008TE22NK
L 151	Helical coil	
L 152	Helical coil	
L 201	Variable inductor	LV5015
L 202	.68 µH SMD	LQH3NR68M
L 203	Variable inductor	LV5015
L 204	Variable inductor	LV5015
L 205	.68 µH SMD	LQH3NR68M
L 206	Variable inductor	LV5015
L 211	Variable inductor	LV5015
L 212	.68 µH SMD	LQH3NR68M
L 213	Variable inductor	LV5015
L 214	Variable inductor	LV5015
L 215	.68 µH SMD	LQH3NR68M
L 216	Variable inductor	LV5015
L 222	.1 µH SMD	KQ1008TER10K
L 223	.1 µH SMD	KQ1008TER10K
L 224	.1 µH SMD	KQ1008TER10K

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 401	.1 µH SMD	KQ1008TER10K
L 402	1 µH SMD	ELJ-FC1ROM
L 403	.1 µH SMD	KQ1008TER10K
L 404	.22 µH SMD	KQ1008TER22K
L 405	.22 µH SMD	KQ1008TER22K
Q 131	NPN SOT-23	2SC3356
Q 132	NPN SOT-23	2SC3356
Q 133	NPN SOT-89	2SC3357
Q 134	NPN SOT-89	2SC3357
Q 201	NPN SOT-23	2SC2351
Q 202	NPN SOT-23	2SC2351
Q 203	NPN SOT-23	2SC2714
Q 204	NPN SOT-23	2SC2714
Q 401	NPN SOT-23	2SC2714
Q 402	NPN SOT-23	2SC2714
Q 403	NPN SOT-23	2SC2714
Q 404	NPN SOT-23	2SC2714
Q 405	PNP SOT-23	2SA1162
Q 406	NPN SOT-23	2SC2712
Q 407	PNP SOT-23	2SA1162
Q 408	PNP SOT-23	2SA1162
Q 409	NPN SOT-23	2SC2712
Q 410	NPN SOT-23	2SC3356
Q 411	NPN SOT-23	2SC3356
R 105	200 ohm 1/2W chip	MCR50 EZH J 201
R 106	200 ohm 1/2W chip	MCR50 EZH J 201
R 107	47 ohm 1/8W chip	ERJ-6GMYJ470
R 108	47 ohm 1/8W chip	ERJ-6GMYJ470
R 130	47 ohm 1/8W chip	ERJ-6GMYJ470
R 131	1.2k ohm 1/8W chip	ERJ-6GMYJ122
R 132	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 133	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 134	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 135	47 ohm 1/8W chip	ERJ-6GMYJ470
R 136	10 ohm 1/8W chip	ERJ-6GMYJ100
R 137	33 ohm 1/8W chip	ERJ-6GMYJ330
R 139	330 ohm 1/8W chip	ERJ-6GMYJ331
R 140	330 ohm 1/8W chip	ERJ-6GMYJ331
R 141	18 ohm 1/8W chip	ERJ-6GMYJ180
R 142	270 ohm 1/8W chip	ERJ-6GMYJ271
R 143	1k ohm 1/8W chip	ERJ-6GMYJ102
R 144	390 ohm 1/8W chip	ERJ-6GMYJ391
R 145	220 ohm 1/8W chip	ERJ-6GMYJ221
R 146	220 ohm 1/8W chip	ERJ-6GMYJ221
R 147	330 ohm 1/8W chip	ERJ-6GMYJ331
R 148	330 ohm 1/8W chip	ERJ-6GMYJ331
R 149	18 ohm 1/8W chip	ERJ-6GMYJ180
R 150	270 ohm 1/8W chip	ERJ-6GMYJ271
R 151	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 152	270 ohm 1/8W chip	ERJ-6GMYJ271
R 153	68 ohm 1/8W chip	ERJ-6GMYJ680
R 154	68 ohm 1/8W chip	ERJ-6GMYJ680
R 157	1k ohm 1/8W chip	ERJ-6GMYJ102
R 158	47k ohm 1/8W chip	ERJ-6GMYJ473
R 159	100k ohm 1/8W chip	ERJ-6GMYJ104
R 160	10k ohm 1/8W chip	ERJ-6GMYJ103
R 161	100k ohm 1/8W chip	ERJ-6GMYJ104
R 201	1.8k ohm 1/8W chip	ERJ-6GMYJ182
R 202	680 ohm 1/8W chip	ERJ-6GMYJ681
R 203	47 ohm 1/8W chip	ERJ-6GMYJ470
R 204	220 ohm 1/8W chip	ERJ-6GMYJ221
R 205	560 ohm 1/8W chip	ERJ-6GMYJ561
R 206	1.8k ohm 1/8W chip	ERJ-6GMYJ182
R 207	47k ohm 1/8W chip	ERJ-6GMYJ473
R 208	100k ohm 1/8W chip	ERJ-6GMYJ104
R 211	5.1k ohm 1/8W chip	ERJ-6GMYJ512
R 212	100k ohm 1/8W chip	ERJ-6GMYJ104
R 213	10k ohm 1/8W chip	ERJ-6GMYJ103
R 214	100k ohm 1/8W chip	ERJ-6GMYJ104
R 215	22k ohm 1/8W chip	ERJ-6GMYJ223
R 217	10k ohm 1/8W chip	ERJ-6GMYJ103
R 218	10k ohm 1/8W chip	ERJ-6GMYJ103
R 228	1.8k ohm 1/8W chip	ERJ-6GMYJ182
R 233	1.8k ohm 1/8W chip	ERJ-6GMYJ182
R 234	680 ohm 1/8W chip	ERJ-6GMYJ681
R 235	47 ohm 1/8W chip	ERJ-6GMYJ470
R 236	220 ohm 1/8W chip	ERJ-6GMYJ221
R 237	560 ohm 1/8W chip	ERJ-6GMYJ561
R 239	47k ohm 1/8W chip	ERJ-6GMYJ473
R 240	100k ohm 1/8W chip	ERJ-6GMYJ104
R 243	5.1k ohm 1/8W chip	ERJ-6GMYJ512
R 244	100k ohm 1/8W chip	ERJ-6GMYJ104
R 245	10k ohm 1/8W chip	ERJ-6GMYJ103
R 246	100k ohm 1/8W chip	ERJ-6GMYJ104
R 247	22k ohm 1/8W chip	ERJ-6GMYJ223
R 249	10k ohm 1/8W chip	ERJ-6GMYJ103
R 250	10k ohm 1/8W chip	ERJ-6GMYJ103
R 254	1.8k ohm 1/8W chip	ERJ-6GMYJ182
R 255	680 ohm 1/8W chip	ERJ-6GMYJ681
R 256	47 ohm 1/8W chip	ERJ-6GMYJ470
R 257	220 ohm 1/8W chip	ERJ-6GMYJ221
R 258	10k ohm 1/8W chip	ERJ-6GMYJ103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 259	1k ohm 1/8W chip	ERJ-6GMYJ102
R 260	270 ohm 1/8W chip	ERJ-6GMYJ271
R 261	10 ohm 1/8W chip	ERJ-6GMYJ100
R 262	1k ohm 1/8W chip	ERJ-6GMYJ102
R 401	270 ohm 1/8W chip	ERJ-6GMYJ271
R 402	4.99k ohm 1/8W chip	ERJ-6GMYF4991
R 403	4.99k ohm 1/8W chip	ERJ-6GMYF4991
R 404	100 ohm 1/8W chip	ERJ-6GMYJ101
R 406	2.7k ohm 1/8W chip	ERJ-6GMYJ272
R 407	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 408	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 409	270 ohm 1/8W chip	ERJ-6GMYJ271
R 410	68k ohm 1/8W chip	ERJ-6GMYJ683
R 411	220 ohm 1/8W chip	ERJ-6GMYJ221
R 412	4.3k ohm 1/8W chip	ERJ-6GMYJ432
R 413	1k ohm 1/8W chip	ERJ-6GMYJ102
R 414	47 ohm 1/8W chip	ERJ-6GMYJ470
R 423	10k ohm 1/8W chip	ERJ-6GMYJ103
R 424	10k ohm 1/8W chip	ERJ-6GMYJ103
R 426	10k ohm 1/8W chip	ERJ-6GMYJ103
R 427	1k ohm 1/8W chip	ERJ-6GMYJ102
R 428	1k ohm 1/8W chip	ERJ-6GMYJ102
R 429	820 ohm 1/8W chip	ERJ-6GMYJ821
R 430	220 ohm 1/8W chip	ERJ-6GMYJ221
R 431	47 ohm 1/8W chip	ERJ-6GMYJ470
R 432	47k ohm 1/8W chip	ERJ-6GMYJ473
R 433	100k ohm 1/8W chip	ERJ-6GMYJ104
R 434	33k ohm 1/8W chip	ERJ-6GMYJ333
R 435	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 436	1k ohm 1/8W chip	ERJ-6GMYJ102
R 437	100k ohm 1/8W chip	ERJ-6GMYJ104
R 438	8.2k ohm 1/8W chip	ERJ-6GMYJ822
R 439	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 440	1k ohm 1/8W chip	ERJ-6GMYJ102
R 441	33k ohm 1/8W chip	ERJ-6GMYJ333
R 442	10 ohm 1/8W chip	ERJ-6GMYJ100
R 443	100 ohm 1/8W chip	ERJ-6GMYJ101
R 444	4.7k ohm 1/8W chip	ERJ-6GMYJ472
R 445	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 446	1.2k ohm 1/8W chip	ERJ-6GMYJ122
R 447	150 ohm 1/8W chip	ERJ-6GMYJ151
R 448	33 ohm 1/8W chip	ERJ-6GMYJ330
R 449	1k ohm 1/8W chip	ERJ-6GMYJ102
RV201	4.7k ohm variable chip	MVR32HXBRN472
RV203	4.7k ohm variable chip	MVR32HXBRN472
RV211	4.7k ohm variable chip	MVR32HXBRN472
RV213	4.7k ohm variable chip	MVR32HXBRN472

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 101	Mixer	LRMS-1H
U 102	IC Op Amp	NJM 2904M
U 103	MMIC	ERA 5SM
U 201	IC	MC3371D
U 202	IC Op Amp	NJM2904M
U 203	IC	MC3371D
U 204	IC Op Amp	NJM2904M
U 301	IC 6V regulator	NJM78L06
U 302	IC 12V regulator	NJM78L12
U 303	IC 12V regulator	NJM78L12
U 304	IC 12V regulator	NJM78L12
U 401	IC	MC145191
Y 201	17.5 MHz TCXO	
Z 201	52.95 MHz crystal filter	532-0009-009
Z 202	52.95 MHz crystal filter	532-0009-009
Z 204	450 kHz ceramic filter	SFG4560D
Z 205	450 kHz ceramic filter	SFG4560D
Z 206	450 kHz variable coil	IF0342
Z 211	52.95 MHz crystal filter	532-0009-009
Z 212	52.95 MHz crystal filter	532-0009-009
Z 214	450 kHz ceramic filter	SFG4560D
Z 215	450 kHz ceramic filter	SFG4560D
Z 216	450 kHz variable coil	IF0342

TRANSMIT VCO 132-178 MHz

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
A 007	VCO unit	
C 101	100 pF 50V ceramic chip	GRM40CH101K50
C 102	7 pF 50V ceramic chip	GRM40CH070C50
C 103	100 pF 50V ceramic chip	GRM40CH101K50
C 104	2 pF 50V ceramic chip	GRM40CK020D50
C 105	0.5 pF 50V ceramic chip	GRM40CK020D50
C 106	15 pF 50V ceramic chip	GRM40CH150J50
C 107	56 pF 50V ceramic chip	GRM40CH560J50
C 108	56 pF 50V ceramic chip	GRM40CH560J50
C 109	1000 pF 50V ceramic chip	GRM40B102K50
C 110	0.1 µF 50V ceramic chip	GRM40F104Z50
C 111	10 pF 50V ceramic chip	GRM40CH100J50
C 112	1000 pF 50V ceramic chip	GRM40B102K50
C 113	10 pF 50V ceramic chip	GRM40CH100J50
C 114	1000 pF 50V ceramic chip	GRM40B102K50
C 115	47 pF 50V ceramic chip	GRM40CH470J50
C 116	15 pF 50V ceramic chip	GRM40CH150J50
C 117	1000 pF 50V ceramic chip	GRM40B102K50

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 118	1000 pF 50V ceramic chip	GRM40B102K50
D 101	Detector	HVU202A
D 102	Detector	HVU202A
L 101	10 µH	ELJ-FC100K
L 102	3.5T	
L 103	1 µF	ELJ-FC1ROM
L 104	0.1 µH	LQN21AR10K
Q 101	NPN oscillator SOT-23	2SC3356
Q 102	NPN buffer SOT-23	2SC3356
Q 103	NPN buffer SOT-23	2SC3356
Q 104	NPN active filter SOT-23	2SC2712
R 101	47k ohm 1/8W chip	ERJ-6GMYJ473
R 102	10k ohm 1/8W chip	ERJ-6GMYJ103
R 103	22k ohm 1/8W chip	ERJ-6GMYJ223
R 104	1k ohm 1/8W chip	ERJ-6GMYJ102
R 105	47 ohm 1/8W chip	ERJ-6GMYJ470
R 106	100 ohm 1/8W chip	ERJ-6GMYJ101
R 107	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 108	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 109	2.7k ohm 1/8W chip	ERJ-6GMYJ272
R 110	470 ohm 1/8W chip	ERJ-6GMYJ471
R 111	100 ohm 1/8W chip	ERJ-6GMYJ101
R 112	3.3k ohm 1/8W chip	ERJ-6GMYJ332

EXCITER
PART NO. 585-2061-400 (132-150 MHz)
PART NO. 585-2081-400 (150-178 MHz)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 401	.047 µF 50V ceramic chip	GRM40B473K50
C 409	.01 µF 50V ceramic chip	GRM40B103K50
C 410	.1 µF 50V ceramic chip	GRM40F104Z50
C 416	.1 µF 50V ceramic chip	GRM40F104Z50
C 417	.01 µF 50V ceramic chip	GRM40B103K50
C 418	1000 pF 50V ceramic chip	GRM40B102K50
C 419	.01 µF 50V ceramic chip	GRM40B103K50
C 420	6 pF 50V ceramic chip	GRM40CH060C50
C 421	4.7 µF 20V tantalum chip	SVC1D475M
C 422	.1 µF 50V ceramic chip	GRM40F104Z50
C 423	100 pF 50V ceramic chip	GRM40CH101K50
C 424	.1 µF 50V ceramic chip	GRM40F104Z50
C 425	.1 µF 50V ceramic chip	GRM40F104Z50
C 426	4.7 µF 20V tantalum chip	SVC1D475M
C 428	4.7 µF 20V tantalum chip	SVC1D475M
C 429	470 pF 50V ceramic chip	GRM40CH471K50
C 431	220 pF 50V ceramic chip	GRM40CH221K50
C 432	47 pF 50V ceramic chip	GRM40CH470K50
C 433	10 pF 50V ceramic chip	GRM40CH100J50
C 434	470 pF 50V ceramic chip	GRM40CH471K50
C 443	470 pF 50V ceramic chip	GRM40CH471K50
C 444	470 pF 50V ceramic chip	GRM40CH471K50
C 446	100 pF 50V ceramic chip	GRM40CH101K50
C 452	10 pF 50V ceramic chip	GRM40CH100J50
C 453	820 pF 50V ceramic chip	GRM40CH821J50
C 456	100 pF 50V ceramic chip	GRM40CH101K50
C 457	.022 µF 50V ceramic chip	GRM40B223K50
C 461	.01 µF 50V ceramic chip	GRM40B103K50
C 462	1000 pF 50V ceramic chip	GRM40B102K50
C 463	10 µF 20V tantalum chip	SVC1D106M
C 464	.01 µF 50V ceramic chip	GRM40B103K50
C 465	.01 µF 50V ceramic chip	GRM40B103K50
C 466	1000 pF 50V ceramic chip	GRM40B102K50
C 467	4.7 µF 20V tantalum chip	SVC1D475M
C 469	4.7 µF 20V tantalum chip	SVC1D475M
C 470	1000 pF 50V ceramic chip	GRM40B102K50
C 471	1000 pF 50V ceramic chip	GRM40B102K50
C 472	4.7 µF 20V tantalum chip	SVC1D475M
C 474	4.7 µF 20V tantalum chip	SVC1D475M
C 475	1000 pF 50V ceramic chip	GRM40B102K50
C 476	4.7 µF 20V tantalum chip	SVC1D475M
C 479	.01 µF 50V ceramic chip	GRM40B103K50
C 480	470 pF 50V ceramic chip	GRM40CH471K50
C 481	1 µF 20V tantalum chip	SVB1D105M
C 482	100 pF 50V ceramic chip	GRM40CH101K50
C 483	100 pF 50V ceramic chip	GRM40CH101K50
C 484	100 pF 50V ceramic chip	GRM40CH101K50
C 485	100 pF 50V ceramic chip	GRM40CH101K50
C 496	10 µF 20V tantalum chip	SVB1D106M
C 498	5 pF 50V ceramic chip	GRM40CH050C50
C 499	100 pF 50V ceramic chip	GRM40CH101K50
C 504	.022 µF 50V ceramic chip	GRM40B223K50
C 505	18 pF 50V ceramic chip	GRM40CH180J50
C 506	100 pF 50V ceramic chip	GRM40CH101K50
C 507	470 pF 50V ceramic chip	GRM40CH471K50
C 508	4.7 µF 20V tantalum chip	SVC1D475M
C 509	20 pF 50V ceramic chip	GRM40CH200J50
C 510	20 pF 50V ceramic chip	GRM40CH200J50
C 513	.022 µF 50V ceramic chip	GRM40B223K50
C 514	100 pF 50V ceramic chip	GRM40CH101K50
C 515	.01 µF 50V ceramic chip	GRM40B103K50
C 516	3 pF 50V ceramic chip	GRM40CH030C50

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 517	5 pF 50V ceramic chip	GRM40CH050C50
C 518	4.7 µF 20V tantalum chip	SVC1D475M
C 519	1 µF 50V poly ester film	553M5002-105K
C 520	.1 µF 50V ceramic chip	GRM40F104Z50
C 521	10 pF 50V ceramic chip	GRM40CH100J50
C 522	2.2 µF 20V tantalum chip	SVC1D225M
C 523	10 pF 50V ceramic chip	GRM40CH100J50
C 524	.1 µF 50V ceramic chip	GRM40F104Z50
CR401	9.1V zener	RD9.1ML
CR402	5.1V zener	RD5.1ML B2
CR403	5.1V zener	RD5.1ML B2
J 401	Connector	2520-5002UB
J 402	Connector SMB PCB mount	
L 402	.1 µH	KQE1008TER10K
L 403	22 nH	KQE1008TE22NK
L 405	.1 µH	KQE1008TER10K
L 406	.1 µH	KQE1008TER10K
L 410	47 nH	KQE100847NK
L 411	.1 µH	KQE1008TER10K
L 412	47 nH	KQE100847NK
L 413	22 nH	KQE1008TE22NK
L 413	22 nH	KQE1008TE22NK
Q 403	NPN TCXO buffer SOT-23	2SC3356
Q 404	NPN TCXO buffer SOT-23	2SC3356
Q 405	PNP Switch SOT-23	2SB624
Q 406	NPN VCO buffer SOT-23	2SC3356
Q 407	NPN VCO buffer SOT-23	2SC3356
Q 410	NPN buffer SOT-23	2SC3356
Q 411	NPN buffer SOT-23	2SC3356
Q 412	NPN amplifier SOT-89	2SC3357
Q 413	NPN amplifier SOT-89	2SC3357
Q 414	NPN SOT-23	2SC2712
Q 415	PNP SOT-23	2SA1162
Q 416	PNP SOT-23	2SA1162
Q 417	NPN SOT-23	2SC2712
R 402	10k ohm 1/8W chip	ERJ-6GMYJ103
R 403	10k ohm 1/8W chip	ERJ-6GMYJ103
R 404	1k ohm 1/8W chip	ERJ-6GMYJ102
R 405	1k ohm 1/8W chip	ERJ-6GMYJ102
R 414	12k ohm 1/8W chip	ERJ-6GMYJ123
R 415	5k ohm 1/8W chip	ERJ-6GMYJ502
R 416	270 ohm 1/8W chip	ERJ-6GMYJ271
R 417	10k ohm 1/8W chip	ERJ-6GMYJ103
R 419	12k ohm 1/8W chip	ERJ-6GMYJ123
R 422	100 ohm 1/8W chip	ERJ-6GMYJ101
R 424	10k ohm 1/8W chip	ERJ-6GMYJ103
R 426	0 ohm 1/8W chip	ERJ-6GMYJ0R0
R 427	62k ohm 1/8W chip	ERJ-6GMYJ633
R 428	10 ohm 1/8W chip	ERJ-6GMYJ100
R 429	5k ohm 1/8W chip	ERJ-6GMYJ502
R 430	2.7k ohm 1/8W chip	ERJ-6GMYJ272
R 431	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 432	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 433	270 ohm 1/8W chip	ERJ-6GMYJ271
R 434	150 ohm 1/8W chip	ERJ-6GMYJ151
R 435	470 ohm 1/8W chip	ERJ-6GMYJ471
R 436	100 ohm 1/8W chip	ERJ-6GMYJ101
R 437	100 ohm 1/8W chip	ERJ-6GMYJ101
R 438	10k ohm 1/8W chip	ERJ-6GMYJ103
R 439	1k ohm 1/8W chip	ERJ-6GMYJ102
R 440	1k ohm 1/8W chip	ERJ-6GMYJ102
R 441	47k ohm 1/8W chip	ERJ-6GMYJ473
R 444	10k ohm 1/8W chip	ERJ-6GMYJ103
R 445	82k ohm 1/8W chip	ERJ-6GMYJ823
R 447	1k ohm 1/8W chip	ERJ-6GMYJ102
R 448	10k ohm 1/8W chip	ERJ-6GMYJ103
R 449	10k ohm 1/8W chip	ERJ-6GMYJ103
R 450	10 ohm 1/8W chip	ERJ-6GMYJ100
R 451	2.7k ohm 1/8W chip	ERJ-6GMYJ272
R 452	100 ohm 1/8W chip	ERJ-6GMYJ101
R 453	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 454	1.2k ohm 1/8W chip	ERJ-6GMYJ122
R 455	150 ohm 1/8W chip	ERJ-6GMYJ151
R 456	470 ohm 1/8W chip	ERJ-6GMYJ471
R 457	39 ohm 1/8W chip	ERJ-6GMYJ390
R 458	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 459	150 ohm 1/8W chip	ERJ-6GMYJ151
R 460	39 ohm 1/8W chip	ERJ-6GMYJ390
R 461	150 ohm 1/8W chip	ERJ-6GMYJ151
R 462	220 ohm 1/8W chip	ERJ-6GMYJ221
R 463	56 ohm 1/8W chip	ERJ-6GMYJ560
R 465	1.2k ohm 1/8W chip	ERJ-6GMYJ122
R 466	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 467	1.2k ohm 1/8W chip	ERJ-6GMYJ122
R 468	68 ohm 1/8W chip	ERJ-6GMYJ680
R 476	150 ohm 1/8W chip	ERJ-6GMYJ151
R 477	1.5k ohm 1/8W chip	ERJ-6GMYJ152
R 478	220 ohm 1/8W chip	ERJ-6GMYJ221
R 479	330 ohm 1/8W chip	ERJ-6GMYJ331
R 480	6.8k ohm 1/8W chip	ERJ-6GMYJ682
R 481	1.2k ohm 1/8W chip	ERJ-6GMYJ122

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 486	12k ohm 1/8W chip	ERJ-6GMYJ123
R 489	330 ohm 1/8W chip	ERJ-6GMYJ331
R 494	100k ohm 1/8W chip	ERJ-6GMYJ104
R 495	33k ohm 1/8W chip	ERJ-6GMYJ333
R 496	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 497	1k ohm 1/8W chip	ERJ-6GMYJ102
R 498	100k ohm 1/8W chip	ERJ-6GMYJ104
R 499	8.2k ohm 1/8W chip	ERJ-6GMYJ822
R 500	3.3k ohm 1/8W chip	ERJ-6GMYJ332
R 501	1k ohm 1/8W chip	ERJ-6GMYJ102
RV101	47k variable chip	MVR32HXBRN473
RV401	47k variable chip	MVR32HXBRN473
U 402	IC mod amp/buffer	NJM2904
U 403	IC synthesizer	MC14519F
U 404	IC mod amp/buffer	NJM2904
U 405	+5V regulator	NJM78L05
U 406	+12V regulator	NJM78L12
U 407	IC voltage reference	NJM2904M
Y 401	17.5 MHz TCXO	

110 WATT POWER AMPLIFIER
PART NO. 585-2061-520 (132-150 MHz)
PART NO. 585-2081-520 (150-178 MHz)

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 501	.001 µF ceramic chip	GRM40B102K50PT
C 502	39 pF ceramic chip	GRM40CH390J50PT
C 503	6 pF ceramic chip	GRM40CH060D50PT
C 506	.001 µF ceramic chip	GRM40B102K50PT
C 507	.01 µF ceramic chip	GRM50B103K50PT
C 508	1 µF ceramic chip	GRM40B105K16PT
C 510	.01 µF ceramic chip	GRM40B103K50PT
C 512	10 pF ceramic chip	GRM40CH100D50PT
C 513	3 pF ceramic chip	GRM40CK030C50PT
C 514	.001 µF ceramic chip	GRM50B102K50PT
C 516	.01 µF ceramic chip	GRM40B103K50PT
C 517	.001 µF ceramic chip	GRM50B102K50PT
C 519	4.7 µF electrlytc chip	UWX1H4R7MCR1GB
C 520	.001 µF ceramic chip	GRM40B102K50PT
C 521	.01 µF ceramic chip	GRM40B103K50PT
C 522	.001 µF ceramic chip	GRM40B102K50PT
C 523	.01 µF ceramic chip	GRM40B103K50PT
C 524	4.7 µF electrlytc chip	UWX1H4R7MCR1GB
C 525	.001 µF ceramic chip	GRM40B102K50PT
C 526	.01 µF ceramic chip	GRM40B103K50PT
C 527	.1 µF ceramic chip	GRM40B104K25PT
C 529	.001 µF ceramic chip	GRM40B102K50PT
C 532	.001 µF ceramic chip	GRM40B102K50PT
C 533	.001 µF ceramic chip	GRM40B102K50PT
C 534	24 pF ceramic chip	GRM40CH240J50PT
C 535	24 pF ceramic chip	GRM40CH240J50PT
C 536	24 pF ceramic chip	GRM40CH240J50PT
C 537	24 pF ceramic chip	GRM40CH240J50PT
C 538	.1 µF ceramic chip	GRM40B104K25PT
C 539	.01 µF ceramic chip	GRM40B103K50PT
C 540	.1 µF ceramic chip	GRM40B104K25PT
C 542	.01 µF ceramic chip	GRM40B103K50PT
C 543	.1 µF ceramic chip	GRM40B104K25PT
C 544	.01 µF ceramic chip	GRM40B103K50PT
C 545	4.7 µF electrlytc chip	UWX1H4R7MCR1GB
C 546	.01 µF ceramic chip	GRM40B103K50PT
C 547	.01 µF ceramic chip	GRM40B103K50PT
C 548	4.7 µF electrlytc chip	UWX1H4R7MCR1GB
C 549	.01 µF ceramic chip	GRM40B103K50PT
C 550	.01 µF ceramic chip	GRM40B103K50PT
C 551	.001 µF ceramic chip	GRM50B102K50PT
C 552	.001 µF ceramic chip	GRM50B102K50PT
C 553	.001 µF ceramic chip	GRM50B102K50PT
C 554	.01 µF ceramic chip	GRM40B103K50PT
C 555	.01 µF ceramic chip	GRM40B103K50PT
C 556	.01 µF ceramic chip	GRM40B103K50PT
C 557	4.7 µF electrlytc chip	UWX1H4R7MCR1GB
C 558	.01 µF ceramic chip	GRM40B103K50PT
C 559	.01 µF ceramic chip	GRM40B103K50PT
C 560	.001 µF ceramic chip	GRM50B102K50PT
C 561	.001 µF ceramic chip	GRM50B102K50PT
C 562	.001 µF ceramic chip	GRM50B102K50PT
C 563	.01 µF ceramic chip	GRM40B103K50PT
C 564	100 pF mica chip	UC232A1000J
C 565	100 pF mica chip	UC232A1000J
C 565A	100 pF mica chip	UC232A1000J
C 566	100 pF mica chip	UC232A1000J
C 569	240 pF mica chip	UC232A2400J
C 570	240 pF mica chip	UC232A2400J
C 573	.01 µF ceramic chip	GRM40B103K50PT
C 574	.01 µF ceramic chip	GRM40B103K50PT
C 575	.01 µF ceramic chip	GRM40B103K50PT
C 576	1 µF ceramic chip	GRM40B105K16PT
C 577	39 pF ceramic chip	GRM40CH390J50PT
C 578	.001 µF ceramic chip	GRM50B102K50PT
C 579	.01 µF ceramic chip	GRM50B103K50PT
C 580	4.7 µF electrlytc chip	UWX1H4R7MCR1GB

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 581	.001 µF ceramic chip	GRM50B102K50PT
C 582	.01 µF ceramic chip	GRM40B103K50PT
C 583	.01 µF ceramic chip	GRM40B103K50PT
C 584	33 µF electrolytic chip	UWX1E330MCR1GB
C 591	.01 µF ceramic chip	GRM40B103K50PT
C 592	.1 µF ceramic chip	GRM40B104K25PT
C 593	.01 µF ceramic chip	GRM40B103K50PT
C 594	.001 µF ceramic chip	GRM50B102K50PT
C 598	33 pF mica chip	UC232H0330J
C 599	33 pF mica chip	UC232H0330J
C 600	33 µF electrolytic chip	UWX1E330MCR1GB
C 601	45 pF trimmer	CV01C450
C 602	45 pF trimmer	CV01C450
C 603	91 pF ceramic chip	GRM40B910J50PT
C 604	91 pF ceramic chip	GRM40B910J50PT
C 605	68 pF ceramic chip	GRM40B680J50PT
C 606	68 pF ceramic chip	GRM40B680J50PT
C 607	120 pF mica chip	UC232A1200J
C 608	120 pF mica chip	UC232A1200J
C 609	68 pF mica chip	UC232A0680J
C 610	68 pF mica chip	UC232A0680J
C 611	120 pF mica chip	UC232A1200J
C 612	120 pF mica chip	UC232A1200J
C 613	33 pF mica chip	UC232A0330J
C 614	33 pF mica chip	UC232A0330J
C 615	33 pF mica chip	UC232A0330J
C 616	33 pF mica chip	UC232A0330J
C 617	20 pF mica chip	UC232A0200J
C 618	20 pF mica chip	UC232A0200J
CR501	6.2V zener	RF6.2MB2
CR502	6.2V zener	RF6.2MB2
Q 501	Pre-driver	2SK2973
Q 502	Final amplifier	MRF275L
Q 503	Final amplifier	MRF275L
R 501	82 ohm chip	TDR6G-820-J
R 502	82 ohm chip	TDR6G-820-J
R 503	Zero ohm chip	TDR6G-0R00-J
R 503A	82 ohm chip	TDR6G-820-J
R 504	100 ohm chip	TDR6G-101-J
R 505	1k ohm chip	TDR6G-102-J
R 506	3.9k ohm chip	TDR6G-392-J
R 507	47 ohm chip	TDR6G-470-J
R 509	200 ohm chip	TDR6G-201-J
R 510	0.03 ohm power chip	R030
R 511	200 ohm chip	TDR6G-201-J
R 512	2k ohm chip	TDR6G-202-J
R 513	2k ohm chip	TDR6G-202-J
R 514	200 ohm chip	TDR6G-201-J
R 515	200 ohm chip	TDR6G-201-J
R 516	0.03 ohm power chip	R030
R 517	4.7k ohm chip	TDR6G-472-J
R 518	5k variable chip	
R 519	2.2k ohm chip	TDR6G-222-J
R 520	4.7k ohm chip	TDR6G-472-J
R 521	10k ohm chip	3216
R 522	80k chip thermistor	
R 523	2k ohm chip	TDR6G-202-J
R 524	200 ohm chip	TDR6G-201-J
R 525	200 ohm chip	TDR6G-201-J
R 526	0.03 ohm power chip	R030
R 527	4.7k ohm chip	TDR6G-472-J
R 528	5k variable chip	
R 529	2.2k ohm chip	TDR6G-222-J
R 530	4.7k ohm chip	TDR6G-472-J
R 531	10k ohm chip	3216
R 532	80k chip thermistor	
R 533	240 ohm chip	TDR6G-241-J
R 534	56 ohm chip	TDR6G-560-J
R 536	75 ohm chip	TDR6G-750-J
R 537	100k ohm 1% chip	TDR6G-104-F
R 538	301k ohm 1% chip	3013
R 539	470 ohm chip	TDR6G-471-J
R 540	2.2 ohm chip	ERJ1WY2R2H
R 541	2.2 ohm chip	ERJ1WY2R2H
R 542	2.2 ohm chip	ERJ1WY2R2H
R 543	2.2 ohm chip	ERJBG2R2
R 544	2.2 ohm chip	ERJBG2R2
U 501	Driver (132-150 MHz)	M57719L
	Driver (150-178 MHz)	M57719L
U 502	+8V regulator	TA78L08F
U 503	Current sensor	MAX472ESA
U 504	Current sensor	MAX472ESA
U 505	+5V regulator	78L05
U 507	Temperature sensor	LM35D
U 508	DC amplifier	NJM2904M
U 509	current sensor	MAX472ESA

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	LOW-PASS FILTER PART NO. 023-2004-600	
A 620	Low pass filter assembly	023-2004-620
MP600	LPF mounting plate	017-2222-264
	FORWARD/REVERSE POWER DETECTOR	
C 601	68 pF 50V chip	GRM40CH680J50
C 602	68 pF 50V chip	GRM40CH680J50
C 603	68 pF 50V chip	GRM40CH680J50
C 604	68 pF 50V chip	GRM40CH680J50
C 605	68 pF 50V chip	GRM40CH680J50
C 606	68 pF 50V chip	GRM40CH680J50
C 607	1000 pF 50V chip	GRM40B102K50
C 608	68 pF 50V chip	GRM40CH680J50
C 609	1000 pF 50V chip	GRM40B102K50
C 610	1000 pF 50V chip	GRM40B102K50
C 611	4.7 µF 20V tantalum SMD	SVC1D475M
C 612	1000 pF 50V chip	GRM40B102K50
C 613	68 pF 50V chip	GRM40CH680J50
C 614	5 pF 50V chip	GRM40CH050C50
C 651	68 pF 50V chip	GRM40CH680J50
C 652	68 pF 50V chip	GRM40CH680J50
C 653	68 pF 50V chip	GRM40CH680J50
C 654	68 pF 50V chip	GRM40CH680J50
C 655	68 pF 50V chip	GRM40CH680J50
C 656	68 pF 50V chip	GRM40CH680J50
C 657	68 pF 50V chip	GRM40CH680J50
C 658	1000 pF 50V chip	GRM40B102K50
C 659	1000 pF 50V chip	GRM40B102K50
C 660	68 pF 50V chip	GRM40CH680J50
C 661	1000 pF 50V chip	GRM40B102K50
C 662	4.7 µF 20V tantalum SMD	SVC1D475M
C 663	4.7 µF 20V tantalum SMD	SVC1D475M
C 664	1000 pF 50V chip	GRM40B102K50
C 665	4.7 µF 20V tantalum SMD	SVC1D475M
C 666	68 pF 50V chip	GRM40CH680J50
C 667	4.7 µF 20V tantalum SMD	SVC1D475M
CR601	Veri-cap diode	1SS306
CR651	Vari-cap diode	1SS306
L 602	8T	
L 603	8T	

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 652	8T	
L 653	8T	
L 654	8T	
R 601	51 ohm 1/8W chip	ERJ-6GMYJ510
R 603	150 ohm 1/8W chip	ERJ-6GMYJ151
R 604	51 ohm 1/8W chip	ERJ-6GMYJ510
R 605	10k ohm 1/8W chip	ERJ-6GMYJ103
R 606	10k ohm 1/8W chip	ERJ-6GMYJ103
R 607	22k ohm1/8W chip	ERJ-6GMYJ223
R 608	10k ohm 1/8W chip	ERJ-6GMYJ103
R 610	150 ohm 1/8W chip	ERJ-6GMYJ151
R 612	10k ohm 1/8W chip	ERJ-6GMYJ103
R 613	10k ohm 1/8W chip	ERJ-6GMYJ103
R 615	470 ohm 1/8W chip	ERJ-6GMYJ471
R 616	22k ohm 1/8W chip	ERJ-6GMYJ223
R 651	51 ohm 1/8W chip	ERJ-6GMYJ510
R 653	51 ohm 1/8W chip	ERJ-6GMYJ510
R 654	51 ohm 1/8W chip	ERJ-6GMYJ510
R 655	10k ohm 1/8W chip	ERJ-6GMYJ103
R 656	22k ohm 1/8W chip	ERJ-6GMYJ223
R 657	10k ohm 1/8W chip	ERJ-6GMYJ103
R 658	10k ohm 1/8W chip	ERJ-6GMYJ103
R 659	10k ohm 1/8W chip	ERJ-6GMYJ103
R 660	150 ohm 1/8W chip	ERJ-6GMYJ151
R 662	10k ohm 1/8W chip	ERJ-6GMYJ103
R 663	7.5k ohm 1/8W chip	ERJ-6GMYJ752
R 664	12k ohm 1/8W chip	ERJ-6GMYJ123
R 665	470 ohm 1/8W chip	ERJ-6GMYJ471
R 666	220 ohm 1/8W chip	ERJ-6GMYJ221
R 667	47 ohm 1/8W chip	ERJ-6GMYJ470
R 669	22k ohm 1/8W chip	ERJ-6GMYJ223
RV601	4.7k ohm variable chip	MVR32HXB4RN472
RV651	4.7k ohm variable chip	MVR32HXB4RN472
U 601	DC amplifier SO-8	NJM2904M
U 651	DC amplifier SO-8	NJM2904M
U 652	+5V regulator 78L05	NJM78L05
	POWER AMPLIFIER MECHANICAL PART NO. 023-2004-732	
B 252	24V DC fan 3.14" sq x 1.26"	529-2002-027
EP200	6-14 ground lug	586-0007-070

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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

800W POWER SUPPLY MAIN BOARD
PART NO. 023-2000-810

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER	SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 200	18 ohm ±5% 1206 SMD	569-0115-180	R 249	3.4k ohm ±1% 1206 SMD	569-0111-352
R 201	180 ohm ±5% 1206 SMD	569-0115-181	R 250	2.49k ohm ±1% 1206 SMD	569-0111-339
R 202	20k ohm ±5% 1206 SMD	569-0115-203	R 251	200 ohm ±5% 1206 SMD	569-0115-201
R 203	2k ohm ±5% 1206 SMD	569-0115-202	R 252	1k ohm ±5% 1206 SMD	569-0115-102
R 204	2k ohm ±5% 2512 SMD	569-0175-202	R 253	4.7k ohm ±5% 1206 SMD	569-0115-472
R 205	10 ohm ±5% 1206 SMD	569-0115-100	R 254	1k ohm single turn trimmer	562-0112-102
R 206	10 ohm ±5% 1206 SMD	569-0115-100	R 255	4.3k ohm ±5% 1206 SMD	569-0115-432
R 207	180 ohm ±5% 1206 SMD	569-0115-181	R 256	2k ohm ±1% 1206 SMD	569-0111-330
R 208	51 ohm ±5% 1206 SMD	569-0115-510	R 257	10k ohm ±5% 1206 SMD	569-0115-103
R 209	820 ohm ±5% 1206 SMD	569-0115-821	R 258	36k ohm ±5% 1206 SMD	569-0115-363
R 210	820 ohm ±5% 1206 SMD	569-0115-821	R 259	13k ohm ±5% 1206 SMD	569-0115-133
R 211	12.4k ohm ±1% 1206 SMD	569-0111-410	R 260	68 ohm ±5% 1206 SMD	569-0115-680
R 212	2.26k ohm ±1% 1206 SMD	569-0111-335	R 261	24 ohm ±5% 1206 SMD	569-0115-240
R 213	200 ohm ±5% 1206 SMD	569-0115-201	R 262	29.4k ohm ±1% 1206 SMD	569-0111-446
R 214	1k ohm ±5% 1206 SMD	569-0115-102	R 263	2.49k ohm ±1% 1206 SMD	569-0111-339
R 215	6.2k ohm ±5% 1206 SMD	569-0115-622	R 264	2k ohm ±1% 1206 SMD	569-0111-330
R 216	1k ohm single turn trimmer	562-0112-102	R 265	3.3k ohm ±5% 1206 SMD	569-0115-332
R 217	1.2k ohm ±5% 1206 SMD	569-0115-122	R 266	1k ohm ±5% 1206 SMD	569-0115-102
R 218	4.7k ohm ±5% 1206 SMD	569-0115-472	R 267	430 ohm ±5% 1206 SMD	569-0115-431
R 219	470 ohm ±5% 1206 SMD	569-0115-471	R 268	4.7k ohm ±5% 1206 SMD	569-0115-472
R 220	2k ohm ±1% 1206 SMD	569-0111-330	R 269	360 ohm ±5% 1206 SMD	569-0115-361
R 221	36k ohm ±5% 1206 SMD	569-0115-363	R 270	33k ohm ±5% 1206 SMD	569-0115-333
R 222	Zero ohm ±5% 1206 SMD	569-0115-001	R 271	3.3k ohm ±5% 1206 SMD	569-0115-332
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 315	820 ohm ±5% 1206 SMD	569-0115-821

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
RT101	8A 2.5 ohm NTC thermistor	569-3014-001
RT102	8A 2.5 ohm NTC thermistor	569-3014-001
T 101	0.5 line freq. bias transformer	592-3041-004
T 103	1:200 current transformer	592-3041-002
T 104	1:200 current transformer	592-3041-002
T 105	100:1 current transformer	592-3041-005
T 106	1:1 transformer	592-3041-003
T 107	4.5:1 switch mode transformer	592-3041-001
U 102	PFC/PWN combo SOIC	544-2002-035
U 104	Quad 2-in AND SOIC HC08	544-3766-008
U 105	5V regulator LM78L05ABD	544-2603-039
U 106	5V regulator LM78L05ABD	544-2603-039
U 107	Opto-isolator surface mt	544-9022-001
U 108	Opto-isolator	544-2010-005
U 109	Programmable TL431AID	544-2003-097
U 110	Quad op amp LMC660 SOIC	544-2020-020
U 111	Adj volt reg full temp LM317T	544-2003-094
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 shakeproof 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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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 014	10 µF 16V tantalum SMD	510-2625-100
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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	8k ROM masked DIP-40 8052	544-5010-448
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 019	Triple line receiver	544-2023-003
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 SN65176	544-2023-025
U 024	Differential bus xcvr SN65176	544-2023-025
U 025	MPC boot code	023-9998-277
U 026	BCD 7 latch DIP-16 MC14495	544-3014-495
U 027	CPU v25 PLCC-84 MPD7032	544-5002-016
U 028	EEPROM PLCC32R 28C64	544-5002-412
U 029	Dual inline driver	544-2023-002
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
C 184	.01 µF ±10% X7R chip	510-3606-103
C 185	.01 µF ±10% X7R chip	510-3606-103
C 186	.01 µF ±10% X7R chip	510-3606-103
C 187	.01 µF ±10% X7R chip	510-3606-103
C 188	.01 µF ±10% X7R chip	510-3606-103
C 189	.01 µF ±10% X7R chip	510-3606-103
C 190	.01 µF ±10% X7R chip	510-3606-103
C 191	.01 µF ±10% X7R chip	510-3606-103
C 192	.01 µF ±10% X7R chip	510-3606-103
C 193	.01 µF ±10% X7R chip	510-3606-103
C 194	.01 µF ±10% X7R chip	510-3606-103
C 195	.01 µF ±10% X7R chip	510-3606-103
C 196	.01 µF ±10% X7R chip	510-3606-103
C 197	.01 µF ±10% X7R chip	510-3606-103
C 198	.01 µF ±10% X7R chip	510-3606-103
C 199	.01 µF ±10% X7R chip	510-3606-103
C 200	.01 µF ±10% X7R chip	510-3606-103
C 201	.01 µF ±10% X7R chip	510-3606-103
C 202	.01 µF ±10% X7R chip	510-3606-103
C 203	.01 µF ±10% X7R chip	510-3606-103
C 204	.01 µF ±10% X7R chip	510-3606-103
C 205	.01 µF ±10% X7R chip	510-3606-103
C 206	.01 µF ±10% X7R chip	510-3606-103
C 207	1 µF tantalum SMD	510-2625-109
C 208	.01 µF ±10% X7R chip	510-3606-103
C 209	.01 µF ±10% X7R chip	510-3606-103
C 210	.01 µF ±10% X7R chip	510-3606-103
C 211	.01 µF ±10% X7R chip	510-3606-103
C 212	.01 µF ±10% X7R chip	510-3606-103
C 213	.01 µF ±10% X7R chip	510-3606-103
C 214	.01 µF ±10% X7R chip	510-3606-103
C 215	.01 µF ±10% X7R chip	510-3606-103
C 216	.01 µF ±10% X7R chip	510-3606-103
C 217	.01 µF ±10% X7R chip	510-3606-103
C 218	.01 µF ±10% X7R chip	510-3606-103
C 219	.01 µF ±10% X7R chip	510-3606-103
C 220	.01 µF ±10% X7R chip	510-3606-103
C 221	.01 µF ±10% X7R chip	510-3606-103
C 222	.01 µF ±10% X7R chip	510-3606-103
C 223	.01 µF ±10% X7R chip	510-3606-103
C 224	.01 µF ±10% X7R chip	510-3606-103
C 225	.01 µF ±10% X7R chip	510-3606-103
C 226	.01 µF ±10% X7R chip	510-3606-103
C 227	.01 µF ±10% X7R chip	510-3606-103
C 228	.01 µF ±10% X7R chip	510-3606-103
C 229	.01 µF ±10% X7R chip	510-3606-103
C 230	.01 µF ±10% X7R chip	510-3606-103
C 231	.01 µF ±10% X7R chip	510-3606-103
C 232	.01 µF ±10% X7R chip	510-3606-103
C 233	.01 µF ±10% X7R chip	510-3606-103
C 234	.01 µF ±10% X7R chip	510-3606-103
C 235	1 µF 16V tantalum SMD	510-2625-109
C 236	.001 pF ±2% NPO 1206	510-3616-102
C 237	.033 µF ±5% X7R 1210	510-3610-333
C 238	.047 µF ±5% X7R 1206	510-3609-473
C 239	.068 µF ±5% X7R 1206	510-3609-683
C 240	1 µF 16V tantalum SMD	510-2625-109
C 241	15 µF 20V tantalum SMD	510-2626-150
C 242	15 µF 20V tantalum SMD	510-2626-150
C 247	.1 µF ±10% X7R chip	510-3606-104
C 249	.1 µF ±10% X7R chip	510-3606-104
C 251	15 µF 20V tantalum SMD	510-2626-150
C 254	.1 µF ±10% X7R 1206	510-3606-104
C 255	47 µF 10V tantalum SMD	510-2624-470
C 256	15 µF 20V tantalum SMD	510-2626-150
C 257	47 µF 10V tantalum SMD	510-2624-470
C 258	47 µF 10V tantalum SMD	510-2624-470
C 262	.01 µF ±10% X7R chip	510-3606-103
C 263	.01 µF ±10% X7R chip	510-3606-103
C 264	.01 µF ±10% X7R chip	510-3606-103
C 265	.01 µF ±10% X7R chip	510-3606-103
C 266	.01 µF ±10% X7R chip	510-3606-103
C 267	47 µF 10V tantalum SMD	510-2624-470
C 268	47 µF 10V tantalum SMD	510-2624-470
C 269	47 µF 10V tantalum SMD	510-2624-470

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 270	47 µF 10V tantalum SMD	510-2624-470
C 271	.01 µF ±10% X7R chip	510-3606-103
C 272	.01 µF ±10% X7R chip	510-3606-103
C 273	.01 µF ±10% X7R chip	510-3606-103
C 276	.0022 µF ±2% NPO 1206	510-3616-222
C 277	.0047 µF ±2% NPO 1206	510-3616-472
C 278	.0068 µF ±2% NPO 1206	510-3617-682
C 279	.22 µF ±5% X7R 1210	510-3610-224
C 280	.022 µF ±5% X7R 1206	510-3609-223
C 281	820 pF ±2% NPO 1206	510-3616-821
C 282	.1 µF ±10% X7R 1206	510-3606-104
C 283	.1 µF ±10% X7R 1206	510-3606-104
C 285	470 µF 25V radial low temp	510-4064-471
C 286	10 µF tantalum SMD	510-2625-100
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 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 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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
J 100	Green horizontal tip jack .080	105-2204-105
J 101	Speaker jack 0.1 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	Minisert 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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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	Compatible modem Bell-202	544-3988-014
U 110	Compatible modem Bell-202	544-3988-014
U 111	CMOS 87C52	544-5011-948
U 112	Main Audio Card/LTR-Net	023-9998-455
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 MC33178	544-2019-018
U 136	+8V 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 501	.015 µF ±10% X7R chip	510-3606-153
C 502	.1 µF ±10% X7R 1210	510-3607-104
C 503	150 pF ±5% NPO 1206 chip	510-3602-151
C 504	10 µFD 16V tantalum SMD	510-2625-100
C 505	10 µFD 16V tantalum SMD	510-2625-100
C 506	10 µFD 16V tantalum SMD	510-2625-100
C 507	10 µFD 16V tantalum SMD	510-2625-100
C 508	33 µF 10V tantalum SMD	510-2624-330

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 509	1 µF 16V tantalum SMD	510-2625-109
C 510	33 µF 10V tantalum SMD	510-2624-330
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 520	.1 µF ±10% X7R chip	510-3607-104
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 524	10 µFD 16V tantalum SMD	510-2625-100
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 528	.01 µF ±10% X7R chip	510-3606-103
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
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
CR522	5.1V zener SOT-23	523-2016-519

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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
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
PC500	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

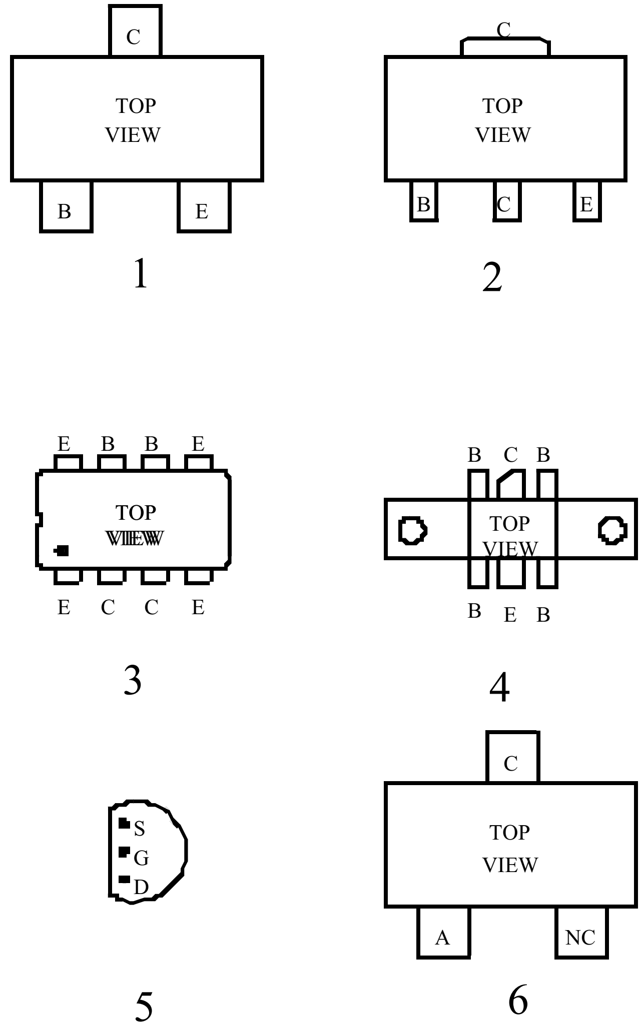
SYMBOL NUMBER	DESCRIPTION	PART NUMBER
Q 503	Si NPN SOT-23 2N3904	576-0003-658
Q 504	NPN dig SOT-23F RN1404	576-0003-616
Q 505	NPN dig SOT-23F RN1404	576-0003-616
R 500	4.7k ohm ±5% 1206 SMD	569-0115-472
R 501	4.7k ohm ±5% 1206 SMD	569-0115-472
R 502	430 ohm ±5% 1/4W CF	569-0513-431
R 503	5.1k ohm ±5% 1206 SMD	569-0115-512
R 504	1k ohm ±5% 1206 SMD	569-0115-102
R 505	2k ohm ±5% 1206 SMD	569-0115-202
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
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 538	100k ohm ±5% 1206 SMD	569-0115-104
R 539	100k ohm ±5% 1206 SMD	569-0115-104
R 540	100k ohm ±5% 1206 SMD	569-0115-104
R 541	200 ohm ±5% 1206 SMD	569-0115-201
R 542	10k ohm ±5% 1206 SMD	569-0115-103
R 543	10k ohm ±5% 1206 SMD	569-0115-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
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 570	1k ohm ±5% 1206 SMD	569-0115-102
R 571	10k ohm ±5% 1206 SMD	569-0115-103
R 572	16k ohm ±5% 1206 SMD	569-0115-163
R 573	5.1k ohm ±5% 1206 SMD	569-0115-512
R 574	51k ohm ±5% 1206 SMD	569-0115-513
R 575	82k ohm ±5% 1206 SMD	569-0115-823
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
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

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 508	Hex open drain buffer SO-14	544-3716-906
U 509	Quad op amp SOIC	544-2020-008
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 515	NPN out opto isolator 4N35	544-2010-001
U 516	NPN out opto isolator 4N35	544-2010-001
U 517	Transparent latch SOIC	544-3766-573
U 518	D flip flop SOIC 74HC574	544-3766-574
U 519	Low pwr FM IF SO-16	544-2026-008
U 520	NPN out opto isolator 4N35	544-2010-001
U 521	Transparent latch SOIC	544-3766-573
U 522	+12V regulator TO-92 78L12	544-2003-032
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		
PART NUMBER	BASING NUMBER	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		



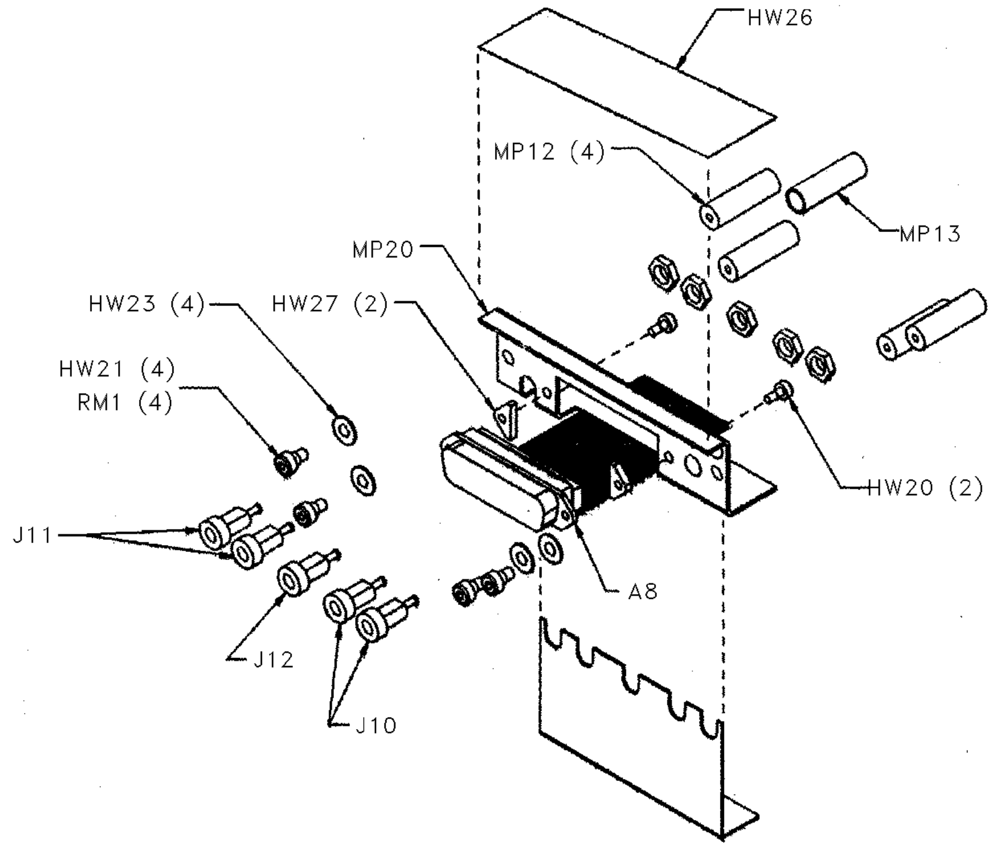
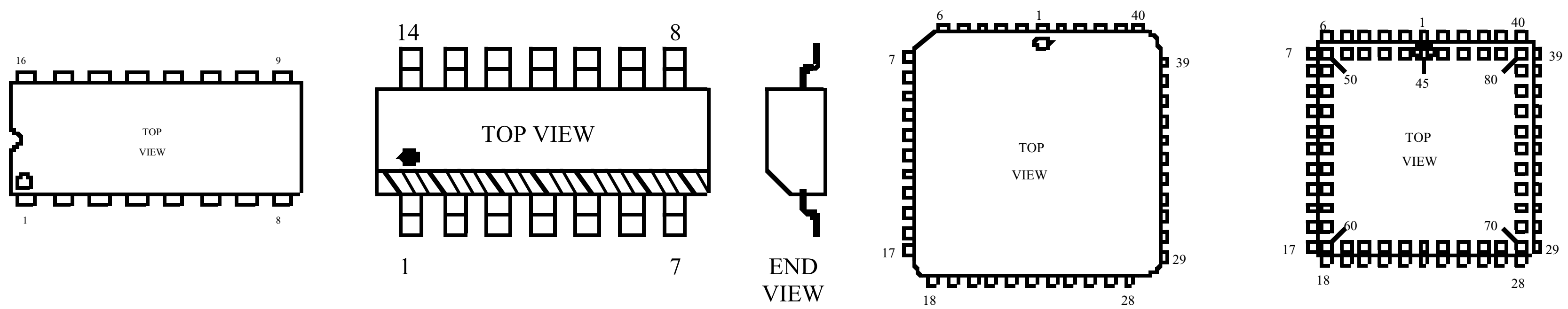


FIGURE 10-1 RF MODULE INTERFACE CONNECTOR

INTEGRATED CIRCUITS



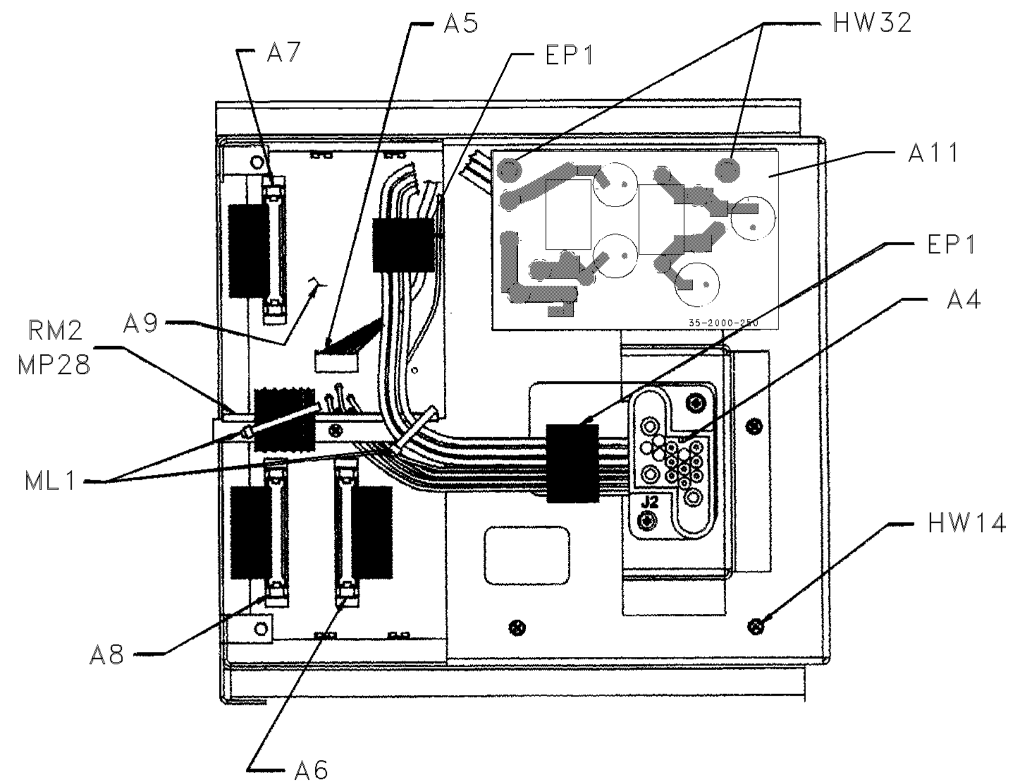
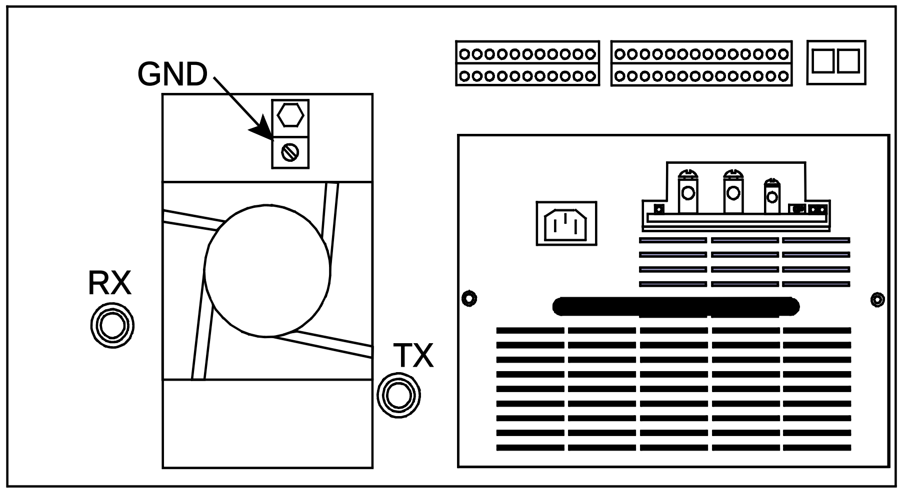
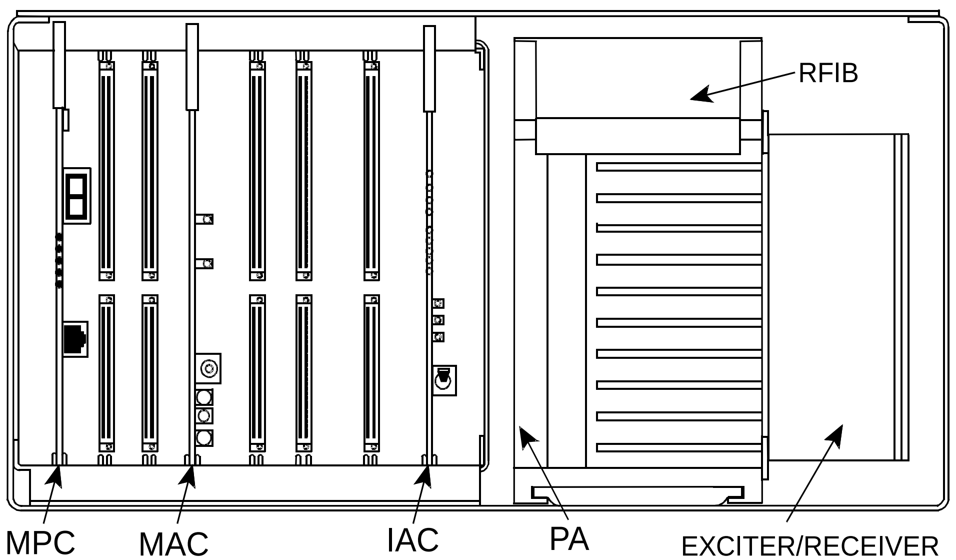


FIGURE 10-2 BACKPLANE CABLE CONNECITONS

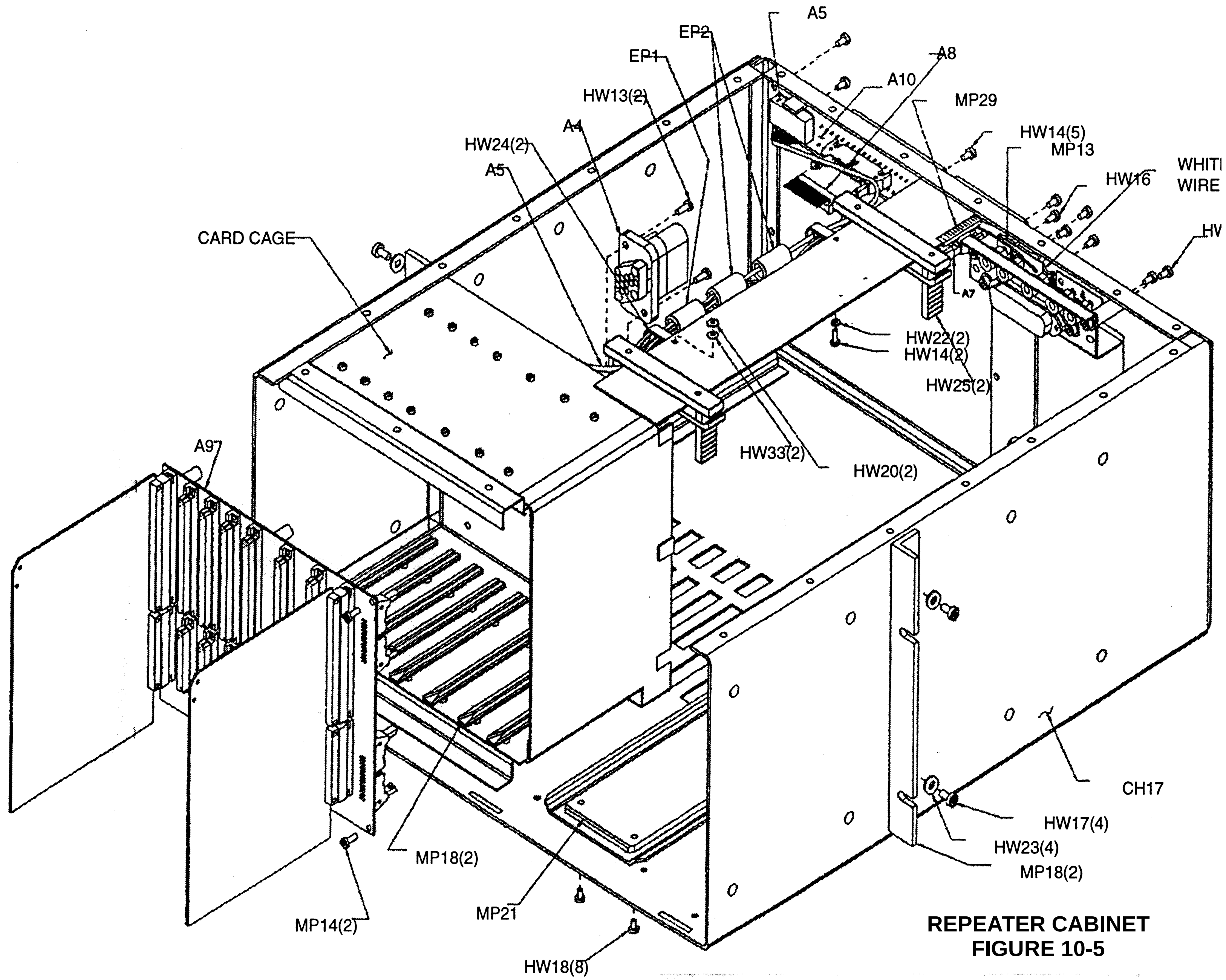
FOLDOUT



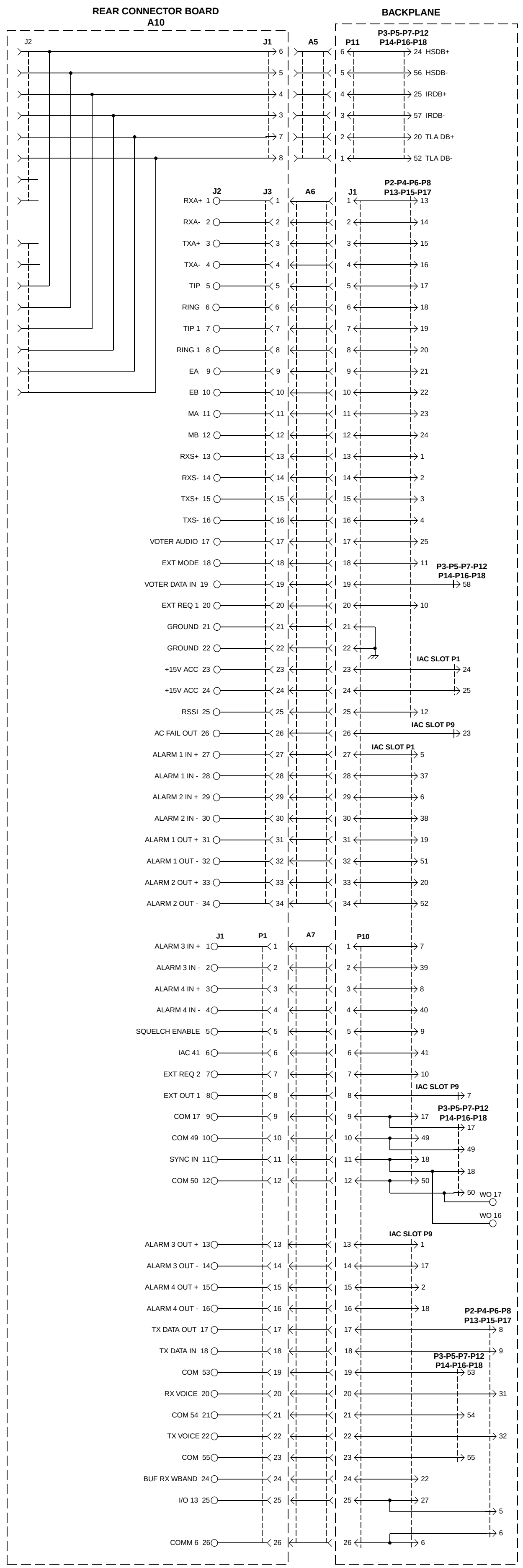
REPEATER REAR VIEW
FIGURE 10-3



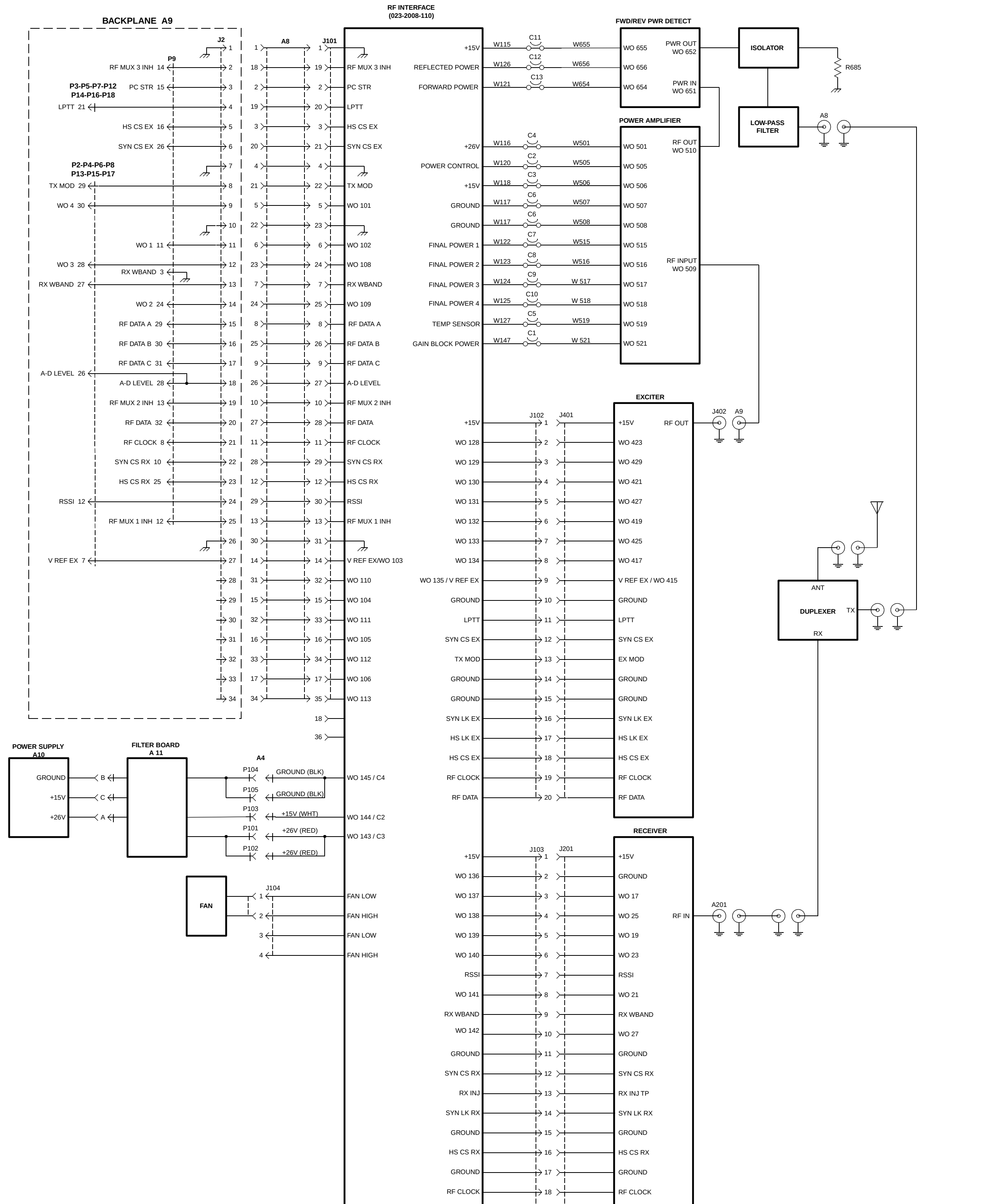
REPEATER FRONT VIEW
FIGURE 10-4



REPEATER CABINET
FIGURE 10-5

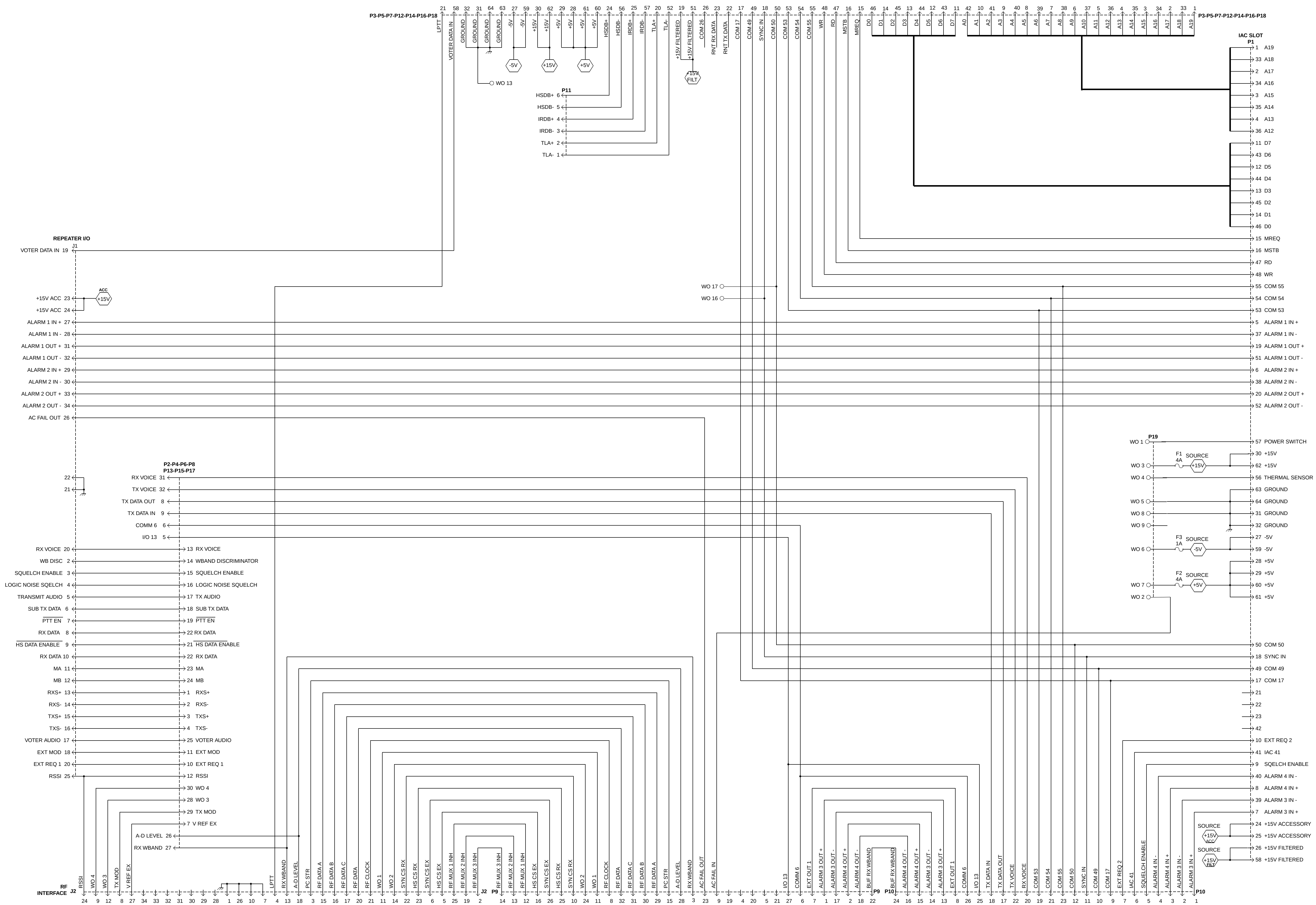


INPUT/OUTPUT ALARM INTERFACE
FIGURE 10-6

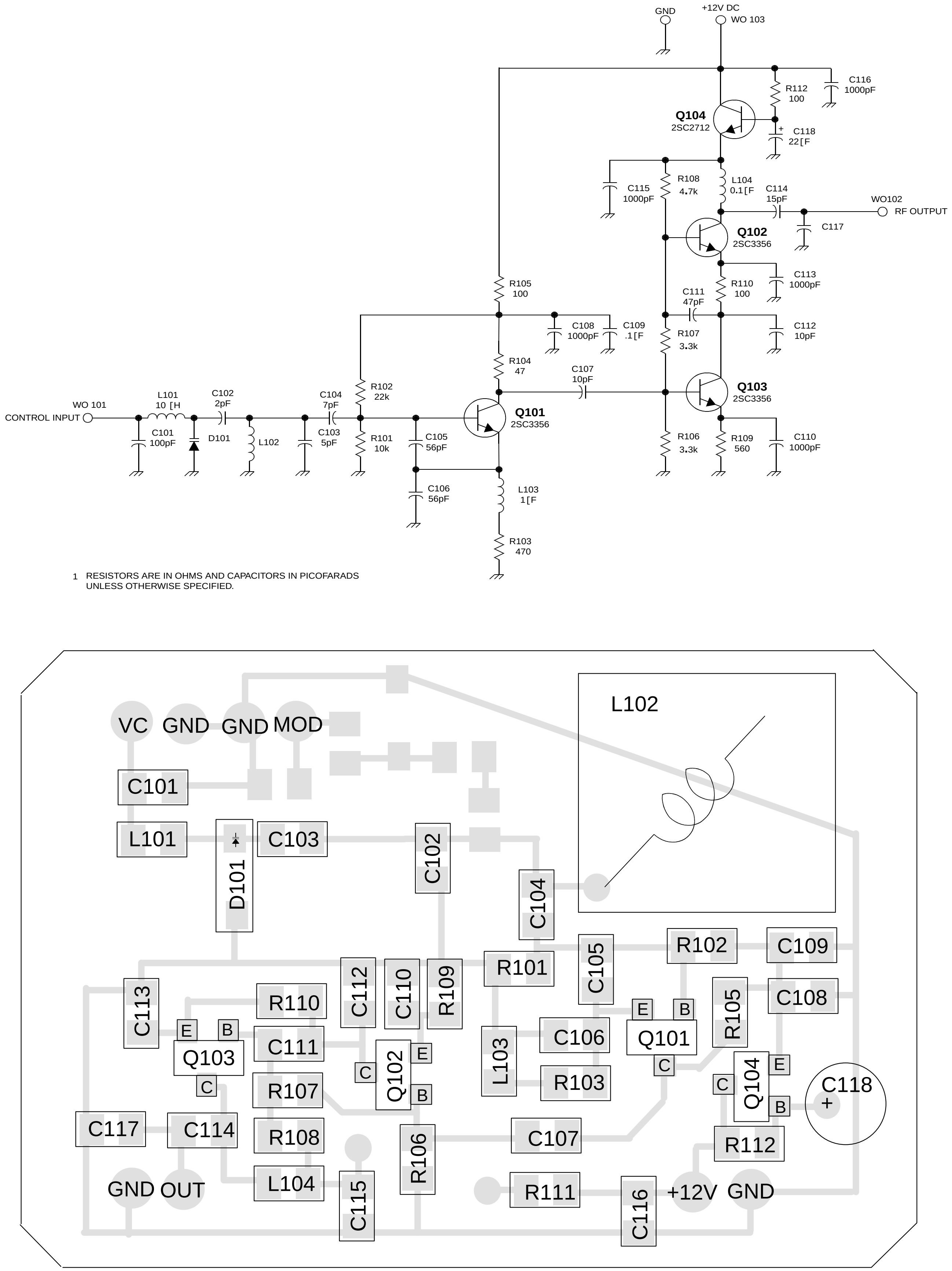


RF INTERFACE
FIGURE 10-7

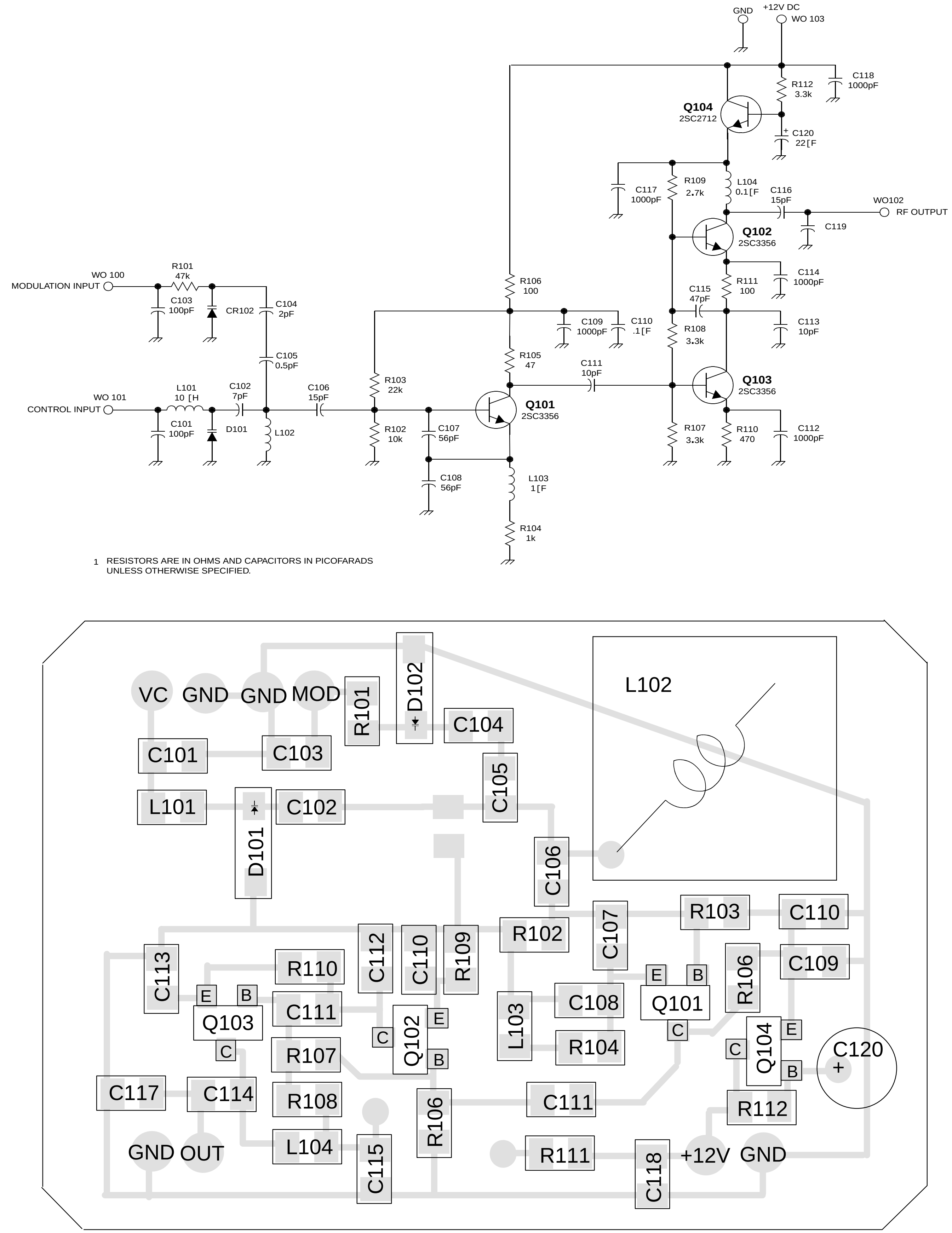
FOLDOUT



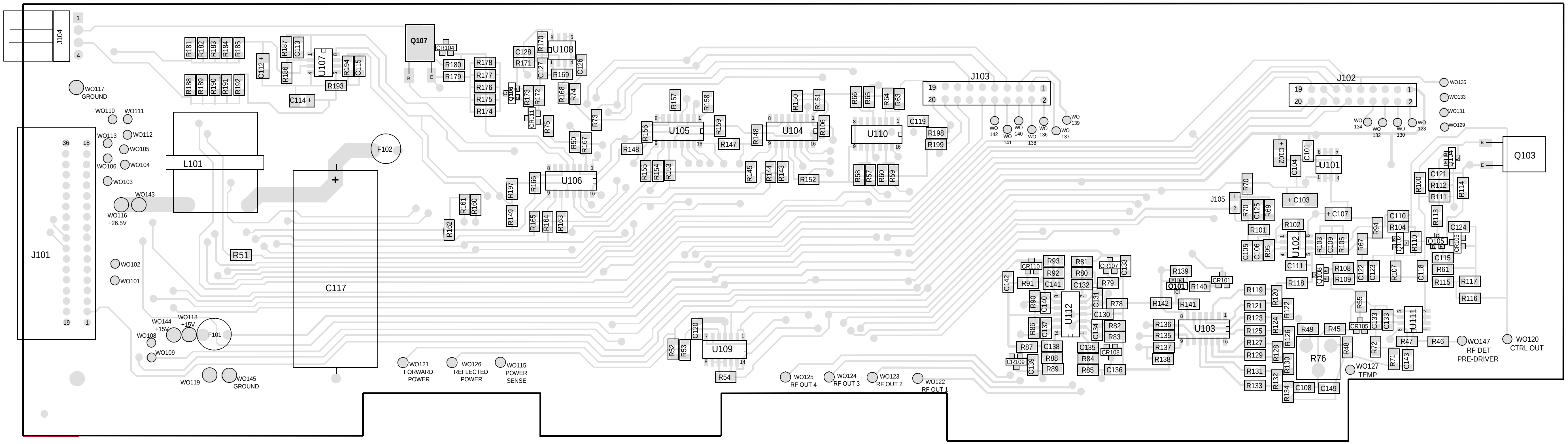
BACKPLANE INTERCONNECT
FIGURE 10-8



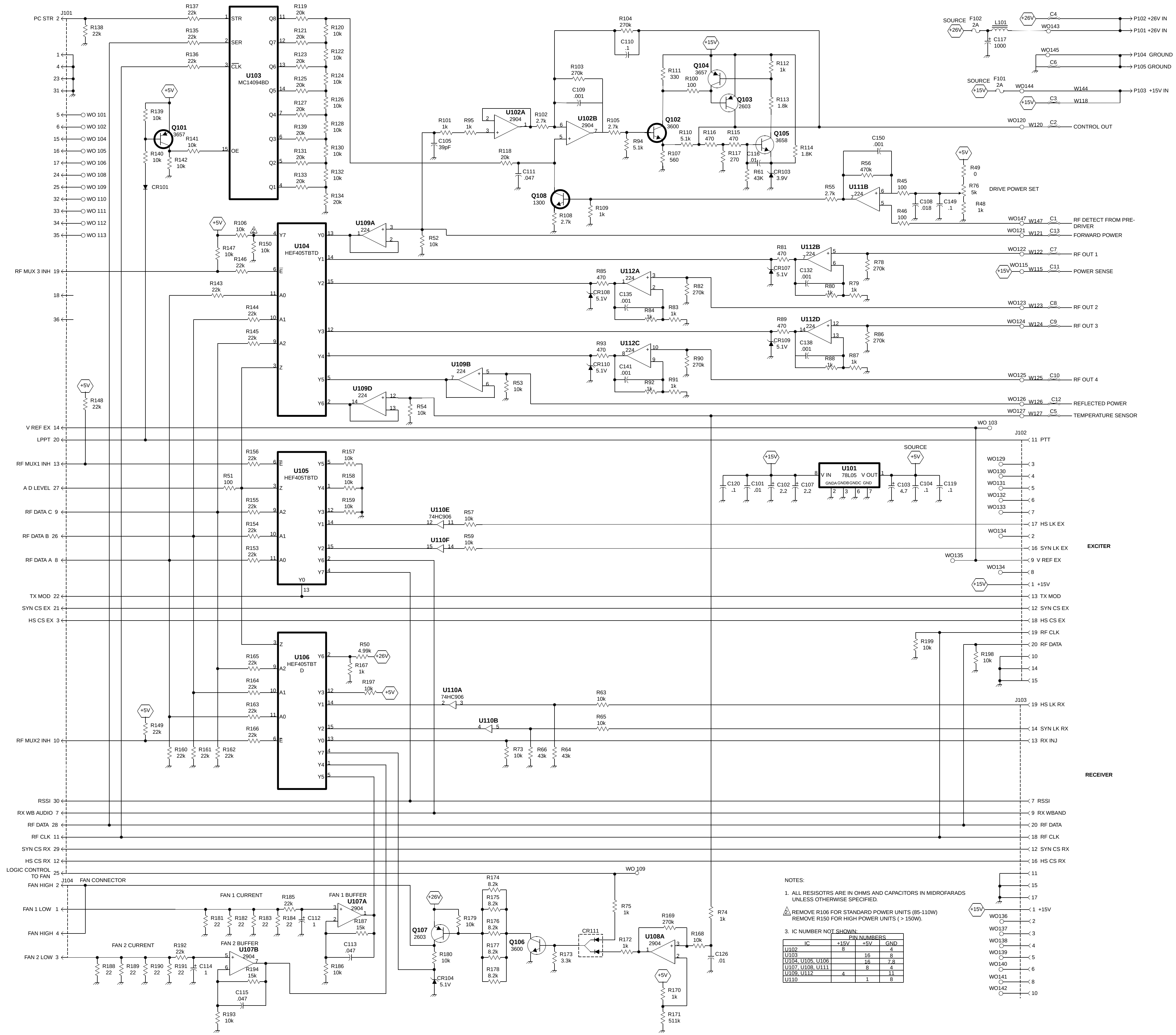
RECEIVE VCO
FIGURE 10-9



TRANSMIT VCO
FIGURE 10-10



RF INTERFACE BOARD COMPONENT LAYOUT
FIGURE 10-11



NOTES:

1. ALL RESISOTRS ARE IN OHMS AND CAPACITORS IN MIDROFARADS UNLESS OTHERWISE SPECIFIED.

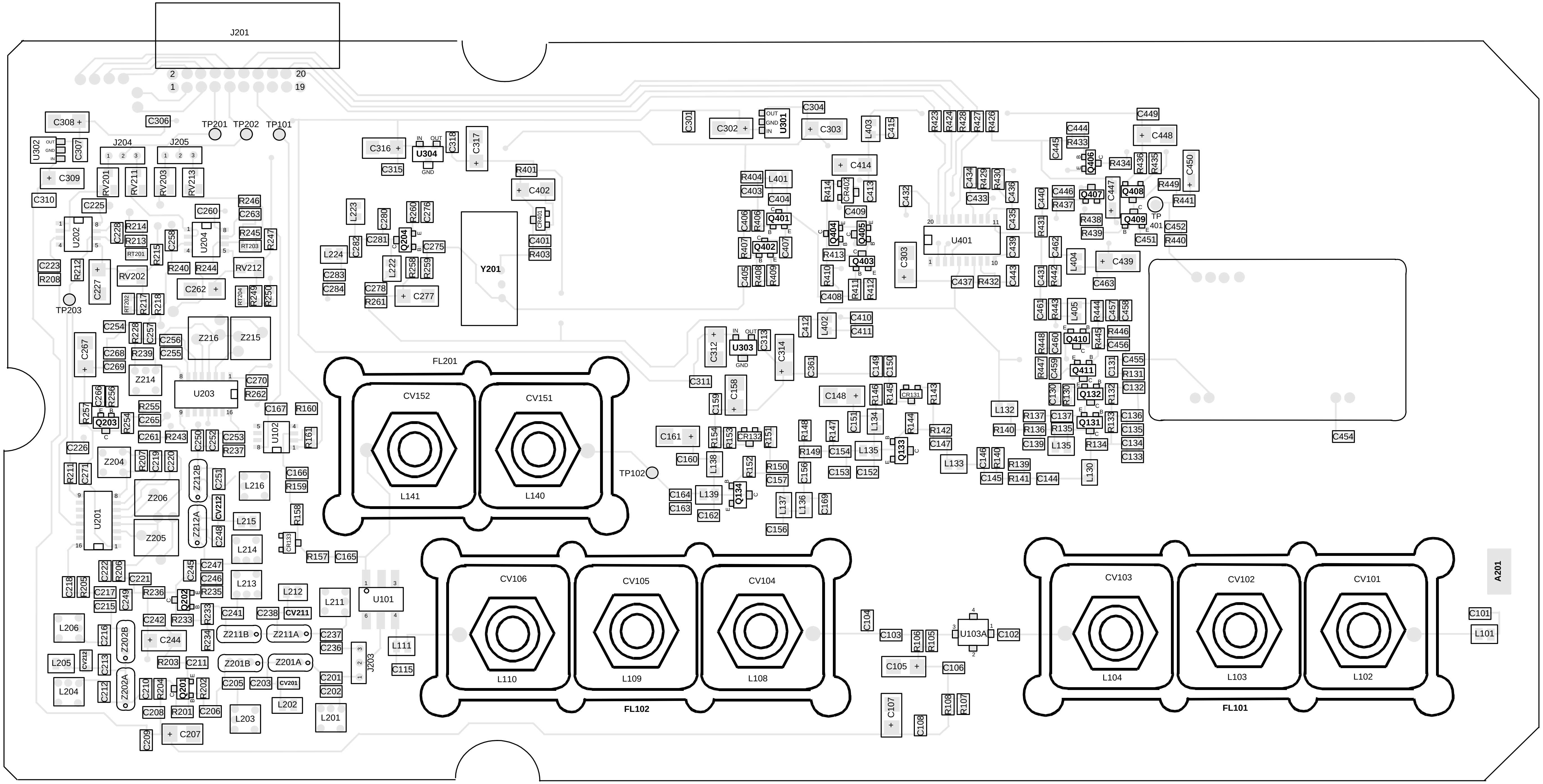
2. REMOVE R106 FOR STANDARD POWER UNITS (85-110W)
REMOVE R150 FOR HIGH POWER UNITS (> 150W).

3. IC NUMBER NOT SHOWN:

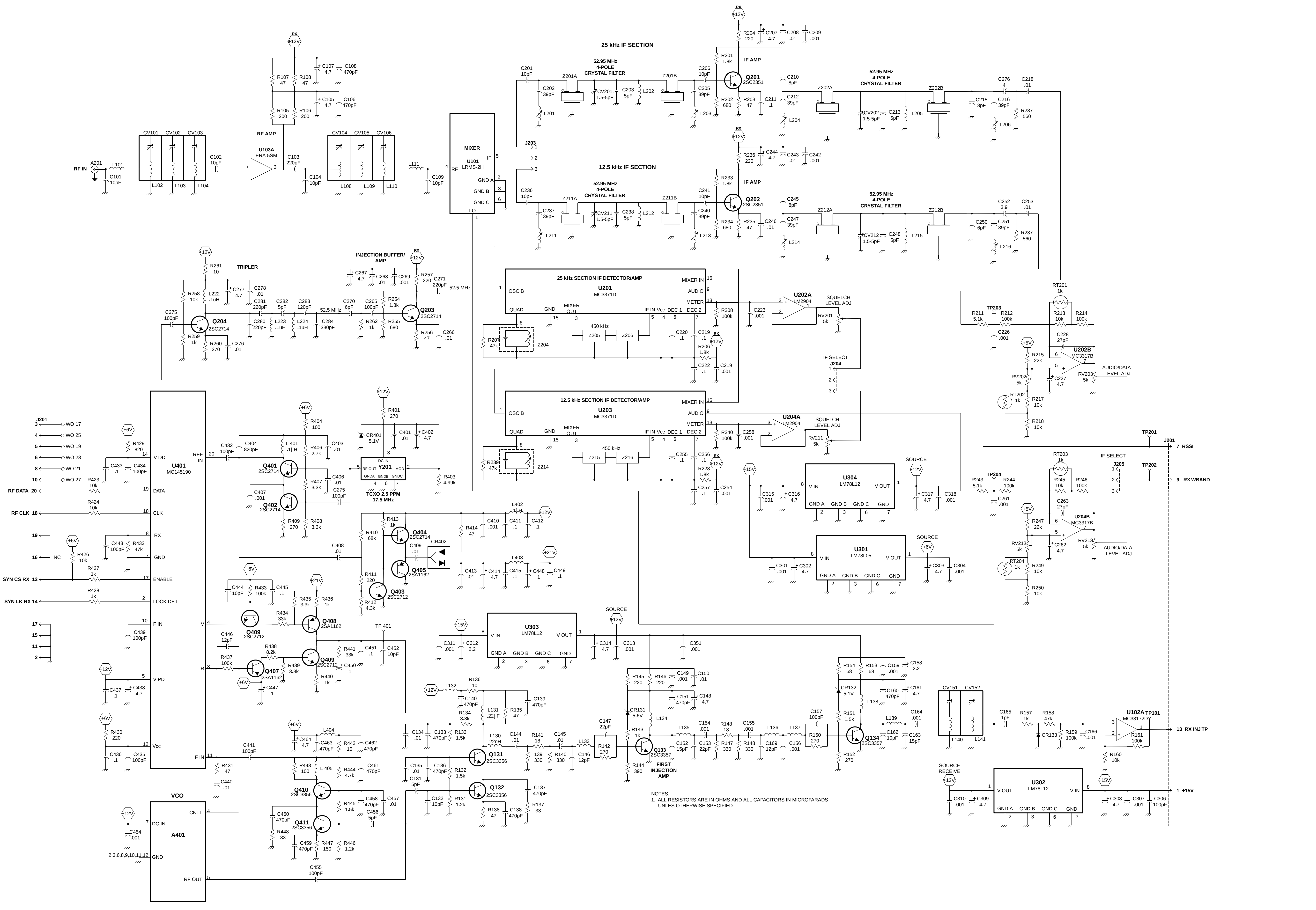
IC	PIN NUMBERS +15V	+5V	GND
U102	8		4
U103		16	8
U104, U105, U106		16	7,8
U107, U108, U111		8	4
U109, U112	4		11
U110		1	8

RF INTERFACE BOARD SCHEMATIC
FIGURE 10-12

FOLDOUT

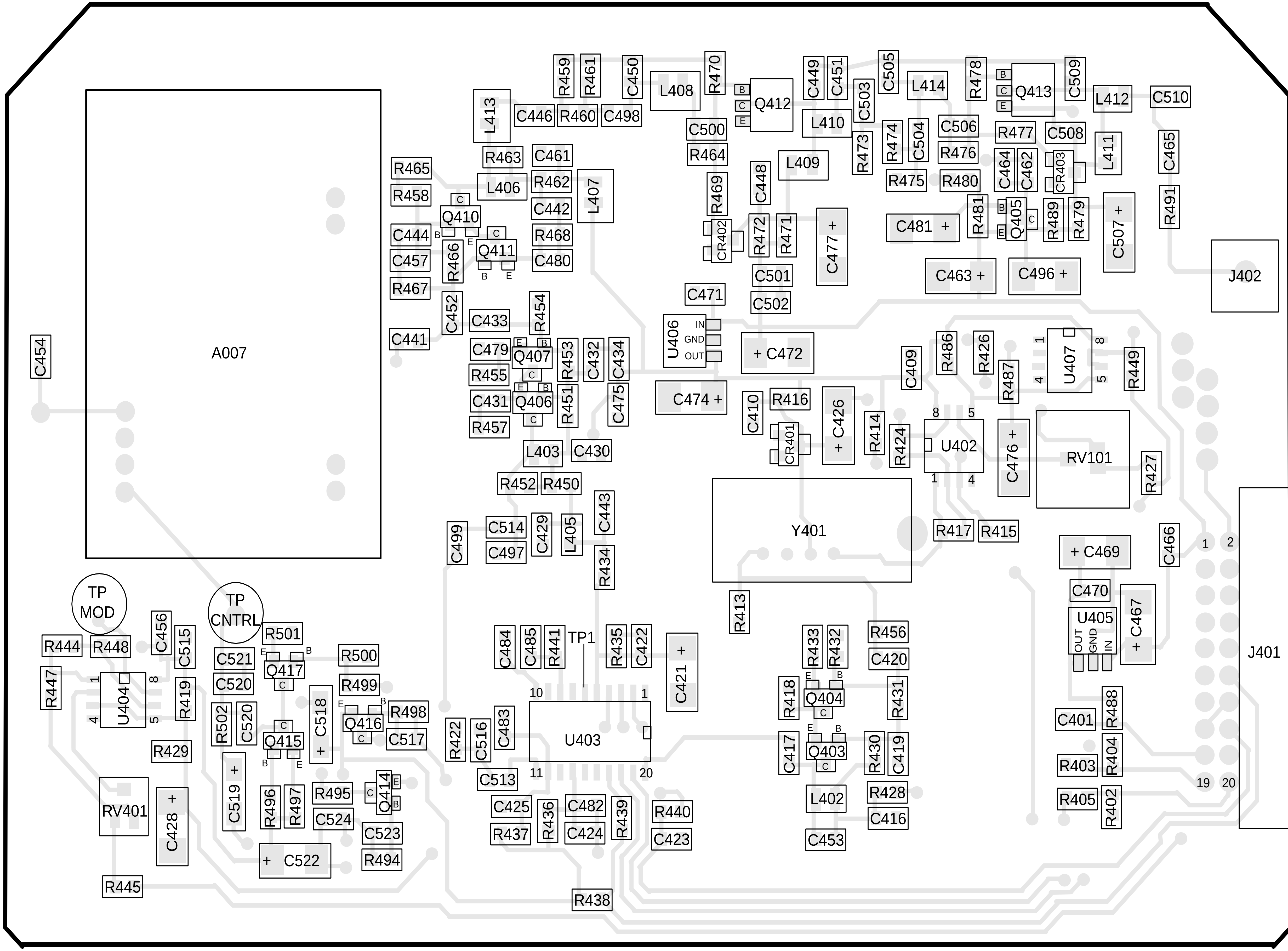


RECEIVER COMPONENT LAYOUT
FIGURE 10-13



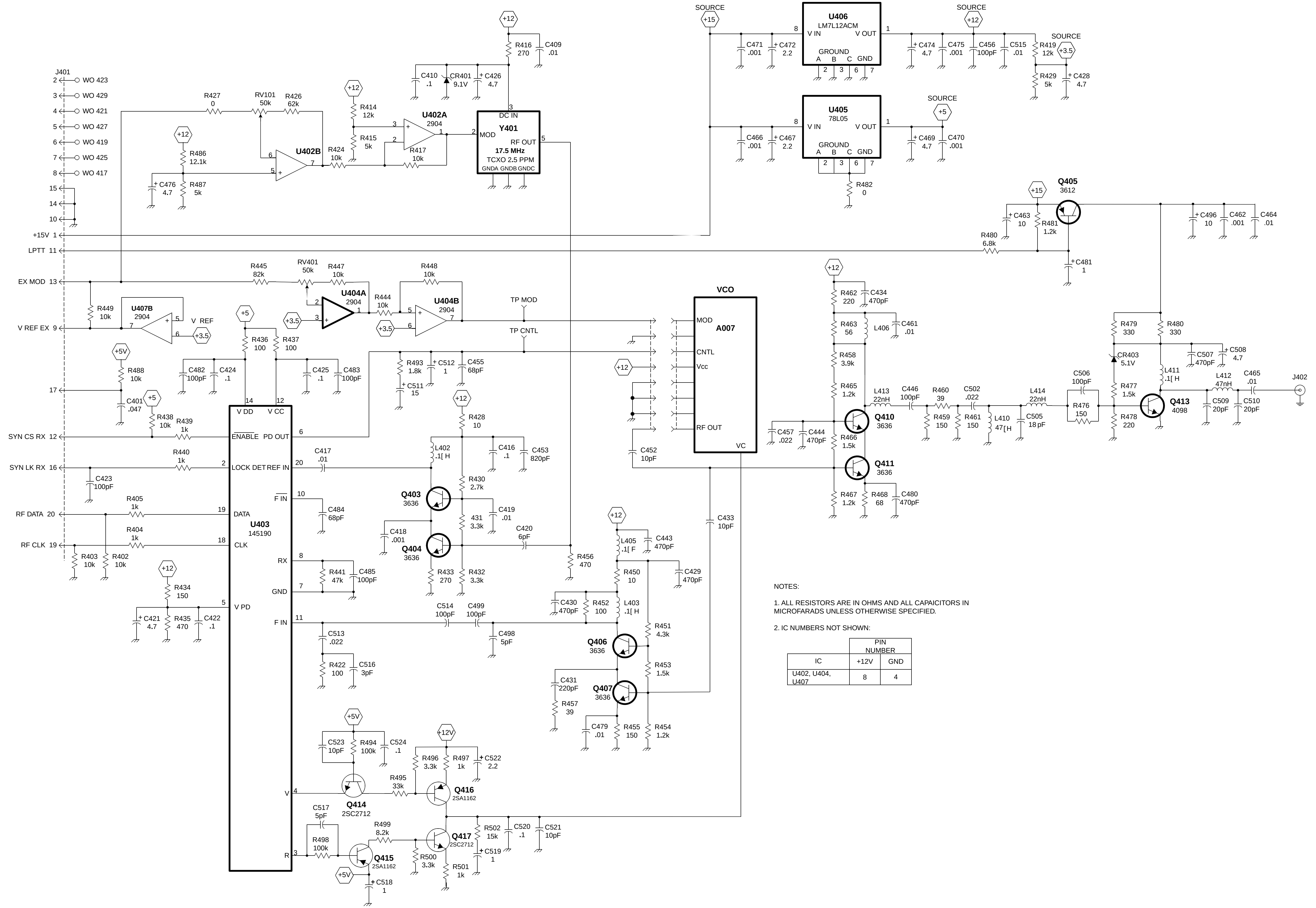
RECEIVER SCHEMATIC
FIGURE 10-14

FOLDOUT



EXCITER COMPONENT LAYOUT
FIGURE 10-15

August 2000
Part No. 001-2001-200



NOTES:

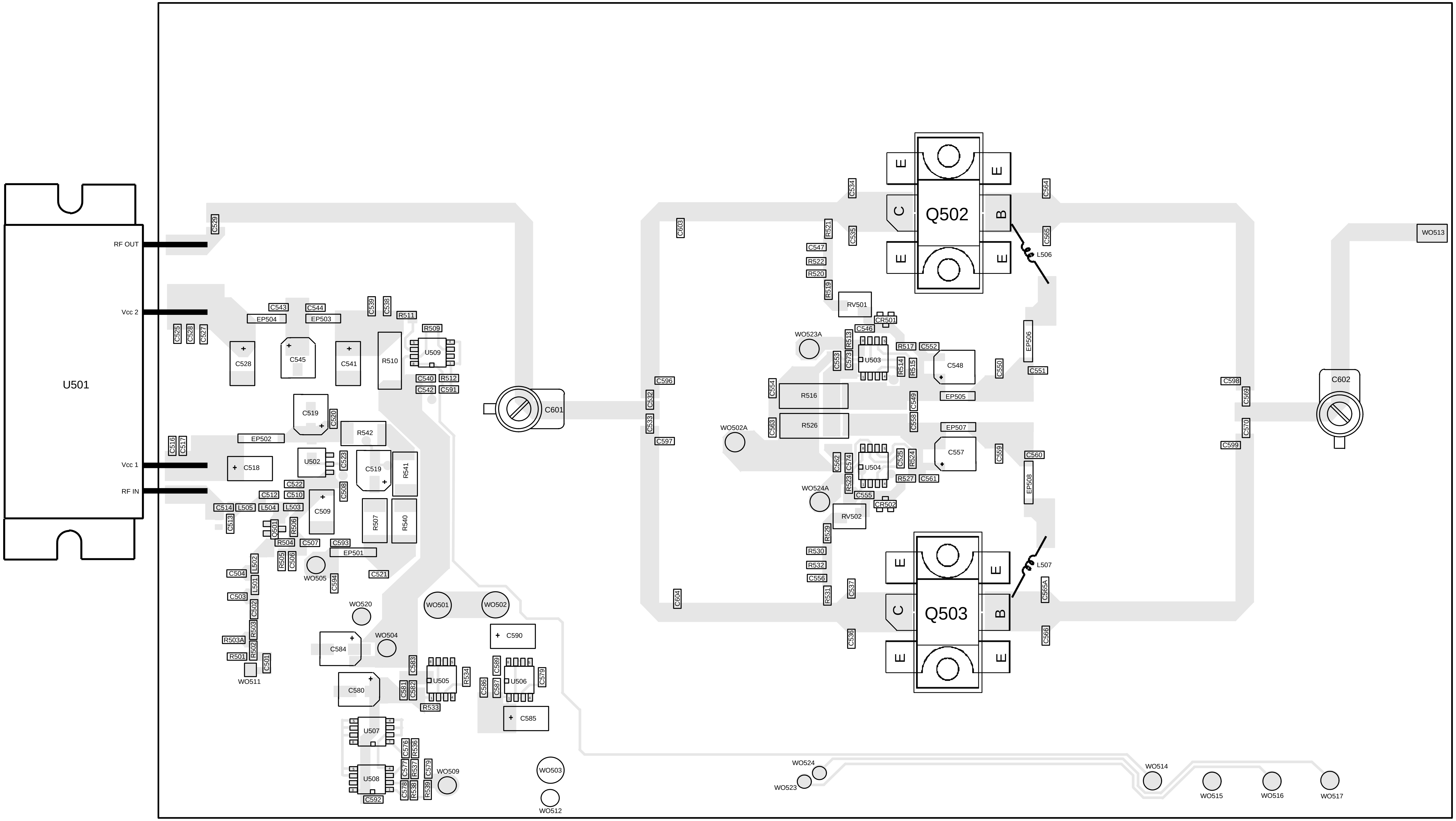
1. ALL RESISTORS ARE IN OHMS AND ALL CAPAICITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

2. IC NUMBERS NOT SHOWN:

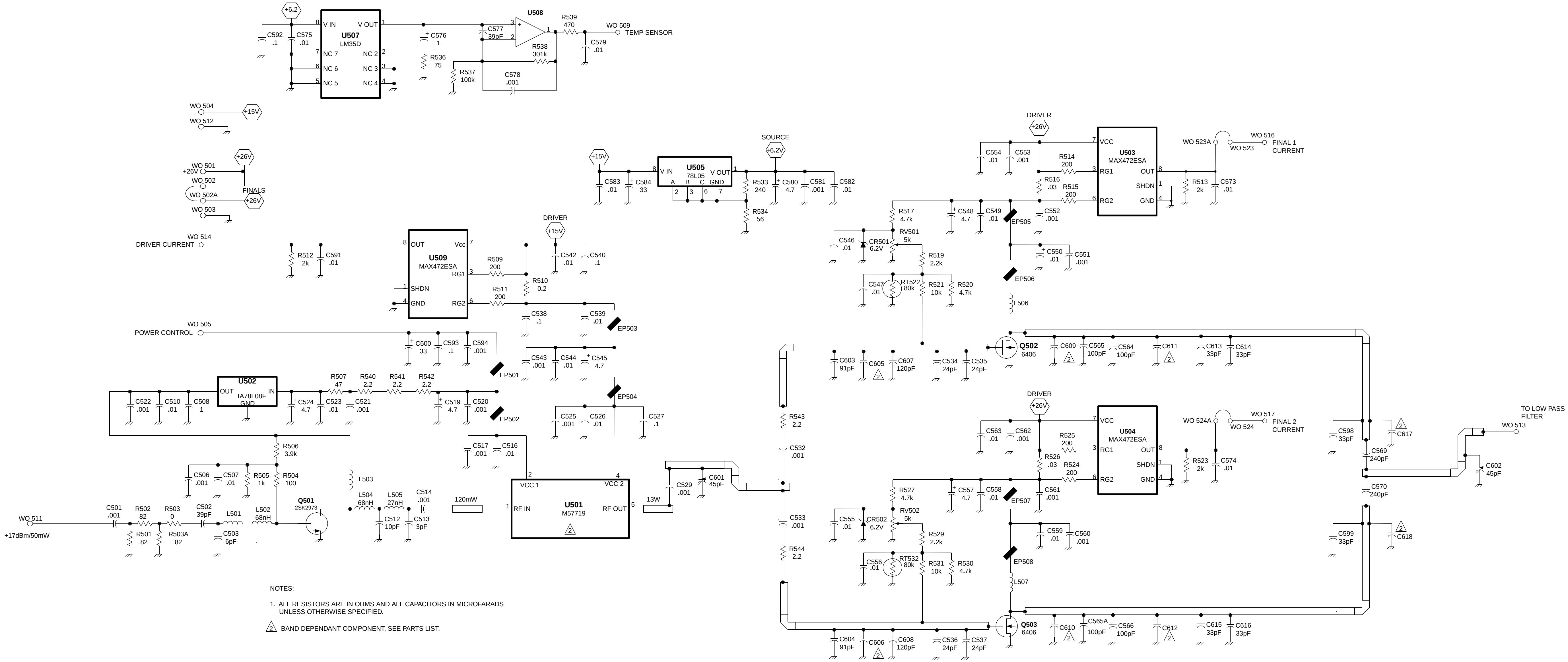
IC	PIN NUMBER +12V	PIN NUMBER GND
U402, U404, U407	8	4

EXCITER SCHEMATIC
FIGURE 10-16

FOLDOUT



110W POWER AMPLIFIER COMPONENT LAYOUT
FIGURE 10-17



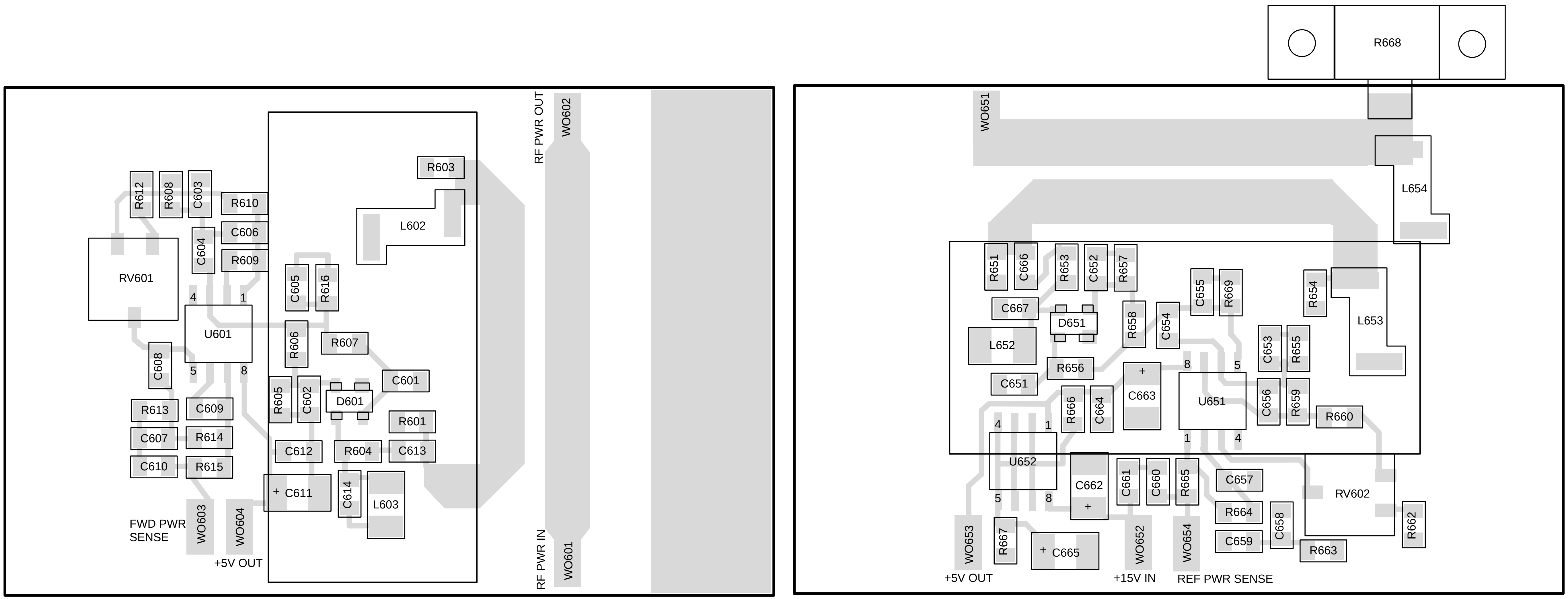
NOTES:

1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

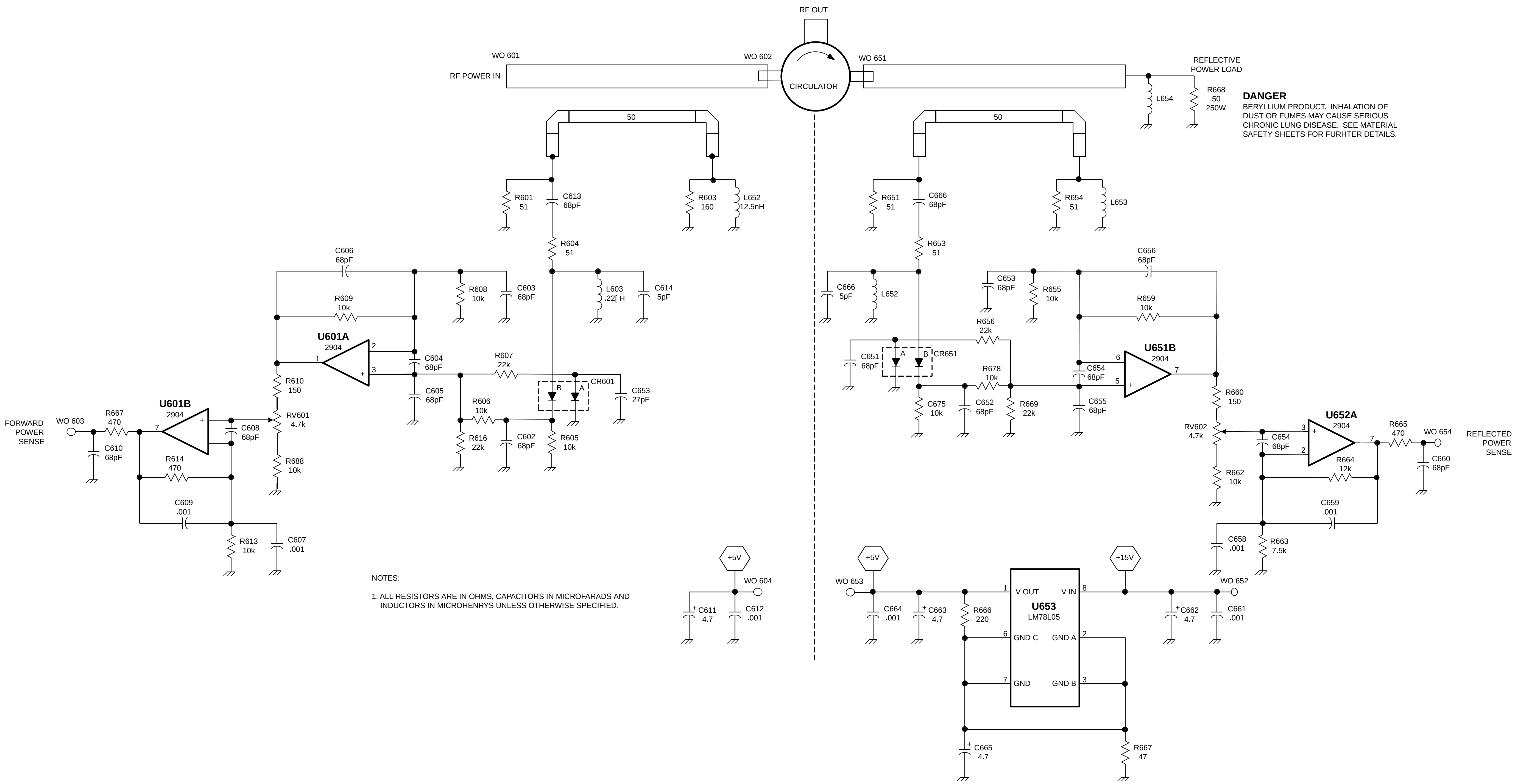
2 BAND DEPENDANT COMPONENT, SEE PARTS LIST.

110W POWER AMPLIFIER SCHEMATIC
FIGURE 10-18

FOLDOUT

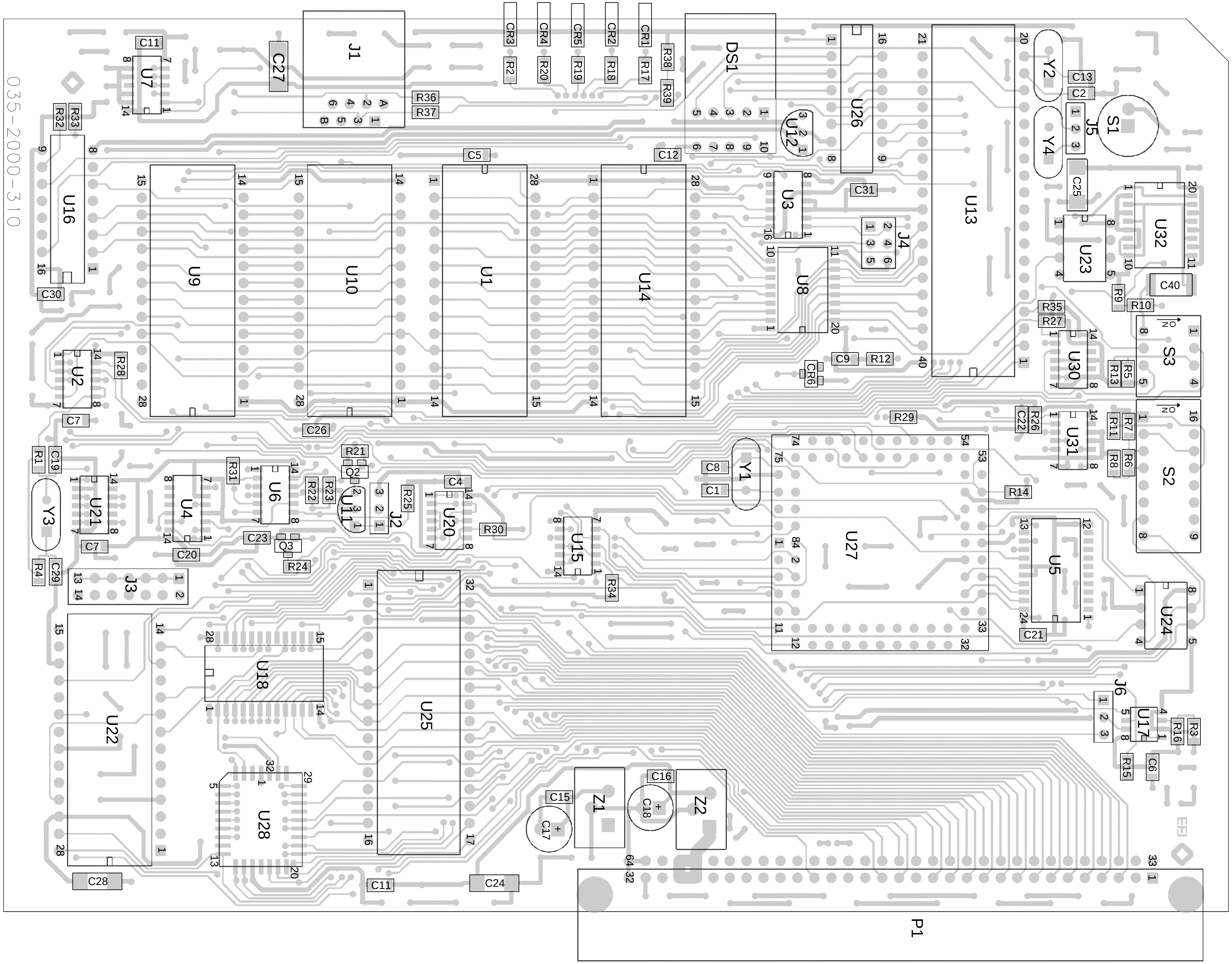


FORWARD/REVERSE POWER DETECT BOARD
COMPONENT LAYOUT
FIGURE 10-19

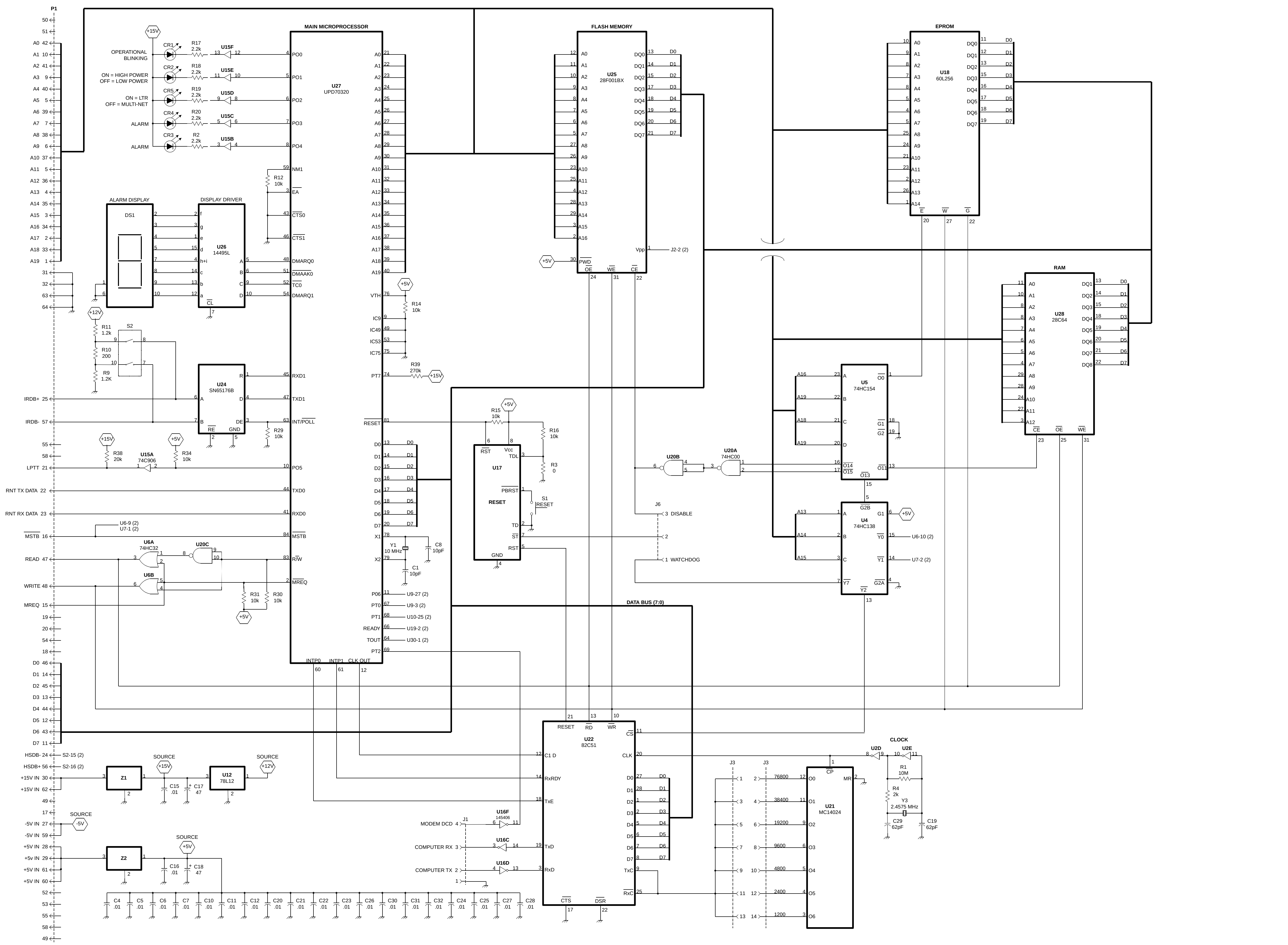


FORWARD/REVERSE POWER DETECT SCHEMATIC
FIGURE 10-20

FOLDOUT

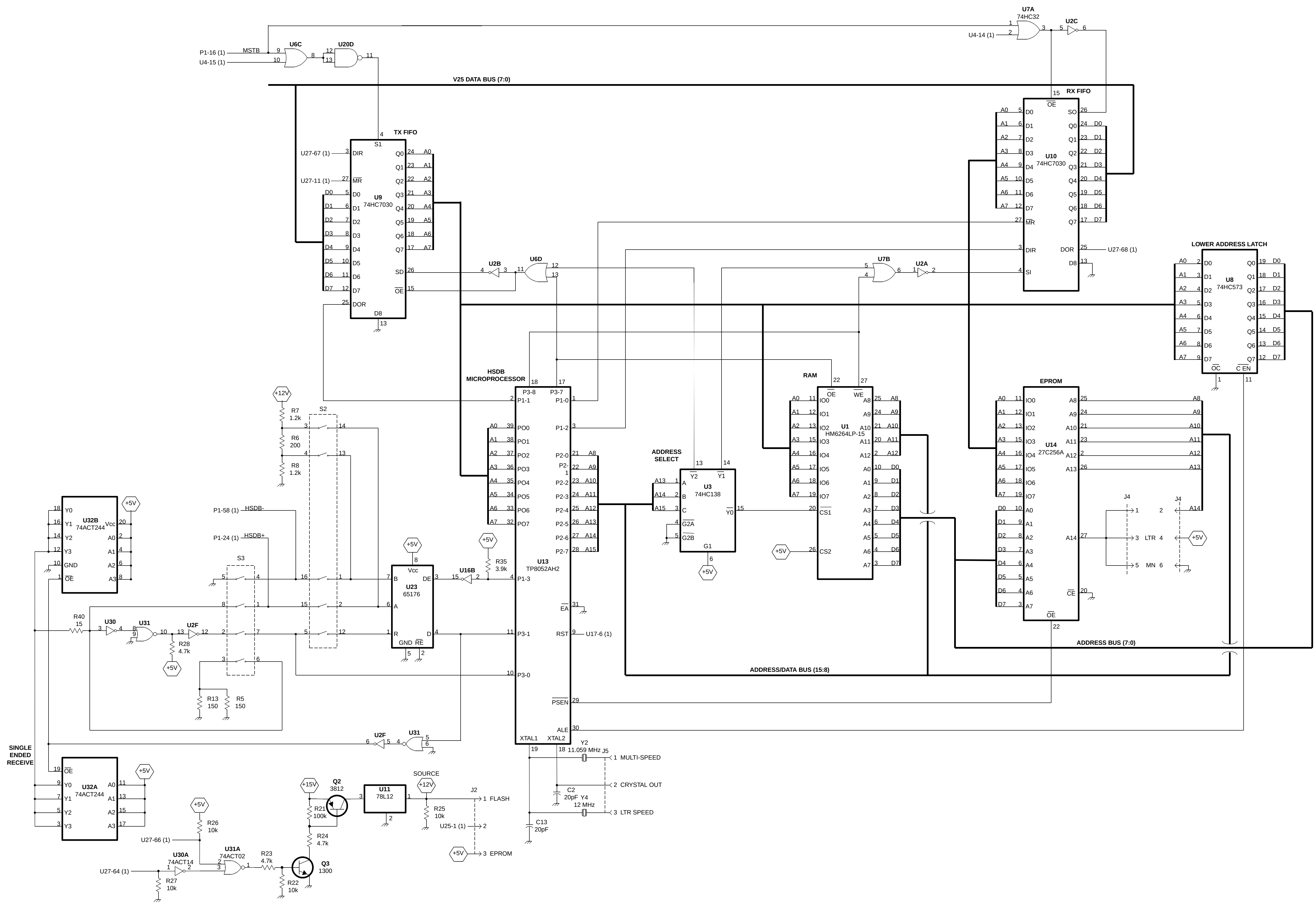


MAIN PROCESSOR CARD COMPONENT LAYOUT
FIGURE 10-21



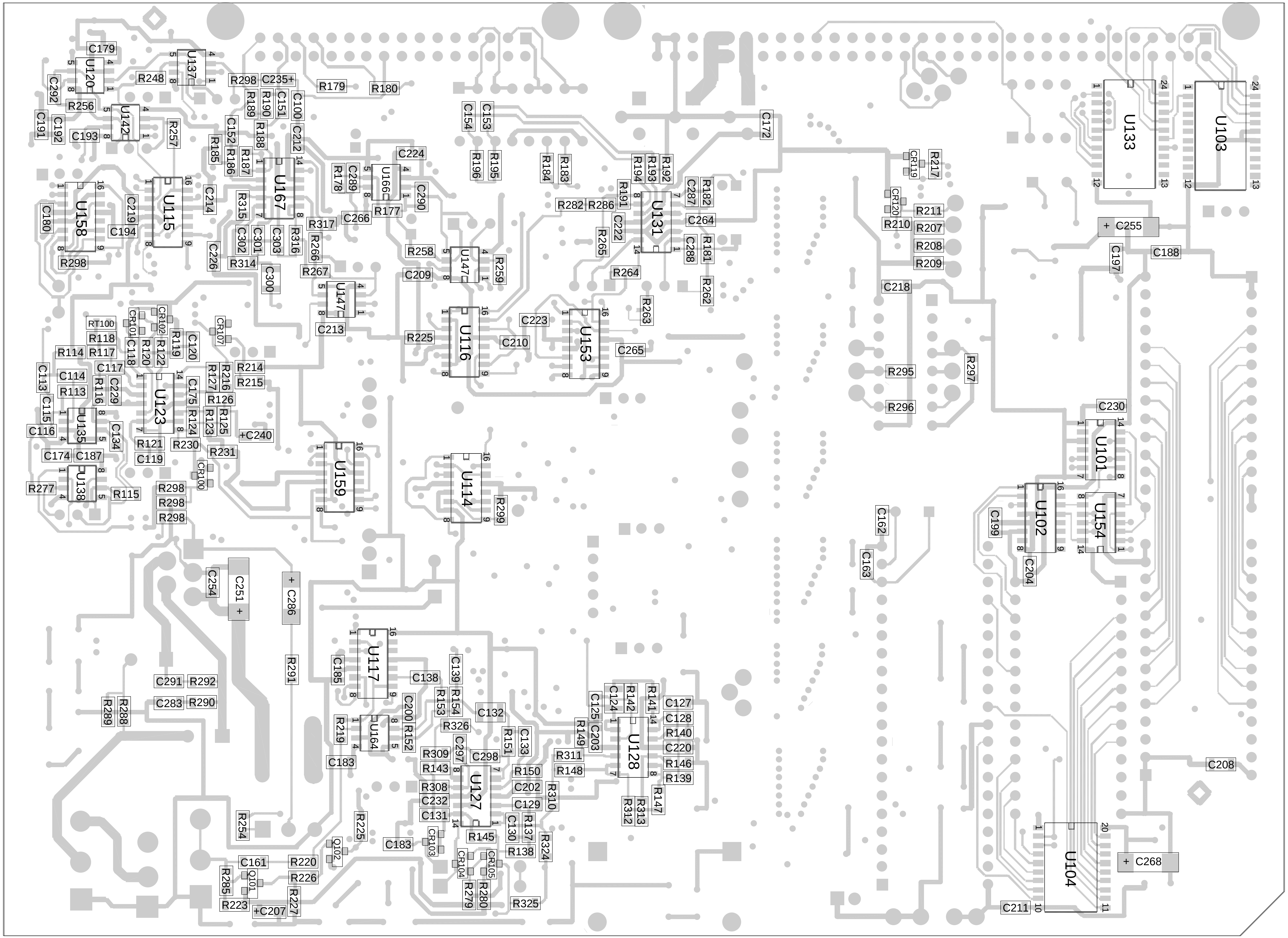
MPC SCHEMATIC (1 OF 2)
FIGURE 10-22

FOLDOUT



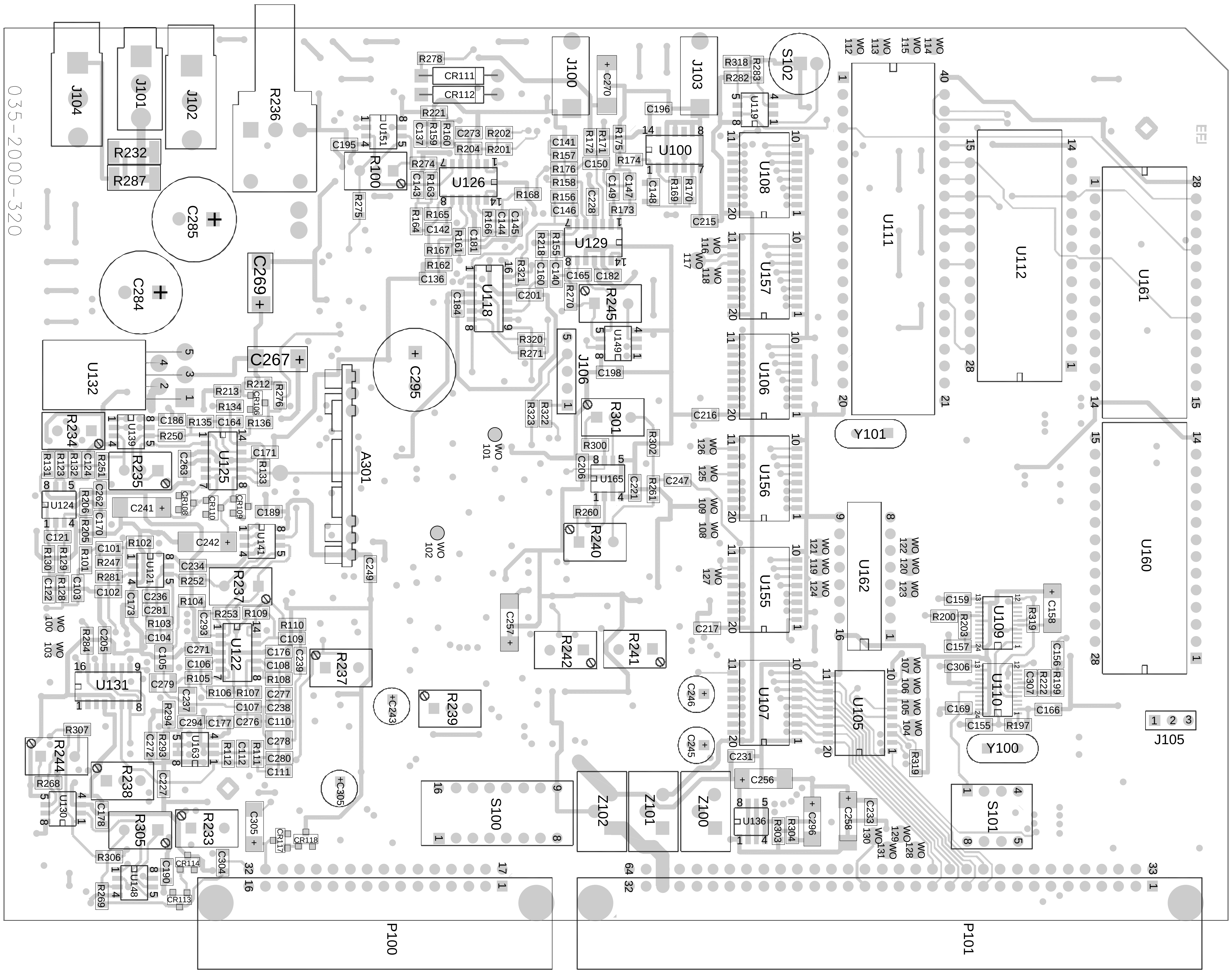
August 2000
Part No. 001-2001-200

MPC SCHEMATIC (2 OF 2)
FIGURE 10-23



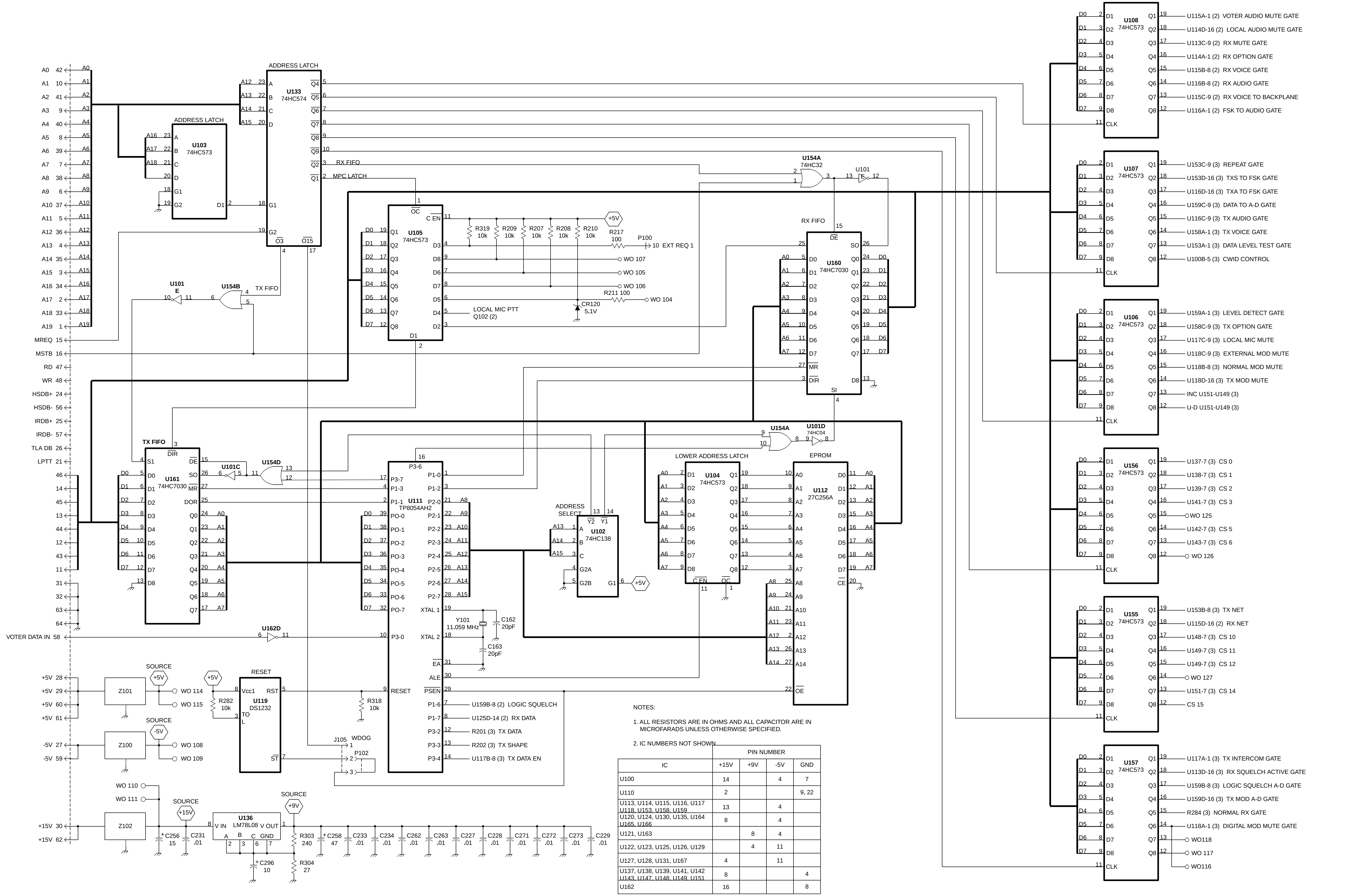
MAC COMPONENT LAYOUT (OPP COMP SIDE)
FIGURE 10-24

FOLDOUT →



MAC COMPONENT LAYOUT (COMPONENT SIDE)

FIGURE 10-25



NOTES:

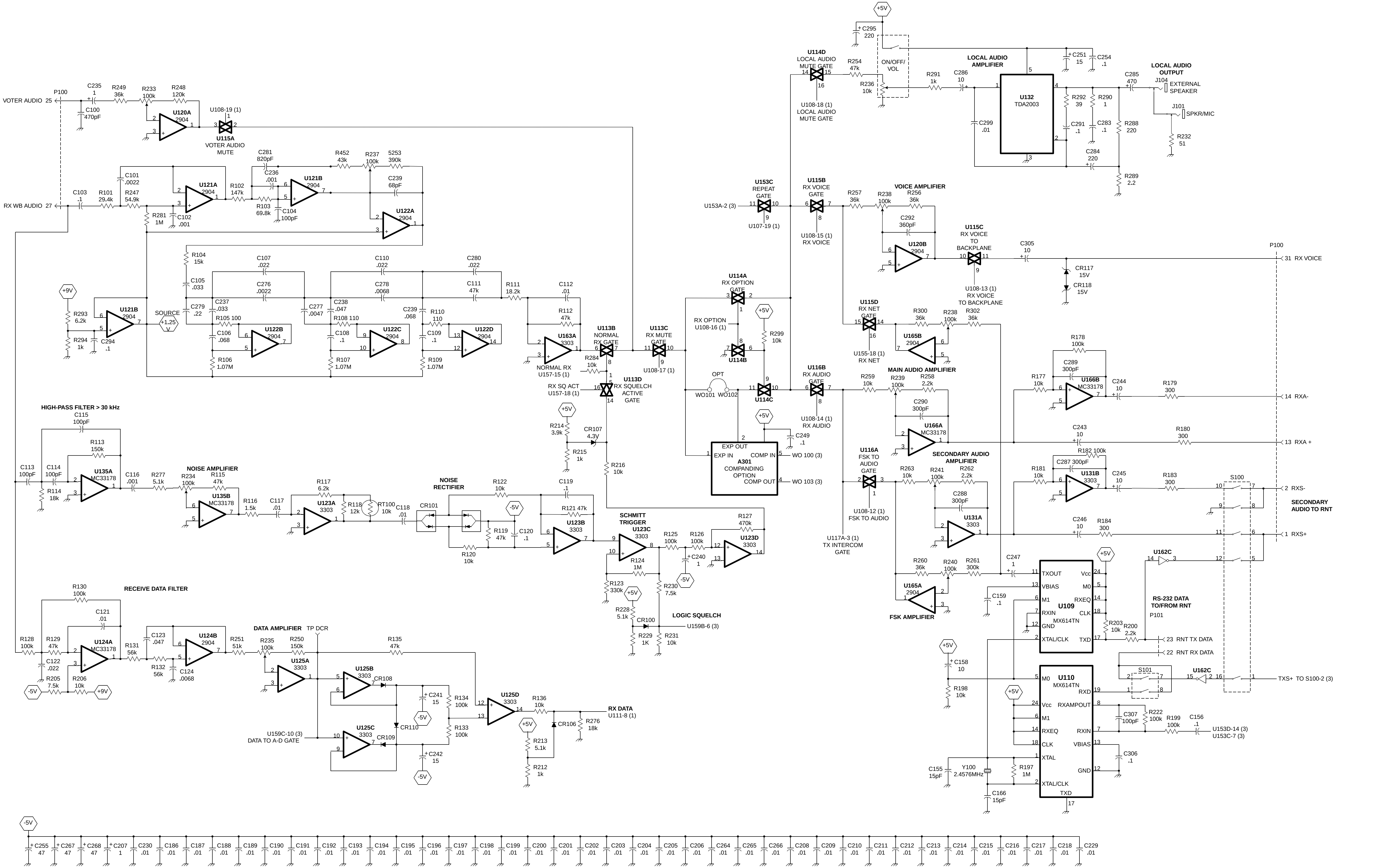
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITOR ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

2. IC NUMBERS NOT SHOWN

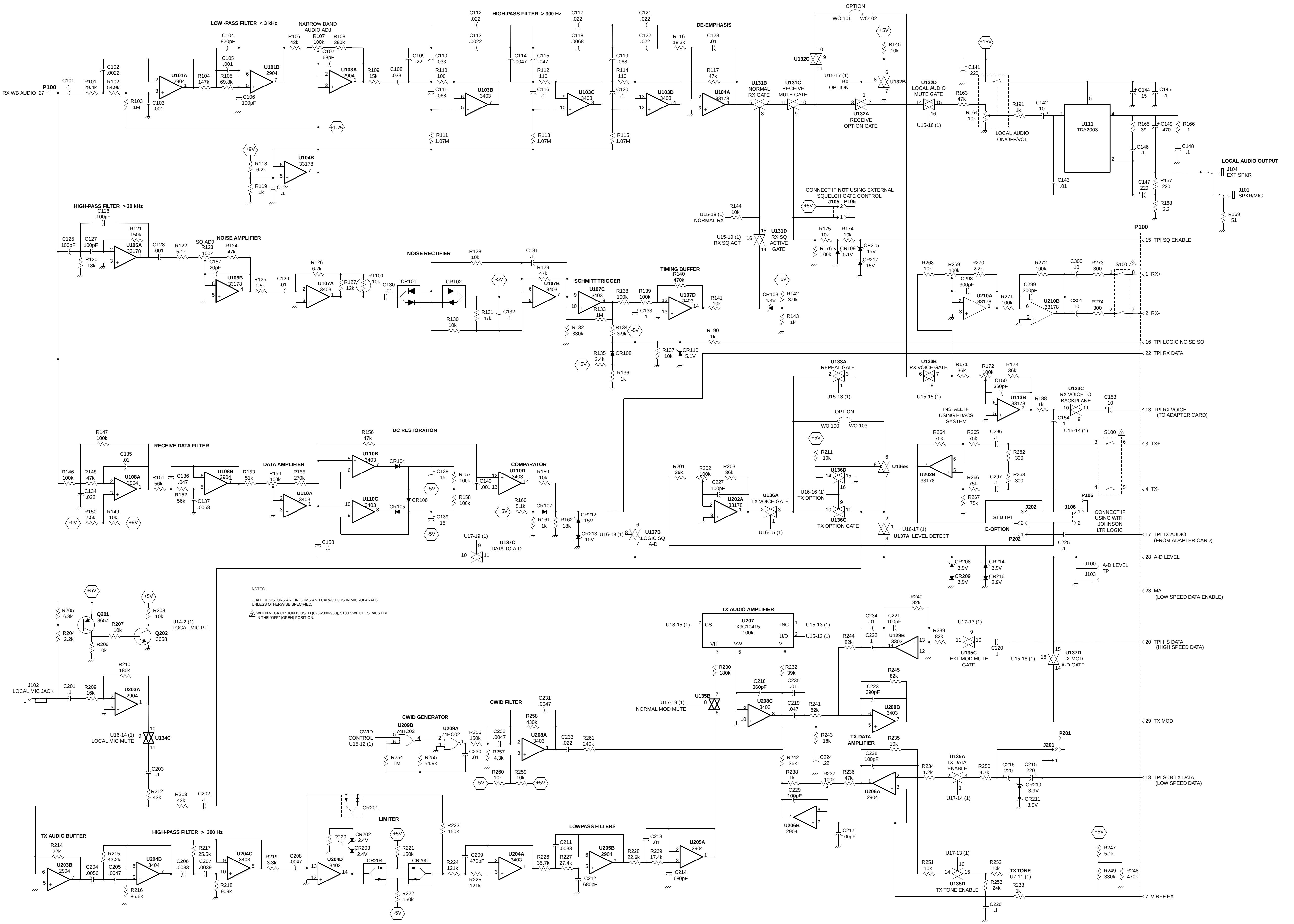
	PIN NUMBER			
IC	+15V	+9V	-5V	GND
U100	14		4	7
U110	2			9, 22
U113, U114, U115, U116, U117 U118, U153, U158, U159	13		4	
U120, U124, U130, U135, U164 U165, U166	8		4	
U121, U163		8	4	
U122, U123, U125, U126, U129		4	11	
U127, U128, U131, U167	4		11	
U137, U138, U139, U141, U142 U143, U147, U148, U149, U151	8			4
U162	16			8

MAIN AUDIO CARD SCHEMATIC (1 OF 3)
FIGURE 10-26

FOLDOUT

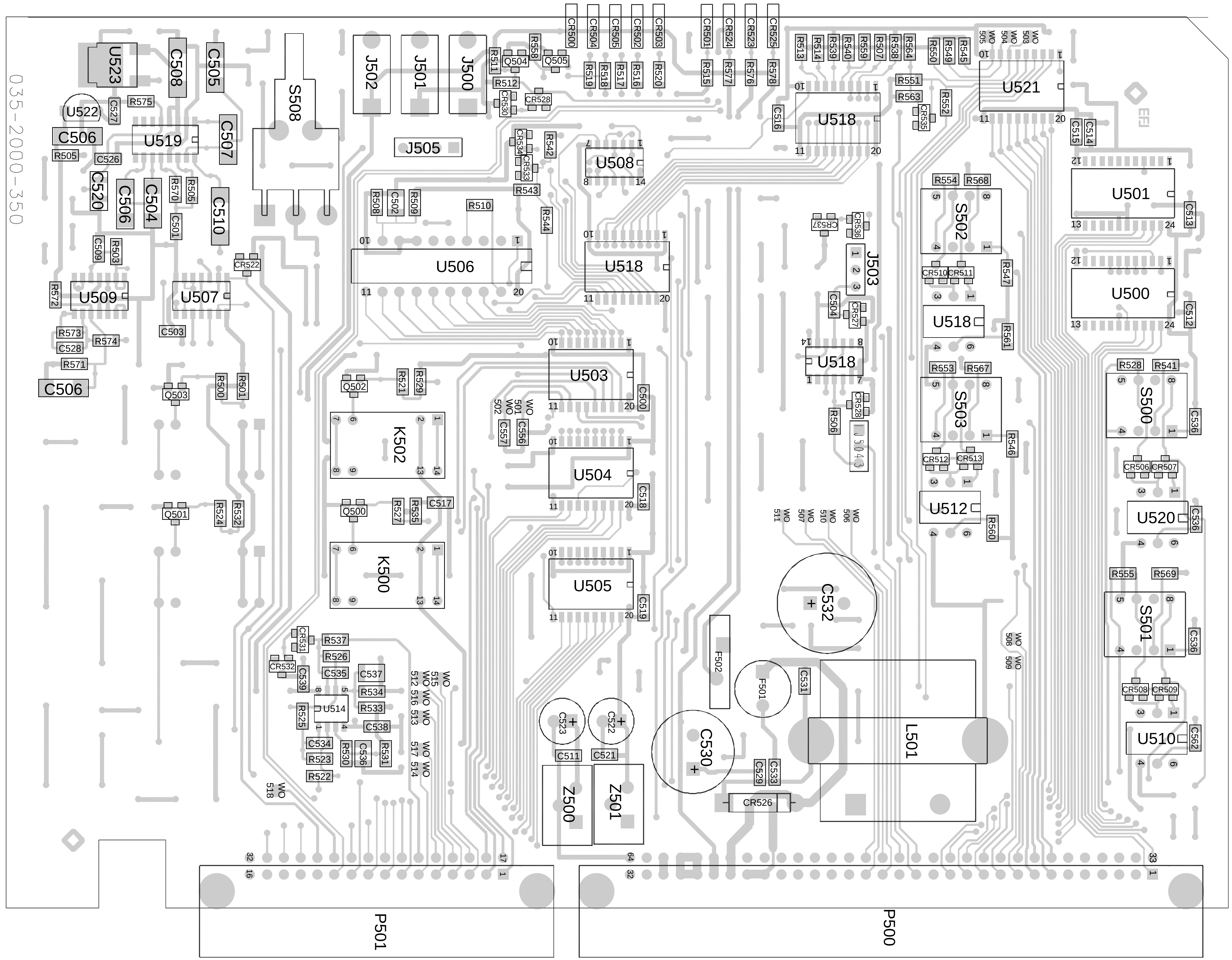


MAIN AUDIO CARD SCHEMATIC (2 OF 3)
FIGURE 10-27

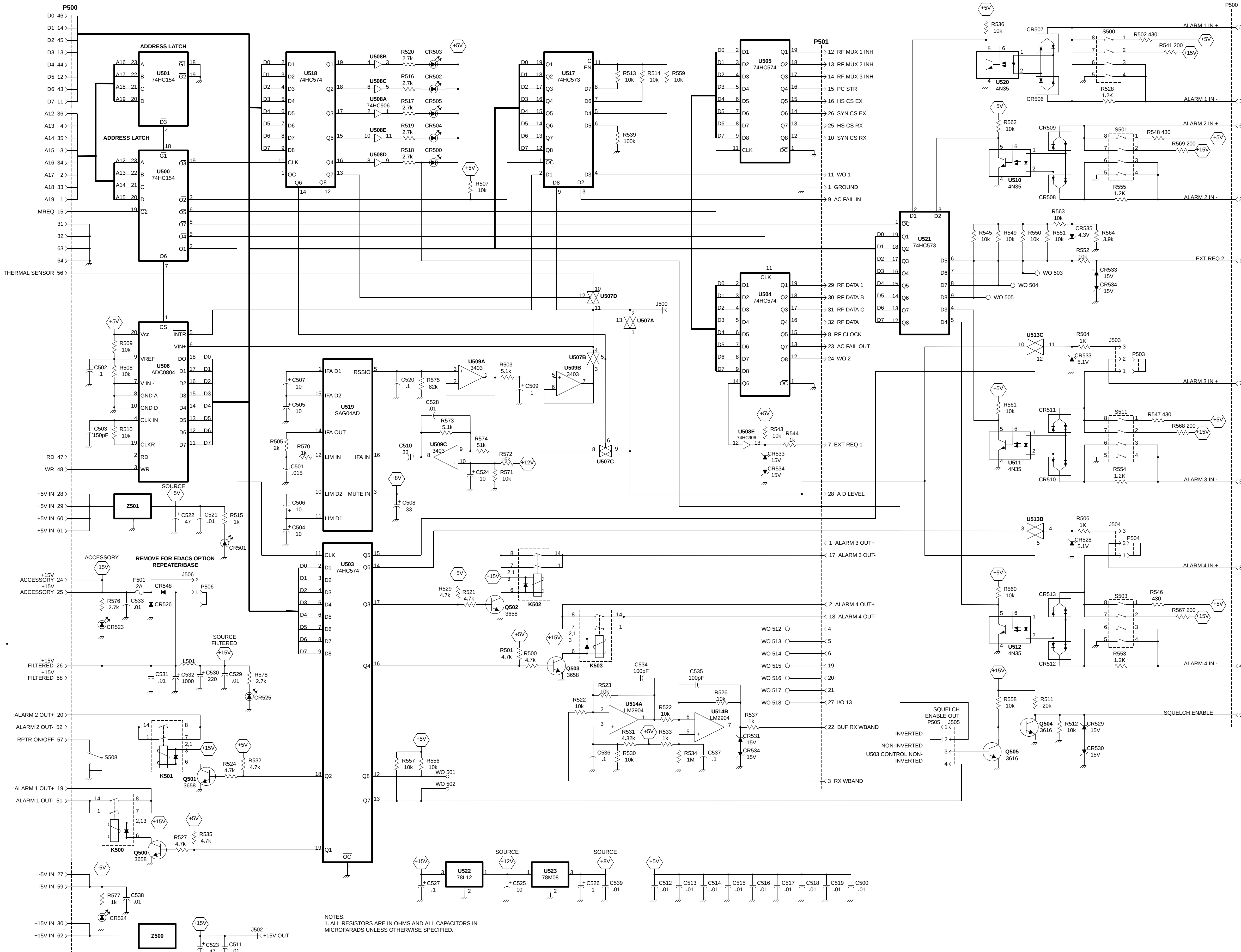


MAIN AUDIO CARD SCHEMATIC (3 OF 3)
FIGURE 10-28

FOLDOUT

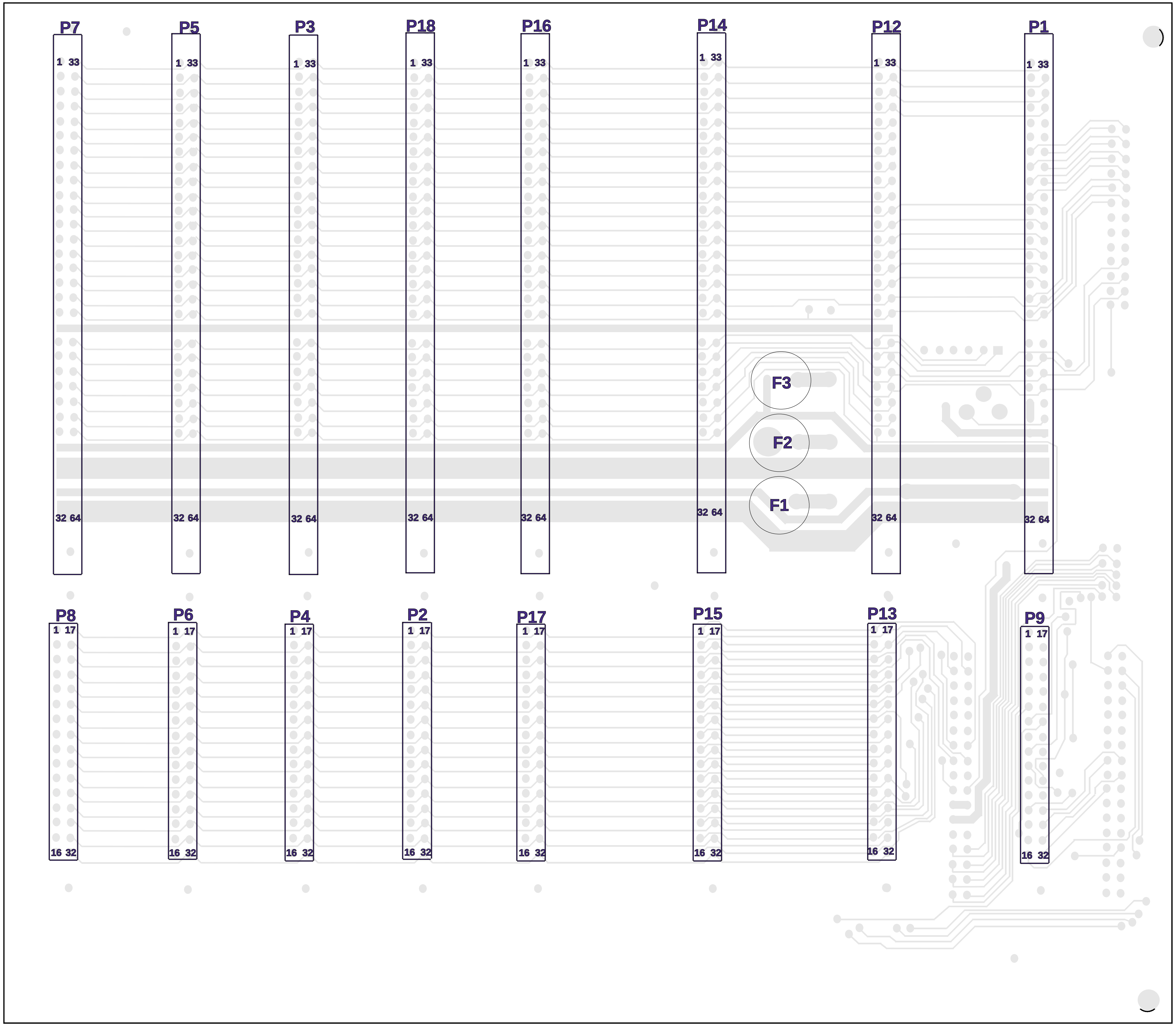


IAC COMPONENT LAYOUT
FIGURE 10-29

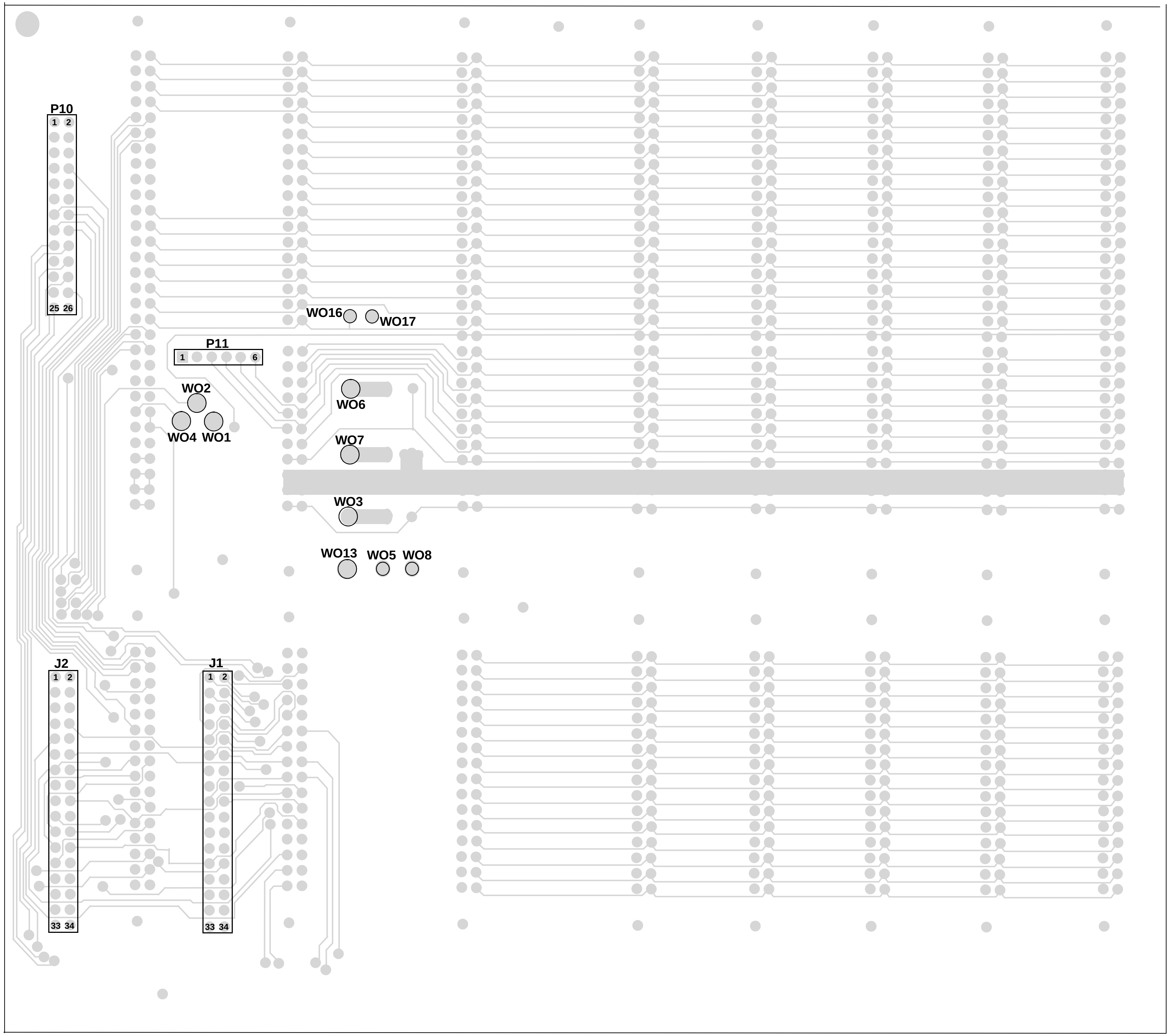


IAC SCHEMATIC
FIGURE 10-30

FOLDOUT

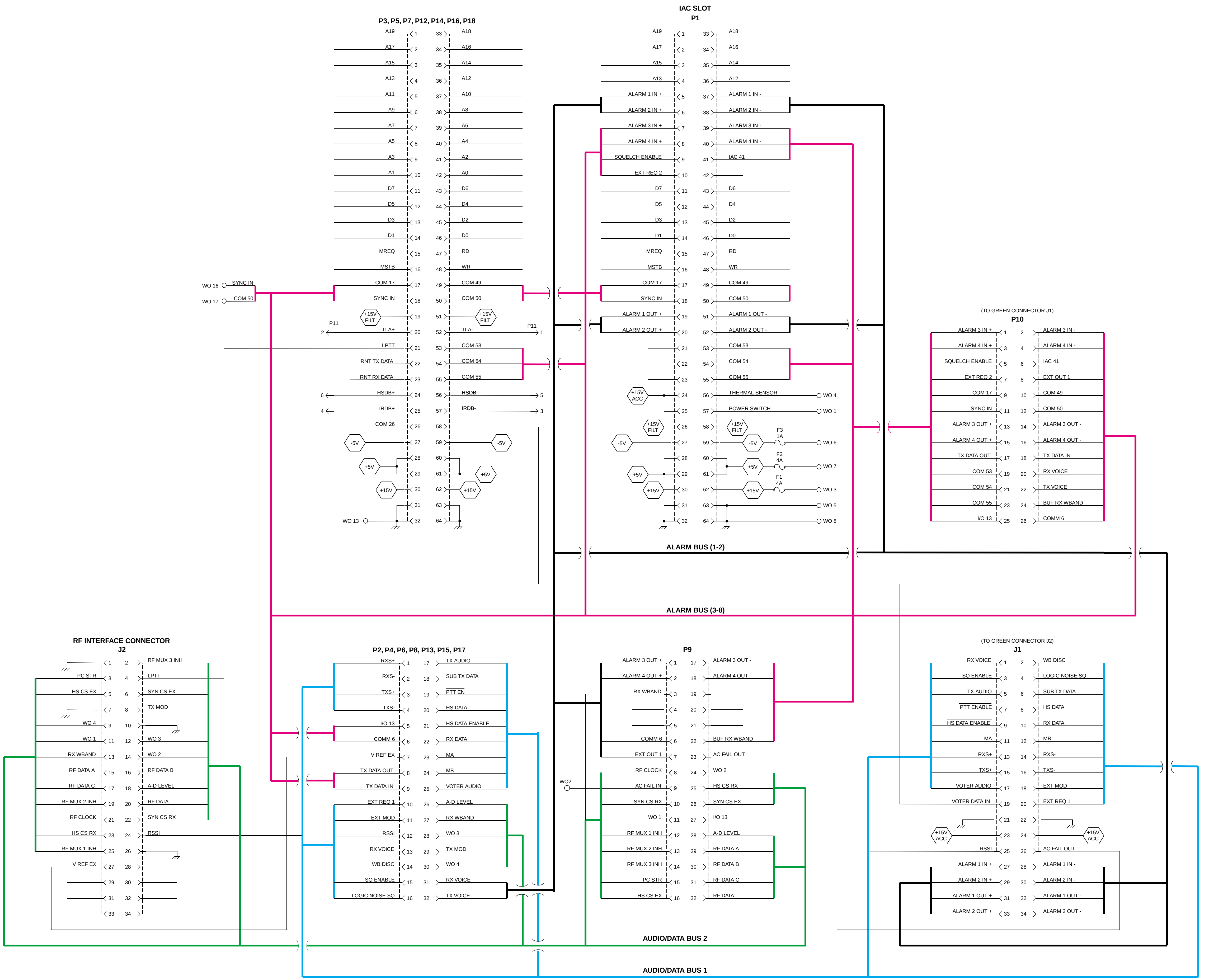


BACKPLANE COMPONENT LAYOUT (CARD SIDE)
FIGURE 10-31



BACKPLANE COMPONENT LAYOUT (CABLE SIDE)
FIGURE 10-32

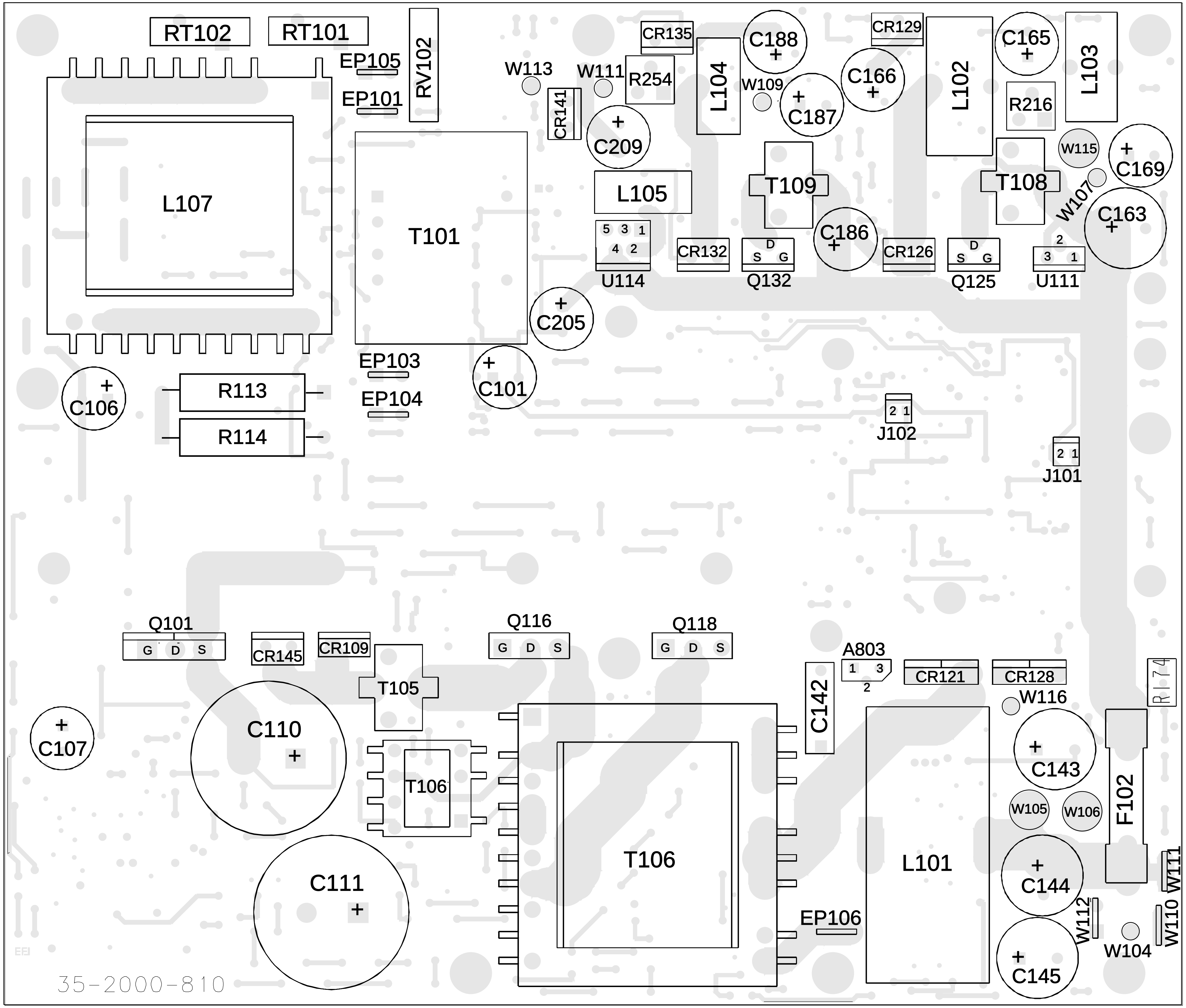
FOLDOUT



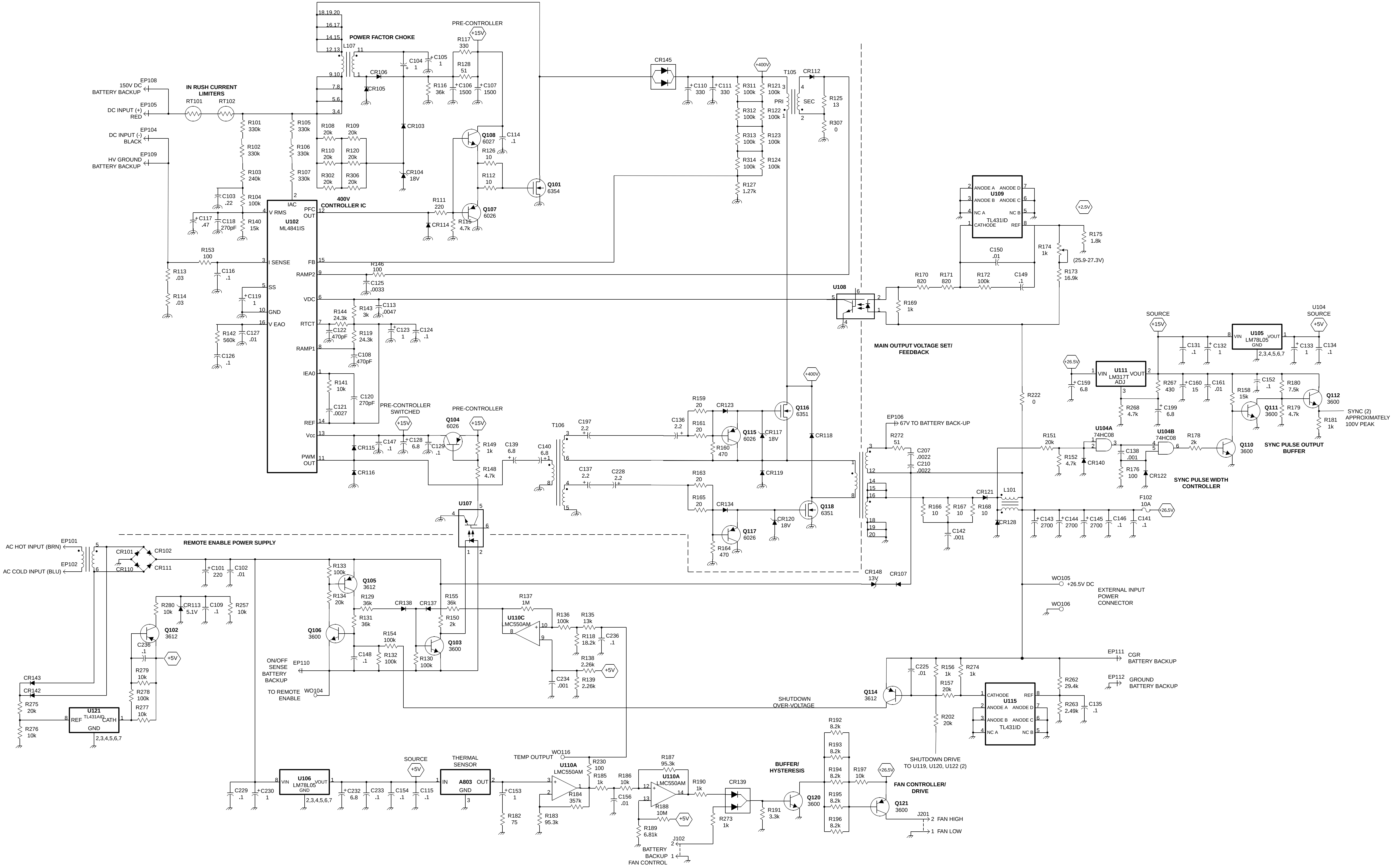
BACKPLANE SCHEMATIC
FIGURE 10-33

800W POWER SUPPLY COMPONENT LAYOUT
(OPPOSITE COMPONENT SIDE)
FIGURE 10-34

FOLDOUT

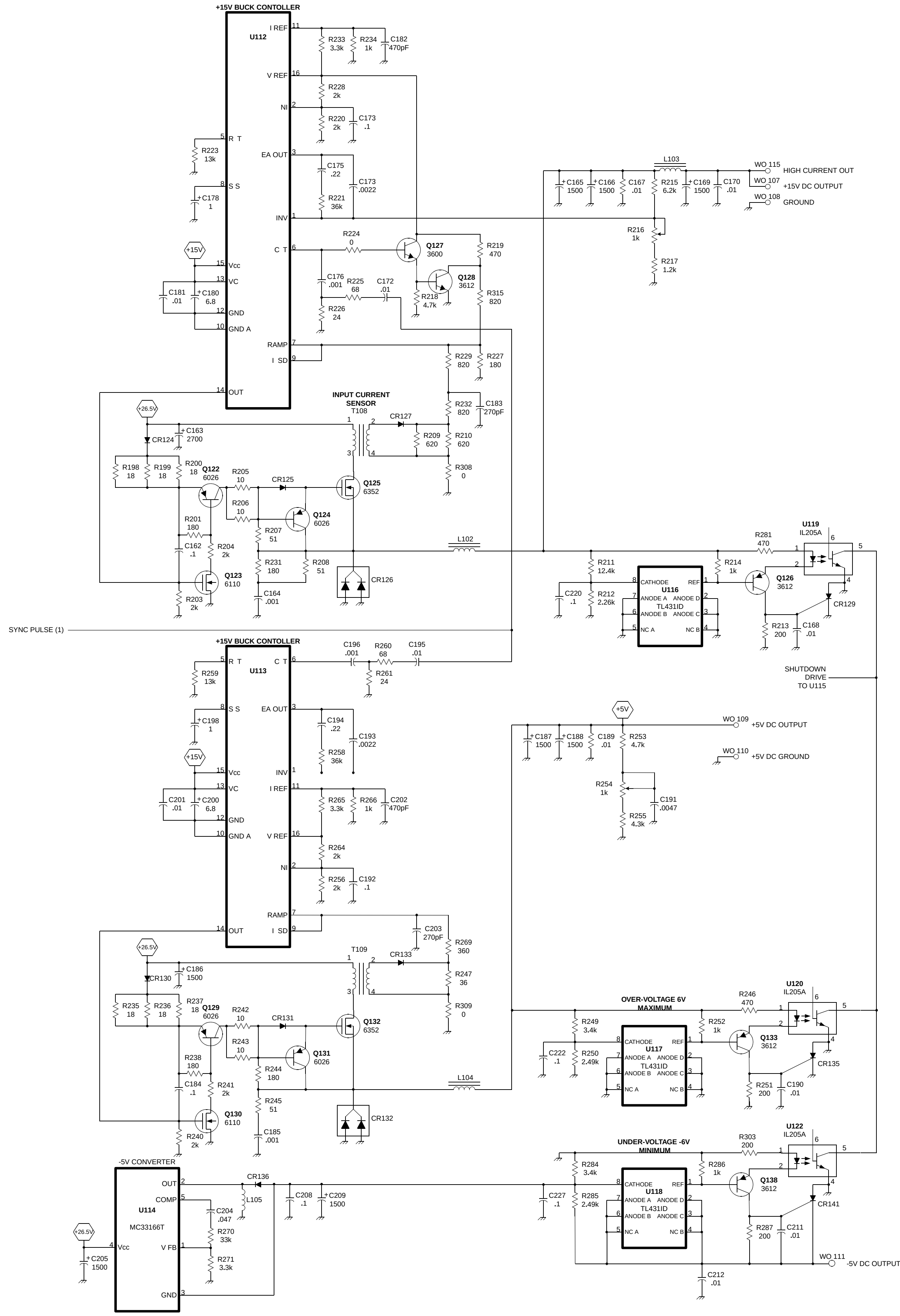


800W POWER SUPPLY COMPONENT LAYOUT
(COMPONENT SIDE VIEW)
FIGURE 10-35

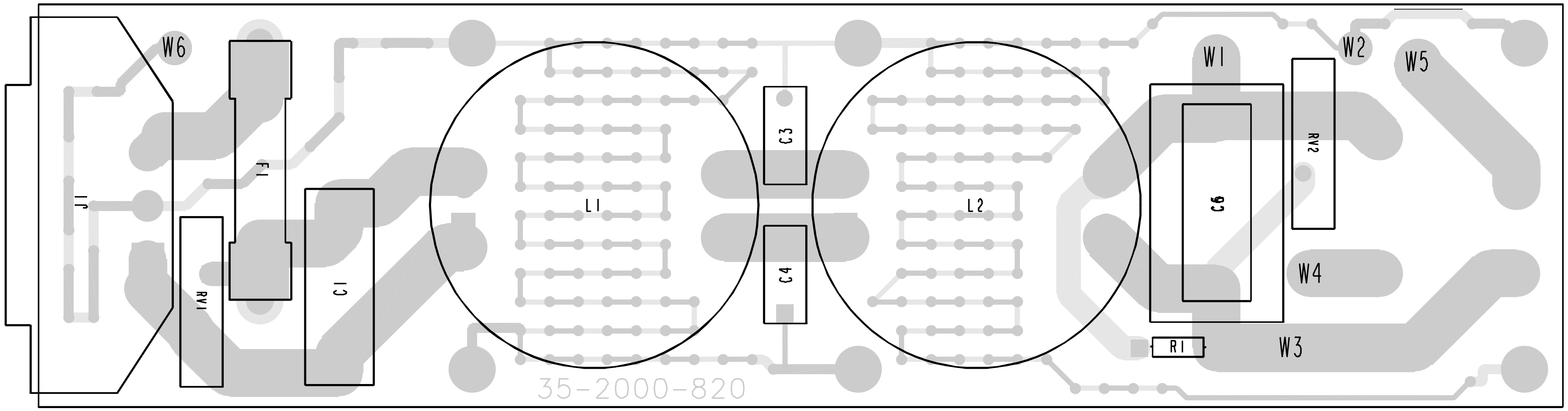


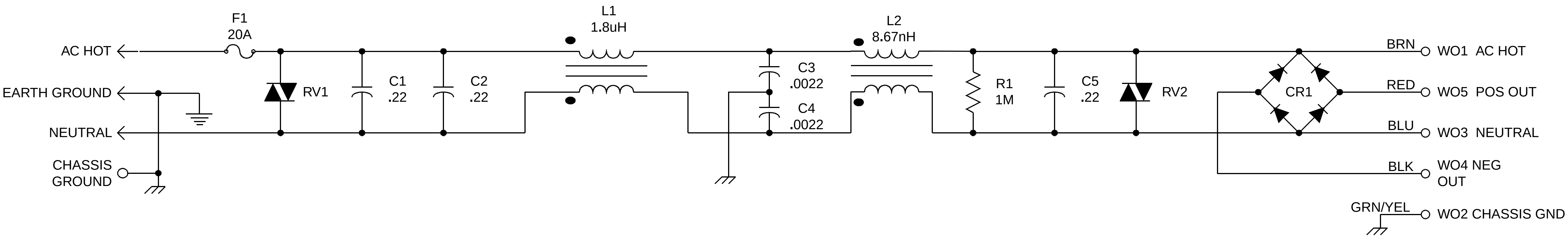
800W POWER SUPPLY SCHEMATIC (1 OF 2)
FIGURE 10-36

FOLDOUT



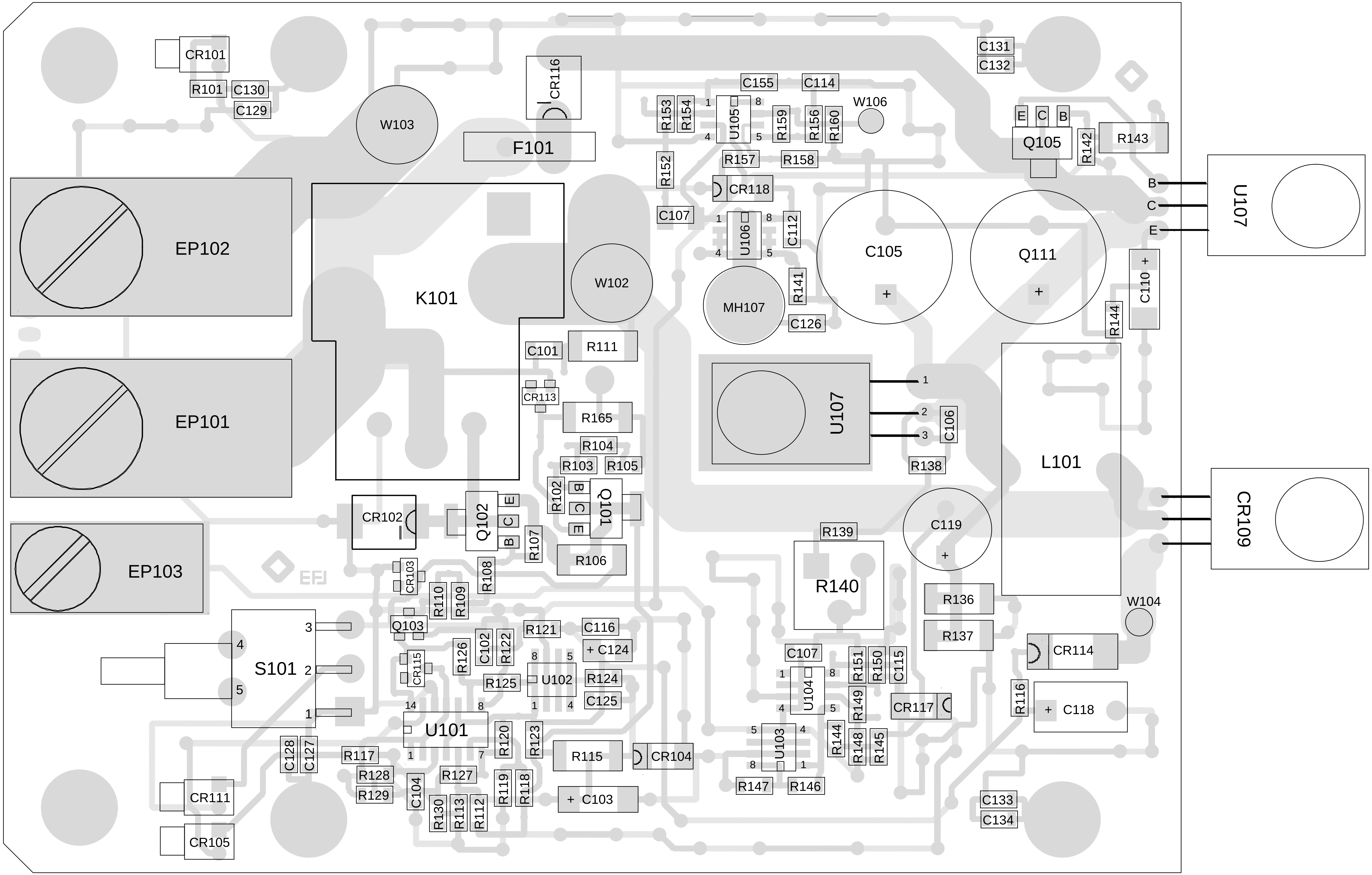
800W POWER SUPPLY SCHEMATIC (2 OF 2)
FIGURE 10-37



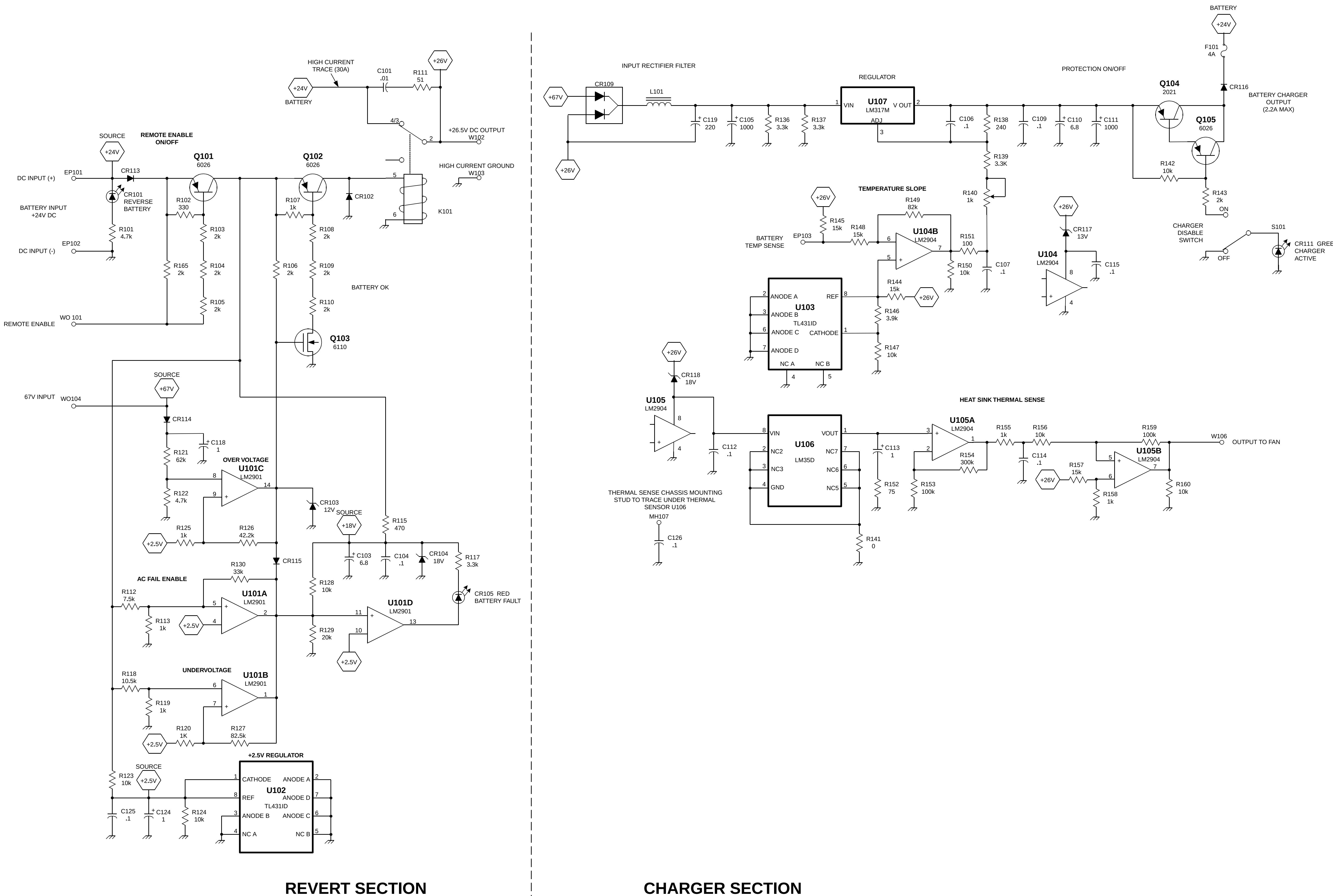


AC FILTER BOARD
FIGURE 10-38

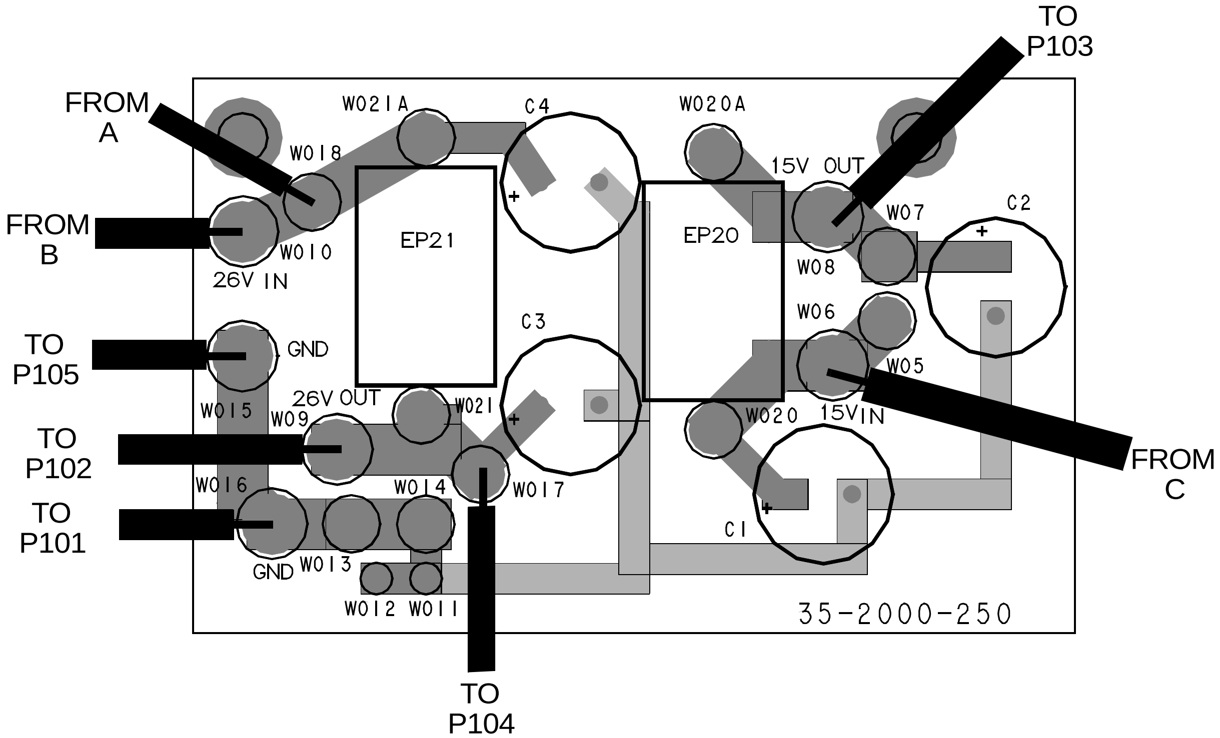
FOLDOUT



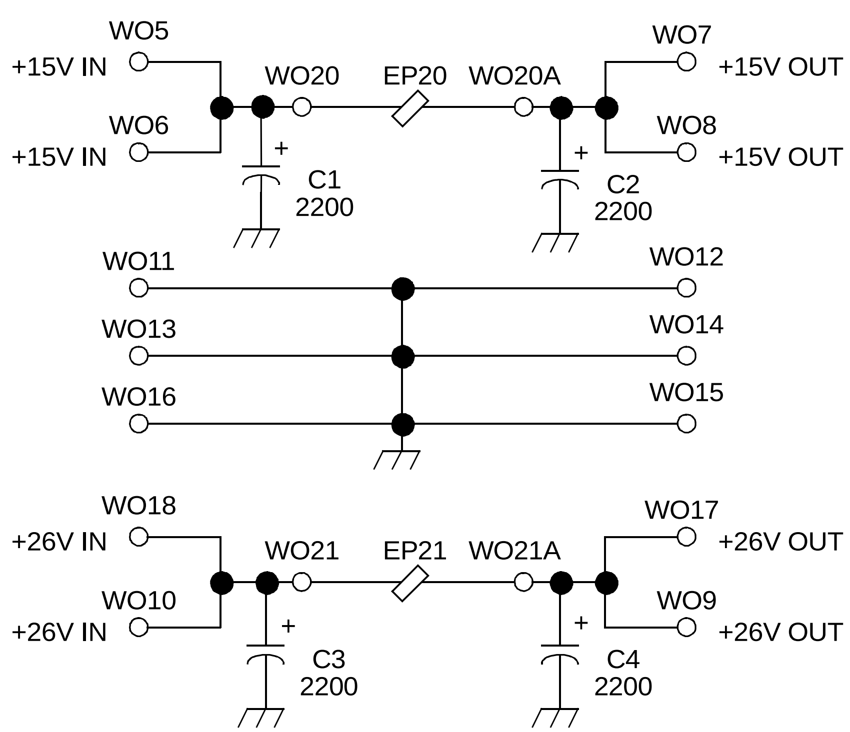
BATTERY BACK-UP COMPONENT LAYOUT
FIGURE 10-39



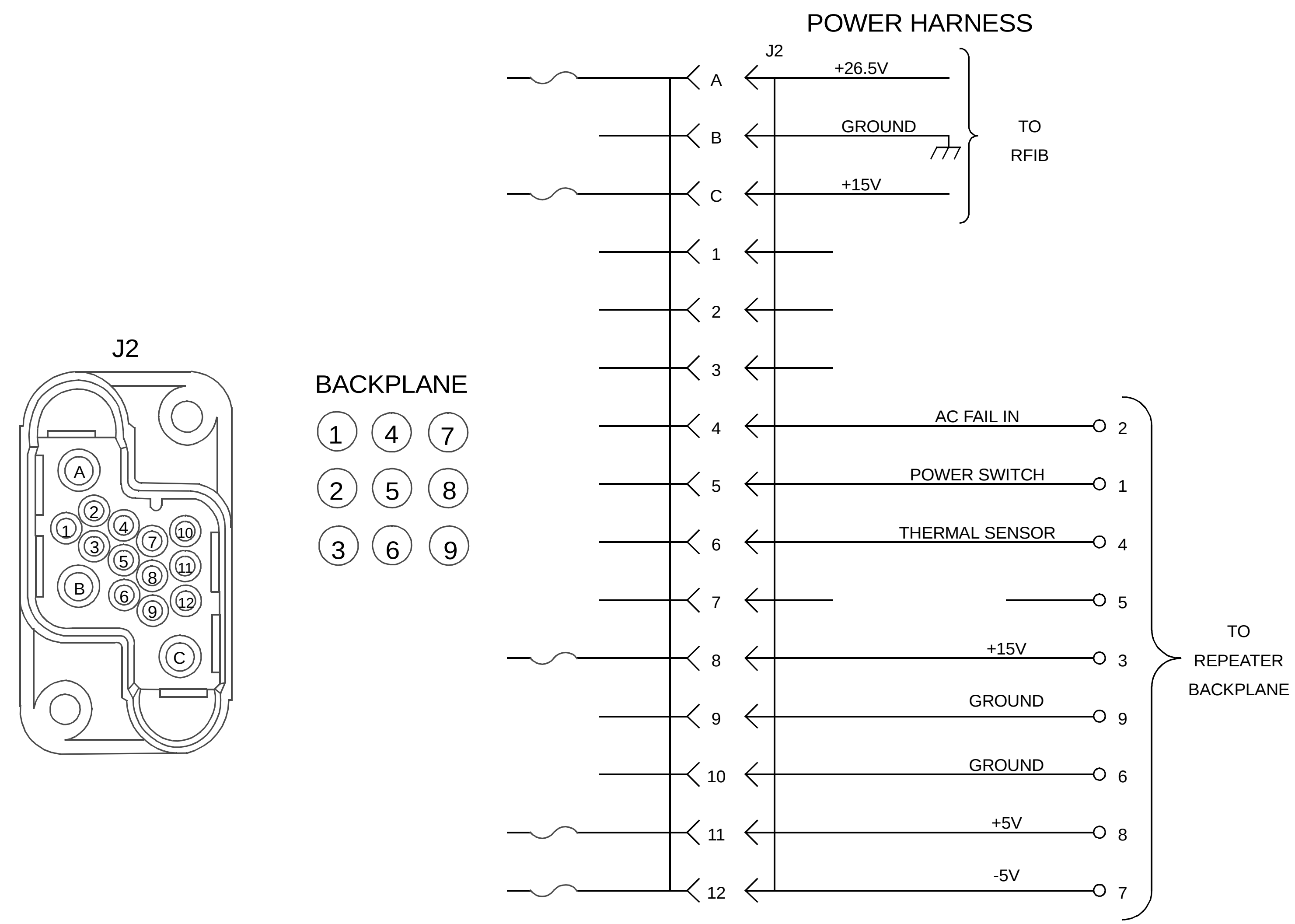
BATTERY BACK-UP SCHEMATIC
FIGURE10-40



POWER FILTER BOARD COMPONENT LAYOUT
FIGURE 10-41



POWER FILTER BOARD SCHEMATIC
FIGURE 10-42



POWER CABLE CONNECTOR AND SCHEMATIC
FIGURE 10-43

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