Heath

SS-9000

SERVICE MANUAL

HF Synthesized Transceiver

Service Manual

Model SS-9000
HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022
575-3

Copyright © 1983
Heath Company
All Rights Reserved
Printed in the United States of America

TABLE OF CONTENTS

INTRODUCTION

The Heath Model SS-9000 HF Synthesized Transceiver covers the high frequency amateur bands (plus approximately 75 kHz above and below most bands) from 1.8 to 29.7 MHz. This microprocessor-based Transceiver is entirely solid-state and delivers 100 watts to a 50 ohm load. Broadband tuning eliminates the necessity to "peak" circuits within a band. Just turn the Band switch and select the desired frequency.

A large, dual readout displays the operating frequency directly. (In split operation, the transmit and receive frequencies are displayed simultaneously.) A crystal-controlled time base provides high accuracy on all bands and eliminates the necessity of a calibrator. A smoked window, which provides subdued lighting and high visibility, covers the frequency display.

A VOX Delay control is conveniently located on the front panel to facilitate adjustments for operators who work both CW and SSB. VOX or PTT operation is switch selectable and you can switch the AGC action to fast, slow, or off. Jacks are provided on the rear panel for ALC input from an amplifier, and for remote switching an amplifier between transmit and receive.

Power for the Transceiver can be furnished by a power supply (such as the Heath Model PS-9000) or directly from an automobile battery.

The Transceiver's front panel meter always indicates S-units in receive. In transmit, you can select an indication of ALC, relative power, or compression.

Your Heath HF Synthesized Transceiver also gives you:

- Microprocessor circuitry that controls the entire operation of the Transceiver.
- An optical tuning encoder for smooth, linkage-free tuning with no backlash.
- Complete versatility in switching from transceive to split-frequency operation. In the split-frequency mode of operation, the display indicates the transmit and receive frequencies simultaneously on a large dual readout, and you can change the receive frequency while transmitting.
- Extended memory on each band. The internal memory stores the two frequencies indicated on the display plus an alternate frequency on each band. This results in a total of 27 selectable frequencies stored in RAM (random access memory). Also, a battery circuit keeps the memory alive during temporary power interruptions.
- An internal noise blanker to reduce impulse-type noise.
- An internal, front panel adjustable, RF speech processor.
- Two sideband filters for excellent receiver selectivity.
- Incremental plus and minus passband shift to help reduce adjacent frequency interference.

- RIT (receiver incremental tuning), which allows you to shift the receiver frequency without affecting the transmit frequency.
- Low-level RF, available for use with other station accessories.
- A VSWR, over-current, and thermally protected power amplifier.
- An internal diagnostic capability that indicates various malfunctions (if they occur) on the display.
- RTTY capability.
- **And the following accessory:**
  - **— Customer Service Manual.**

SPECIFICATIONS

GENERAL

Frequency Readout	Two 6-digit electronic displays.
Readout Accuracy	To the nearest 100 Hz.
Frequency Control	Synthesized VFO, HFO, and BFO for stability and easy tuning.
Tuning	100 Hz per step, 5 kHz per knob rotation. Pushbuttons provided for up/down tuning (rate is internally adjustable).
Operation	Split transmit/receive or transceive from either readout.
Synthesized Lock Indicator	Visual indication when the synthesizer is un-locked. Transmitter is disabled when the synthesizer is unlocked.
Frequency Coverage (megahertz)	**1.8 to 2.0*.** **3.5 to 4.0*.** **7.0 to 7.3*.** **10.1 to 10.15.** **14.0 to 14.350*.** **18.068 to 18.168*.** **21.0 to 21.450*.** **24.890 to 24.990.** **28.0 to 29.7.** **WWV @ 15.0**

*** Extended receiver coverage (above and below these bands).**

Frequency Stability .... Less than 3 ppm drift from turn-on for first 15 minutes.
Less than 3 ppm/hour drift after 15 minutes warm-up.
Less than 20 ppm drift from 0° C to +40° C.
(Single crystal-controlled 10 MHz frequency standard.)

Modes of Operation .... **LSB.**
USB.
CW-Wide.
CW-Medium (400 Hz filter).
CW-Narrow (200 Hz filter).
RTTY (LSB, 400 Hz filter).

Operating Temperature Range .... 0° C to +40° C.

Speech Processing .... Adjustable RF speech compressor.

IF Shift .... **Incremental plus and minus passband shift (−600, −400, −200, −100, 0, +100, +200, and +400 Hz) in the SSB modes.**

Power Requirements* .... 11 to 16 VDC with a nominal current maximum of 25 amperes at 100 watts CW output. Receiver current is 2 amperes nominal.

Front Panel Connectors .... Microphone, headphones.

Rear Panel Connectors & Control .... **Antenna (SO-239).**
Linear ALC In.
Linear ALC Adjust.
Low Power Enable.
Spares (5).
DC Power Input.
CW Key Jack.
External Transmit Audio In (2).
Speaker Out.
External Receiver Audio.
T/R In.
T/R Out.
Mute.
Mute (inverted).
External Relay (linear).
RS-232 Computer interface.

*All specifications are referenced to 13.8 VDC at 25°C ambient.

Front Panel Meter	Receive: S units. Transmit (selectable: ALC, relative RF power, or speech compression).
Phone Patch Impedance	4 ohm output to speaker, high impedance input to transmitter.
Available Accessories	**AC power supply/speaker with built-in dual time 12/24-hour clock.** **Customer Service Manual.**
Cabinet Dimensions	6-1/8" high × 14" wide × 13-3/4" deep (15.6 × 35.6 × 34.9 cm).
Weight	35 lbs (15.9 kg).

TRANSMITTER

RF Power Output	**SSB: 100 watts PEP.** **CW & RTTY: 100 watts.**
Duty Cycle	100% with appropriate automatic power output reduction by an internal thermal sensor. This reduction is determined by the time factor and the ambient temperature. The nominal parameters are as follows:

Ambient Temperature:	+25° C.
Supply Voltage:	+13.8 VDC.
Frequency:	14.1 MHz.
Mode:	CW key down, 100% duty cycle.

Example:

Power Output	Time
100 watts	0 min.
80 watts	3 min.
60 watts	10 min.
40 watts	Infinite

Load Impedance	50 ohms.
VSWR	This Transceiver is stable at any VSWR and load impedance. The VSWR cutback circuitry guarantees at least 80% of rated power at any VSWR less than 2:1 and a minimum of 15 watts at any VSWR.
Transmitter Protection	Thermally protected. High VSWR cut-back. Overcurrent protection.
Carrier Suppression	50 dB down from a 100 watt, single-tone (1000 Hz) output.
Unwanted Sideband Suppression	55 dB down from a 100 watt, single-tone (1000 Hz) output.
Harmonic Radiation	50 dB down below 50 MHz; 65 dB down above 50 MHz.
Spurious Radiation	50 dB down, except at 17 meters (40 dB down).
Third Order Distortion	30 dB down from a 100-watt, PEP, two-tone output.
T/R Operation	SSB: PTT or VOX. CW: Semi break-in.
CW Sidetone	**To speaker or headphones (800 Hz tone, adjustable level).**
Microphone Input	High impedance (25 k ohm) with a rating of −55 dBm.

RECEIVER

Sensitivity	0.3 μV for 10 dB (S+N)/N SSB on the 40 thru 10 meter bands; 0.5 μV on the 160 and 80 meter bands.
Selectivity	2.1 kHz at 6 dB down; 5 kHz at 60 dB down. CW filters: CWM: 400 Hz at 6 dB down; 1.5 kHz at 60 dB down. CWN: 200 Hz at 6 dB down; 1 kHz at 60 dB down.
Overall Gain	Less than 1 microvolt for a .25 watt audio output.
Audio Output	1.5 watts into 4 ohms at less than 10% THD.
AGC	Fast-attack with switch selectable Off, Fast, and Slow decay.
Intermodulation Distortion 20 kHz spacing	−70 dB.
Image Rejection	−80 dB (except −65 dB on the 17 and 12 meter bands).
Second IF Rejection	−90 dB.
First IF Rejection	−80 dB (except −60 dB on the 40 and 30 meter bands).
Internally Generated Spurious Signals	Generally below the noise level; all below 1 μV equivalent.
RIT	± 250 Hz.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the "Transceiver Block Diagram" (fold-in) and the "Transceiver Schematic" (fold-in) as you read this "Circuit Description." The component numbers are arranged in the following groups to help you locate specific parts on the Schematic, circuit boards, and chassis.

1-99	Parts mounted on the chassis and meter circuit board.
101-199	Parts mounted on the synthesizer circuit board.
201-299 2001-2099	Parts mounted on the transmit/receive (T/R) circuit board.
301-399 3001-3099	Parts mounted on the main audio circuit board.
401-499	Parts mounted on the front panel and LED circuit boards.
501-599	Parts mounted on the preamp circuit board.
601-699 701-799	Parts mounted on the power amplifier (PA) circuit board.
801-899	Parts mounted on the controller circuit board.
901-974	Parts mounted on the bandpass filter circuit board.
975-999	Parts mounted on the external ALC circuit board.
1001-1099	Parts mounted on the inverter circuit board and subchassis.
1201-1299	Parts mounted on the power interface circuit board.
1400-1499	Parts mounted on the motor drive circuit board.
1500-1599	Parts mounted on the Transmitter (TX) audio circuit board.
1900-1999	Parts mounted on the ALC circuit board.

This Transceiver is a conventional dual-conversion receiver/transmitter for CW and SSB use. The first IF operates at approximately 9 MHz, while the second IF operates at 3.395 MHz.

Signals present at the antenna first pass through the high-pass and low-pass filters on the PA circuit board. These filters form a broad-band tuned circuit front end for the receiver. The signal passes through this tuned circuit before it is applied to the receiver preamplifier on the preamp circuit board. A PIN diode RF attenuator circuit on the preamp circuit board allows you to limit the amplitude of the signal by the RF Gain control before it is applied to the bandpass filter circuit board.

Nine electronically-switched, two-pole bandpass filters provide more filtering for the signal before it is applied to the first mixer on the T/R circuit board. In addition, the filter circuit board contains a 32 MHz low-pass filter and, on 20, 17, and 15 meters, a 24 MHz low-pass filter.

The local oscillator for the first mixer operates at a frequency that is above the first IF frequency. This local oscillator is called the HFO and tunes each of the nine amateur bands (160-10 meters) in 50 kHz steps. The actual HFO frequencies depend upon the band selected.

The 9 MHz signal from the first mixer is applied to the first IF amplifier (a dual-gate MOSFET stage with four poles of LC filtering) and then to the second mixer. Here, the first IF signal is mixed with a signal from the IFO (approximately 12.4 MHz) and a 3.395 MHz second IF signal results. The IFO frequency covers a 50 kHz range in 100 Hz steps.

The 3.395 MHz IF signal passes through a SSB filter, a MOSFET IF amplifier, CW filters (if selected), a second MOSFET amplifier, a second IF filter, a third IF amplifier, and then to the product detector.

Audio from the product detector is controlled by a mute gate on the audio circuit board (which inhibits the receiver audio in the transmit mode), and passes through the AF Gain control, a low-pass filter (to restrict the audio bandpass), and the integrated circuit power amplifier. The resulting boosted audio is of sufficient amplitude to drive a speaker or headphones.

In the transmit mode, the transmitter audio (from the microphone, external audio input, or CW sidetone) is first applied to the transmitter audio preamp. The audio is then applied to the VOX circuit and the balanced modulator on the T/R circuit board.

The VOX circuit passes a "request to transmit" (T_{REQ}) to the microprocessor which, after checking the status of the other circuits, passes a $\overline{T_{OK}}$ signal back to the timing circuit on the audio circuit board. This circuit generates the actual receive and transmit command signals required by the other circuits in the Transceiver.

On the T/R circuit board, the balanced modulator generates a double-sideband signal which passes through FL204 and speech compression in the transmit second IF, is refiltered by FL201 before it is applied to the second mixer. Here, the signal is mixed with the IFO signal to produce a 9 MHz IF signal. The signal then passes through the first IF amplifier (in the opposite direction from the receive signal), the first mixer, and the proper filter on the bandpass filter circuit board before it is applied to the preamp circuit board.

The filtered signal is amplified by the transmit predriver, passed through a high-pass filter on the PA circuit board, and then amplified again by the transmit predrivers and power amplifiers. The resulting 100-watt signal is then passed through a low-pass filter, a VSWR detector circuit, and a relative power sensor before it is applied to the antenna.

ALC and other protection circuits on the preamp and PA circuit boards protect the transmitter circuits from high temperatures, over current, and high VSWR. These protection circuits all control the RF attenuator in the same manner as the RF Gain control in the receive mode.

A two-stage IF amplifier on the T/R circuit board provides speech compression for the transmitter audio. The output from the second IF amplifier is further amplified by another IF amplifier and applied to a detector stage. This detector applies an AGC voltage to the first two IF amplifiers and effectively holds the output of these stages constant. The time constant of this AGC loop determines the amount of speech compression.

A basic frequency standard and the three synthesizer loops for the voltage-controlled oscillator sections on the T/R circuit board (HFO, IFO, and BFO) form the synthesizer.

The HFO loop consists of a conventional frequency divider/phase detector which has a basic reference frequency of 25 kHz. The divider action of U202B provides 50 kHz steps to the input of the first mixer.

The IFO loop contains a down-mixer and a divide-by-four stage. The IFO VCO operates at four times the IFO output frequency applied to the second mixer. This four times frequency (approximately 49.6 MHz) is mixed with 40 MHz, coming from the frequency standard, and results in a 9.6 MHz difference frequency. This frequency is applied to the divide-by-N2 divider and then to the phase detector, where it is locked against a 3.2 kHz reference. The combination of the divide-by-four stage and the fractional divide technique results in 100 Hz steps at the output of the IFO (this is the local oscillator input to the second mixer).

The BFO loop operates similarly to the HFO loop in that it involves no mixing. The 3393.5 kHz BFO VCO is divided down by N3 and then drives the phase detector, which has a 1.6 kHz reference frequency. Like the IFO loop, however, this loop uses a fractional divide technique and produces 100 Hz steps.

The main divider (U110-U113) provides the various reference frequencies for the three synthesizer loops plus a 2 MHz standard for the microprocessor. This divider uses the 10 MHz clock, which is the basic standard for the Transceiver.

A controller circuit forms the "intelligent" heart of this Transceiver. This circuit performs an interface function between external requests, via front panel controls and terminal interface, and the internal circuits (on the synthesizer and T/R circuit boards). The controller consists of a CPU, a peripheral interface adapter, a static memory interface, a read only memory (for the program sequence), 256 bytes of CMOS RAM, and various latches and gates.

Signals from the Band, Mode, Passband Shift, and Frequency Scan switches, together with signals from the rotary shaft encoder, are decoded on the front panel circuit board. The visual outputs include status indicators and the 16-digit (12 actually used) vacuum fluorescent display tube.

Switching circuitry is also provided on the front panel circuit board to switch the meter between the various functions. These functions include S units in the receive mode and ALC, relative power, or compression level in the transmit mode.

Other support assemblies for this Transceiver include an inverter circuit board and a power interface circuit board. The inverter circuit board uses the +13.8-volt input source to provide a regulated +28 volts for the display circuits and the +12, −5, and −12 volts for the controller circuit board. The interface circuit board provides overvoltage and reverse polarity protection for the Transceiver as well as keying and muting signals for external accessories.

The heart of the terminal interface circuit is an asynchronous communications element (ACE). This device performs the functions of the conventional UART; but in addition, has an internal software programmable baud rate generator, as well as modem control and a self test function. The clock is derived from the 2 MHz CPU clock on the controller circuit board.

POWER INTERFACE CIRCUIT BOARD

The power interface circuit board contains an overvoltage protection circuit for the main 13.8-volt supply. This circuit board also provides keying for an external linear amplifier as well as muting for other station equipment.

Transistors Q1201 and Q1202 form the overvoltage protection circuit. When the main supply voltage increases above 16 VDC, diode D1202 holds the voltage at the base of Q1201 to 16 volts. This causes Q1201 to conduct and turn off Q1202. When Q1202 is off, relay K1 deenergizes and removes the main supply voltage from all other circuits.

A high voltage keying circuit is formed by Q1203, Q1204, Q1205, and Q1206. This circuit has the capability of working with linear amplifiers that require either positive or negative 150 volts for switching in transmit.

In the transmit mode, a signal from the audio circuit board causes the base of Q1203 to go high. The resulting low on the collector of Q1203 causes the collector of Q1204 to go high. This high causes the emitter of Q1205 to go low. Since the emitter of Q1203 is also high, the collector of Q1206 is low. If a negative 150 VDC is present at External Relay jack J14, this voltage is passed to ground through D1205 and Q1205. If a positive 150 VDC is present at J14, this voltage is passed to ground through D1207 and Q1206.

Also in the transmit mode, the base of Q1207 is high, which causes the collectors of Q1208, Q1211, and Q1212 to go low. The lows on Q1211 and Q1212 cause jacks J3 (T/R Out) and J10 (Mute) to be grounded. The low on Q1208 causes the collector of Q1209 to be high and present an open circuit to jack J9 (Mute).

INVERTER CIRCUIT BOARD

The inverter circuit board provides the +28-volt supply for the front panel circuit board and the +12, −12, and −5-volt supplies for the controller circuit board.

The output of U1001 drives Q1001 and Q1002, which provide a higher current capability to drive the voltage multipliers. D1005 and D1006 provide approximately −12 volts to Q817 on the controller circuit board. U1004 provides a regulated −5 volts for the controller circuit board. The remaining voltage mutiplier provides the input to U1003, which is a 12-volt regulator that is bootstrapped to provide approximately 28 volts regulated for the front panel circuit board. This insures that the intensity of the display does not vary with changes in the supply voltage. Regulator U1002, which is also supplied by the same voltage multiplier, provides +12 volts for the controller circuit board. L1001, C1001, C1002, and C1004 form a low-pass filter to prevent any pulses from appearing on the +13.8-volt supply.

BANDPASS FILTER CIRCUIT BOARD

The bandpass filter circuit board contains electronically-switched bandpass filters for each band. In receive, these filters feed the antenna input (via the PA and preamp circuit boards) to the first mixer on the T/R circuit board. The filters remain in the line between the transmit/receive circuit board and the power amplifier circuit board in transmit.

In the 160-meter position, the Band switch places +8 VDC at resistors R902 and R903, which forward biased diodes D901 and D902. Diodes D903 through D909, D911 through D919, and D921 are reversed biased. This places the 160-meter filter, which consists of C902, C904, C905, L901, and L902, in the signal path and effectively removes all other filters from operation. Similarly, the Band switch selects the filters for the 80- through 10-meter bands.

L912, L913, L914, and C939 form a 24 MHz low-pass filter, which is used only on the 15-, 17-, and 20-meter bands. The 32 MHz low-pass filter formed by L915, C941, C942, and C943 is used on all nine bands.

FRONT PANEL CIRCUIT BOARD

The front panel circuit board contains the circuitry for the display, meter function selection, LED driver, and the shaft encoder.

U401 receives binary scan data (in one's complement form) from the controller circuit board and causes outputs Q15 through Q4 to go low one at a time. Outputs Q15, Q14, Q13, Q12, Q11, and Q6 are connected to groups of switches. As each of these outputs go low, closed switch contacts cause the diodes connected to those contacts to conduct and take the corresponding switch lines low.

As each output of U401 goes low, the corresponding output of U402 or U403 goes high. U405 and U406 translate this TTL high to 28 volts, which is applied to the grid of the corresponding digit in the display. After a particular digit is selected, the controller circuit board supplies the appropriate segment information to U404 to form the required character. U404 translates the TTL logic high to 28 volts and applies it to the segment anodes. Like segments of all digits are tied together inside the display tube, but only those of the selected digit can light. Every 12 milliseconds, the switches and displays are updated.

The shaft encoder uses two slotted optical switches and an encoder disc that has alternating transparent and opaque strips. The optical switches consist of an infrared emitter and a photo transistor on opposite sides of the slot. When a transparent section of the disc is between the emitter and the photo transistor, the photo transistor is turned on. The spacing between these switches is set so that, as the disc rotates, there are four distinct states: both on, both off, and one or the other on by itself.

Counterclockwise rotation of the disc produces a different sequence of states than a clockwise rotation. This allows the controller circuit board to determine the direction of rotation. Q406 and Q407 form a Schmitt trigger for one of the shaft encoders to provide clean transitions and prevent false stepping. Q408 and Q409 perform the same function for the other shaft encoder.

U411E, U412, and U413B function as a divide-by-3 counter. When you first turn the Transceiver on, C407 and R432 reset this counter. The output of U411B inverts the high on the output of U413B and lights LED D453, which is the ALC meter indicator. The counter advances each time you push Meter switch SW415. U411C and U411D debounce this switch to prevent erratic operation. U414 is a quad analog switch. When the control input to a switch section is high, the switch is in an "on" state and passes the appropriate signal to the meter. In the receive mode, only switch U414D is on. This passes the S-meter level to the meter regardless of the selected transmit meter function. In the transmit mode, U413A, U413C, or U413D turn on the appropriate section of U414.

U410 drives the status LEDs, which are mounted on the LED circuit board in front of the display.

The circuit formed by Q401, U409A, and Q402 through Q405 pulse each half of display V401 to insure uniform intensity of all digits.

CONTROLLER CIRCUIT BOARD

The controller circuit board performs the following functions:

1. Supplies frequency information to the display.
2. Scans most of the front panel switches for any change in status and updates the appropriate frequencies and functions.
3. Performs an algorithm to determine the IFO, HFO, and BFO frequencies which correspond to the current operating frequency and switch settings. It then programs the divider circuitry of the three phase-locked loops accordingly.
4. Preserves frequency and display status for each band when the Transceiver is off.
5. Checks the selected transmit and receive frequencies against internal limit tables.
6. Monitors the phase-locked loops for an out-of-lock condition and reports such a condition via the display. If the Transceiver is in the transmit mode when the condition occurs, the controller forces the Transceiver to change back to the receive mode.
7. Provides terminal functions via an EIA serial port.
8. Performs tests on ROM and the asyncronous communications element (ACE) each time you turn the Transceiver on. It also tests RAM if the standby battery supply has been interrupted.

The heart of the controller circuit board is U806, a 3850 (F8) CPU. U801, a static memory interface (SMI), interfaces the CPU with the memory. Digit select signals (in one's complement form) to the display appear on the four least significant bits of port 0 on U806. These are decoded on the front panel circuit board into twelve lines which scan the display and the switches. Port 1 of U806 supplies the segment information. The four most significant bits at port 0 input the status of the switches as they are scanned.

U805, a peripheral input/output (PIO) device, provides the remainder (except the divider data to the loops) of the required inputs and outputs. Data to the programmable dividers are latched into hex-D flip-flops U812 through U816 in a manner to be described later. These devices communicate with each other via the data bus and the five ROMC lines. They share common "o" and "write" lines, which provide the timing information.

Communication between the controller and various other sections of the Transceiver is provided by U805. The functions of each of its I/O lines are described below.

Port 4

Bits 0, 1, and 2 — These lines are interrupts from the out-of-lock circuits in the HFO, IFO, and BFO loops respectively.

Bit 4 — Provides the signal to the stepper motor driver circuitry to allow band selection via the terminal interface.

Bit 5 — Mute control output. This line allows the controller to mute receiver audio briefly upon turn-on, and during band or mode changes, to avoid audio transients as the loops relock.

Bit 6 — Up/down. When a transition occurs on the EXT. INT. line, the level on this line determines whether the frequency is to increment or decrement by 100 Hz. The inputs to these two lines come from the shaft encoder and are quadrature signals. If the EXT. INT. goes low while this line is high, or goes high while this line is low, the frequency increments.

Bit 7 — TX REQ. When this input goes low, the controller interprets it as a request to go to the transmit mode. It first checks the transmit frequency to see if it is within the valid range for the band selected. If it is a valid frequency, it reprograms the IFO and HFO loops as necessary, waits for the loops to lock, and then takes TX OUT low.

Port 5

Bit 0 — RX status. The level on this line determines which "R" LED lights.

Bit 1 — TX status. The level on this line determines which "T" LED lights.

Bit 2 — This line is high only in the RTTY mode. Its output is "OR'ed" with bit 5. If either of these lines is high, it disables the microphone audio input.

Bit 3 — CW narrow. This line goes high in the CW-N mode to switch in the 200 Hz IF filter.

Bit 4 — CW medium. This line goes high in the CW-M mode to switch in the 400 Hz IF filter.

Bit 5 — CW wide. This line goes high in all three CW modes to enable the sidetone oscillator and disable the rear panel transmit audio inputs.

Bit 6 — ACE reset. This line provides a positive reset pulse to the ACE chips shortly after turn-on.

Bit 7 — TX OUT. This line goes low in response to the TX REQ. input. It does so only in after the controller determines that the selected transmit frequence is valid and the loops are locked. If a loop unlocks in the transmit mode, this line goes high until lock reoccurs.

INT. REQ. — This line is initially programmed to respond to a positive-going edge. When it receives this edge from the shaft encoder, the controller checks the level on port 4, bit 6 to determine the required step direction. The INT. REQ. line is then programmed to be active low to await the next (low-going) transition. This allows two 100 Hz steps for each of the 25 "slots" in the encoder disk and results in 50-kHz-per-disc rotation.

A 3-to-8 line decoder, U804, and gate packages U802 and U803 select the memory devices and latches. ROM U807 stores the main controller program code.

Since the circuit formed by Q803 and D806 reset the CPU upon turn-on, the CPU looks for its first instruction at address 0 (this ROM is addressed at the 2k block between 0 and $7FF_{16}$). When address lines A13 through A14 are low, a low on A12 enables U804 to take its "0" output line low which enables U802B. When the CPU needs to read data or instructions from memory, it takes the CPU READ line high. U802A inverts this high, which causes U803C to go low and enable U807 as required.

The ROM containing the program for the terminal interface (U808) is addressed by the 2k block between 800_{16} and FFF_{16}. In this case A11 is high, which causes the output of U803A to go low and enable U808.

RAM, U809 and U810, is addressed at 2000_{16}. While A12, A13, and A15 are low, A14 is high. This causes the "1" output of U804 to be low and enable the RAM ICs.

U811, an ACE IC, contains its own chip select circuitry. This IC is connected to respond to addresses in the $C000_{16}$ block.

Note that ROM, RAM, and the ACE IC all respond to addresses that have an even first digit (0, 2, or C_{16}). Since A12 is low in this case, U804 is enabled regardless of the state of the RAM WRITE line.

Since $\overline{\text{RAM WRITE}}$ is normally high, U804 is disabled by the low at the output of U803B when A12 is high (first digit is odd). To latch new data into HFO latches U812 and U813, the CPU forms an address using this data as A0 through A9 with a 7 as the first digit. The CPU then writes to this address, just as it would to RAM. When $\overline{\text{RAM WRITE}}$ pulses low, U803B enables U804, which decodes the 7 and a 3 and reproduces the low-going $\overline{\text{RAM WRITE}}$ pulse on its 3-output line. This line clocks the input to U812 and U813, which latch the data on address lines A0 through A9 on the positive-going edge of the pulse. Any data on the data bus at this time is ignored.

The data to the IFO and BFO dividers is latched into U814 through U816 in a similar manner. Here, the first digit in the address is 9, which causes the $\overline{\text{RAM WRITE}}$ pulse to pass to output "4" of U804. This clocks the data on A0 through A9 into U814 and U815. In addition, the data on data lines D0 through D5 is latched into U816.

U809 and U810 have a second chip-enable, which is used to disable the RAM when the Transceiver is off or the power is interrupted. When the 13.8-volt input falls below about 7.5 volts, the output of 5-volt regulator U819 begins to go out of regulation. This could cause an extraneous WRITE to occur and compromise the contents of RAM. C815 disables RAM prior to this time by discharging quickly through D801. This causes Q801 to turn off as the 13.8-volt line drops below 7.5 volts. Q802 also turns off and allows R825 to take CE2 low, thus placing the RAM in the standby mode.

When you turn the Transceiver on, C815 charges through R819. This provides a delay of approximately 10 milliseconds and allows the voltages to stabilize before Q801 turns on. Q801 then turns on Q802 to enable the RAM.

When the Transceiver is on, U820 provides 5 volts to U809 and U810. The ground terminal of this regulator is one diode drop above ground (D804) to allow for the loss across D803. This causes the cathode of D803 to have a 5-volt potential on it. D802 is back-biased by this potential since it has 4.5 volts on its anode as provided by the batteries. When the Transceiver is off, D803 becomes back-biased by the batteries as D802 begins to conduct. The CMOS RAM will retain data when it is disabled, as long as its supply voltage is at least 2 volts.

The first time power is applied to the Transceiver, or the first time after you replace the batteries, the CPU looks at the contents of a particular address in RAM for the alternating bit pattern 55_{16}. If this data is not present, the CPU determines that the RAM has not yet been initialized and does not yet contain valid data. The CPU then checks the RAM in an attempt to locate any defective cells. If this test fails, the display will indicate "IC1". If this test passes, a particular byte is sent to 55_{16} to indicate to the CPU, the next time power is applied, that RAM has now been tested and may now contain valid data. (This data would be lost by another test. The 55_{16} is an alternating pattern of 01010101, which is very unlikely to occur in RAM that has lost power.)

The CPU also checks the ROM containing the main program, U807, by adding the contents of each byte and comparing the sum to a checksum. If an error occurs, the display will indicate a pattern of segments. The CPU also checks to see if the ACE IC is installed. If the ACE is installed, the CPU runs a rather complete test on it and indicates a failure with an "IC3" on the display. If these tests are successful, the CPU performs a checksum test on ROM U808, which contains the interface routines. The display indicates a failure with "IC2". These tests, except for the RAM tests, are performed each time you turn the Transceiver on.

If the CPU senses an out-of-lock condition in one or more of the phase-locked loops, the display will indicate an "*FO unloc" warning. The "*" indicates which loops are unlocked. If only one loop is unlocked, the display is self-explanatory (such as "bFO unlock"). If the "*" is a 3, 5, 6, or 7, this digit represents the sum of numbers assigned to those loops which are unlocked. (HFO = 1, IFO = 2, BFO = 4).

A ROM containing the required routines (U808), an asynchronous communications element (U811), and two EIA/TTL interface chips (U817 and U818) provide the terminal functions.

Addresses between 800_{16} through FFF_{16} select U808 while $C000_{16}$ through $C006_{16}$ provide access to the various internal registers in U811. U811 performs the functions of a conventional UART and also has an internal software-programmable baud rate generator as well as modem control and self-test functions. External clock is provided by the same 2 MHz source as the CPU.

SYNTHESIZER CIRCUIT BOARD

The synthesizer circuit board, together with the voltage-controlled oscillators (VCOs) on the T/R circuit board, generates the HFO, IFO, and BFO signals.

Master Oscillators and Reference Dividers

A 10 MHz crystal-controlled oscillator produces reference frequencies that are used to phase-lock the IFO, HFO, BFO, and the 2 MHz clock signal which is required by the microprocessor and the UART.

Q108 and its associated components form a parallel-mode oscillator. D104 clamps the output of this oscillator so that only the positive pulses are passed to Q109. These pulses drive Q109 into saturation, thus providing TTL logic levels. U110C steers the output signal from Q109 to divider U111.

A second oscillator, similar to the one just described, provides the RIT feature. Q101 and Q102 form the second oscillator, which is tuned by D101 and RIT control R5. In the RIT mode, the output of the oscillator described above continues to drive the reference divider (U111), but the variable oscillator now provides the input to the loop mixer (Q105). U101B, U101C, U101D, and Q105 perform the required switching. U101D disables the RIT oscillator in the transmit mode or when the RIT mode is not selected.

U111, U112, and U113 form the reference divider. U111 first divides the 10 MHz reference by 5 to produce the 2 MHz clock signal referred to earlier. U111 divides this 2 MHz signal again by 5 to produce a 400 kHz signal. U112 then divides the 400 kHz signal by 4 to produce a 100 kHz signal which it divides again by 4 to generate the 25 kHz reference for the HFO. U111 also divides the 400 kHz signal by 25 to generate a 16 kHz signal. U113 divides this signal by 5 to generate the 3.2 kHz IFO reference and again by 2 to generate the 1.6 kHz BFO reference.

Q104 amplifies the fourth harmonic of the 10 MHz signal coming from U101C (which comes from either the fixed or the variable oscillator described earlier). Loop mixer Q105 mixes the resulting 40 MHz signal from Q104 with the IFO VCO signal coming from the T/R circuit board. Since the VCO signal is between 49.5804 and 49.7800 MHz, the resulting signal from Q105 is between 9.5804 and 9.7800 MHz. This signal is broadly tuned by the PI-network consisting of C119, L104, and C117 before it is amplified by Q106 to a TTL compatable signal and then shaped by U102A. The signal coming from U102A is the input to the IFO divider, which is described next.

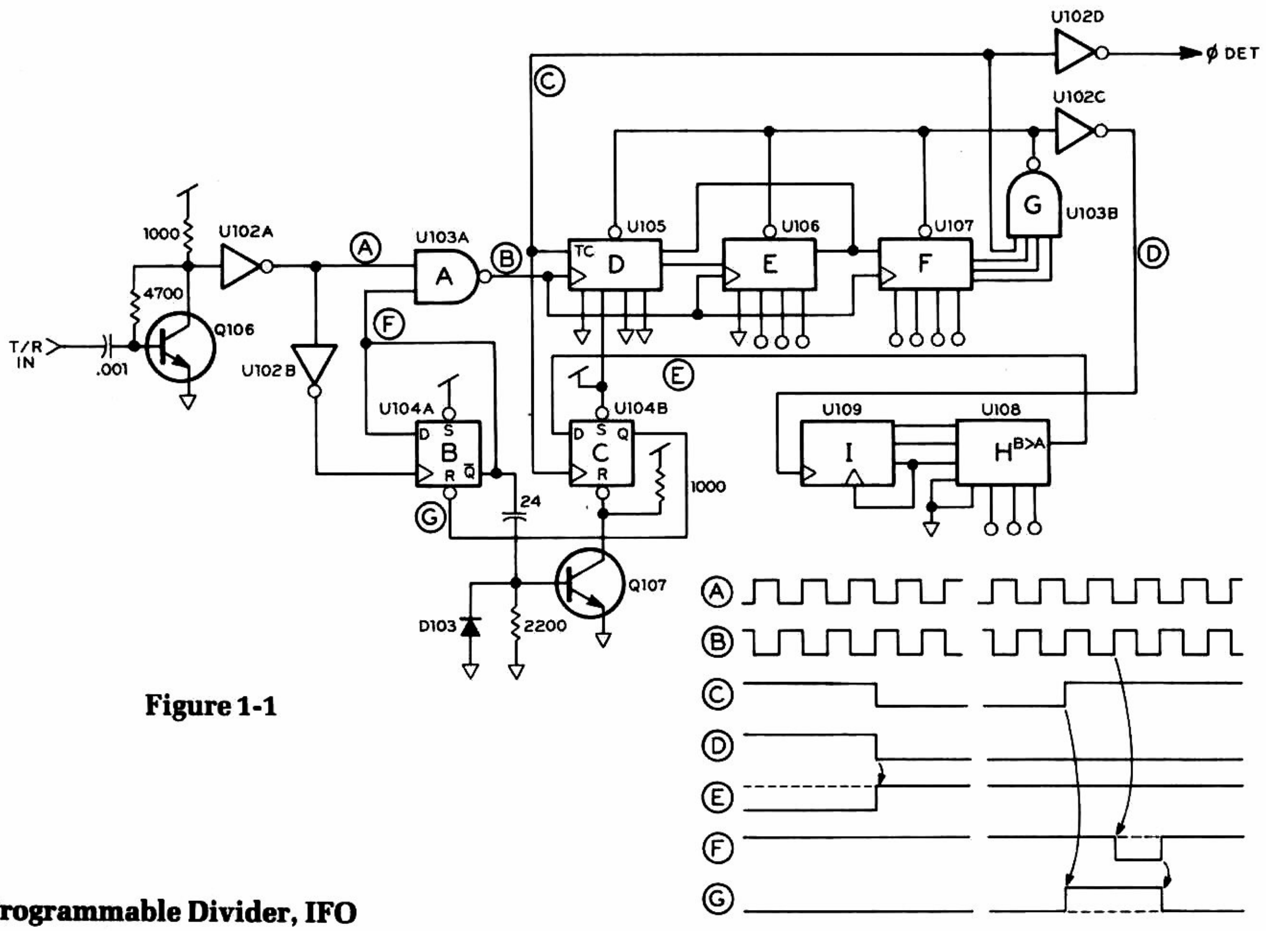


Figure 1-1

Programmable Divider, IFO

The programmable divider used in the IFO differs from the usual divide-by-N divider, since it allows the divisor to have a fractional part. This is accomplished by dividing by N part of the time, and by N+1 part of the time. This results in an average N.

U105, U106, and U107 form a conventional divider containing cascaded up-counters. These counters are connected with 4-input NAND gate U103B so they divide by the one's complement of the number presented to their inputs by the controller circuit board (lines I0 through I9). Each time this counter reaches its terminal count, this number is reloaded by a negative-going pulse coming from U103B. Each time this pulse occurs, a similar (but wider) pulse, which is buffered by U102D, is passed to phase detector U114. This pulse also increments U109, which is connected as a divide-by-8 counter.

The number that the controller circuit board presents to 4-bit comparator U108 determines how many times out of eight the divisor N will increment to N+1. The overall divisor will therefore average out to have a fractional part that steps in increments of 1/8. Since the reference frequency to the phase detector (U114) is 3.2 kHz, this results in 400 Hz steps from the VCO. Because the VCO output frequency is divided by 4 on the T/R circuit board before it is applied to loop mixer Q105, the result is the desired 100 Hz steps.

Division by N+1 is accomplished as follows:

U103A is disabled to cause a single clock pulse to be "hidden" from the input to the divisor. This raises the divisor to N+1 as shown in Figure 1-1. The reset state of U104B normally holds U104A in the reset state. When the terminal count is reached, point C goes high and clocks the level of the "B>A" output of U108 onto the reset pin of U104A. If B>A is high, U104A is enabled and performs its function of deleting a clock pulse. The clock pulse which follows the clock pulse that caused the terminal count will toggle U104A to its "set" state. This results in a low at point F, which holds point B (the clock input to the divider) high.

The next pulse at point A will therefore not reach the divider, but will toggle U104A again. This enables U103A and resets U104B, which holds U104A in its reset state. Several clock pulses later, point C will go low and point D will go low. U109 now increments and updates the input to U108.

As an example, assume the required IFO output frequency is 12.3965 MHz. This requires the VCO to operate at 4 × 12.3965 or 49.5860 MHz. The output of the loop mixer is 49.5860 – 40.000 = 9.5860 MHz. In this case, N is a 9.5860 MHz/3.2 kHz or 2995.625. U105, U106, and U107 are loaded with the binary number 0100 0100 1100, which is the one's complement of 2995. (Decimal 2995 = 1011 1011 0011_2). The five most significant digits are hardwired low (grounded).

Since the fractional part of the required divisor is 5/8 (.625), the number presented to the controller circuit board to U108 is the one's complement of 5 (010). This causes the B>A output to be high for 5 out of 8 of the output pulses that clock U109. The average divisor is therefore (2995 × 3/8) + (2995 × 5/8) or 2995.625 as required.

Programmable Divider, BFO

The programmable divider used in the BFO is nearly identical in configuration and operation to the one in the IFO. This divider also divides by fractions, but since U129 is connected as a divide-by-16 counter and all four inputs to 4-bit comparator U128 are used, the step size is one-sixteenth. Since the reference frequency for this loop is 1.6 kHz, the VCO frequency steps in 100 Hz increments.

Only seventeen of the possible output frequencies are needed. The frequency actually selected by the controller circuit board is dependent upon the mode you have selected and the passband shift offset. The following table lists all of the possible combinations:

	SHIFT (Hz)							
	-600	-400	-200	-100	0	100	200	400
LSB	3.3959	3.3961	3.3963	3.3964	3.3965	3.3966	3.3967	3.3969
USB/CW	3.3941	3.3939	3.3937	3.3936	3.3935	3.3934	3.3933	3.3931
RTTY	← 3.3965 →							

When you change the passband shift offset, the IFO and BFO move in the same direction an equal amount to the the offset, which effectively shifts the audio passband. The direction they move is dependent only upon the mode. Also note that in the RTTY mode, the lower sideband is forced, the CW-M (400 Hz passband) IF filter is switched in, and zero offset is forced. This centers the 2125 Hz mark and 2295 space tones in the passband.

Phase Detectors

The phase detector used in each of the loops (U114, U120, and U131) is a CMOS device. Each is connected to respond to the positive-going edges of the reference input to its "PCB" port, and to the positive-going edges of the programmable divider output to its "PCA" input port. The "PC2" port normally floats when the positive-going edges to both inputs coincide (phase locked). Any phase difference between these edges causes the "PC2" output to pulse to ground or to +5 volts for a corresponding period of time. When this pulse is integrated by the loop filter, it corrects the phase of the VCO to minimize its phase error.

All three phase detector circuits are similar. Note that U119A and Q116, with its associated components, stretch the pulse from the output of the HFO programmable divider. The shorter pulse would not be wide enough to operate phase detector U120 on the higher bands.

Synthesizer Speed-Up

Quad CMOS switches U137 in the BFO and U138 in the IFO speed up the loop responses by increasing the loop bandwidth whenever there is a phase error. Since these speed-up circuits are identical, only the BFO circuit is described below.

Normally, the "PCP" output of phase detector U131 (pin 1) is high and contains a series of very narrow low-going pulses. The width of these pulses is proportional to the phase error between the two inputs to the phase detector. U137A acts as an inverter and produces high-going pulses at pin 9. When there is a large enough phase error, such as during frequency stepping, C169 is able to charge to the threshold of U137D. U137B turns on and applies +5 volts to U137C and U137D.

These switches, which are normally held off by R187, are in parallel with resistor R186. Decreasing the effective value of R186 increases the bandwidth of the loop and allows it to settle quickly. Once the phase error is small enough, the pulse width is too narrow to keep U137D turned on. This narrows the loop bandwidth and provides the required attenuation of the reference frequency. The time constant of R195 and C169 is adjusted so that whenever the loop is locked, the voltage at the control input of U137D is near threshold.

Loop Filters

Since the loop filters in the IFO, HFO, and BFO are similar, only the IFO filter is described. U115 and its associated components form a low-pass filter which integrates the phase detector pulses and provides the tune voltage for the VCO. C139 further reduces the high-frequency gain to reduce the reference sidebands. This improves the loop response by keeping U115 from saturating on input transients. R142, R143, and C141 provide a filtered 2.5-volt reference for U115.

An active low-pass filter formed by Q112 and Q113 (with a cutoff frequency of approximately 650 Hz) further reduces the reference sidebands.

Out-of-Lock Detection

The out-of-lock detection circuits used in the three loops are identical. Only the IFO circuit is described.

When the loop is locked, the "PCP" output of U114 is at a logic high and has very narrow low-going pulses. Q110 is held on and prevents D105 from conducting. If a large phase error occurs between the reference and divider inputs to U114, the pulses increase in width. This allows Q110 to turn off long enough for C138 to begin to charge through D105 and R141. If this condition lasts long enough for C138 to charge to approximately 0.6 volts, Q111 conducts. The controller circuit board senses this logic zero on the collector of Q111.

AUDIO CIRCUIT BOARD

The audio circuit board contains all of the circuitry required to process the receiver and transmitter audio.

In the receive mode, the audio output from the product detector (on the T/R circuit board) is coupled to the AF Gain control on the front panel, mute gate Q303, and low-level amplifier Q304. The audio coming from the AF Gain control passes through a 2400 Hz active low-pass filter (formed by Q310 and its associated components) to audio amplifier U302. The resultant audio is then fed to the speaker and headphone jacks. Audio from mute gate Q303 is fed to the AGC circuit, which is comprised of an amplifier (Q305 and Q306), a detector (D302, Q308, and C308), and a DC level amplifier (U310A, Q313, U310D, and Q309).

The transmitter audio chain begins with the input selector switch (U1502), which selects the microphone audio, external transmitter audio, or the CW sidetone audio. U1503B amplifies the selected audio before it is applied to VOX amplifier U303C and VOX detector D308. U303B then compares the detected audio from the VOX amplifier against the audio from the anti-VOX amplifier, U310B.

Timing is applied to the resulting signal by D306, D307, U304A, U313C, and U305F, and forms the $\overline{T_{REQ}}$ signal for the microprocessor (on the controller circuit board). After the microprocessor checks for valid operating conditions, it passes a $\overline{T_{OK}}$ signal back to the audio circuit board. Here, the $\overline{T_{OK}}$ signal passes through several timing circuits (U305D, U306B, U304C, and U306D), which generate the receive and transmit commands for the rest of the Transceiver circuits. The audio circuit board also contains several small switching networks and a voltage-to-current converter (U303A and Q319) for the speech compressor metering circuit.

Mute Circuit

An L-type audio attenuator network, which consists of R303 and Q303, forms the mute circuit. When the gate to source voltage of Q303 is zero, the internal resistance of Q303 is very low, causing considerable audio attenuation. If the gate to source voltage is a high negative voltage, however, Q303 turns off and presents a very high impedance which results in minimum attenuation.

Switches U305E and Q302 control the gate to source voltage of Q303. When Q303 is turned on, the mute switch is off. When U305E turns on, it turns off Q302 and mutes the receiver audio. A receive command from the audio circuit board turns on Q302 while a mute signal from the microprocessor drives U305E. The RC combinations in the base of Q302 (R309, D301, R311, and C306) form a timing circuit which inhibits the audio output for approximately 10 milliseconds after the transmit-to-receive transition. Emitter follower Q304 supplies receiver audio to external receiver audio jack on the rear panel of the Transceiver.

AGC Circuit

The AGC amplifier consists of Q305 and Q306, which are connected as a simple feedback amplifier. Since the audio output of this amplifier is taken from both the collector and emitter of Q306, the result is a pair of equal amplitude (but out of phase by 180°) audio signals. These signals then drive the detector circuit formed by D302, D303, Q307, and Q308. The detected output is applied to charge resistor R322 and charge capacitor C311 to determine the AGC attack time, while R324 and R325 set the decay time. The resulting signal passes through voltage follower U310A, and a voltage-to-current converter consisting of U310D and Q309. This forms the AGC1 signal and is passed to the T/R circuit board.

A second AGC loop, which consists of U310C, R336, and C313, provides a delayed and shaped DC voltage for AGC2 on the T/R circuit board and, together with the output of U310D, drives the S meter on the front panel.

Transmitter Audio Circuit

NOTE: Since this circuit board is piggy-backed on the main audio circuit board and is closely tied in to the main audio circuits, it is electrically considered as part of the main audio circuit.

Quad bilateral switch U1502 forms the beginning of the transmitter audio chain. This switch simply selects which of the three audio sources (microphone, external, or CW sidetone) is passed to amplifier U1503. The command signals for U1502 actually come from the Mode switch on the front panel by way of the controller. In the RTTY mode, the microphone and CW sidetone audio are disabled and only the external transmitter audio jacks on the rear panel are active. In the CW mode, only the CW sidetone is active; the microphone and external jacks are disabled. In the SSB mode, the microphone and external jacks are enabled while the CW sidetone audio is disabled.

SOURCE/MODE	SSB	CW	RTTY
Microphone	E	D	D
External transmit	E	D	E
Audio Side Tone oscillator	D	E	D

E = Enabled
D = Disabled

The audio from transmit audio amplifier U1503 is applied to the T/R circuit board (where it drives the balanced modulator) and to the VOX circuit described next.

VOX Circuit

The VOX circuit begins with VOX amplifier U303C and VOX detector D308, which provides a DC voltage that is representative of the level of the transmitter audio signal. This voltage is then compared against a detected sample of the speaker audio from U310B and detector D305. If the detected transmitter audio is greater than the detected speaker audio, Schmitt trigger U303B is driven high and charges capacitor C336.

This, in turn, drives Schmitt trigger U304A, which provides the transmit request signal ($\overline{T_{REQ}}$). The VOX Delay control on the front panel determines the decay time constant of C336.

In the PTT (push-to-talk) mode, the switch on the VOX Delay control is open and disables Schmitt trigger U303B by causing a high to be applied to this trigger via R373.

D321, U313, and D315 form a debounce circuit that momentarily shuts off U303 when you change the setting of the Mode switch.

Sidetone Oscillator

The sidetone oscillator formed by U308C, U313B, U313F, and the associated components operates at approximately 800 Hz. This oscillator is enabled when you push the Tune button or when you select one of the CW modes and close the key.

The output of the sidetone oscillator is a square wave that is filtered by the 2-stage active low-pass filter formed by Q311 and Q312. This filtered output is then applied, via Sidetone Level control R353, to the audio power amplifier (U302) which provides an audible sidetone in the speaker. CW Level control R358 also couples the signal from the oscillator to U1502C, which drives the transmitter audio circuit.

Command Signals

After the microprocessor receives the "request to transmit" ($\overline{T_{REQ}}$), explained earlier, it examines the state of the Transceiver to insure that all synthesizer loops are locked and that all commands are legal. If all checks pass, the microprocessor returns an "okay to transmit" ($\overline{T_{OK}}$) signal. This signal passes through inverters U305D, U306B, and U304C. A pair of timing circuits, R3005 and C341 in receive and R3009 and C342 in transmit, insure that there is no overlap between the receive and transmit signals. A minimum of 0.5 millisecond exists between the transitions from receive to transmit or transmit to receive.

The three receiver commands are called R1, R2, and R3. R1 drives the T/R and audio circuit boards, R2 drives the PA and front panel circuit boards, and R3 drives the synthesizer.

The two transmit commands are called T1 and T2. T1 drives the T/R circuit board while T2 drives the PA and power interface circuit boards. Q318 and its associated components inhibit the T2 signal to the PA circuit board when you first turn on the Transceiver. This prevents unwanted transmitter keying.

Miscellaneous Circuits

Voltage converters U305A and U305B provide a switching interface between the microprocessor and the CW filters on the T/R circuit board.

U303A and Q319 form a voltage-to-current converter which controls the speech processor, on the T/R circuit board, by comparing the compressor reference level and the compressor AGC level.

Regulator U307 provides the +8-volt source for the circuits on the audio circuit board, while U309 provides the +5-volt source. These two regulators are driven by the 13.8-volt supply coming from relay K1 on the chassis.

You can key the transmitter with the push-to-talk switch on your microphone or by grounding the T/R In jack on the rear panel. Either of these two inputs activates Schmitt trigger U304B, which then activates Schmitt trigger U304A in the VOX circuit. This initiates a $\overline{T_{REQ}}$ signal as described earlier.

TRANSMIT/RECEIVE (T/R) CIRCUIT BOARD

The T/R circuit board is the nucleus of the transmitter and receiver in this Transceiver. The major stages of the receiver are the first mixer, first IF, second mixer, second IF, and product detector. The major stages of the transmitter include the balanced modulator, second IF, second mixer, first IF, and first mixer. Noise blanker circuitry for the receiver, as well as a speech compressor for the transmitter, are also included on this circuit board.

Designed for an optimum balance of strong signal capabilities, excellent selectivity, and freedom from spurious signals, a high degree of commonality is used between the transmitter and receiver circuits to reduce the number of components. The basic circuit consists of a conventional double-conversion superheterodyne with the first IF at approximately 9

MHz and the second IF at 3.395 MHz. In addition, cascaded single-sideband filters and CW filters provide the ultimate in selectivity. The first and second mixers use hot carrier, double-balanced mixers, while the first three IF stages use dual gate MOSFET's. The last receiver IF, product detector, and balanced modulator use IC's for superior performance.

HFO Oscillator and Divider

The HFO oscillator consists of five individually switched JFET Hartley oscillators. These oscillators drive an ECL digital divider circuit which, in turn, drives the balanced mixer. Since the 160- and 80-meter bands share the same oscillator, Q201 is turned on for 160 meters. This connects C207 in the circuit to lower the oscillator frequency. Since all of the HFO oscillators are basically the same, only the operation of the 40-meter oscillator is described below.

Transistor Q203 is the active device in the 40-meter HFO oscillator and varactor D206 provides the frequency tuning. The output of Q203 passes through diode gate D208 to buffer amplifier Q207. Q207 drives ECL divider U202A, and the output of this divider is applied directly to first mixer U203.

U202B divides the output of U202A by an additional factor of 2. The output of this divider is passed to the synthesizer circuit board via J202. The basic oscillator operates at twice the frequency applied to the first mixer, while the signal applied to the synthesizer is one-half that applied to the mixer.

First Receiver Mixer and IF Amplifier

First mixer U203 mixes the signal from the antenna (via the PA, preamp, and bandpass filter circuit boards) with the HFO signal and the 9 MHz (approximate) first IF signal results.

Coils L208 and L209, together with the associated capacitors, form a 2-pole LC filter for the IF signal; while L207, C259, and C263 provide impedance matching between the first mixer and the LC filter.

The image trap formed by C259, C261, C262, L206, and R257 remove the undesired sideband and HFO products that appear on the output of the mixer.

The filtered 9 MHz signal now passes through IF transistor Q211 and D219 to another 2-pole LC filter formed by L210, L211, and the associated components. The signal from this first receiver IF, which has a bandwidth of about 100 kHz at a center frequency of 9 MHz and a gain of about 16 dB, is then applied to the second mixer.

Second Mixer and Second IF Amplifier

Second mixer U208 mixes the 9 MHz first IF signal with the output of the IFO (which operates at approximately 12.4 MHz) to produce the 3.395 MHz second IF.

The signal from the second mixer passes through SSB filter FL201 and diode gate D232 to the second IF amplifier, Q222. Coil L214 and capacitor C2042 match the impedance of the second mixer to that of the SSB filter.

Coil L217 resonates the output of Q222 before the signal is applied to the CW switching circuit formed by U211 and U212. These switches, which are both quad bilateral CMOS switches, are used on each side of each filter and are selected by an 8-volt control voltage. This voltage comes from U217A and U217B and is controlled by the main audio circuit board. U211D and U212D, when activated, bypass the CW filters during single-sideband operation. If either CW filter is selected, diode OR gates D235 and D234 turn on shunt gate U211A and transistor Q229, which turns off U211D and U212D. The signal, whichever path through the filter network it takes, is then amplified by the second stage of the second IF (Q223), tuned by L218 and C2066, and applied to SSB filter FL204.

After the second IF signal is filtered by FL204, it is amplified by the third stage of the second IF (U214) and passed to the product detector.

IFO Oscillator

The IFO oscillator operates similarly to the HFO oscillator. Oscillator transistor Q231 operates at 4 times the frequency applied to the second mixer, while varactor D221 performs the tuning voltage function. Q232 buffers the output of oscillator Q231 while Q212 buffers the signal applied to the synthesizer circuit board via jack J205. The output of Q232 also drives the divide-by-4 divider (U207) before the signal is applied to the second mixer.

The "tune" signal coming from the phase detector, on the synthesizer circuit board, passes through a 2-section filter before it is applied to IFO oscillator Q231. The first filter is a 400 Hz notch filter formed by resistors R282 through R284 and capacitors C287 through C291.

Product Detector and BFO

Product detector U215 mixes the second IF signal with a signal from the BFO. The resulting audio signal then passes to the main audio circuit board for further processing and amplification.

The BFO oscillator is formed by Q226 and associated LC components L221, C2092, C2093, C2094, and C2095 in a Colpitts configuration. In this oscillator, varactor diode D238 performs the variable voltage function. Transistors Q227 and Q228 are buffers for the BFO signal, while Q224, Q225, and D236 form a high isolation, switching-type of buffer for the transmitter balanced modulator (U213).

The "tune" signal coming from the phase detector, on the synthesizer circuit board, passes through a 100 Hz, single T notch filter (formed by resistors R2113 through R2115 and capacitors C2087 through C2089) before it is applied to BFO oscillator Q226.

Circuit Operation in Transmit

In the transmit mode, the BFO signal and the transmitter audio, from the main audio circuit board, are applied to balanced modulator U213. The resultant 3.395 MHz double-sideband signal is then filtered by SSB filter FL204 to form a SSB signal and amplified by speech compressor/IF amplifier Q217/Q218.

The RF output of the speech compressor is applied via D229 and R2064 to SSB filter FL201 and to the input of detector amplifier Q219. Q219 drives the high speed RF amplifier/detector formed by Q221 and D231. The output of this detector charges C2039, which produces an AGC voltage that is applied to Q234. Q234 is a controlled-voltage amplifier that works in conjunction with Q235 and Q236.

When the compressor circuit is activated by the front panel switch, Q236 turns on Q234. Q235 in conjunction with the RF Compressor control, on the front panel, sets the gain of Q234. The output of Q234 is applied to gates G2 on Q218 and Q217. This negative AGC voltage holds the output of Q217 constant with wide variations at the input. The external VOX Delay control, on the front panel, and C2039 determine the time constant of this AGC loop. This time constant also determines the speech compression capability of the circuit. With a long time constant, speech compression is minimal; a short time constant produces maximum compression.

The output of FL201 is applied to mixer U208. U208 mixes this signal with the IFO signal to produce a 9 MHz first IF. Since Q211 is now turned off and Q210 is turned on, the IF signal passes through the first IF amplifier in the opposite direction from the receiver IF signal. These two dual-gate MOSFETs are connected back-to-back to form a bilateral IF amplifier which shares the same tuned circuits on the input and output.

The output of the first IF amplifier is now applied to U203, where it is mixed with the HFO signal to produce the desired output frequency before it is fed to jack J203.

Noise Blanker

Capacitor C2005 couples a portion of the first IF signal to the first noise blanker IF amplifier, Q213. The signal then passes through second noise blanker IF amplifier U210 to the diode detector circuit formed by D225 and D226. R2024 and C2022 filter the resulting demodulated RF before it is applied to DC amplifier Q214, where it serves as an AGC signal to control U210. The lightly-filtered, demodulated RF signal is amplified by pulse amplifier Q215 and shaped by U216A. D227 and R2034 limit the length of the noise blanker pulse before it is applied to Q233, which turns off the IFO signal for the duration of the noise pulse. The noise blanker is turned off when an open appears on the switch line from the Noise Blanker (NB) switch on the front panel, or when a "T1" signal is applied to D223 and R2016.

Transmit/Receive Switches

Transistors Q208 and Q209 transform the transmit and receive signals, coming from the Main audio circuit board, into 8-volt switching levels. These levels, called "R1" and "T1", perform the various transmit and receiver functions required by the T/R circuit board.

PREAMP CIRCUIT BOARD

The preamp circuit board boosts the transmitter RF signal in the transmit mode, turns off the receiver in the transmit mode, and performs feedback control for VSWR, ALC, and thermal sensing.

RF Preamplifiers

In the transmit mode, the transmitter RF signal, coming from the T/R circuit board via the bandpass filter circuit board, passes through C501, D502, C512, and D506 to transistor Q504. Q504 and Q506 form a broad-banded amplifier which has a gain of 25 dB. The boosted RF signal then passes through C528 and is routed to the PA (power amplifier) circuit board.

In the receive mode, the antenna RF signal, coming from the PA circuit board, passes through C531 and D508 to transistor Q505. Q505 is a broad-banded amplifier which provides a gain of 12 dB for the antenna signal before it passes through C513, D502, and C501 to the T/R circuit board via the bandpass filter circuit board.

PI Attenuator

A PI attenuator circuit, formed by PIN diodes D501, D502, and D507, controls the RF level in the transmit mode and the RF gain in the receive mode. Diode D502 is normally forward-biased and allows the RF signal to pass through. As voltage is applied to D501 by D503 or D504, D502 approaches reverse bias. This attenuates the RF signal and shunts it to ground through D507.

Receive/Transmit Switch

In the receive mode, a low is applied to pin 5 of U501B and results in a low at pin 7 which is applied to pin 10 of U501C. The low at pin 8 biases the base of Q511, which turns it on. This biases D506 off and turns on Q505.

A transmit request "high" from the main audio circuit board is applied to pin 5 of U501B. The resultant "high" is applied to U501D which turns on Q515, Q516, and Q517. This biases D506 on and turns on Q504 and Q506. This "high" biases D508 off. The "high" from pin 7 of U501B is applied to U501C and the resulting low is applied to Q511. This low turns off Q511 which removes the biases from D506 and turns off Q505.

U502 is an 8-volt regulator that provides a reference voltage to U501B and to the ALC circuit.

ALC Circuit

P502 pin 3 provides the input for all sources of ALC control. These sources include ALC detection, thermal protection, overcurrent protection, and VSWR.

These input voltage levels are applied to Q512, which acts as a voltage comparator for Q509. Q509, in conjunction with control R544, establishes the maximum output level and acts as an ALC limiter. Q507 is a current source for the ALC timing circuit comprised of R525, R526, C525, and C526. Q501, Q502, and Q503 provide isolation between the PIN diodes and the ALC timing circuit.

A positive-going voltage from thermal sensor U603 (on the PA circuit board) is applied to the ALC circuit for thermal protection.

Q518 drives the front panel meter to indicate transmit ALC.

Regulator Circuit

Transistor Q514 is a simple series regulator/hash filter which isolates the 13.8-volt DC source from the PA circuit board. This circuit also filters out any high- or low-frequency content present on the DC source.

PA (Power Amplifier) CIRCUIT BOARD

The PA circuit board boosts the low-level RF signal coming from the preamp circuit board to a high level, provides high- and low-pass filtering for both the transmit and receive RF signals, provides thermal sensing, and forms the transmit voltage for the preamp circuit board.

High-Pass Filters

Each amateur band has its own selectable, elliptical high-pass filter. These filters (between Band switch sections SW601A and SW601B) roll off the low-frequency signals, while passing the high-frequency signals. Each filter has a cutoff frequency that is approximately 5% below its band edge.

Low-Pass Filters

Each amateur band also has its own selectable, elliptical low-pass filter. These filters (between Band switch sections SW601C and SW601D) roll off the high-frequency signals, while passing the low-frequency signals. Each filter has a cutoff frequency that is approximately 5% above its band edge.

RF Amplifiers

The RF amplifier is formed by a predriver, driver, and push-pull RF amplifier.

In the transmit mode, the RF signal from the preamp circuit board first passes through the high-pass filter, described earlier, and then through D602 to predriver transistors Q601, Q602, and Q603. The amplified RF signal is coupled through C658 to T601, which transforms the signal from 50 ohms down to 12 ohms as required at the base of Q605.

R623 and one winding of T602 provide negative feedback to hold the gain and impedance of Q605 constant over the entire frequency range.

Driver transistor Q605 boosts the RF signal coming from T601 to drive the push-pull RF amplifier formed by Q609 and Q611.

T602 transforms the RF signal from a low impedance to 50 ohms before it is coupled to T603. T603 first transforms the RF signal down to approximately 3 ohms before it feeds the signal to the bases of push-pull RF amplifier Q609 and Q611.

Q609 amplifies the positive-going half of the RF signal, while Q611 amplifies the negative-going half. T604 combines the signals from Q609 and Q611 and transforms the signal back to 50 ohms once again. Resistors R635 through R638 combined with capacitors C674 and C675 provide these transistors with feedback, which holds the gain and impedance of the stage constant for better linearity and stability.

The 100-watt signal from T604 passes through the low-pass filter, described earlier, to the antenna.

Bifilar-wound transformer RFC605 supplies DC current to Q609 and Q611, but prevents the RF from getting into the DC source. Capacitors C668, C672, C681, C682, C683, C684, C685, and C688 bypass the RF to ground and provide a low-impedance path for all frequencies.

U604 provides an 8-volt reference voltage for the base bias circuit of Q609 and Q611. U603A, in conjunction with control R648, sets the idle current and Q608 is the base current driver.

Q607 monitors the current flow in R633. When the base current in Q609 and Q611 exceeds a predetermined level, the voltage drop across R627 increases. This voltage is fed to the ALC circuit on the preamp circuit board to reduce the power output.

Q612 is used as a heatsink-mounted thermal sensor. If Q609 and Q611 exceed their designed operating temperatures, Q612 works with U603B to feed a control voltage back to the ALC circuit to reduce the power output. Control R651 sets the threshold reference for U603B. U602, U601A, Q604, and Q606 perform the same function for driver transistor Q605.

Antenna relay K601 receives its control voltage from the receive/transmit circuit on the preamp circuit board.

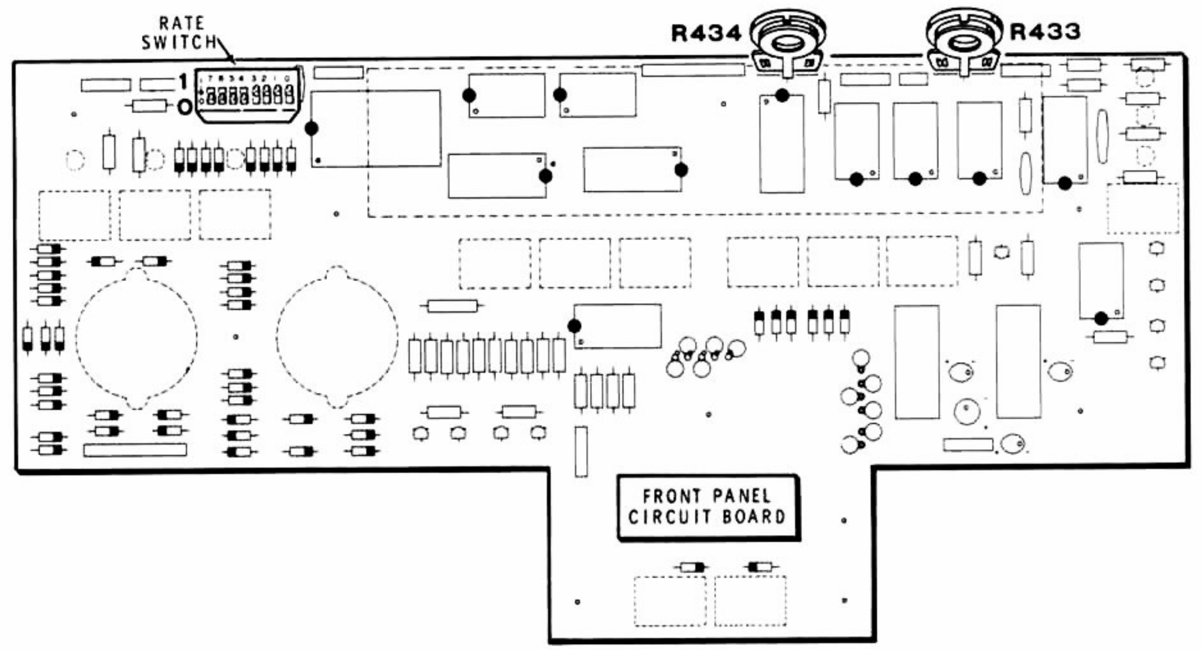


Figure 2-3

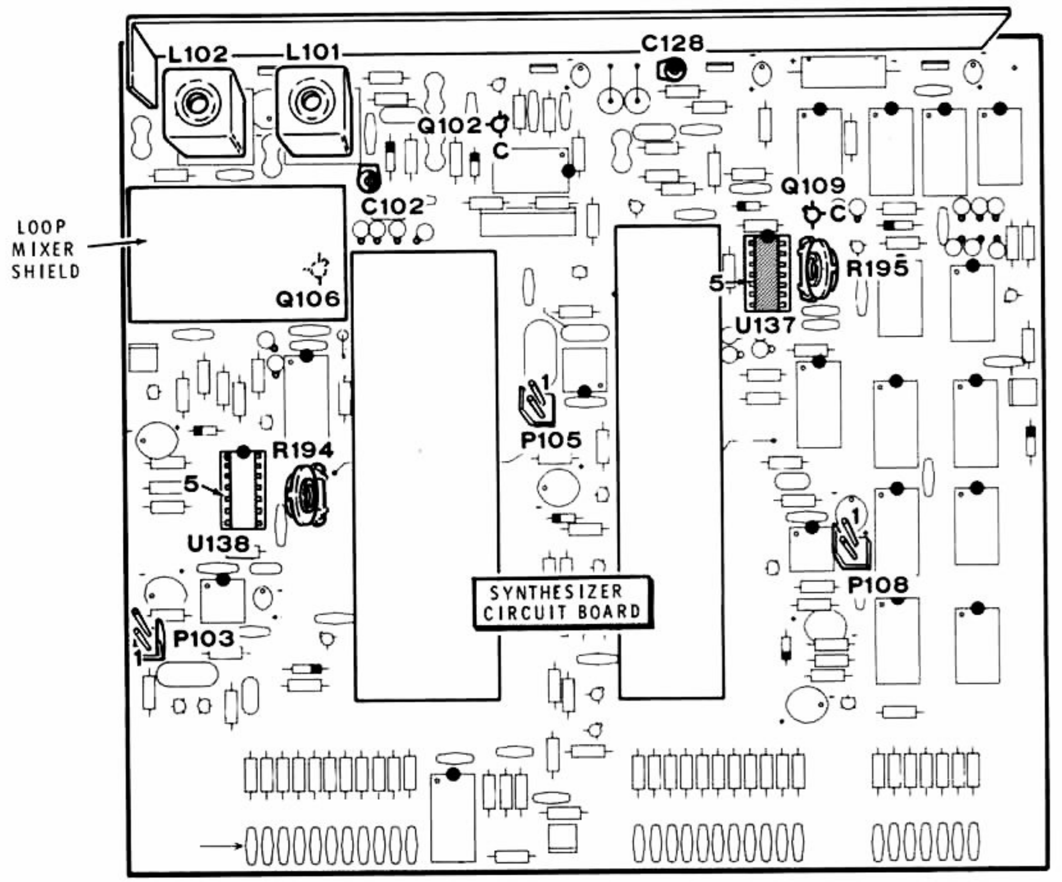


Figure 2-2

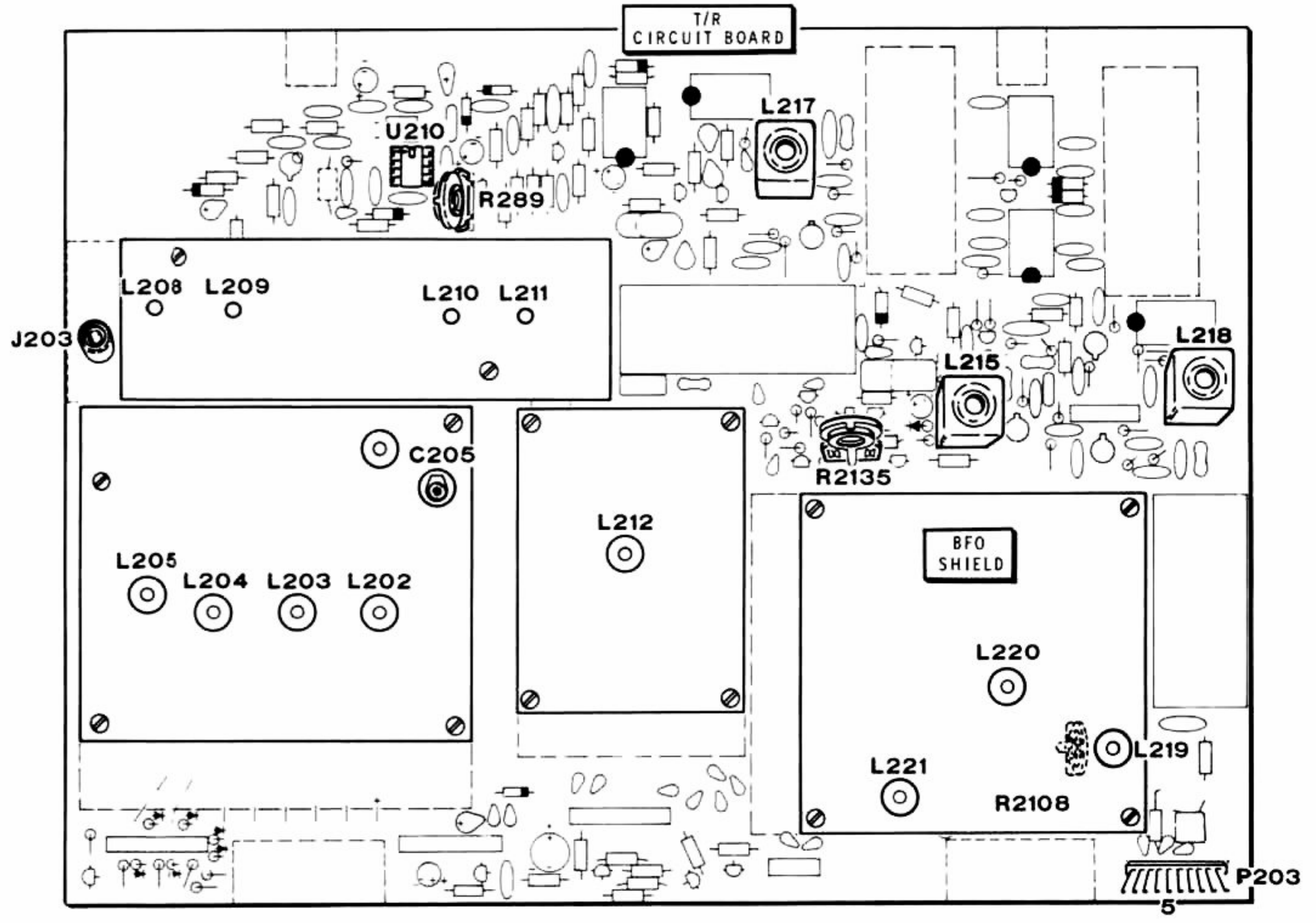


Figure 2-1

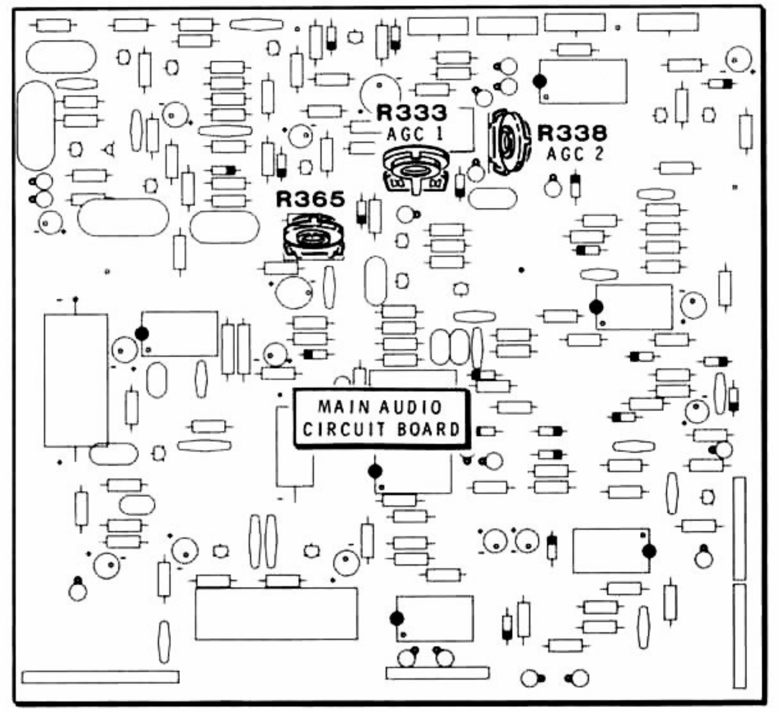


Figure 2-4

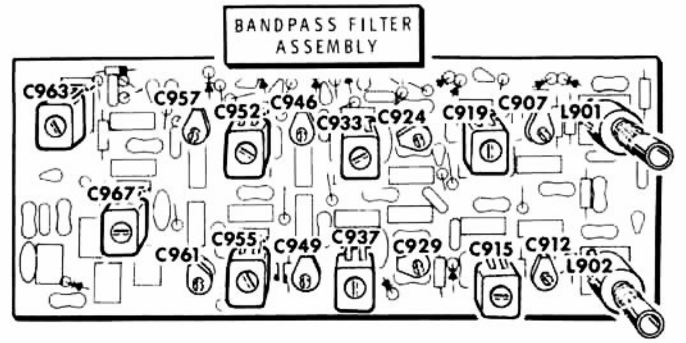


Figure 2-5

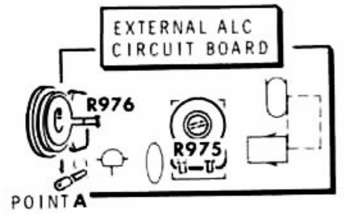


Figure 2-6

EXTERNAL ALC CIRCUIT BOARD

This circuit is designed to operate from a negative ALC voltage that comes from an external linear amplifier. A J-FET transistor, a 5000 ohm control in the source, and a 7.5 megohm control in the gate circuit (EXT. ALC Input) provide the input stage. The drain of the J-FET is connected through an 8200 ohm load resistor to a 10-volt DC source and to the input of an NPN emitter-follower transistor. This transistor then drives the PIN diode attenuator in the ALC circuit on the preamp circuit board.

ALC CIRCUIT BOARD

Pickup coil L1901 is placed around the antenna line between the PA circuit board and the antenna connector. This coil senses both the forward and reflected power levels.

The RF signal (transmit) induces a voltage in L1901 that is directly proportional to the RF current. Capacitor C1901 cancels any stray capacitance and balances the pickup circuit.

Components D1901, R1902, and C1904 rectify and filter the forward voltage induced in L1901 to form an ALC voltage. This voltage is routed through plug P1901 pin 1 to the PA circuit board.

Components C1905, R1907, D1902, R1906, and C1906 rectify and filter the forward voltage induced in L1901 to form a relative power voltage. This voltage is routed through plug P1901 pin 2 to the meter circuit (via the preamp circuit board).

The out-of-phase reflected voltage induced in L1901 is rectified and filtered and applied to the base of Q1902. Q1902 and Q1901 work together with control R1909 to establish a reference voltage for VSWR control of the transmitter. As the reflected voltage increases, the resultant increased reference voltage is applied to the center top of L1901, where it is summed with the ALC voltage. As the ALC voltage (which is very small) increases over the threshold voltage, power output decreases.

Control lines coming from the temperature and power adjust circuits are fed via plug P1901 pins 3 and 4. Resistor R1916 also applies some of these control voltages to the center top of L1901.

TERMINAL INTERFACE

Refer to the schematic diagrams for the controller and motor driver circuit boards as you read the following paragraphs.

The heart of the Terminal Interface is U811, an asynchronous communications element (ACE). This device performs the functions of the conventional UART, but in addition, has an internal software-programmable baud rate generator, as well as modem control and a self-test function. The external clock is derived from the 2 MHz CPU clock.

The input and output ports of U811 are TTL levels, but the signals that are routed to interface connector S2 are converted to and from EIA levels by line driver U817 and line receiver U818.

U811 is selected by internal chip-select circuitry when address lines A14 and A15 are high and address line A13 is low. The internal registers are selected depending upon on the state of address lines A0, A1, A2, and the CPU read (DOSTR) and write (DISTR) signals. U811 is reset on power-up by a positive pulse from U805.

The controller circuit board jumper is required to allow a TR(ansmit) command from the terminal to be executed. If the interface is used with a modem, the jumper is removed and pin 25 of the interface is connected to pin 8 of the modem. The signal on this line will only be active when a carrier (audio tone) from the modem is present. If the telephone connection is lost, the Transceiver will be forced into the receive mode.

U808 is a ROM (read only memory) that contains the Terminal Interface program.

The motor driver circuit board boosts the low, current-sinking capability of U805 to meet high current requirement of the motor. When you execute a band change, U805 pin 31 pulses low and turns on Q1401. Q1401 turns on the Darlington pair (Q1402 and Q1403), which energizes the motor.

The motor moves the Band switch one position while the CPU compares the new position to see if it matches the command band. If a match is not made, the motor steps repeatedly until a match is made or the CPU detects an error. If an error occurs, the terminal will print an error message.

C1401 holds Q1401 off at power-up until the voltages stabilize.

INSTRUMENT ALIGNMENT

NOTE: Refer to the "Disassembly" section of this Manual (beginning on Page 109) to gain access to the various circuit boards referred to in this section.

Instrument realignment of your Transceiver is not normally required. The following information is provided in case you need to realign the Transceiver at some future time after replacing parts.

CAUTION: Do not attempt to align this Transceiver unless you have had previous alignment experience, a thorough knowledge of the theory involved, and the necessary equipment.

You will need the following equipment to align the receiver sections of your Transceiver:

VTVM
Frequency counter (to 50 MHz)
RF signal generator (1-30 MHz)
Audio voltmeter

You will need the following equipment to align the transmitter sections of your Transceiver:

Tracking generator (to at least 30 MHz)
Spectrum analyzer
Audio voltmeter or oscilloscope
RF meter (terminated in 50 ohms)
Dummy load
Wattmeter (to 100 watts)

Depending upon what circuits need realignment, some of the above equipment may not actually be needed.

NOTE: Due to the large variety of test equipment that is available, no control settings of the test equipment is provided. Knowledge and use of the test equipment as well as its limitations are the responsibility of the operator.

Refer to the following illustrations for the locations of the controls, coils, trimmers, and test points when you align your Transceiver:

T/R circuit board .... Figure 2-1
(fold-out from Page 28)
Synthesizer circuit board .... Figure 2-2
(fold-out from Page 28)
Front panel circuit board .... Figure 2-3
(fold-out from Page 28)
Main audio circuit board .... Figure 2-4
(fold-out from Page 28)
Bandpass filter assembly .... Figure 2-5
(fold-out from Page 28)
External ALC circuit board ...... Figure 2-6
(fold-out from Page 28)
PA circuit board .... Figure 2-7
(fold-out from Page 41)
Preamp circuit board .... Figure 2-8
(fold-out from Page 41)
ALC circuit board .... Figure 2-9
(fold-out from Page 41)

NOTE: Unless otherwise noted, all instrument connections are to be made from the point indicated to chassis ground.

SYNTHESIZER ALIGNMENT

NOTE: The three phase-locked loops (BFO, IFO, and HFO) may or may not be all locked when you begin this alignment procedure. After you complete this procedure, all loops should be locked.

BFO LOOP

Use the following procedure to adjust the BFO loop:

1. Preset the front panel controls and switches as follows:

RIT switch	OFF (out)
R pushbutton	So the left display is selected for receive
PASSBAND SHIFT	−4
MODE	USB
BAND	160 M

2. Set the four left-most RATE switches on the front panel circuit board (switches 7, 6, 5, and 4) to their 0 (down) positions. NOTE: Do not change the settings of the four right-most switches if you are using your Transceiver with a computer.

3. Set your VTVM to measure 15 VDC. Then connect the meter probe to connector P108 pin 1 on the synthesizer circuit board.

4. Adjust coil L221, on the T/R circuit board, until you notice a transition from high to low or from low to high. When you locate this transition point, slowly adjust coil L221 for 5 volts DC (±0.3V). NOTE: The core in this coil should be approximately 1/8" from the top of the coil.

5. Turn the MODE switch to LSB. The display on the Transceiver should not change from what it indicated in USB (the display may indicate an unlocked condition or a frequency at this time). The voltmeter should now indicate 6.5 volts DC (±0.3V).

6. Rotate the PASSBAND SHIFT either clockwise or counterclockwise and watch the voltmeter. The voltage should change about 0.2 volts. If this voltage does not change, refer to "Synthesizer Problems" in the "In Case of Difficulty" section of this Manual.

7. Disconnect the VTVM from the Transceiver.

IFO LOOP

Use the following procedure to adjust the IFO loop:

1. Preset the front panel controls and switches as follows:

RIT switch	OFF (out)
R pushbutton	So the left display is selected for receive
PASSBAND SHIFT	0
MODE	LSB
BAND	160 M

2. Set the four left-most RATE switches on the front panel circuit board (switches 7, 6, 5, and 4) to their 0 (down) positions, if this has not already been done. NOTE: Do not change the settings of the four right-most switches if you are using your Transceiver with a computer.

3. Set your VTVM to measure 15 VDC. Then connect the meter probe to connector P103 pin 1 on the synthesizer circuit board.

4. Push the DOWN SCAN pushbutton until the frequency reaches the bottom of the 160-meter band (1.745 MHz).

5. Adjust coil L212, on the T/R circuit board, until the voltmeter indicates 5.2 volts DC (±0.3V).

6. Slowly turn the TUNING knob clockwise and watch the voltmeter. The voltage should quickly jump to 7 volts DC (±0.3V) at 1.751.5 MHz, and then slowly decrease to about 5 volts. This voltage transition should repeat itself every 50 kHz. If it does not, refer to "Synthesizer Problems" in the "In Case of Difficulty" section of this Manual.

7. Disconnect the VTVM from the Transceiver.

HFO LOOP

Use the following procedure to adjust the HFO loop:

1. Preset the front panel controls and switches as follows:

RIT switch	OFF (out)
R pushbutton	So the left display is selected for receive
PASSBAND SHIFT	0
MODE	LSB

2. Set the four left-most RATE switches on the front panel circuit board (switches 7, 6, 5, and 4) to their 0 (down) positions, if this has not already been done. NOTE: Do not change the settings of the four right-most switches, if you are using your Transceiver with a computer.

3. Set your VTVM to measure 15 VDC. Then connect the meter probe to connector P105 pin 1 on the synthesizer circuit board.

4. Set the frequency of each band (160 through 10 meters) to the low end of the band.

5. Turn the BAND switch to 80M. Then adjust coil L201 on the T/R circuit board until the voltmeter indicates 4.5 volts DC (±0.3V).

6. Use the SCAN UP pushbutton to scan up to the high end of the 80-meter band. The voltmeter should now indicate 7 volts DC (±0.3V).

7. Use the same procedure to adjust the VCO's on each band. Refer to the following chart for the adjustment (coil or trimmer) and the voltages for band. NOTE: All voltages are ±0.3V.

BAND	ADJUST	FOR (low end of band)	HIGH END INDICATION
160 M	C205	4.5 VDC	7V
40 M	L202	6 VDC	8V
30 M		NO ADJUSTMENT	
20 M	L203	5.5 VDC	8.5V
17 M		NO ADJUSTMENT	
15 M	L204	4.5 VDC	8.5V
12 M		NO ADJUSTMENT	
10 M	L205	4.5 VDC	8.5V

NOTE: The voltage on each band should increase approximately 0.1 volt DC as you tune across the band.

8. Disconnect the VTVM from the Transceiver.

LOOP MIXER

Use the following procedure to adjust the loop mixer:

1. Preset the front panel controls and switches as follows:

MODE	LSB
RIT pushbutton	OFF (out)
BAND	160 M
PASSBAND SHIFT	−6

2. Flex the sides of the loop mixer shield, on the synthesizer circuit board, outward and remove the shield.

3. Set your VTVM to read 5 VDC. Then connect the meter probe to the case of transistor Q106 on the synthesizer circuit board.

4. Adjust coil L101 for a maximum indication on the voltmeter. Then adjust coil L102 for a maximum indication on the voltmeter.

5. Disconnect the VTVM from your Transceiver. Then reinstall the mixer shield on the synthesizer circuit board.

IFO/BFO TIMING ADJUSTMENT

Use the following procedure to adjust the IFO and BFO timing circuits:

1. Set your VTVM to measure 5 VDC. Then connect the meter probe to integrated circuit U138 pin 5 on the synthesizer circuit board.

2. Adjust control R194 either direction until the voltmeter indicates 4 to 5 volts DC. Now turn this control in the opposite direction until the voltmeter indicates 0 volts.

3. Connect the meter probe to integrated circuit U137 pin 5 on the synthesizer circuit board.

4. Adjust control R195 either direction until the voltmeter indicates 4 to 5 volts DC. Now turn this control in the opposite direction until the voltmeter indicates 0 volts.

5. Disconnect the VTVM from your Transceiver.

REFERENCE OSCILLATOR ADJUSTMENTS

NOTE: You can either use a frequency counter to adjust the reference oscillators or you can use the on-the-air signal from station WWV. The frequency counter method, however, is the preferred method.

Frequency Counter Method

Use the following procedure to adjust the reference oscillators:

1. Connect the frequency counter to the collector (C) of transistor Q109 on the synthesizer circuit board.

2. Adjust trimmer C128 until the frequency counter indicates 10,000,000 Hz.

3. Connect the frequency counter to the collector (C) of transistor Q102.

4. Turn the RIT control on the front panel so it is exactly on 0.

5. Adjust trimmer C102 until the frequency counter indicates 10,000,000 Hz.

6. Disconnect the frequency counter from your Transceiver.

WWV Method

Use the following procedure to adjust the reference oscillators:

1. Be sure the RIT pushbutton is OFF (out).

2. Press the R pushbutton so that the left display is controlling the receiver frequency.

3. Be sure the PASSBAND SHIFT switch is at 0, the MODE switch is at USB, and the BAND switch is at 20 M. Also be sure the RF GAIN control is fully clockwise.

4. Turn the TUNING knob until the left display indicates 15.000.8.

5. Press the R pushbutton so that the right display is now controlling the receiver frequency.

6. Turn the TUNING knob until the right display indicates 14.999.2.

NOTE: Perform the next two steps during a period when station WWV is not transmitting an audio tone.

7. Press the R pushbutton so the left display is again in control and turn the MODE switch to LSB.

8. Switch between the left display (LSB mode) and the right display (USB mode) several times and adjust trimmer C128, on the synthesizer circuit board, until the CW note that you hear has the same pitch.

9. Be sure the RIT control is at 0. Then depress the RIT pushbutton to turn the RIT on.

10. Adjust trimmer C102, on the synthesizer circuit board, until the CW note that you hear is the same with the RIT on or off.

RECEIVER ALIGNMENT

FIRST & SECOND IF

Use the following procedure to align the first and second receiver IF stages:

1. Preset the front panel controls and switches as follows:

BAND	160 M
TUNING	1.975.0 MHz
MODE	USB
PASSBAND SHIFT	0
RF GAIN	Fully clockwise
AGC	OFF

2. Unplug the POWER SELECT socket on the rear panel.

3. Connect your audio voltmeter across the speaker or audio load that is connected to the SPKR jack on the rear panel. Then adjust the audio voltmeter and the AF GAIN control on the Transceiver for a zero reference (on noise).

4. Connect your RF generator to the ANTENNA connector on the rear panel. Then adjust the generator frequency for a peak indication on the audio voltmeter.

NOTE: When you align the receiver coils, in the following steps, keep the output of the generator at a low level (no more than 10 dB above the noise level).

5. Adjust coils L208, L209, L210, and L211 on the T/R circuit board, in the order listed, for peak indications on the audio voltmeter. Repeat this step until you notice no further improvement on the voltmeter.

6. Adjust coils L217, L218, L219, and L220 on the T/R circuit board, in the order listed, for peak indications on the audio voltmeter. Repeat this step until you notice no further improvement on the voltmeter.

7. Turn the BAND switch to 80 meters and tune to 4.000.0 MHz. Also set the RF generator to 4.000.00 MHz.

8. Repeat steps 5 and 6 above at this new frequency.

S METER, AGC, & IF GAIN ADJUSTMENTS

Use the following procedure to perform these adjustments:

1. Preset the front panel controls and switches as follows:

MODE	USB
BAND	Any
RF GAIN	Fully clockwise
AGC	FAST

2. Set the controls on the main audio circuit board as follows (controls are viewed from the knob side):

AGC 1 (R333)	Fully clockwise
AGC 2 (R338)	Fully counterclockwise

3. Set the S-METER SENSITIVITY control (R434) on the front panel circuit board fully counterclockwise.

4. Remove the BFO shield (four screws) from the T/R circuit board. Then turn the RECEIVER IF GAIN control (R2108) fully clockwise, as viewed from the back of the control.

5. Set your VTVM to measure 1.5 VDC. Then connect the meter probe to integrated circuit U310 pin 14 on the main audio circuit board. The VTVM should indicate 0.1 volt DC or less.

6. Set your RF generator for 1.5 microvolts output (still connected to the Antenna connector) and set it to the receiver frequency.

7. The VTVM indication should now be at least 0.2 volt.

8. Adjust the generator frequency for a peak indication on the VTVM. Then adjust the RECEIVER IF GAIN control (R2108) on the T/R circuit board counterclockwise until the VTVM indicates 0.3 volt. NOTE: The control pointer should be at the 1 or 2 o'clock position, as viewed from the back of the control.

9. Turn the RF generator off.

10. Be sure the audio voltmeter is still connected to the SPKR jack on the rear panel. Then adjust the AF GAIN control on the front panel to some reference level.

11. Adjust the AGC 1 control (R333), on the main audio circuit board, counterclockwise to the point where the audio voltmeter decreases about 0.5 dB or 2 millivolts from the reference level.

12. Adjust the AGC 2 control (R338), on the main audio circuit board, clockwise until you notice a slight decrease in the indication on the audio voltmeter. Then turn the control counterclockwise until the meter just indicates the reference voltage. NOTE: You may wish to repeat this adjustment to make sure you have it set correctly.

13. Turn the RF generator on and set it for an output of 50 millivolts (S9 + 60 dB) at the receiver frequency. Then adjust the S-METER SENSITIVITY control (R434) on the front panel circuit board for a full scale indication on the S meter.

14. Reduce the output of the generator to 50 microvolts. The S meter should be indicating S-9 (with the Transceiver setting upright). Readjust AGC 2 control (R338) slightly if the meter is not indicating S-9.

NOISE BLANKER ADJUSTMENT

Use the following procedure to adjust the noise blanker:

1. Set the front panel controls and switches as follows:

BAND	160 M
MODE	USB
PASSBAND SHIFT	0
NOISE BLANKER (NB)	Depressed (ON)
AGC	FAST

2. Inject a noise source into the ANTENNA jack on the rear panel. You can use an outside antenna, a pulse generator, or an audio square wave generator (set to 100 Hz). Increase the noise until the S meter indicates S6.

3. Turn control R289 fully counterclockwise, as viewed from the knob side of the control.

4. Set your VTVM to read 5 VDC. Then connect the meter probe to integrated circuit U210 pin 5 on the T/R circuit board. The meter should indicate about 4 volts DC.

5. Slowly turn control R289 clockwise to the point where the VTVM indication does not decrease any further. Then turn the control slightly more clockwise. The pointer on the control should be at the 12 or 1 o'clock position and the VTVM should indicate 2.5 to 3 volts DC.

TRANSMITTER ALIGNMEMT

WARNING: Do not attempt to align the transmitter stages unless you have the necessary equipment and a thorough understanding of transmitter alignment procedures.

BANDPASS FILTER ALIGNMENT

Use the following procedure to align the bandpass filter assembly:

1. Set the output of your tracking generator to − 23 dBm at 1.745 MHz.

2. Set your spectrum analyzer for 10 dB/division.

3. Connect the output cable from the tracking generator to the input of the spectrum analyzer. Then adjust the analyzer for a 0 dB reference on its screen.

4. Unplug connector J203 from the T/R circuit board. Then connect the end of this cable to the output of the tracking generator.

5. Unplug connector P501 from the preamp circuit board. Then connect the end of this cable to the spectrum analyzer.

6. Align each filter as shown in the following chart. NOTE: The first coil or trimmer listed is for the low-frequency end of the band and the second coil or trimmer is for the high-frequency end of the band. The last column in the chart shows the typical insertion loss that you can expect across each band.

7. Disconnect the generator and the analyzer from the filter assembly. Then reconnect the filter cables to the T/R and preamp circuit boards.

Bandpass Filter Alignment Chart

BAND	ALIGNMENT	LOW/HIGH FREQUENCIES (MHz)	TYPICAL INSERTION LOSS (dB)
160	L901, L902	1.745, 2.055	3-4
80	C907, C912	3.425, 4.075	2-3
40	C915, C919	6.925, 7.375	2-3
30	C924, C929	10.100, 10.150	2-4
20	C933, C937	13.925, 15.000.8	2-3
17	C946, C949	17.699, 18.200	3-4
15	C952, C955	20.925, 21.760	3-4
12	C957, C961	24.890, 24.990	3-4
10	C963, C967	28.000, 29.700	4-5

TRANSMITTER IF ADJUSTMENT

Use the following procedure to adjust the transmitter IF:

1. Preset the front panel controls and switches as follows:

BAND	160 M
TUNING	1.975 MHz
MODE	USB
PASSBAND SHIFT	0
SPEECH COMPRESSION	OFF
PTT/VOX	PTT
METER	COMP
AGC	SLOW

2. Unplug the POWER SELECT plug on the rear panel.

3. Depress the TUNE pushbutton. Then adjust the TONE FREQ. control (R365) on the main audio circuit board for the desired frequency. NOTE: This control is factory set for a 800 Hz tone. Increasing the tone frequency decreases the tone amplitude, which decreases the output power.

4. Connect your AC voltmeter to plug P203 pin 5 on the T/R circuit board. Then adjust the CW LEVEL control (R358) on the main audio circuit board for 140 millivolts on the meter (or 0.4 volts peak-to-peak on an oscilloscope).

5. Release the TUNE pushbutton.

6. Unplug connector P501 from the preamp circuit board. Then connect this cable to an RF voltmeter. Set the meter to read 30 millivolts.

7. Depress the TUNE pushbutton. Then adjust coil L215 on the T/R circuit board for a maximum indication on the meter.

8. Set IF GAIN control R2135 on the T/R circuit board for 16 millivolts (−23 dBm).

9. Release the TUNE pushbutton.

10. Reconnect the cable coming from the bandpass filter assembly to S501 on the preamp circuit board.

PRELIMINARY EXTERNAL ALC ADJUSTMENT

NOTE: This adjustment sets the threshold ALC level. Refer to your Owner's Manual for information on how to adjust the ALC to your particular linear amplifier.

1. Set your VTVM to read 5 volts DC. Then connect your VTVM probe to point A on the external ALC circuit board (yellow wire).

2. Adjust control R976 on the external ALC circuit board until the voltage at point A is 4.2 volts. NOTE: This is **not** the control that is accessible through the hole in the rear panel. This control is accessible from the top of the Transceiver.

IDLE CURRENT ADJUSTMENT

NOTE: You will have to remove the PA shield (left side panel) to perform the following adjustments.

Use the following procedure to adjust the idle currents on the PA circuit board.

1. Unplug connector P601 from the PA circuit board.

2. Unplug the red wire from S609. Then connect a DC ammeter (1000 mA capability) between this red wire and S609.

3. Push the TUNE pushbutton and adjust control R648, on the PA circuit board, slowly for an indication of 500 mA. Then release the TUNE pushbutton.

4. Unplug the red wire from S607. Then connect the DC ammeter between the red wire and S607.

5. Push the TUNE pushbutton and adjust control R621 slowly for an indication of 300 mA. Then release the TUNE pushbutton.

6. Reconnect the red wire to S607 and S609 on the PA circuit board.

7. Reconnect the shielded cable to S601 on the PA circuit board.

ALC & 100 WATT ADJUSTMENT

NOTE: You will have to remove the PA shield (left side panel) to perform the following adjustments.

Use the following procedure to adjust these circuits:

1. Preset the front panel controls and switches as follows:

BAND	20 M
TUNING	14.200 MHz
MODE	USB
PASSBAND SHIFT	0
PTT/VOX	PTT
POWER OUTPUT	Fully counterclockwise

2. Preset control R544 on the preamp circuit board fully clockwise, as viewed from the knob side of the control.

3. Preset control R1908 on the ALC circuit board fully counterclockwise and trimmer C1908 to midrange.

4. Carefully remove the shield on the ALC circuit board (only enough to gain access to the unbanded lead of diode D1903). Be sure the shield does not short to Band switch SW604D. This diode lead will be referred to as test point A.

5. Connect a thru-line type RF wattmeter between the ANTENNA connector on the rear panel and a 50-ohm, nonreactive dummy load.

6. Connect your VTVM probe to test point A on the ALC circuit board (lead of diode D1903).

7. Turn the Transceiver on. After about 30 seconds, depress the TUNE pushbutton. There should be very little, if any, power output and the voltmeter should indicate about 8 volts DC.

8. Slowly turn the POWER OUTPUT control to its fully clockwise position. The power output should be less than 50 watts.

9. Adjust trimmer C1908 on the ALC circuit board for a peak indication on the voltmeter. Note this voltage.

10. Adjust control R544 on the preamp circuit board clockwise until the wattmeter indicates 80 watts. Then quickly adjust trimmer C1908 so the voltage is the same or very close to the voltage in step 9 above.

11. Adjust control R544 on the preamp circuit board for 100 watts output on the wattmeter.

12. Release the TUNE pushbutton.

13. Disconnect the VTVM from the ALC circuit board. Then reinstall the shield.

14. Turn the BAND switch to 160 meters.

15. Depress the TUNE pushbutton. Then readjust control R544, as necessary, for 100 watts output.

16. Release the TUNE pushbutton.

17. Turn the POWER OUTPUT control fully counterclockwise.

18. Turn the BAND switch to 80 meters and set the TUNING to 3.9 MHz.

19. Disconnect the dummy load from your wattmeter. Leave the wattmeter connected to the ANTENNA connector.

20. Depress the TUNE pushbutton. Then slowly turn the POWER OUTPUT control fully clockwise. At no time should the power output be greater than 10 watts (open circuit power). If you have more than 10 watts, make sure control R1908 on the ALC circuit board is fully counterclockwise.

21. With the POWER OUTPUT control fully clockwise, adjust control R1908 on the ALC circuit board for 15 to 20 watts output.

22. Release the TUNE pushbutton.

RELATIVE POWER ADJUSTMENT

Use the following procedure to adjust the meter for relative power:

1. Connect a thru-line type RF wattmeter between the ANTENNA connector on the rear panel and a 50 ohm, nonreactive dummy load.

2. Depress the TUNE pushbutton. Then adjust the POWER OUTPUT control on the front panel for 100 watts on the wattmeter.

3. Push the METER SELECT pushbutton until the meter indicates relative power.

4. Adjust control R433 on the front panel circuit board so the meter indicates 100 watts (on the bottom meter scale).

5. Release the TUNE pushbutton.

THERMAL CUTBACK ADJUSTMENTS

Use the following procedure to adjust the thermal cutback circuit:

1. Preset the front panel controls and switches as follows:

BAND	Any
MODE	USB

2. Unplug connector P601 from the PA circuit board.

3. Connect a thru-line type RF wattmeter between the ANTENNA connector on the rear panel and a 50 ohm, nonreactive dummy load.

4. Temporarily connect a jumper wire from the lead at the top of resistor R652 (1800 Ω) and the lead at the top of capacitor C695 (1 μF) on the PA circuit board.

5. Connect your VTVM probe (low range) to integrated circuit U603 pin 6.

6. Depress the TUNE pushbutton and write down the voltage on the VTVM. Then release the TUNE pushbutton.

7. Connect your VTVM probe to integrated circuit U603 pin 5.

8. Depress the TUNE pushbutton. Then adjust control R651 until the meter indicates slightly less than the indication in step 6 above.

9. Reconnect P601 to the PA circuit board.

10. Depress the TUNE pushbutton. Then adjust the POWER OUTPUT control for 95 watts output.

11. Quickly adjust control R651 until you notice a slight decrease in output power. Then turn control R651 back until you again have 95 watts output.

12. Release the TUNE pushbutton and turn the Transceiver off.

13. Disconnect your VTVM from the Trånsceiver. Then disconnect the jumper wire that you installed on the PA circuit board.

CURRENT DRIVEN ALC LIMIT ADJUSTMENT

Use the following procedure to adjust the current limiting circuit:

1. Preset the front panel controls and switches as follows:

BAND	160 M
MODE	USB
PASSBAND SHIFT	0
POWER OUTPUT	Fully counterclockwise

2. Turn control R625 on the PA circuit board fully counterclockwise, as viewed from the knob side of the control.

3. Connect a thru-line RF wattmeter between the ANTENNA connector on the rear panel and a 50 ohm, nonreactive dummy load.

4. Connect your VTVM probe to the collector (C) of transistor Q607 on the PA circuit board.

5. Depress the TUNE pushbutton and adjust the POWER OUTPUT control on the front panel for 85 watts output.

6. Slowly turn control R625 on the PA circuit board clockwise until the VTVM indicates 0.2 volt DC.

7. Release the TUNE pushbutton.

8. Turn the BAND switch to 80 meters.

9. Depress the TUNE pushbutton and write down the VTVM indication. Then release the TUNE pushbutton.

10. Continue this procedure for each band and write down the VTVM indication.

11. Turn the BAND switch to the band that had the highest meter indication.

12. Depress the TUNE pushbutton and increase the output power to 100 watts.

13. Adjust control R625 on the PA circuit board for 0 volt DC on the VTVM. Then turn the control clockwise 1/4 turn further. When you have this control properly set, the pointer on its knob will be at 10 or 11 o'clock.

14. Release the TUNE pushbutton and turn the Transceiver off.

15. Disconnect your test equipment from the Transceiver.

LOW & HIGH PASS FILTER ADJUSTMENTS

None of the low-pass filters require adjustment. The only high-pass filter that is adjustable is the 30-meter filter. The following steps show you how to adjust this filter. NOTE: The Transceiver does not need to be turned on to perform this adjustment.

1. Set the BAND switch to 30 meters.

2. Set the spectrum analyzer for 0.2 dB/division. Then calibrate the analyzer and the tracking generator for a zero dB reference (with the generator set for approximately −20 dBM output).

3. Unplug plug P601 from the PA circuit board. Then connect the tracking generator to socket S601.

4. Unplug plug P602 from the PA circuit board. Then connect the spectrum analyzer to plug P602.

5. Peak coils L611, L612, and L613 on the PA circuit board for a flat response curve between 10.1 and 10.9 MHz. The response curve should drop 3 dB at 10.0 and 11.0 MHz. NOTE: The insertion loss of this filter is 1 to 2 dB.

6. Disconnect the test equipment from the PA circuit board. Then reconnect plugs P601 and P602 to their sockets on the PA circuit board.

IN CASE OF DIFFICULTY

TABLE OF CONTENTS

INTRODUCTION

The "Table of Contents" above shows you the different types of information that are available here to help you locate a problem.

Before you try to locate the cause of difficulty, be sure to check the operation of the controls on your Transceiver. A review of the "Operation" and "In Case of Difficulty" sections of your Owner's Manual may help you locate an improperly set switch or control.

You may also wish to refer to the "Schematic" and the "Circuit Description" section of this Manual as you troubleshoot your Transceiver. The "Block Diagram" may also help you see the signal flow through the various circuits.

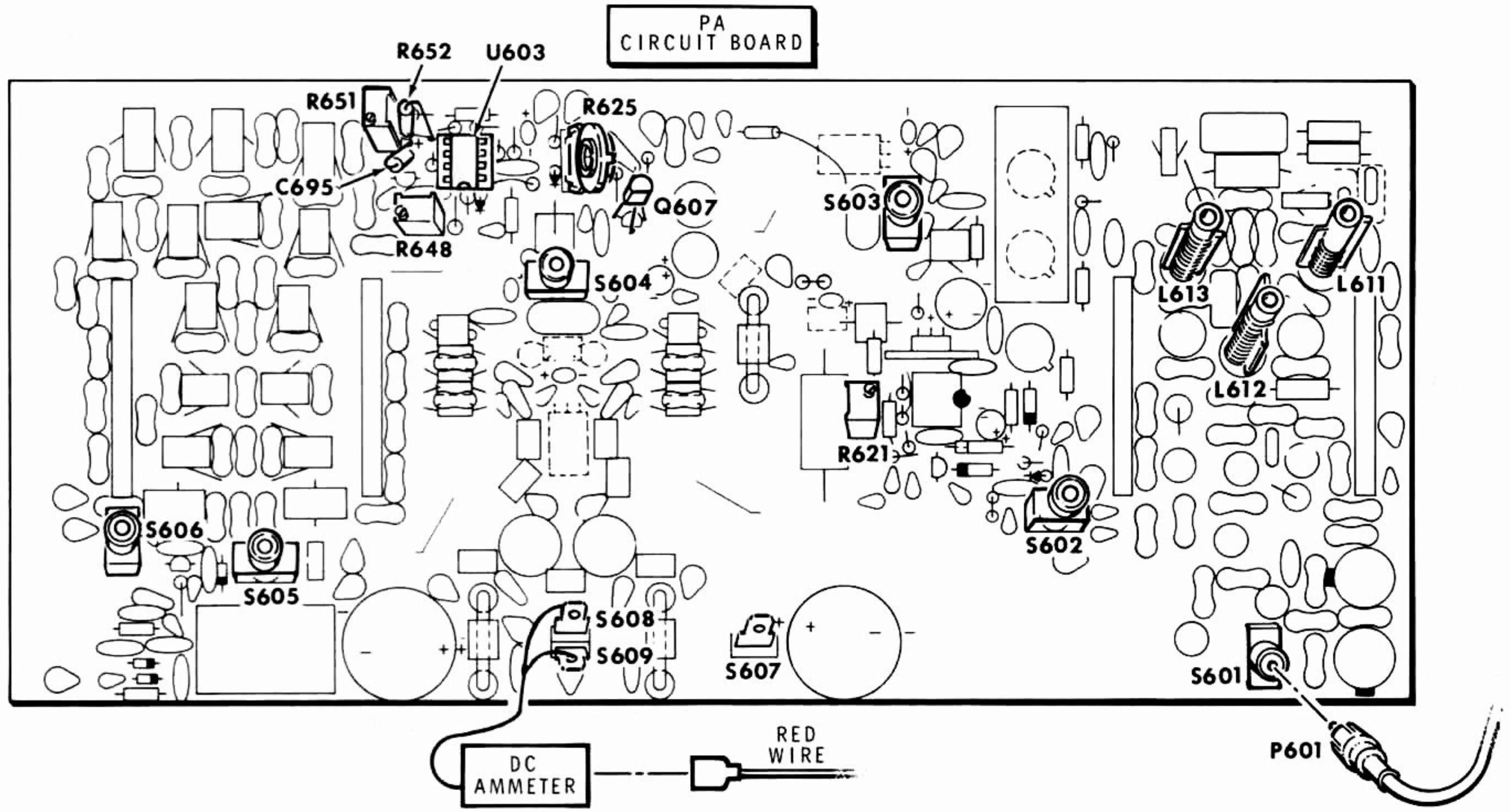


Figure 2-7

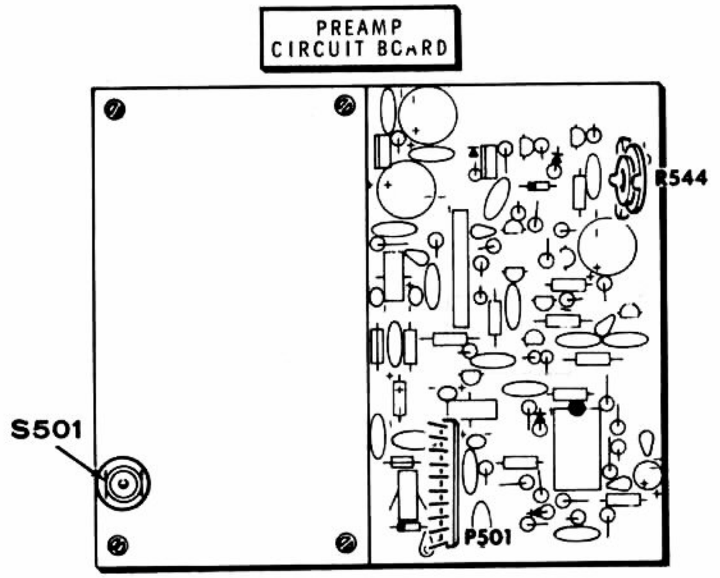


Figure 2-8

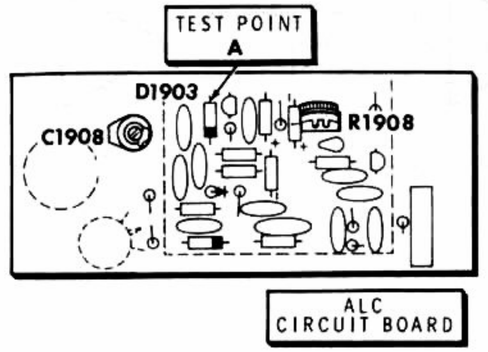
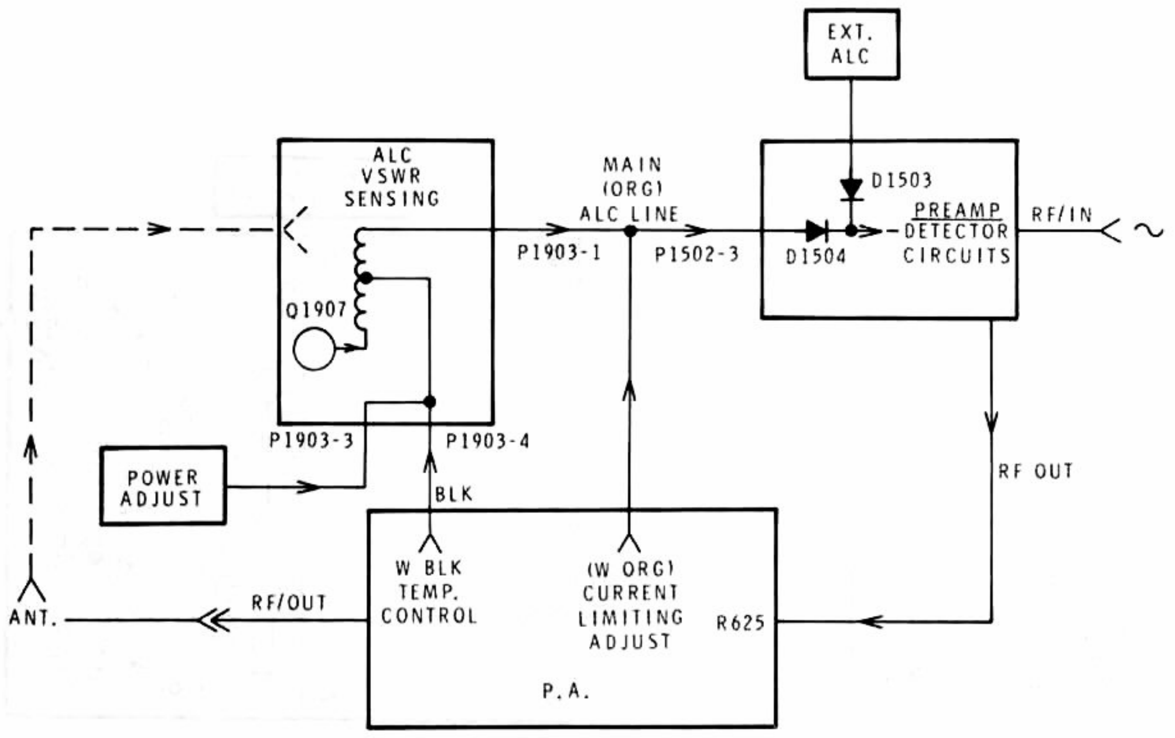
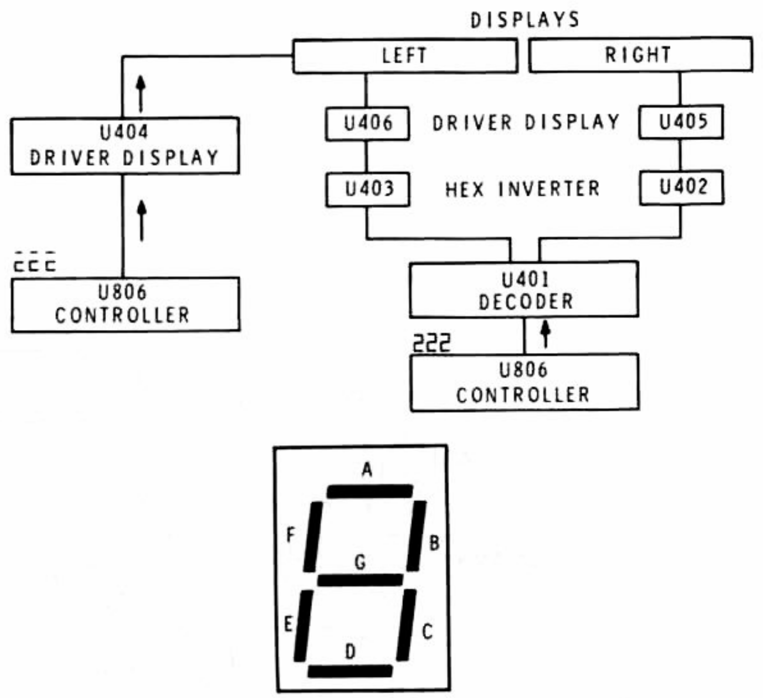


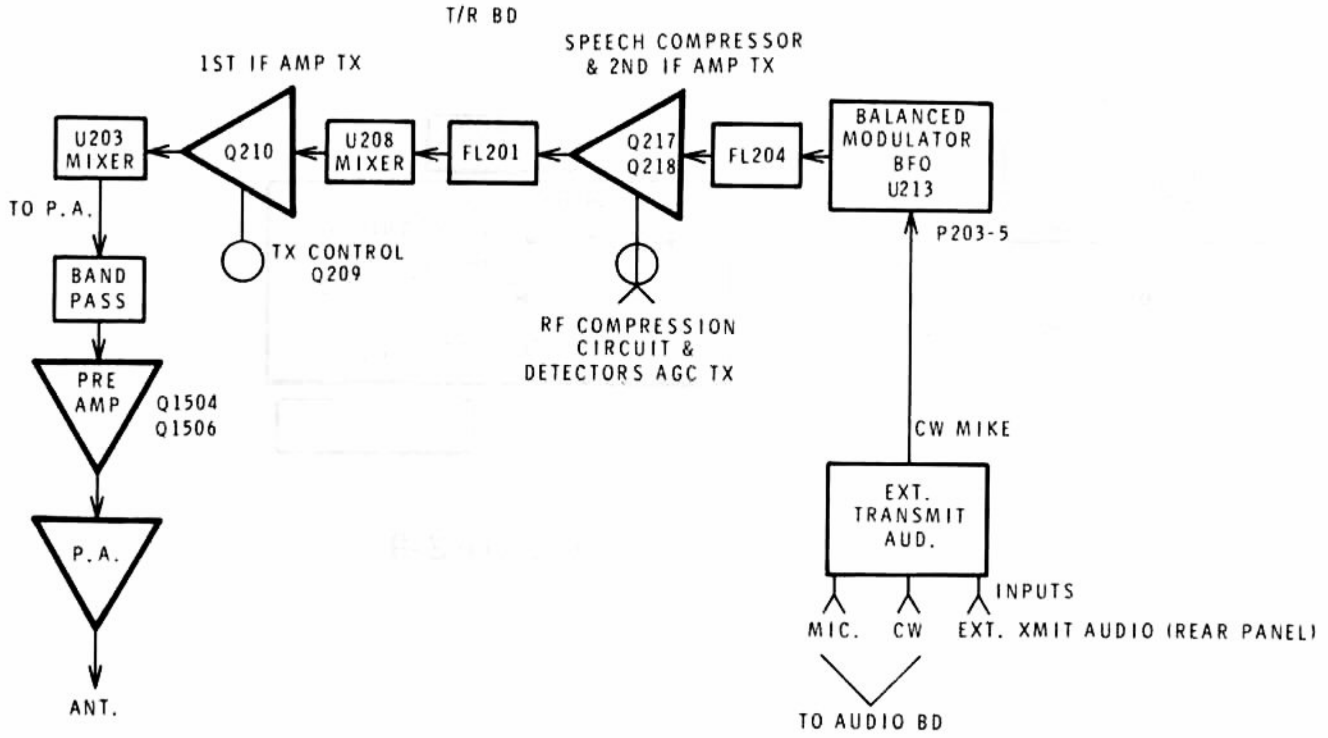
Figure 2-9



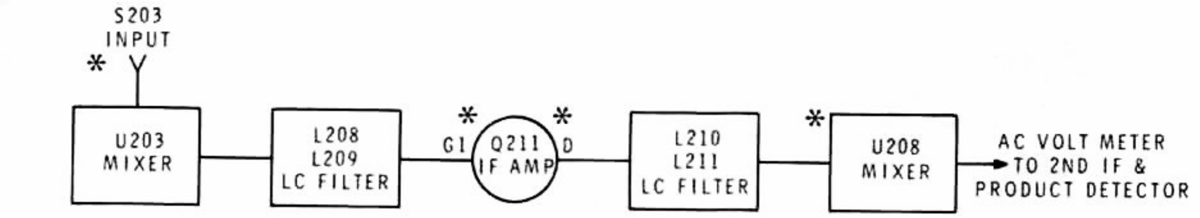
ALC CONTROL BLOCK DIGARAM



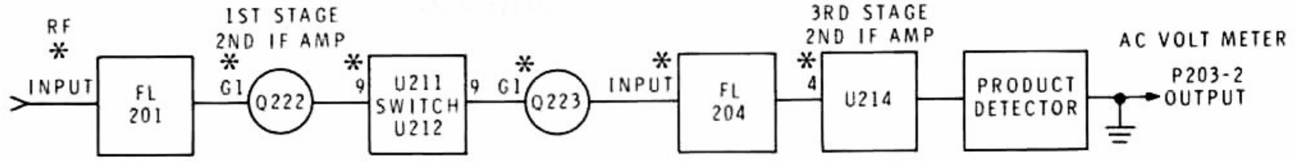
DISPLAY BLOCK DIAGRAM



TRANSMITTER BLOCK DIAGRAM



FIRST IF BLOCK DIAGRAM



SECOND IF BLOCK DIAGRAM

The component numbers are arranged in the following groups to help you locate specific components on the Schematic, circuit boards, photographs, and chassis:

1-99	Parts mounted on the chassis and meter circuit board.
101-199	Parts mounted on the synthesizer circuit board.
201-299 2001-2099	Parts mounted on the transmit/receive (T/R) circuit board.
301-399 3001-3099	Parts mounted on the main audio circuit board.
401-499	Parts mounted on the front panel and LED circuit boards.
501-599	Parts mounted on the preamp circuit board.
601-699 701-799	Parts mounted on the power amplifier (PA) circuit board.
801-899	Parts mounted on the controller circuit board.
901-974	Parts mounted on the bandpass filter circuit board.
975-999	Parts mounted on the external ALC circuit board.
1001-1099	Parts mounted on the inverter circuit board and subchassis.
1201-1299	Parts mounted on the power inteface circuit board.
1401-1499	Parts mounted on the motor driver circuit board.
1501-1599	Parts mounted on the transmitter (TX) audio circuit board.
1901-1999	Parts mounted on the ACL circuit board.

NOTE: Refer to "Component Locations" section for the physical locations of components.

TRANSCEIVER

VISUAL CHECKS

Begin your search for any trouble by following the steps listed below.

1. Check for loose connectors. Make sure the connectors on each of the circuit boards are properly connected.

2. Check for broken wires on the chassis and between the circuit boards.

3. Make sure all hardware is tight, particularly where a faulty ground could result.

If you have still not located the trouble after you complete the "Visual Checks" and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram (fold-in). Be sure you read the following "Precautions for Troubleshooting" before you make any measurements. NOTE: All voltage measurements were taken with a high-impedance input voltmeter. The supply voltage was 13.8 volts DC. Voltages may vary as much as ±20%.

Several oscilloscope patterns are provided at the rear of this Manual to help you troubleshoot the signal circuits.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when you test diode and transistor circuits. Although they have almost unlimited life when used properly, they are much more sensitive to excessive voltage or current than other components.

2. Be sure you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short across components or voltage sources, it is very likely to cause damage to one or more transistors or diodes.

ASSISTANCE BY THE HEATH COMPANY

If you are unable to solve a difficulty, refer to the "Customer Service" information inside the rear cover of your "Owner's Manual." Your Heath Warranty is located inside the front cover of your "Owner's Manual."

LOCALIZING THE TROUBLE

Before you look for any other circuit malfunction, be sure you have the correct supply voltage. Do this by checking the voltage at relay K1 lug 30. This voltage should be 13.8 volts DC. All schematic voltages were taken with this supply voltage.

Now use one of the following methods to localize the trouble to a particular area (such as a circuit board).

- Study the Block Diagram and the "Circuit Description" carefully. Then try to pinpoint your trouble to a particular area. If neither the transmitter nor the receiver is operating, for example, look for your trouble in one of the circuits that is common to both of them.

- If you know your trouble is in the synthesizer, transmitter, receiver, readout circuits, or power supply, refer to one of the following sections:

  "Synthesizer Problems" ...... Page 60
  "Transmitter Problems" ...... Page 55
  "Receiver Problems" .... Page 50
  "Display Problems" .... Page 46

After you localize your trouble to one area:

- Refer to the correct "Troubleshooting Chart."

- Very carefully check the front panel, rear panels, and the chassis for any broken wires.

- Read "Voltage and Continuity Checks" before you make any measurements. Also refer to "Checking Transistors and Diodes."

When you make repairs on this Transceiver, be sure to eliminate **both the cause and the effect** of the trouble. If you should find a damaged resistor, for example, be sure you find out what caused the resistor to become damaged. If you do not eliminate the cause, the replacement resistor may also be damaged when you turn the Transceiver on again.

VOLTAGE AND CONTINUITY CHECKS

To measure voltages, use a voltmeter with a high input impedance (11 megohms or higher). A meter with a low input impedance may load down a circuit and cause the readings to be abnormally low.

An ohmmeter is very useful for measuring resistors, determining the continuity of conductors and inductors, and making a rough check of the service ability of diodes and transistors (see "Checking Transistors and Diodes" on Page 44). But before you check a component on any circuit board, check for the presence of the proper DC input voltage and check the ground connections from the circuit boards to the chassis.

When a troubleshooting chart mentions a particular component as a possible cause of trouble, check the voltages around the component against those shown on the Schematic. Consider any voltage that deviates any more than 20% as possibly indicating some sort of malfunction.

There are various causes of a voltage variation. The main supply voltage may have changed, there may be a malfunction in your power supply, a resistor between a particular test point and the voltage source may have changed value, or a bypass capacitor may have become shorted. Use your voltmeter and trace the voltage back until you get a normal voltage reading. When you reach this point, you can limit the probable cause of trouble to a very few components, which you can then investigate thoroughly.

CAUTION: When you check transistors, be very careful that you do not touch two leads at the same time with your meter probe. This can instantly destroy a transistor.

The complete absence of a designated voltage indicates a break in a foil, a power supply failure, or a similar problem. In such cases, turn the Transceiver off and use your ohmmeter (on its R × 1 range) to check the continuity of the path to the voltage source. Use the corresponding "X-Ray View" and the Schematic to determine where the path is.

CHECKING TRANSISTORS AND DIODES

Silicon Bipolar Transistors

To check a transistor accurately, you should use a transistor tester. However, if one is not available, you can use an ohmmeter to determine the general condition of any one of the bipolar transistors in this Transceiver. The ohmmeter you use must have at least 1 volt DC at the probe tips to exceed the threshold of the diode junctions in the transistor you are testing. Most vacuum tube voltmeters meet this requirement.

To check a transistor with an ohmmeter, proceed as follows:

1. Remove the transistor from the circuit.

2. Set the ohmmeter to the R × 1000 range.

3. Connect one of the ohmmeter test leads to the base (B) of the transistor. Touch the other meter lead to the emitter (E) and then the collector (C). Both readings should be the same, but may be either high or low. If one of the readings is high and the other low, the transistor should be replaced. (Use the Semiconductor Identification Chart on Page 138 to identify the transistor leads.)

4. Interchange the test leads and repeat step 3. The readings will be exactly opposite at each pair of leads.

NOTE: In the unusual case when the readings are all low, or all high, no matter which ohmmeter lead is connected to the base, the transistor should also be replaced.

Mosfets

Insulated gate type MOSFETs are used at Q210, Q211, Q213, Q217, Q218, Q222, and Q223 on the transmit/receive (T/R) circuit board and at Q105 on the synthesizer circuit board. Usually, any defect in these devices is an internal short circuit between the source and one of the gates. You can check them in the circuit with a high impedance input voltmeter (10 megohms or higher). An abnormally low source voltage may indicate an internal short circuit.

Diodes

To check a diode, unsolder one end from the circuit board, pull the lead up and out of the circuit board hole, and proceed as follows:

1. Set the ohmmeter to the R × 1000 range.

2. Connect one of the ohmmeter test leads to the lead at the cathode (banded) end of the diode. Connect the other test lead to the other diode lead. Note the meter reading. Then interchange the meter leads and take another reading. One reading should be high and the other low (at least 10:1). If both readings are either high or low, replace the diode.

POWER INTERFACE AND INVERTER PROBLEMS

CONDITION	POSSIBLE CAUSE
Transceiver is completely inoperable.	1. Check external power supply. 2. Fuse F1 3. Transistor Q1. 4. Power supply voltage is too high.
No external relay.	1. Transistor Q1203, Q1204, Q1205, or Q1206.
No T/R out.	1. Integrated circuit U306. 2. Transistor Q318. 3. Capacitor C307. 4. Transistor Q1207 or Q1212.
No Mute.	1. Transistor Q1207, Q1208, or Q1209. 2. Also see "Receiver Problems."
No $\overline{\text{Mute}}$.	1. Transistor Q1207 or Q1211. 2. Also see "Receiver Problems."
No +28V, +12V, −12V or −5V.	1. Integrated circuit U1001. 2. Transistor Q1001 or Q1002. 3. Relay K1. 4. Coil L1001.
Low +28V supply.	1. Integrated circuit U1003. 2. Diode D1003 or D1004. 3. Feedthrough capacitor C1012.
Low +12V supply.	1. Integrated circuit U1002. 2. Diode D1002 or D1003. 3. Feedthrough capacitor C1017.
Low −12V supply.	1. Diode D1005 or D1006. 2. Feedthrough capacitor C1027.
Low −5V supply.	1. Integrated circuit U1004. 2. Diode D1005 or D1006. 3. Feedthrough capacitor C1024.

DISPLAY PROBLEMS

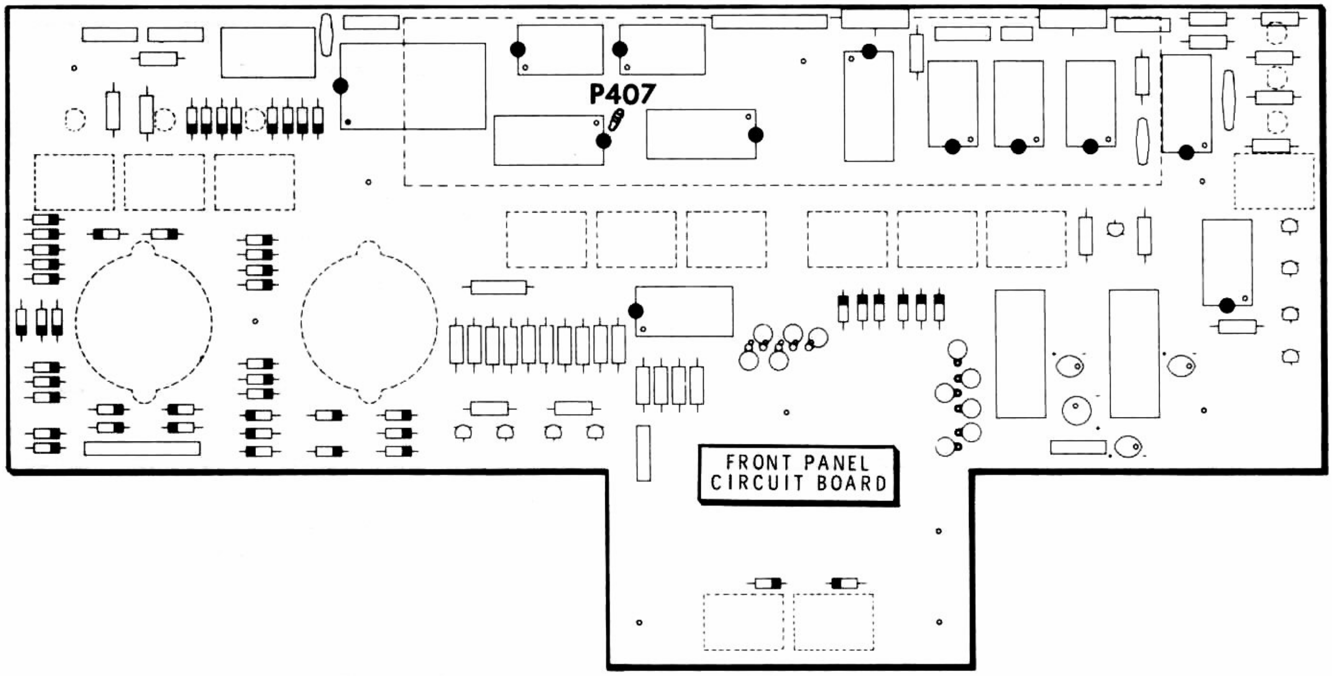


Figure 3-1

NOTE: A good oscilloscope or a VTVM will be very helpful when you troubleshoot the display circuits. If you do not have one of these instruments available, you can use a built-in test circuit to locate many problems.

The test point connector (P407) is located on the component side of the front panel circuit board near integrated circuit U405 (see Figure 3-1). The test indicator is located in the lower right corner of the right-hand display (see Figure 3-2).

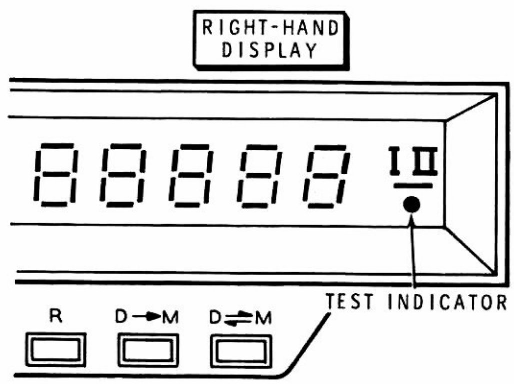


Figure 3-2

When you connect the test point P407 to various logic lines, the indicator will light. This indicator will help you determine if a particular display problem is on the front panel circuit board, or one of the other circuit boards. For example, assume that the decimal point in the displays do not light. The Display Block Diagram, Schematic, and circuit description show that this signal begins at integrated circuit U806 pin 14 on the controller circuit board, and is decoded by U404 on the front panel circuit board. Now, connect test point P407 to connector P402 pin 2 on the front panel circuit board (this is the input to the decoder IC). If the test indicator lights, the problem is on the front panel circuit board. If the test indicator does not light, however, the problem is on the controller circuit board.

NOTE: In many cases, you can determine where a particular problem is by simply observing the segment patterns on the displays. For example, assume that only the right half of the display does not operate correctly. In this case, you would troubleshoot components that are common to that display. To help locate a faulty component, you could interchange integrated circuits between the displays (U405 with U406 or U402 with U403). If the problem moves to the other display, you have located the faulty component.

LOCATING IMPROPER DISPLAYS

Refer to Figure 3-3 as you read the following information.

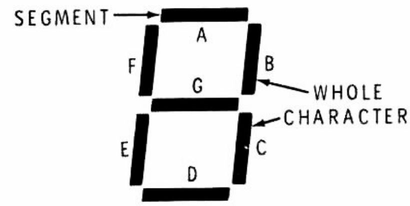


Figure 3-3

NOTE: All like segments in each of the display digits are connected together, but only the digit that is selected by the microprocessor can light.

You can now place a display problem into one of two groups:

1. Problems that have a pattern (all like segments are inoperable).

2. Problems that do not have a pattern (random segments are inoperable).

Non-Pattern Problems

CONDITION	POSSIBLE CAUSE
No display, meter pegs.	1. Shorted or no +8-volt supply. 2. Integrated circuit U408. 3. Plug P408.
No display, only ALC, PWR, or COMP indicators light.	1. Shorted or no +5-volt supply. 2. Integrated circuit U407.
Same as above, but relay on the PA circuit board keys for approximately 6 seconds when you turn the Transceiver on.	1. See "Power Interface and PA Interface Problems."
No display, all front panel indicators light.	1. Integrated circuit U806.
Display shows a single 8, front panel indicators light.	1. No −5-volt supply (see "Power Interface and Inverter Problems"). 2. 2 MHz clock signal missing (see "Synthesizer Problems"). 3. Integrated circuit U806. 4. No +5-volt supply (see "Synthesizer Problems").

Pattern Problems

CONDITION	POSSIBLE CAUSE
Both displays are dim.	1. Low +28-volt supply (see "Power Interface and Inverter Problems").
One half of display is noticably brighter than other half.	1. Transistor Q401, Q402, Q403, Q404, or Q405. 2. Integrated circuit U409.
Single segment is inoperable.	1. Use test indicator to check the matching input to U404. If the indicator lights, check U404. If indicator does not light, check U806 on controller circuit board or check for loose connector.
Single character is inoperable.	1. Connect the test pin to the corresponding output pin of U401. If the indicator lights, interchange like ICs between the displays. If the light does not light, check U401.
No display, all front panel indicators operate.	1. No +28V (see "Power Interface and Inverter Problems"). 2. Integrated circuit U409.
Tuning knob does not change the display indication. Last digit in display flashes. Scan buttons operate.	1. connect the test pin to the collector (C) of Q409. Then turn the dial slowly. If the indicator does not light, measure the voltage at the base (B) of Q408. The voltage should alternate between 0.4V and 1V. If it does, check Q408 or Q409. If it does not, check U416. 2. If the indicator lights when you perform the above test, check U806 on the controller circuit board.
Same problem as above, except the last digit does not flash. Tuning is locked-up.	1. Repeat above test, but on Q406, Q407, and U415. 2. See "Synthesizer Problems".
Display indicates an unlocked condition.	1. See "Receiver Problems".
Display indicates IC1, IC2, or IC3.	1. See "Synthesizer Problems".

FRONT PANEL SWITCHING PROBLEMS

CONDITION	POSSIBLE CAUSE
Band switching problem. HFO unlocks on one or more band.	1. Use an oscilloscope to check for the proper switching at U401 pin 17. 2. Switch contacts 3. Loose connector at P405. 4. Diodes to switch SW3A. 5. Integrated circuit U806 on the controller circuit board.
Mode switching problem.	1. Repeat above test, but at U401 pin 16. 2. Switch contacts. 3. Diodes to switch SW402. 4. See "Receiver Problems".
Passband switching problem.	1. Repeat above test, but at U401 pin 15. 2. Switch contacts. 3. Diodes on SW401. 4. See "Synthesizer Problems".
Meter locks up in one function.	1. Connect test pin to U411 pin 6. The indicator should light when you press the Meter Select pushbutton. If it does not, check U411.
Meter does not operate on one or more functions.	1. Connect the test pin to the corresponding pin on U414. The indicator should light when you press the Tune pushbutton. 2. If the indicator does not light, check for the proper indications at the IC pins in the "Meter Test Chart" (at the end of this section).

METER TEST CHART

	METER FUNCTION							
	ALC		COMP		REL POWER		S METER	
IC	PIN	INDICATION	PIN	INDICATION	PIN	INDICATION	PIN	INDICATION
U411	11,5	ON	14	ON	3	ON		
U411	12	OFF						
U412	9	ON	1	ON	5	ON		
U413	4	ON	1	OFF	8	OFF		
U413	13	OFF	2	OFF	9	OFF		
U413	11	ON	3	ON	10	ON		
U413	12	OFF						
U414							12	ON

RECEIVER PROBLEMS

Refer to the Schematic and the Receiver Block Diagram as you read the following information. Before you begin to troubleshoot the receiver, try to determine exactly what the symptoms are. For example: Are the phase-locked loops operating (front panel display is okay)? Does the S meter operate properly? Can you hear any audio hiss? Is the problem on only one band? Armed with this information, you should be able to look at the Block Diagram and determine the approximate location of a fault for many problems.

To gain access to the receiver circuits, remove the two screws from the T/R circuit board as shown in Figure 3-4. Then lower the T/R circuit board to its open position.

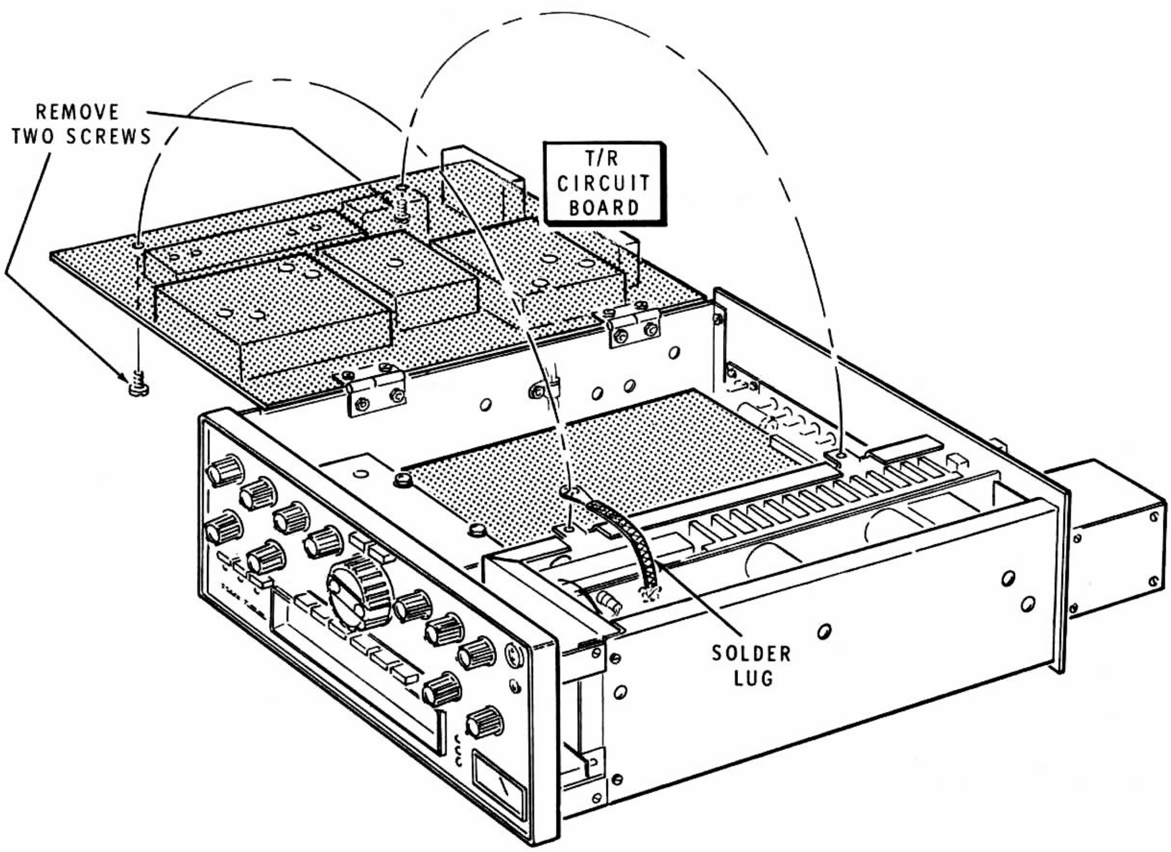


Figure 3-4

RECEIVER/AUDIO PROBLEMS

CONDITION	POSSIBLE CAUSE
No receiver audio.	1. Integrated circuit U302. 2. Also see "IF/Audio."
Weak or no receive signals.	1. Connect an RF generator directly to J203 on the T/R circuit board. If you hear a tone, see "PA/Preamp/Bandpass". If you do not hear a tone, see "IF/Audio." 2. AGC problem. To test this, inject a 1000 Hz audio signal at hole A on the audio circuit board. Then monitor the voltage at U310 pin 14. The voltage should vary as you change the signal level. If it does not vary, see "No AGC 1 and 2." If it does vary, see "IF/Audio."

IF/AUDIO PROBLEMS

No audio output.	1. Speaker connections. 2. Integrated circuit U302. 3. Open phone jack. 4. AF Gain control. 5. Transmitter is keyed.
Distorted or weak audio.	1. Integrated circuit U302. 2. Transistor Q310. 3. Capacitor C314 or C324. 4. Low signal injection from the T/R circuit board. 5. Integrated circuit U305. 6. Transistor Q302 or Q303. 7. Check for a DC voltage at P302 pin 1. If there is a voltage present, check U805. 8. Check the voltage at hole K on the audio circuit board. You should have 8 to 9 volts at this point and it should increase with a strong signal. If this voltage is not correct, see "No AGC 1". 9. Check the voltage at hole C on the audio circuit board. You should have about 2 volts at this point and it should decrease on strong signals. 10. Check for a DC voltage at P202 pin 2. If you do not have a voltage at this point, check U204, Q209, or U805. 11. RF Gain control is turned down. 12. Check the voltage at P204 pin 1. If you have more than 7 volts at this point, check Q241 or Q243.
No AGC 1 and 2.	1. Check for +8-volt source. If no +8 volts is present, check U307. 2. Transistor Q305, Q306, Q307, or Q308. 3. Integrated circuit U310.
No AGC 1.	1. Transistor Q309. 2. Resistor R323.
No S-meter deflection.	1. Integrated circuit U414. 2. AGC switch is off. 3. No AGC 2.

CONDITION	POSSIBLE CAUSE
No first IF.	1. See "First IF Tests" at the end of this section. 2. Transistor Q208 or Q211. 3. Integrated circuit U203. 4. Diode D219 or D220. 5. No AGC 2.
No second IF.	1. See "Second IF Tests" at the end of this section. 2. Filter FL201 or FL204. 3. Transistor Q209 or Q222. 4. Integrated circuit U204, U214, or U215.
Tuning knob does not vary the frequency.	1. Transmit request is being produced. See "Transmitter Problems."
Narrow CW filter is inoperable.	1. Check for a low at P203 pin 10. If no low is present, check U305. 2. Check for +5 volts at P302 pin 5. If no +5 volts is present, check U805. 3. Integrated circuit U211, U212, or U217. 4. Filter FL202.
Medium CW filter is inoperable.	1. Check for a low at P203 pin 9. If no low is present, check U305. 2. Check for +5 volts at P302 pin 4. If no +5 volts is present, check U805. 3. Integrated circuit U211, U212, or U217. 4. Filter FL203.

VCO (Phase-Locked Loop) PROBLEMS

HFO is unlocked on all bands. Audio hiss is present in speaker.	1. Integrated circuit U201. 2. Integrated circuit U202. 3. Transistor Q207. 4. Shielded cable between the synthesizer and T/R circuit boards. 5. Diode in HFO section of the T/R circuit board. 6. See "Display Problems." 7. See "Synthesizer Problems."
Display indicates "7FO unloc."	1. No 10 MHz clock signal See "Synthesizer Problems."
HFO is unlocked on one or more bands.	1. HFO oscillator not operating. 2. No +8 volts to HFO circuits (check U201). 3. Oscillator transistor (Q201-Q206). 4. Transistor Q251. 5. Check connector P201 or P211. 6. Also see "Display Problems."
Display indicates "IFO unloc."	1. Integrated circuit U205 or U206. 2. Transistor Q212, Q231, or Q232. 3. Out of alignment. 4. Check cable connections. 5. Also see "Synthesizer Problems."
Display indicates "BFO unloc."	1. Transistor Q226, Q227, or Q228. 2. No +8 volts to BFO circuit (check U216). 3. Out of alignment. 4. Check cable connections. 5. Also see "Synthesizer Problems."

NOISE BLANKER PROBLEMS

CONDITION	TEST OR POSSIBLE CAUSE
Noise blanker does not operate.	1. Adjustment of control R289. 2. Check for a sawtooth pulse on the anode of D226. If no pulse is present, check D226. 3. Check for correct voltage on Q213, U210, and Q214. If voltages are okay, check Q215, U204, and U216. 4. Also see "Noise Blanker Tests."

PA/PREAMP/BANDPASS PROBLEMS

NOTE: This troubleshooting information assumes that the VCO's and other receiver circuits checked okay.

CONDITION	TEST OR POSSIBLE CAUSE
One band weak or not operating. Transmitter is also affected.	1. Check PA high-pass filter for the affected band. 2. Switch SW601 contacts. 3. Check bandpass filter for affected band. 4. Also see "PA/Preamp/Bandpass Tests."
All bands are weak or not operating. Transmitter is okay.	1. RF Gain control turned down. 2. Transistor Q505. 3. Check for 6 volts or more at P501 pin 6. Then remove resistor R204 on the T/R circuit board. If the voltage drops to less than 5 volts, check AGC circuits. If voltage does not change, check ALC control circuits. Also check transistor Q501 or Q513.

TRANSMITTER PROBLEM CHART

CONDITION	AREA OF DIFFICULTY (CIRCUIT BOARD, ETC.) CONTROLLER	AUDIO	T/R	BANDPASS	PREAMP	PA	ALC	ANTENNA
Transceiver is locked in transmit.	SEE TEST A							
No power or low power output. Compression operates normally. Relay on PA circuit board keys. Receives normally.					SEE TEST D	SEE TEST D	SEE TEST C	SEE TEST C
No power output. Power supply may shut down.					SEE TEST C		SEE TEST C	
No power output. Sidetone is okay. No compression. Receives normally. Relay on PA circuit board keys.	SEE TEST B							
No or very low sidetone. VOX operates normally. Relay on PA circuit board keys.		SEE TEST E						
No external audio. Tune pushbutton and microphone (in VOX mode) will key the relay on the PA circuit board.		SEE TEST F						
CW and voice are okay. Compression is okay. Relay on PA circuit board does not key.					SEE TEST G	SEE TEST G		
One band has low output. Compression operates normally.				SEE TRANSMITTER DATA				
Transmitter and audio operate normally. No or low compression on CW or voice.			SEE TEST H					
No or low power. Excessive current drain in transmit.				SEE TEST J	SEE TEST J	SEE TEST J		
VCOs unlock.			SEE RECEIVER PROBLEMS					

FIRST IF TESTS

Refer to the First IF Block Diagram (fold-out from Page 42) as you read the following information.

1. Unplug the cable from J203 on the T/R circuit board. Then inject an RF signal at (approximately 10 μV) at J203 (50 Ω input impedance). Adjust the generator frequency to the same frequency as on the display so you can hear the audio signal. If you cannot find the signal, proceed through the IF stages until you locate the defective stage. For example, if you find the signal at the gate (G) of Q211, but not on the drain (D), check transistor Q211.

2. Check for the proper gain through the first IF stages as shown in the following chart. Use a 1 mV input signal and measure the gain in millivolts at P203 pin 2.

INPUT CONNECTION	VOLTAGE
FL201	125-200 mV
Q211 gate 1 (G1)	450-600 mV
Q211 drain (D)	300-400 mV
U208 input	500-600 mV

3. Check for the proper VCO frequencies. Use an oscilloscope or a frequency counter to check these.

SECOND IF TESTS

Refer to the Second IF Block Diagram (fold-out from Page 42) as you read the following information.

1. Adjust an RF generator for a 3.395 MHz signal at approximately 10 millivolts output.

2. Turn the AGC control on the front panel of the Transceiver to Off.

3. Inject the RF signal at the input to filter FL201. You should be able to hear a tone. If you hear a tone, see "First IF Tests." If you do not hear a tone, proceed through the stages of the second IF until you locate the defective stage.

4. Check for the proper gain through the second IF stages as shown in the following chart. Use a 10 millivolt input signal and check the gain in millivolts at P203 pin 2.

INPUT CONNECTION	VOLTAGE
FL201	210 mV
Q222 gate 1 (G1)	200 mV
U211 pin 9	27 mV
Q223 gate 1 (G1)	35 mV
FL204	4-5 mV
U214 pin 4	17 mV

NOISE BLANKER TESTS

1. Be sure the Power Select plug on the rear panel is unplugged.

2. Preset the front panel switches and controls as follows:

Band	160 M
Mode	USB
RF Gain	Fully clockwise.
Noise Blanker (NB)	Off (out)

3. Use a short length of wire to short the Antenna input to U402 pin 9. You should hear noise pulses. Now depress the Noise Blanker pushbutton. The noise should now be gone or greatly reduced. If you do not hear any difference, see "Noise Blanker Problems" earlier in this section.

PA/PREAMP/BANDPASS TESTS

Refer to the PA/Preamp/Bandpass Block Diagram (fold-out from Page 61) as you read the following information.

1. Use an RF generator to trace the signal through the stages shown in the Block Diagram. Also note whether the problem is on one or more bands. If the problem does not occur on all bands, the problem is most likely in the low-pass, high-pass, or bandpass filter stages.

2. Check the signal levels through each stage as shown in the following chart.

STAGE	LEVEL (gain or loss)
High- and low-pass filters	2 to 3.5 dB loss
Preamp circuit	15 to 20 dB gain
Bandpass filter	2 to 4 dB loss

TRANSMITTER PROBLEMS

Some circuits are used in both the receiver and the transmitter. Therefore, this section assumes that the receiver is operating normally.

Refer to the Transmitter Block Diagram (fold-out from Page 42) as you read the following information.

The following chart lists some typical problems that could occur with the transmitter. Look down the left side of the chart for your particular problem. The top of the chart shows you what area may be at fault. To the right of each problem, you will find a notation such as "Test A." Perform the steps in that test to locate faulty part or parts. At the end of this section, you will find transmitter signal data and some ohmmeter checks.

TEST A

Symptom: Transceiver is locked in the transmit mode. The Tuning knob may or may not vary the frequency.

1. Unplug the Power Select plug on the rear panel of the Transceiver.

NOTE: Push the Tune pushbutton when you make the following tests.

2. Measure the voltage at hole UU on the PA circuit board. This voltage should measure 7-8 volts DC. Then unplug S202 on the T/R circuit board. If the voltage goes low, proceed to the next test. If the voltage remains high, check integrated circuit U204 or transistor Q209 on the T/R circuit board.
3. Reconnect S202. Then measure the voltage at hole UU on the PA circuit board while you unplug S302 on the audio circuit board. If the voltage goes low, check integrated circuit U805 on the controller circuit board. If the voltage remains high, proceed to the next step.
4. Reconnect S302. Then measure the voltage at hole UU on the PA circuit board as you short across control R374 on the audio circuit board. If the voltage remains high, check socket S302 pin 3 or integrated circuits U304, U305, or U306. If the voltage goes low, check socket S302 pin 2 or integrated circuits U303, U304, U305, or U313.

TEST B

Symptom: No power output. Sidetone is present when you press the Tune pushbutton. Relay on the PA circuit board may or may not operate.

1. Check voltages in "Test A."

TESTS C and D

Symptom: High or no or low power output. Compression operates properly.

Keep in mind that this type of problem could be caused by a fault in one of the transmitter control or protection circuits (refer to the ALC Control Block Diagram, fold-out from Page 42). These circuits are:

1. Temperature cutback.
2. Current limiting.
3. VSWR sensing.
4. ALC preamp.
5. Power output control.
6. External ALC.

Test C

NOTE: Since many of these problems are closely related, this test is broken down into two different symptoms. Proceed to the symptom that most closely matches your problem.

Symptom: No or low power output. High ALC indication on the meter.

1. Turn the Transceiver off. Mark the setting of control R625 on the PA circuit board so you can return it to its original setting later. Then turn the control fully clockwise.

2. Unplug S1903 from the ALC circuit board.

3. Turn the Transceiver on. Then push the Tune pushbutton and watch for an increase in power, or a decrease on the front panel meter. If you obtained the proper results, the problem is related to the ALC control circuits. If you did not obtain the proper results, proceed to the next symptom.

4. Turn the Transceiver off. Then turn control R625 counterclockwise a small amount.

5. Turn the Transceiver on. You should notice an increase in power output. DO NOT exceed 100 watts.

6. Turn the Transceiver off. Return control R625 to its "marked" position.

Symptom: Transceiver operates at full power output. No or low ALC indication on the meter. Power supply may shut down.

1. Turn the Transceiver off. Mark the setting of control R625 on the PA circuit board so you can return it to its original setting later. Then turn the control fully clockwise.

2. Unplug S1903 from the external ALC circuit board.

3. Turn the Transceiver on. Then push the Tune pushbutton and watch for a decrease in power output (should be less than 70 watts). If you did not obtain the proper results, proceed to "Test D." If you did obtain the proper results, proceed to the next step.

4. Lower the T/R circuit board to its open position. Mark the setting of control R2133 so you can return it to its original setting later. Then turn the control fully clockwise.

5. Unplug S204 from the T/R circuit board. Then connect a 68 ohm resistor between P204 pin 1 and ground.

6. Push the Tune pushbutton and watch for an increase in power. Then slowly adjust the control counterclockwise very slowly. If you cannot obtain 100 watts output, proceed to "Test D." If the power output is still low, proceed to "Test J."

7. Turn the Transceiver off. Then return controls R2133 and R625 to their "marked" positions.

Test D

NOTE: To perform the following tests, you must remove the PA assembly from the chassis. You must also remove the cover from the preamp circuit board.

The following steps require a 0- to 10-volt variable power supply.

1. Unplug P1903 from the ALC circuit board. Then turn the Power Output control on the front panel fully counterclockwise. Connect the external power supply to P502-3 (orange wire) on the preamp circuit board.

2. Set the external power supply for 0 volts. Then connect a voltmeter to FB504.

3. Push the Tune pushbutton. The voltmeter should indicate 2-4 volts DC. Now slowly increase the voltage from the external power supply. The voltmeter should increase very quickly to 7 volts or more.

4. If you obtain the proper results in the above step, check transistor Q501, Q502, and Q503 and diode D504. If you did not obtain the proepr results in the above step, check transistor Q507, Q508, Q509, or Q512.

TEST E

Sympton: No or very low sidetone. VOX operates properly Relay on the PA circuit board operates when you press the Tune pushbutton.

1. Check for a 5-volt (approximate) peak-to-peak square wave at integrated circuit U313 pin 15 on the main audio circuit board. If you have the correct signal at this point, check transistor Q211 or Q212. If you do not have the correct signal at this point, check integrated circuit U308 or U313 on the main audio circuit board.

TEST F

Sympton: No external transmitter audio.

1. Unplug the Power Select plug on the rear panel.

2. Push the Tune pushbutton and check for .4 volts peak-to-peak at P203 pin 5 on the T/R circuit board. If you did not obtain the proper results, check integrated circuit U1501 or U1502 on the TX audio circuit board.

TEST G

Symptom: PA will not key.

1. Check for a high at P501 pin 4 on the preamp circuit board. If this voltage is high, proceed to the next step. If this voltage is low, check U306 on the main audio circuit board.

2. Check for 12- to 13-volts DC on the brown wire of the Power Select socket on the rear panel. If you did not obtain the proper voltage, the problem is in the relay circuit. If you did obtain the proper voltage, check integrated circuit U501 or transistor Q515, Q516, or Q517.

TEST H

Symptom: Transmit audio and transmitter operate normally. No compression indication in CW or voice.

Refer to the Balanced Modulator Block Diagram (fold-out from Page 61) as you perform the following tests.

1. Set the Transceiver controls and switches to the following settings:

Mode	USB
Band	160 M
Power Select socket	Unplugged

2. Connect an RF generator to P203 pin 5 on the T/R circuit board. Then adjust the generator for .4 volts peak-to-peak output.

3. Use a good quality RF voltmeter to measure the signal levels as shown in the following chart:

CONNECTION	VOLTAGE
U213 pin 4	.4V peak-to-peak
U213 pin 9	110 mV
Q218 gate 1 (G1)	65 mV
Q218 drain (D)	210 mV
Q217 gate 1 (G1)	210 mV
Q217 drain (D)	1000 mV
FL210 input	600 mV
Q210 gate 1 (G1)	55 mV
Q210 drain (D)	940 mV
J203	80 V

TEST J

Symptom: No or low power output. Excessive current drain in transmit.

NOTE: This test assumes that the ALC checks produced the proper results. It also assumes that you have normal compression and the relay on the PA circuit board keys when you push the Tune pushbutton.

1. Select the 160-meter band and unplug S503 from the preamp circuit board.

2. Check for the proper voltages at the points shown in "Transmitter Data" at the end of this section. If the voltages are okay, proceed to the next step. If the voltages are not correct, check for .9 volts peak-to-peak on the collector (C) of Q504 and .4 volts peak-to-peak on the collector (C) of Q506.

3. Turn the Transceiver off. Then unplug connector S608 on the PA circuit board.

4. Check the ohmmeter indications against those shown in "Ohmmeter Tests."

TRANSMITTER DATA

		BAND AND FREQUENCY								
CONNECTION POINT		160M 1.9 MHz	80M 3.75 MHz	40M 7.2 MHz	30M 10.125 MHz	20M 14.2 MHz	17M 18.1 MHz	15M 21.2 MHz	12M 24.9 MHz	10M 28.9 MHz
Output of bandpass filter.		−23 to −20dB on all bands (16 to 22.5mV)								
Preamp gain (Input to output). NOTE: Unplug P1901 to disable ALC.		16dB 115mV	17dB 150mV	17dB 140mV	18dB 155mV	20dB 180mV	22dB 210mV	23dB 300mV	24dB 350mV	25dB 300mV
Drive required at input of PA circuit board for 100 watts output.		42mV	35mV	45mV	45mV	50mV	64mV	80mV	95mV	160mV
Gain of predriver stage (3 points shown).		50-60mV				100mV				250mV
Output of driver stage (3 points shown).		15W				26W				31W
Bandpass filter loss.		3-4dB	2-3dB	2-3dB	2-4dB	2-3dB	3-4dB	3-4dB	3-4dB	4-5dB
High-pass filter	Loss	1-2dB	1dB	1-2dB	1-2dB	1dB	1-2dB	1-2dB	1dB	1dB
	Cutoff Frequency	1.5 MHz	3.1 MHz	6.8 MHz	10-11 MHz*	13 MHz	19-37 MHz*		23.5-37.5 MHz*	
Low-pass filter	Loss	Less than .5 dB on all bands								
	Cutoff Frequency	2.0 MHz	4.4 MHz	7.5 MHz	12.8 MHz	16.1 MHz	22.9 MHz	22.9 MHz	36.0 MHz	36.0 MHz

*This filter actually forms a bandpass filter.

OHMMETER CHECKS

The following chart shows typical ohmmeter readings for transistors on the PA circuit board. All readings are from the point indicated to ground. If you do not obtain the correct readings the first time, try interchanging the ohmmeter leads before you consider the transistor to be bad. NOTE: Some points may take several seconds to reach the correct indication. This is due to the slow charging rate of capacitors in some of the circuits.

TRANSISTOR LEAD	TRANSISTOR					
	Q601	Q602	Q603	Q605	Q609	Q611
Emitter (E)	82 Ω	27 Ω	27 Ω	0 Ω	0 Ω	0Ω
Base (B)	3000-7000 Ω	82 Ω	82 Ω	45-55Ω	40-55 Ω	40-55 Ω
Collector (C)	800-1600 Ω	800-1600 Ω	800-1600 Ω	600-1700 Ω	600-1500 Ω	600-1500 Ω

The following chart shows typical ohmmeter readings between some of the transistor leads on the PA circuit board. All readings were taken with the ohmmeter set to its R × 100 range. Readings are shown with the ohmmeter leads connected one way (forward) and then connected the other way (reverse).

TRANSISTOR LEADS	FORWARD READING	REVERSE READING
Q601 B to E	800 Ω	1500 Ω
Q601 B to C	800 Ω	3000 Ω
Q601 C to E	900 Ω	600 Ω
Q602 C to E	800 Ω	500 Ω
Q603 C to E	800 Ω	500 Ω
Q605 B to C	500 Ω	900 Ω
Q609 B to C	500 Ω	900 Ω
Q611 B to E	500 Ω	900 Ω

SYNTHESIZER PROBLEMS

The frequency synthesizer consists of three phase-locked-loop circuits. These circuits form the IFO (intermediate frequency oscillator), the BFO (beat frequency oscillator), and the HFO (high frequency oscillator). These three loops work together mathematically to produce the desired operating frequency. Because these circuits are connected in a loop arrangement, they are the most difficult to troubleshoot.

One of the easiest things to check is the synthesizer power supply circuit. Make sure that the regulator integrated circuits (U133, U134, U135, and U136) are each producing +5 volts DC. If only one of the regulators appears to be faulty, check the associated integrated circuit. Also check the filter capacitor (C179, C181, C182, or C183) that is connected to the output of that integrated circuit. If all of the regulators appear to be faulty, check for +13.8 volts DC at socket P101 pin 1. Also check input filter capacitors C177 and C178.

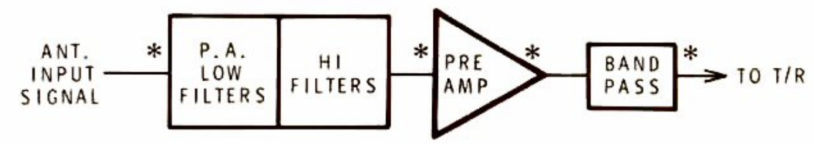
If the power supply seems to be operating properly, try to determine which loop or loops are not functioning. If the display indicates "IFO unloc", "bFO unloc", or "hFO unloc", this tells you which single loop is not operating. If more than one loop is inoperable, the display will indicate with something similar to "3FO unloc." The number represents the sum of the loops that are unlocked (HFO = 1, IFO = 2, BFO = 4). In this example, "3FO unloc" indicates that the HFO and IFO loops are unlocked (1 + 2 = 3). An indication of "7FO unloc" indicates that all three loops are unlocked (1 + 2 + 4 = 7).

Each of the phase-locked-loops consist of a reference divider, program lines, a loop-divider chain, and a phase detector.

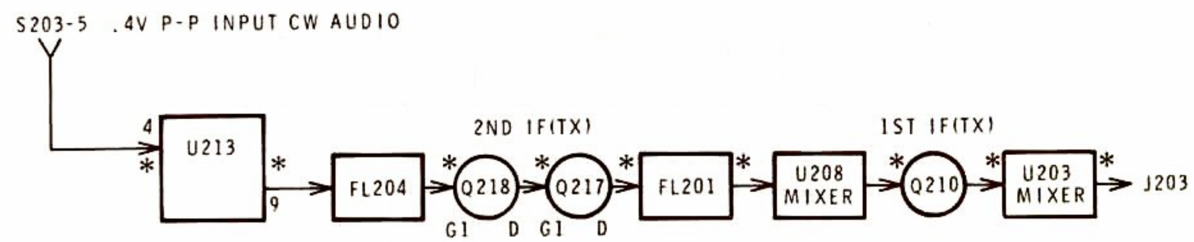
NOTE: To troubleshoot the synthesizer circuits properly, you should have a VTVM, an oscilloscope, and a frequency counter.

The following information provides you with a logical procedure for troubleshooting the synthesizer. Refer to the Schemaitc Diagram and the Transceiver Block Diagram as you read this information. For component locations, refer to the "Component Locations" section of this Manual. Locate the condition in the following chart that best describes the problem you are experiencing. The chart will have you check specific components, give you some additional tests, or direct you to proceed to another part of this section. NOTE: Since all three loops are similar, you can locate a faulty integrated circuit in one of the loops by interchanging it with its counterpart in one of the other loops. When the problem changes to a different loop, you have located the faulty integrated circuit.

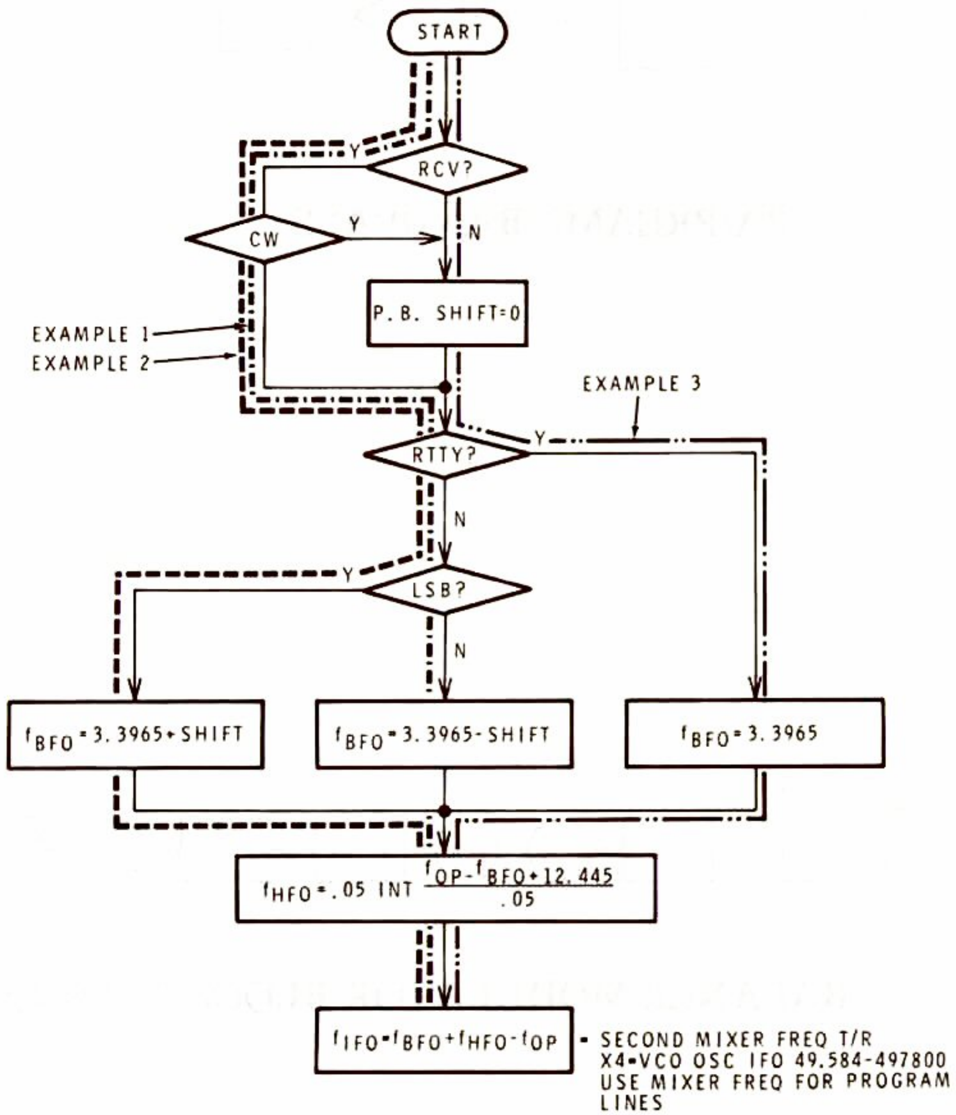
CONDITION	TEST OF POSSIBLE CAUSE
No display.	1. Check for + 5 volts at the output of U136. 2. Check for 10 MHz at integrated circuit U111 pin 4. If you have the correct frequency at this pin, check transistors Q108 and Q109, integrated circuit U110, and crystal Y102.
Display indicates "7FO unloc."	1. Perform step 2 above under "no display". 2. Integrated circuit U111.
Display indicates a single "8."	1. Check for 2 MHz at integrated circuit U102 pin 12. If you do not have the correct frequency at this pin, check integrated circuits U102 or U111.
Display indicates "hFO unloc."	1. Check for 100 kHz at integrated circuits U111 pin 13 and U112 pin 13. If you do not have the correct frequencies at these pins, check integrated circuits U111 and U112. If you have the correct frequencies, proceed to "Theory of Operation", which follows this problem chart.
Display indicates "IFO unloc."	1. Check for 16 kHz at integrated circuit U112 pin 9. If you do not have the correct frequency at this pin, check integrated circuit U112. 2. Check for 3.2 kHz at integrated circuit U113 pin 8. If you do not have the correct frequency at this pin, check integrated circuit U113. If you have the correct frequency, proceed to "Theory of Operation," which follows this problem chart.
Display indicates "bFO unloc."	1. Check for 1.6 kHz at integrated circuit U113 pin 9. If you do not have the correct frequency at this pin, check integrated circuit U113. If you have the correct frequency, proceed to "Theory of Operation," which follows this problem chart.
Display indicates "6FO unloc."	1. Check for 400 kHz at integrated circuit U111 pin 9. If you do not have the correct frequency at this pin, check integrated circuit U111. 2. Check for 16 kHz at integrated circuit U112 pin 9. If you do not have the correct frequency at this pin, check integrated circuit U112. If you have the correct frequency, proceed to "Theory of Operation," which follows this problem chart.



PA/PREAMP/BANDPASS



BALANCE MODULATOR BLOCK DIAGRAM



SYNTHESIZER FLOW CHART

THEORY OF OPERATION

Before you troubleshoot the synthesizer any farther, you must understand how the various frequencies are mathematically mixed together to produce the desired operating frequency. When you understand how the synthesizer operates, you will be able to determine what binary information should be on the HFO data lines (H0 through H9), the IFO data lines (I0 through I9), and the BFO data lines (B0 through B5) for a given set of parameters (band, frequency, passband shift, etc.).

Refer to the "Synthesizer Flow Chart" as you read each of the following examples. These examples show you what frequencies the BFO, HFO, and IFO must operate at to produce particular sets of parameters. You will then be shown how to determine what information must be present on the corresponding data lines for Example 1. This information will help you determine what part of a particular loop is faulty.

Example 1:

The tuning dial is set to 14.1234 MHz, USB mode, and the Passband Shift is set to −200 Hz. As shown on the flow chart:

f<BFO> = 3.3935 – (The passband shift)
= 3.3935 – (– .0002)
= 3.3935 + .0002
= 3.3937 MHz. This is the BFO operating frequency.

f<HFO> = .05 × the integer part of

$$\frac{14.1234 - 3.3937 + 12.445}{.05}$$

= .05 × the integer part of

$$\frac{23.1747}{.05}$$

= .05 × the integer part of 463.494
= .05 × 463
= 23.15 MHz. This is the HFO operating frequency.

f<IFO> = f<BFO> + f<HFO> – 14.1234
= 3.3937 + 23.15 – 14.1234
= 12.4203 MHz. This is the IFO operating frequency.

Example 2:

The tuning dial is set to 3.8678 MHz, LSB mode, and the Passband Shift is set to +100 Hz. As shown on the flow chart:

f<BFO> = 3.3965 + (the passband shift)
= 3.3965 + .0001
= 3.3966 MHz.

f<HFO> = .05 × the integer part of

$$\frac{3.8678 - 3.3966 + 12.445}{.05}$$

= .05 × the integer part of

$$\frac{12.9162}{.05}$$

= .05 × the integer part of 258.324
= .05 × 258
= 12.9 MHz.

f<IFO> = f<BFO> + f<HFO> – 3.8678
= 3.3966 + 12.9 – 3.8678
= 12.4288 MHz.

Example 3:

The tuning dial is set to 14.0987 MHz, RTTY mode, and the Passband Shift is set to +200 Hz. As shown on the flow chart:

NOTE: In the RTTY mode, the passband shift is forced to 0, regardless of the switch setting.

f<BFO> = 3.3965 MHz.

f<HFO> = .05 × the integer part of

$$\frac{14.0987 - 3.3965 + 12.445}{.05}$$

= .05 × the integer part of

$$\frac{23.1472}{.05}$$

= .05 × the integer part of 462.944
= .05 × 462
= 23.1 MHz.

f<IFO> = f<BFO> + f<HFO> − 14.0987
= 3.3965 + 23.1 − 14.0987
= 12.3978 MHz.

N<BFO> = 33,983 − (10,000 × f<BFO>

N<HFO> = 1023 − (20 × f<HFO>

N<IFO> = 124,575 − (10,000 × f<IFO>)

These equations, however, produce decimal numbers. To determine the states of the data lines, you must convert these decimal numbers to binary numbers. One of the simplest ways of doing this conversion is to repeatedly divide the decimal number by 2 and note the remainder (which must be either zero or one). You keep dividing the result by 2 until the result is 0 with or without a remainder. For example, to convert the number 185 to binary, you would perform the following divisions:

	REMAINDER	
185/2 = 92	1	Least-significant bit
92/2 = 46	0	
46/2 = 23	0	
23/2 = 11	1	
11/2 = 5	1	
5/2 = 2	1	
2/2 = 1	0	
1/2 = 0	1	Most-significant bit

When you arrange these numbers so the most-significant bit is on the left and the least-significant bit is on the right, you obtain 10111001.

Now, you can use this information to determine the bit pattern that must be on the data lines for Example 1.

N<BFO> = 33,983 − (10,000 × 3.3937)
= 33,983 − 33,937
= 46 decimal
= 101110 binary

These bits are presented on the BFO data lines as follows:

1	0	1	1	1	0
B5	B4	B3	B2	B1	B0

N<HFO> = 1023 − (20 × 23.15)
= 1023 − 463
= 560 decimal
= 1000110000 binary

These bits are presented on the HFO data lines as follows:

1	0	0	0	1	1	0	0	0	0
H9	H8	H7	H6	H5	H4	H3	H2	H1	H0

N<IFO> = 124,575 − (10,000 × 12.4203)
= 124,575 − 124,203
= 372 decimal
= 101110100

These bits are presented on the IFO data lines as follows. NOTE: Since there are only nine bits shown, and there are ten lines, you must add a zero to the left of the numbers (line I9).

0	1	0	1	1	1	0	1	0	0
I9	I8	I7	I6	I5	I4	I3	I2	I1	I0

TROUBLESHOOTING CONTINUED

Before you continue, check the HFO, IFO, and BFO data lines to make sure the bit patterns are correct. NOTE: If you are not sure what frequency the Transceiver is tuned to (because the display shows an unlocked condition), you can read the frequency by quickly turning the Tuning knob and observing the display. The display will briefly indicate the operating frequency before it returns to the unlocked condition.

If the bit patterns are all correct, you can assume that the controller circuit board is not at fault. If the bit patterns are not all correct, the problem is most likely on the controller circuit board. If the problem appears to be on the controller circuit board, you can interchange similar integrated circuits, one at a time, between the good loop and the faulty loop. When the problem moves to a different loop, you have isolated the faulty component.

Now that you have determined that the problem is on the syntehsizer circuit board, you can further isolate the problem to either the programmable dividers or the phase detector. The following information shows you how to determine which circuit contains the fault, and how to locate the faulty component. NOTE: The following procedure is for the HFO loop. You can use the same procedure for the IFO and BFO loops. You will be given alternate procedures for the IFO and BFO where they differ.

Use one of the following procedures to troubleshoot the HFO loop:

With RF Generator

NOTE: You will need the following equipment to use the following procedure:

RF Generator (to 50 MHz)
Frequency counter (to 50 MHz)
Oscilloscope (helpful)

1. Preset the controls on the Transceiver as follows:

Mode	USB
Passband Shift	0
Tuning	15.000.0
RIT	OFF

2. Unplug connector J202 from the T/R circuit board. Then connect your RF generator to the end of this cable. (Use the cable from J205 for the IFO or the cable from J207 for the BFO.)

3. Set the RF generator for .1 to .3 volts RMS output at 24.050 MHz. (The frequencies would be 49.774 MHz for the IFO loop and 3.3935 MHz for the BFO loop.)

4. Use a frequency counter to check the frequency at the collector (C) of transistor Q115. This frequency should be 1/2 the generator frequency (12.025 MHz) with an amplitude of .3 volts peak-to-peak. If you do not have the correct frequency at this point, check integrated circuit U141 and transistors Q114 and Q115.

NOTES:

A. For the IFO loop, check for 9.7741 MHz (.2 volts peak-to-peak) at the collector (C) of transistor Q106. If you do not have the correct frequency at this point, check for 40 MHz at gate 2 (G2) of transistor Q105 (.5 volts peak-to-peak). Also check for 10 MHz at pin 8 of integrated circuit U101. If these frequencies are not both correct, check transistor Q104 or integrated circuit U101 (depending upon which frequency is not correct). If all frequencies are correct, check transistors Q105 or Q106.

B. For the BFO loop, check for 3.3935 MHz (4 volts peak-to-peak) at the collector (C) of transistor Q121. If this frequency is not correct, check transistor Q121.

5. Use a frequency counter to check the frequencies at the following inputs of integrated circuit U119:

Pin 10	3 MHz at 4 volts peak-to-peak
Pin 12	1.5 MHz at 4 volts peak-to-peak
Pin 13	750 kHz at 4 volts peak-to-peak

If any of these frequencies are not correct, interchange integrated circuits U116, U117, U118, and U119 (one at a time) with their counterparts in one of the other loops until you locate the faulty IC. If all frequencies are correct, proceed to step 6.

NOTES:

A. For the IFO loop, check the frequencies at the following inputs of integrated circuit U103:

Pin 10	2.4448 MHz at 3-4 volts peak-to-peak
Pin 12	1.2224 MHz at 3-4 volts peak-to-peak
Pin 13	13,611.2 MHz at 3-4 volts peak-to-peak

If any of these frequencies are not correct, interchange integrated circuits U103, U105, U106, and U107 with their counterparts in one of the other loops until you locate the faulty IC. If all frequencies are correct, proceed to step 6.

B. For the BFO loop, check the frequencies at the following inputs of integrated circuit U125:

Pin 11	212 kHz
Pin 12	424 kHz
Pin 13	848 kHz

If any of these frequencies are not correct, interchange integrated circuits U123, U124, U125, and U126 with their counterparts in one of the other loops until you locate the faulty IC. If all frequencies are correct, proceed to step 6.

6. Disconnect your RF generator from the Transceiver. Then reconnect the shield cable to the T/R circuit board.

7. If your Transceiver still has a problem, it is most likely in the phase detector circuit. Interchange the phase detector integrated circuit in the faulty loop (U120 for the HFO, U114 for the IFO, or U131 for the BFO) with its counterpart in one of the other loops until you locate the faulty IC.

8. Depress the RIT pushbutton to turn the RIT on. If the display now indicates "IFO unloc", check for 10 MHz (2.5 to 4 volts peak-to-peak) at U101 pin 6. If you do not have the correct frequency at this point, check for a high at U101 pin 4. If you do have a high at pin 4, check U101 or Q103. If you do have a high at pin 4, but do not have the correct frequency at pin 6, check crystal Y101 and transistors Q101 and Q102. (There should be a 10 MHz, 2-3 volt peak-to-peak signal at the collector (C) of transistor Q102.)

Without RF Generator

NOTE: You will need the following equipment to use this procedure:

Frequency counter (to 50 MHz)
Variable DC power supply (0 to 12 volts)
Oscilloscope (helpful)
VOM, or VTVM (helpful)

1. Preset the controls on the Transceiver as follows:

Mode	USB
Passband Shift	0
Tuning	15.000.0 MHz.

2. Unplug connector P105 from the synthesizer circuit board. Then connect your variable DC power supply to the end of this cable. (Use the cable from P103 for the IFO or the cable from P108 for the BFO.)

3. Connect a frequency counter to P106 pin 1 on the synthesizer circuit board (not the end of the cable). Then adjust the variable DC supply until the frequency counter indicates 24.050 MHz.

NOTES:

A. For the IFO loop, connect the frequency counter to P102 pin 1 and adjust the variable power supply for 49.774 MHz.

B. For the BFO loop, connect the frequency counter to P107 pin 1 and adjust the variable power supply for 3.3935 MHz.

4. Use a frequency counter to check the frequency at the collector (C) of transistor Q115. This frequency should be 12.025 MHz with an amplitude of .3 volts peak-to-peak. If you do not have the correct frequency at this point, check integrated circuit U141 and transistors Q114 and Q115.

NOTES:

A. For the IFO loop, check for 9.7741 MHz (.2 volts peak-to-peak) at the collector (C) of transistor Q106. If you do not have the correct frequency at this point, check for 40 MHz at gate 2 (G2) of transistor Q105 (.5 volts peak-to-peak). Also check for 10 MHz at pin 8 of integrated circuit U101. If these frequencies are not both correct, check transistor Q104 or integrated circuit U101 (depending upon which frequency is not correct). If all frequencies are correct, check transistors Q105 or Q106.

B. For the BFO loop, check for 3.3935 MHz (4 volts peak-to-peak) at the collector (C) of transistor Q121. If this frequency is not correct, check transistor Q121.

5. Use a frequency counter to check the frequencies at the following inputs of integrated circuit U119:

Pin 10	3 MHz at 4 volts peak-to-peak
Pin 12	1.5 MHz at 4 volts peak-to-peak
Pin 13	750 kHz at 4 volts peak-to-peak

If any of these frequencies are not correct, interchange integrated circuits U116, U117, U118, and U119 (one at a time) with their counterparts in one of the other loops until you locate the faulty IC. If all frequencies are correct, proceed to step 6.

NOTES:

A. For the IFO loop, check the frequencies at the following inputs of integrated circuit U103:

Pin 10	2.4448 MHz at 3-4 volts peak-to-peak
Pin 12	1.2224 MHz at 3-4 volts peak-to-peak
Pin 13	13,611.2 kHz at 3-4 volts peak-to-peak

If any of these frequencies are not correct, interchange integrated circuits U103, U105, U106, and U107 with their counterparts in one of the other loops until you locate the faulty IC. If all frequencies are correct, proceed to step 6.

B. For the BFO loop, check the frequencies at the following inputs of integrated circuit U125:

Pin 2	848 kHz
Pin 4	424 kHz
Pin 5	212 kHz

If any of these frequencies are not correct, interchange integrated circuits U123, U124, U125, and U126 with their counterparts in one of the other loops until you locate the faulty IC. If all frequencies are correct, proceed to step 6.

6. Disconnect your variable power supply from the Transceiver. Then reconnect the shielded cable to the T/R circuit board.

7. If your Transceiver still has a problem, it is most likely in the phase detector circuit. Interchange the phase detector integrated circuit in the loop that has the problem (U120 for the HFO, U114 for the IFO, or U131 for the BFO) with its counterpart in one of the other loops until you locate the faulty IC.

8. Depress the RIT pushbutton to turn the RIT on. If the display now indicates "IFO unloc", check for 10 MHz (2.5 to 4 volts peak-to-peak) at U101 pin 6. If you do not have the correct frequency at this point, check for a high at integrated circuit U101 pin 4. If you do not have a high at pin 4, check integrated circuit U101 or transistor Q103. If you have a high at pin 4, but do not have the correct frequency at pin 6, check crystal Y101 and transistors Q101 and Q102. (There should be a 10 MHz, 2-3 volt peak-to-peak signal at the collector (C) of transistor Q102.)

TERMINAL INTERFACE PROBLEMS

The following chart lists some basic problems and possible causes for the Terminal Interface option. If your particular problem is not in this chart, refer to "Terminal Problems" or "Computer Problems," which follows.

CONDITION	POSSIBLE CAUSE
Display indicates "IC2".	1. Integrated circuit U808 on the controller circuit board.
Display indicates "IC3".	1. Integrated circuit U811 on the controller circuit board.
Keyboard works but nothing prints on the terminal.	1. Suspended printout. Type CTRL-Q. 2. Integrated circuit U817 on the controller circuit board.
Terminal has no effect.	1. Disabled communications. Type ESC 1. 2. Different baud rates. 3. Interconnection cable. 4. Integrated circuit U818.
Terminal prints double characters.	1. Terminal is set for half duplex.

TERMINAL PROBLEMS (H/Z-19, etc.)

If you do not obtain the prompt (>) when you press the RETURN key, check the following items:

1. Check the baud rate settings of the terminal and the Transceiver. Make sure these baud rates match.

2. Make sure the interface cable is wired correctly. Refer to your "Owner's Manual."

3. Make sure the terminal is "on line".

4. Type ESC 1 to insure that communications with the Transceiver were not inadvertantly disabled. NOTE: Many of the keys on the H/Z-19 Terminal send ESCape sequences when you press them, which will disable communications. Also, remember that when the Terminal Interface is disabled, it is not automatically re-enabled on turn-on.

COMPUTER PROBLEMS (H/Z-89)

If the demonstration program does not run, check the following items:

1. Be sure the Transceiver is turned on and is connected to the computer. Also be sure the baud rates between the Transceiver and the computer match before you run the program. NOTE: Lines 420 and 430 of the program set the baud rate to 4800.

2. Be sure the interface cable is connected to port 330Q (octal). This is the lowest of the three ports on the serial interface card (plug P605). Also be sure the interrupt jumper is at OFF to use the program as it is written.

3. If the program still does not run after you check the above items, you can configure the computer as a terminal. To do this, unplug the 15-pin connector from P605 on the serial interface card and connect it to plug P404 on the terminal logic circuit board (disconnect the connector that is presently on P404). Be sure to connect the 15-pin connector so the gray wire is down. Now, proceed to "Terminal Problems".

NOTE: Since the Terminal Interface conforms with EIA standard RS-232C, it should be possible to interface the Transceiver with other manufacturer's computer equipment. However, Heath Company cannot offer assistance in resolving interface problems with anything other than Heath/Zenith products.

REPLACEMENT PARTS LIST

CHASSIS

RESISTORS — CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise noted.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1	6-100	10 Ω, 1/2-watt resistor
R2/SW4	19-701	1.5 MΩ control with switch
R3/SW2	19-716	10 kΩ control with switch
R4	10-271	1000 Ω control
R5	10-262	10 kΩ control
R6A, R6B	12-175	Dual 1000 Ω control
R7/SW1	19-127	10 kΩ control with switch
R8	Not used	
R9	10-216	50 kΩ control
R10	Not used	
R11	See "Meter Circuit Board".	
R12	6-391-12	390 Ω resistor
R13	6-112-12	1100 Ω resistor
R14	6-102-12	1000 Ω resistor
R15	6-183-12	18 kΩ resistor
R16	6-101-12	100 Ω resistor
R17	6-104-12	100 kΩ resistor
R18	6-103-12	10 kΩ resistor
R19	6-102-12	1000 Ω resistor

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C1	21-48	.05 μF ceramic
C2	21-48	.05 μF ceramic
C3	21-48	.05 μF ceramic
C4	25-875	1000 μF electrolytic
C5	21-17	270 pF ceramic
C6	21-17	270 pF ceramic
C7	21-17	270 pF ceramic
C8	21-17	270 pF ceramic
C9	21-17	270 pF ceramic
C10	Not used	
C11	21-140	.001 μF ceramic
C12	21-17	270 pF ceramic
C13	21-17	270 pF ceramic
C14	21-192	.1 μF ceramic
C15	21-192	.1 μF ceramic
C16	21-143	.05 μF ceramic
C17	27-138	.033 μF Mylar
C18	21-17	270 pF ceramic
C19	21-17	270 pF ceramic
C20	Not used	
C21	21-17	270 pF ceramic
C22	21-17	270 pF ceramic

DIODES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D1	56-55	1N4753A
D2	56-55	1N4753A
D3	57-65	1N4002
D4	57-65	1N4002

CONNECTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
J1-J5, J8-J11 J13, J14	434-239	10-socket assembly
J6, J7	434-82	2-socket assembly
J12	436-20	Key jack
J16	436-21	Phone jack
J17	436-1099	Microphone jack
S1	Main power socket consists of:	
	432-859	*Socket shell*
	432-753	*Male terminal pin (9)*
S2	Terminal interface socket consists of:	
	432-1032	*Socket shell*
	432-1033	*Male terminal pin (9)*
S3	Power select socket consists of:	
	432-817	*Socket shell*
	432-854	*Male terminal pin (2)*

SWITCHES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
SW1	See "Resistors-Controls" (R7/SW1)	
SW2	See "Resistors-Controls" (R3/SW2)	
SW3A, SW3B	63-1393	Front band switch wafer
SW4	See "Resistors-Controls" (R2/SW4)	
SW5	63-1356	AGC switch

MISCELLANEOUS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
F1	421-6	3-Ampere, 3AG fuse
K1	69-90	Main relay
L1	Input power choke consists of:	
	475-17	*Ferrite core*
	344-150	*Red wire (2 turns)*
L2	475-17	Ferrite core
	344-150	Red wire (2 turns)
L3	475-17	Ferrite core
	344-150	Red wire (2 turns)
Q1	417-254	MJ802 transistor

METER CIRCUIT BOARD

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
PL1	412-601	#2174 lamp
PL2	412-601	#2174 lamp
M1	407-756	Meter
R11	6-150-12	15 Ω, 1/4-watt, 5% resistor

SYNTHESIZER CIRCUIT BOARD

RESISTORS — CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R101	6-473-12	47 kΩ resistor
R102	6-101-12	100 Ω resistor
R103	6-822-12	8200 Ω resistor
R104	6-682-12	6800 Ω resistor
R105	6-331-12	330 Ω resistor
R106	6-271-12	270 Ω resistor
R107	6-151-12	150 Ω resistor
R108	6-103-12	10 kΩ resistor
R109	6-102-12	1000 Ω resistor
R110	Not used	
R111	6-472-12	4700 Ω resistor
R112	6-103-12	10 kΩ resistor
R113	6-473-12	47 kΩ resistor
R114	6-103-12	10 kΩ resistor
R115	6-101-12	100 Ω resistor
R116	6-101-12	100 Ω resistor
R117	6-473-12	47 kΩ resistor
R118	6-102-12	1000 Ω resistor
R119	6-102-12	1000 Ω resistor
R120	Not used	
R121	6-102-12	1000 Ω resistor
R122	6-472-12	4700 Ω resistor
R123	6-222-12	2200 Ω resistor
R124	6-102-12	1000 Ω resistor
R125	6-103-12	10 kΩ resistor
R126	6-101-12	100 Ω resistor
R127	6-822-12	8200 Ω resistor
R128	6-682-12	6800 Ω resistor
R129	6-331-12	330 Ω resistor
R130	Not used	
R131	6-271-12	270 Ω resistor
R132	6-151-12	150 Ω resistor
R133	6-103-12	10 kΩ resistor
R134	6-103-12	10 kΩ resistor
R135	6-103-12	10 kΩ resistor
R136	6-1005-12	10 MΩ, 1% resistor
R137	6-682-12	6800 Ω resistor
R138	6-473-12	47 kΩ resistor
R139	6-103-12	10 kΩ resistor
R140	Not used	
R141	6-102-12	1000 Ω resistor
R142	6-103-12	10 kΩ resistor
R143	6-103-12	10 kΩ resistor
R144	6-682-12	6800 Ω resistor
R145	6-472-12	4700 Ω resistor
R146	6-223-12	22 kΩ resistor
R147	6-103-12	10 kΩ resistor
R148	6-103-12	10 kΩ resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R149	6-103-12	10 kΩ resistor
R150	Not used	
R151	6-103-12	10 kΩ resistor
R152	6-103-12	10 kΩ resistor
R153	6-271-12	270 Ω resistor
R154	6-102-12	1000 Ω resistor
R155	6-102-12	1000 Ω resistor
R156	6-102-12	1000 Ω resistor
R157	6-102-12	1000 Ω resistor
R158	6-222-12	2200 Ω resistor
R159	6-103-12	10 kΩ resistor
R160	Not used	
R161	6-102-12	1000 Ω resistor
R162	6-331-12	330 Ω resistor
R163	6-103-12	10 kΩ resistor
R164	6-102-12	1000 Ω resistor
R165	6-103-12	10 kΩ resistor
R166	6-102-12	1000 Ω resistor
R167	6-103-12	10 kΩ resistor
R168	6-103-12	10 kΩ resistor
R169	6-102-12	1000 Ω resistor
R170	Not used	
R171	6-103-12	10 kΩ resistor
R172	6-103-12	10 kΩ resistor
R173	6-103-12	10 kΩ resistor
R174	6-472-12	4700 Ω resistor
R175	6-103-12	10 kΩ resistor
R176	6-223-12	22 kΩ resistor
R177	6-103-12	10 kΩ resistor
R178	6-222-12	2200 Ω resistor
R179	6-102-12	1000 Ω resistor
R180	Not used	
R181	6-102-12	1000 Ω resistor
R182	6-472-12	4700 Ω resistor
R183	6-103-12	10 kΩ resistor
R184	6-103-12	10 kΩ resistor
R185	6-1005-12	10 MΩ, 1% resistor
R186	6-472-12	4700 Ω resistor
R187	6-473-12	47 kΩ resistor
R188	6-103-12	10 kΩ resistor
R189	6-103-12	10 kΩ resistor
R190	Not used	
R191	6-103-12	10 kΩ resistor
R192	6-473-12	47 kΩ resistor
R193	6-102-12	1000 Ω resistor
R194	10-312	10 kΩ control
R195	10-312	10 kΩ control
R196	6-472-12	4700 Ω resistor
R197	6-223-12	22 kΩ resistor
R198	6-103-12	10 kΩ resistor
R199	3-4-2	9.1 Ω, 2-watt resistor
R1100	Not used	
R1101	3-4-2	9.1 Ω, 2-watt resistor
R1102	6-221-12	220 Ω resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1103	6-221-12	220 Ω resistor
R1104	6-221-12	220 Ω resistor
R1105	6-221-12	220 Ω resistor
R1106	6-221-12	220 Ω resistor
R1107	6-221-12	220 Ω resistor
R1108	6-221-12	220 Ω resistor
R1109	6-221-12	220 Ω resistor
R1110	Not used	
R1111	6-221-12	220 Ω resistor
R1112	6-221-12	220 Ω resistor
R1113	6-221-12	220 Ω resistor
R1114	6-221-12	220 Ω resistor
R1115	6-221-12	220 Ω resistor
R1116	6-221-12	220 Ω resistor
R1117	6-221-12	220 Ω resistor
R1118	6-221-12	220 Ω resistor
R1119	6-221-12	220 Ω resistor
R1120	Not used	
R1121	6-221-12	220 Ω resistor
R1122	6-221-12	220 Ω resistor
R1123	6-221-12	220 Ω resistor
R1124	6-221-12	220 Ω resistor
R1125	6-221-12	220 Ω resistor
R1126	6-221-12	220 Ω resistor
R1127	6-221-12	220 Ω resistor
R1128	6-221-12	220 Ω resistor
R1129	6-221-12	220 Ω resistor
R1130	Not Used	
R1131	6-221-12	220 Ω resistor
R1132	6-221-12	220 Ω resistor
R1133	6-221-12	220 Ω resistor

CAPACITORS — TRIMMERS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C101	21-143	.05 μF ceramic
C102	31-71	3.2-18 pF ceramic trimmer
C103	21-143	.05 μF ceramic
C104	21-3	10 pF ceramic
C105	21-143	.05 μF ceramic
C106	21-722	330 pF ceramic
C107	21-140	.001 μF ceramic
C108	21-143	.05 μF ceramic
C109	21-33	3.3 μF ceramic
C110	Not used	
C111	20-189	140 pF mica
C112	21-143	.05 μF ceramic
C113	21-33	3.3 μF ceramic
C114	21-143	.05 μF ceramic
C115	20-177	125 pF mica
C116	21-3	10 pF ceramic
C117	21-143	.05 μF ceramic
C118	21-111	15 pF ceramic
C119	21-140	.001 μF ceramic
C120	Not used	
C121	21-140	.001 μF ceramic
C122	20-109	62 pF mica
C123	21-143	.05 μF ceramic
C124	21-143	.05 μF ceramic

Capacitors — Trimmers (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C125	21-84	24 pF ceramic
C126	21-143	.05 μF ceramic
C127	21-143	.05 μF ceramic
C128	31-71	3.2-18 pF ceramic trimmer
C129	21-143	.05 μF ceramic
C130	Not used	
C131	21-6	27 pF ceramic
C132	21-722	330 pF ceramic
C133	21-722	330 pF ceramic
C134	21-140	.001 μF ceramic
C135	21-143	.05 μF ceramic
C136	21-143	.05 μF ceramic
C137	21-722	330 pF ceramic
C138	25-212	22 μF tantalum
C139	27-74	.01 μF Mylar
C140	Not used	
C141	25-220	10 μF tantalum
C142	21-7	33 pF ceramic
C143	21-143	.05 μF ceramic
C144	25-200	.68 μF tantalum
C145	27-129	.047 μF Mylar
C146	27-151	.013 μF Mylar
C147	21-192	.1 μF ceramic
C148	21-192	.1 μF ceramic
C149	21-140	.001 μF ceramic
C150	Not used	
C151	21-143	.05 μF ceramic
C152	21-143	.05 μF ceramic
C153	21-143	.05 μF ceramic
C154	21-176	.01 μF ceramic
C155	21-143	.05 μF ceramic
C156	25-212	22 μF tantalum
C157	25-220	10 μF tantalum
C158	27-147	.0056 μF Mylar
C159	21-7	33 pF ceramic
C160	Not used	
C161	21-143	.05 μF ceramic
C162	27-145	.22 μF Mylar
C163	21-143	.05 μF ceramic
C164	21-143	.05 μF ceramic
C165	21-84	24 pF ceramic
C166	21-143	.05 μF ceramic
C167	21-140	.001 μF ceramic
C168	21-143	.05 μF ceramic
C169	21-722	330 pF ceramic
C170	Not used	
C171	25-220	10 μF tantalum
C172	27-129	.047 μF Mylar
C173	21-7	33 pF ceramic
C174	25-838	3.3 μF tantalum
C175	Not used	
C176	25-212	22 μF tantalum
C177	25-885	100 μF electrolytic
C178	25-869	68 μF electrolytic
C179	25-200	.68 μF tantalum
C180	Not used	
C181	25-200	.68 μF tantalum
C182	25-200	.68 μF tantalum
C183	25-200	.68 μF tantalum

HEATH

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

Capacitors — Trimmers (Cont'd)

C184	21-140	.001 µF ceramic
C185	21-140	.001 µF ceramic
C186	21-140	.001 µF ceramic
C187	21-140	.001 µF ceramic
C188	21-140	.001 µF ceramic
C189	21-140	.001 µF ceramic
C190	Not used	
C191	21-140	.001 µF ceramic
C192	21-140	.001 µF ceramic
C193	21-140	.001 µF ceramic
C194	21-140	.001 µF ceramic
C195	21-140	.001 µF ceramic
C196	21-140	.001 µF ceramic
C197	21-140	.001 µF ceramic
C198	21-140	.001 µF ceramic
C199	21-140	.001 µF ceramic
C1100	Not used	
C1101	21-140	.001 µF ceramic
C1102	21-140	.001 µF ceramic
C1103	21-140	.001 µF ceramic
C1104	21-140	.001 µF ceramic
C1105	21-140	.001 µF ceramic
C1106	21-140	.001 µF ceramic
C1107	21-140	.001 µF ceramic
C1108	21-140	.001 µF ceramic
C1109	21-140	.001 µF ceramic
C1110	Not used	
C1111	21-140	.001 µF ceramic
C1112	21-140	.001 µF ceramic
C1113	21-140	.001 µF ceramic
C1114	21-140	.001 µF ceramic
C1115	21-140	.001 µF ceramic

DIODES

D101	56-77	FV1010 varactor
D102	56-56	1N4149
D103	56-26	1N191
D104	56-56	1N4149
D105	56-56	1N4149
D106	56-56	1N4149
D107	56-26	1N191
D108	56-26	1N191
D109	56-56	1N4149

TRANSISTORS

Q101	417-154	2N2369
Q102	417-154	2N2369
Q103	417-801	MPSA20
Q104	417-290	MRF502
Q105	417-240	40673
Q106	417-154	2N2369
Q107	417-154	2N2369
Q108	417-154	2N2369
Q109	417-154	2N2369
Q110	417-801	MPSA20

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

Transistors (Cont'd)

Q111	417-801	MPSA20
Q112	417-801	MPSA20
Q113	417-865	MPSA55
Q114	417-154	2N2369
Q115	417-154	2N2369
Q116	417-801	MPSA20
Q117	417-801	MPSA20
Q118	417-801	MPSA20
Q119	417-154	2N2369
Q120	417-154	2N2369
Q121	417-801	MPSA20
Q122	417-801	MPSA20

INTEGRATED CIRCUITS (ICs)

U101	443-728	74LS00
U102	443-755	74LS04
U103	443-798	74LS20
U104	443-730	74LS74
U105	443-757	74LS161
U106	443-757	74LS161
U107	443-757	74LS161
U108	443-920	74LS85
U109	443-733	74LS293
U110	443-919	74LS126
U111	443-921	74LS390
U112	443-921	74LS390
U113	443-731	74LS290
U114	442-647	CD4046A
U115	442-39	LM301AN
U116	443-757	74LS161
U117	443-757	74LS161
U118	443-934	74S163
U119	443-798	74LS20
U120	442-647	CD4046A
U121	442-39	LM301AN
U122	443-730	74LS74
U123	443-757	74LS161
U124	443-757	74LS161
U125	443-757	74LS161
U126	443-798	74LS20
U127	443-728	74LS00
U128	443-920	74LS85
U129	443-733	74LS293
U130	Not used	
U131	442-647	CD4046A
U132	442-39	LM301AN
U133	442-54	7805
U134	442-54	7805
U135	442-54	7805
U136	442-54	7805
U137	442-99	CD4016AE
U138	442-99	CD4016AE
U139	Not used	
U140	Not used	
U141	443-679	MC10131

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

MISCELLANEOUS

FB	475-10	1.07 μH ferrite bead
L101	40-1617	.16 μH coil
L102	40-1616	.15 μH coil
L103	45-75	.68 μH choke
L104	45-39	4.65 μH choke
Y101	404-426	10 MHz crystal
Y102	404-426	10 MHz crystal

TRANSMIT/RECEIVE CIRCUIT BOARD

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

RESISTORS — CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

R201	6-470-12	47 Ω resistor
R202	6-222-12	2200 Ω resistor
R203	6-103-12	10 kΩ resistor
R204	6-100-12	10 kΩ resistor
R205	6-473-12	47 kΩ resistor
R206	6-474-12	470 kΩ resistor
R207	6-222-12	2200 Ω resistor
R208	6-100-12	10 Ω resistor
R209	6-473-12	47 kΩ resistor
R210	Not used	
R211	6-474-12	470 kΩ resistor
R212	6-100-12	10 Ω resistor
R213	6-222-12	2200 Ω resistor
R214	6-100-12	10 Ω resistor
R215	6-222-12	2200 Ω resistor
R216	6-124-12	120 kΩ resistor
R217	6-473-12	47 kΩ resistor
R218	6-474-12	470 kΩ resistor
R219	6-100-12	10 Ω resistor
R220	Not used	
R221	6-222-12	2200 Ω resistor
R222	6-124-12	120 kΩ resistor
R223	6-473-12	47 kΩ resistor
R224	6-474-12	470 kΩ resistor
R225	6-100-12	10 Ω resistor
R226	6-222-12	2200 Ω resistor
R227	6-124-12	120 kΩ resistor
R228	6-274-12	270 kΩ resistor
R229	6-474-12	470 kΩ resistor
R230	Not used	
R231	6-6491	6490 Ω, 1/2-watt, 1% resistor
R232	6-6491	6490 Ω, 1/2-watt, 1% resistor

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

Resistors — Controls (Cont'd)

R233	6-3201-12	3200 Ω, 1% resistor
R234	6-102-12	1000 Ω resistor
R235	6-473-12	47 kΩ resistor
R236	6-472-12	4700 Ω resistor
R237	6-124-12	120 kΩ resistor
R238	6-124-12	120 kΩ resistor
R239	6-124-12	120 kΩ resistor
R240	Not used	
R241	6-124-12	120 kΩ resistor
R242	6-222-12	2200 Ω resistor
R243	6-471-12	470 Ωresistor
R244	6-271-12	270 Ω resistor
R245	6-471-12	470 Ω resistor
R246	6-471-12	470 Ω resistor
R247	6-471-12	470 Ω resistor
R248	6-471-12	470 Ωresistor
R249	6-271-12	270 Ω resistor
R250	Not used	
R251	6-471-12	470 Ωresistor
R252	6-392-12	3900 Ω resistor
R253	6-272-12	2700 Ω resistor
R254	6-392-12	3900 Ω resistor
R255	6-272-12	2700 Ω resistor
R256	6-470-12	47 Ω resistor
R257	6-470-12	47 Ω resistor
R258	6-124-12	120 kΩ resistor
R259	6-824-12	820 kΩ resistor
R260	Not used	
R261	6-124-12	120 kΩ resistor
R262	6-271-12	270 Ω resistor
R263	6-823-12	82 kΩ resistor
R264	6-333-12	33 kΩ resistor
R265	6-102-12	1000 Ω resistor
R266	6-124-12	120 kΩ resistor
R267	6-271-12	270 Ω resistor
R268	6-102-12	1000 Ω resistor
R269	6-470-12	47 Ω resistor
R270	Not used	

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R271	6-273-12	27 kΩ resistor
R272	6-273-12	27 kΩ resistor
R273	6-272-12	2700 Ω resistor
R274	6-272-12	2700 Ω resistor
R275	6-1071-12	1070 Ω, 1% resistor
R276	6-2401-12	2400 Ω, 1% resistor
R277	6-101-12	100 Ω resistor
R278	6-822-12	8200 Ω resistor
R279	6-220-12	22 Ω resistor
R280	Not used	
R281	6-470-12	47 Ω resistor
R282	6-2551-12	2550 Ω, 1% resistor
R283	6-1691-12	1690 Ω, 1% resistor
R284	6-4202-12	42 kΩ, 1% resistor
R285	6-473-12	47 kΩ resistor
R286	Not used	
R287	6-474-12	470 kΩ resistor
R288	6-222-12	2200 Ω resistor
R289	6-222-12	2200 Ω resistor
R290	Not used	
R291	6-471-12	470 Ω resistor
R292	6-470-12	470 Ω resistor
R293	6-271-12	270 Ω resistor
R294	6-331-12	330 Ω resistor
R295	6-221-12	220 Ω resistor
R296	6-332-12	3300 Ω resistor
R297	6-152-12	1500 Ω resistor
R298	6-102-12	1000 Ω resistor
R299	6-102-12	1000 Ω resistor
R2001	6-471-12	470 Ω resistor
R2002	Not used	
R2003	6-471-12	470 Ω resistor
R2004	6-102-12	1000 Ω resistor
R2005	6-471-12	470 Ω resistor
R2006	6-222-12	2200 Ω resistor
R2007	6-222-12	2200 Ω resistor
R2008	6-470-12	47 Ω resistor
R2009	6-473-12	47 kΩ resistor
R2010	Not used	
R2011	6-473-12	47 kΩ resistor
R2012	6-103-12	10 kΩ resistor
R2013	6-222-12	2200 Ω resistor
R2014	6-221-12	220 Ω resistor
R2015	6-392-12	3900 Ω resistor
R2016	6-392-12	3900 Ω resistor
R2017	6-472-12	4700 Ω resistor
R2018	6-222-12	2200 Ω resistor
R2019	10-318	20 kΩ control
R2020	Not used	
R2021	6-470-12	47 Ω resistor
R2022	6-271-12	270 Ω resistor
R2023	6-824-12	820 kΩ resistor
R2024	6-824-12	820 kΩ resistor
R2025	6-124-12	120 kΩ resistor
R2026	6-823-12	82 kΩ resistor
R2027	6-562-12	5600 Ω resistor
R2028	6-562-12	5600 Ω resistor
R2029	6-221-12	220 Ω resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R2030	Not used	
R2031	6-153-12	15 kΩ resistor
R2032	6-333-12	33 kΩ resistor
R2033	6-103-12	10 kΩ resistor
R2034	6-104-12	100 kΩ resistor
R2035	6-104-12	100 kΩ resistor
R2036	6-221-12	220 Ω resistor
R2037	6-470-12	47 Ω resistor
R2038	6-221-12	220 Ω resistor
R2039	6-273-12	27 kΩ resistor
R2040	Not used	
R2041	6-152-12	1500 Ω resistor
R2042	6-221-12	220 Ω resistor
R2043	6-473-12	47 kΩ resistor
R2044	6-682-12	6800 Ω resistor
R2045	6-563-12	56 kΩ resistor
R2046	6-273-12	27 kΩ resistor
R2047	6-561-12	560 Ω resistor
R2048	6-471-12	470 Ω resistor
R2049	6-101-12	100 Ω resistor
R2050	Not used	
R2051	6-392-12	3900 Ω resistor
R2052	6-103-12	10 kΩ resistor
R2053	6-224-12	220 kΩ resistor
R2054	6-473-12	47 kΩ resistor
R2055	6-225-12	2.2 MΩ resistor
R2056	6-273-12	27 kΩ resistor
R2057	6-472-12	4700 Ω resistor
R2058	6-333-12	33 kΩ resistor
R2059	10-386	10 kΩ control
R2060	Not used	
R2061	6-100-12	10 Ω resistor
R2062	6-820-12	82 Ω resistor
R2063	6-100-12	10 Ω resistor
R2064	6-681-12	680 Ω resistor
R2065	6-392-12	3900 Ω resistor
R2066	6-392-12	3900 Ω resistor
R2067	6-102-12	1000 Ω resistor
R2068	6-104-12	100 k Ω resistor
R2069	6-470-12	47 Ω resistor
R2070	Not used	
R2071	6-271-12	270 Ω resistor
R2072	6-392-12	3900 Ω resistor
R2073	Not used	
R2074	9-27	Thermistor (30 kΩ cold)
R2075	6-103-12	10 kΩ resistor
R2076	6-563-12	56 kΩ resistor
R2077	6-223-12	22 kΩ resistor
R2078	6-273-12	27 kΩ resistor
R2079	6-273-12	27 kΩ resistor
R2080	Not used	
R2081	6-273-12	27 kΩ resistor
R2082	6-273-12	27 kΩ resistor
R2083	6-273-12	27 kΩ resistor
R2084	6-103-12	10 kΩ resistor
R2085	6-103-12	10 kΩ resistor
R2086	6-153-12	15 kΩ resistor
R2087	6-222-12	2200 Ω resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R2088	6-102-12	1000 Ω resistor
R2089	6-104-12	100 kΩ resistor
R2090	Not used	
R2091	6-221-12	220 Ω resistor
R2092	6-470-12	47 Ω resistor
R2093	6-392-12	3900 Ω resistor
R2094	6-103-12	10 kΩ resistor
R2095	6-102-12	1000 Ω resistor
R2096	6-122-12	1200 Ω resistor
R2097	6-101-12	100 Ω resistor
R2098	6-103-12	10 kΩ resistor
R2099	6-102-12	1000 Ω resistor
R2100	Not used	
R2101	6-821-12	820 Ω resistor
R2102	6-102-12	1000 Ω resistor
R2103	6-102-12	1000 Ω resistor
R2104	6-102-12	1000 Ω resistor
R2105	6-103-12	10 kΩ resistor
R2106	6-102-12	1000 Ω resistor
R2107	6-470-12	47 Ω resistor
R2108	10-318	2000 Ω (2 kΩ) control
R2109	6-562-12	5600 Ω resistor
R2110	Not used	
R2111	6-470-12	47 Ω resistor
R2112	6-220-12	22 Ω resistor
R2113	6-1222-12	12.2 kΩ, 1% resistor
R2114	6-1103-12	110 kΩ, 1% resistor
R2115	6-4751-12	4750 Ω, 1% resistor
R2116	6-473-12	47 kΩ resistor
R2117	6-101-12	100 Ω resistor
R2118	6-152-12	1500 Ω resistor
R2119	6-471-12	470 Ω resistor
R2120	Not used	
R2121	6-223-12	22 kΩ resistor
R2122	6-223-12	22 kΩ resistor
R2123	6-471-12	470 Ω resistor
R2124	6-471-12	470 Ω resistor
R2125	6-102-12	1000 Ω resistor
R2126	6-102-12	1000 Ω resistor
R2127	6-101-12	100 Ω resistor
R2128	6-821-12	820 Ω resistor
R2129	6-102-12	1000 Ω resistor
R2130	Not used	
R2131	6-101-12	100 Ω resistor
R2132	6-122-12	1200 Ω resistor
R2133	6-103-12	10 kΩ resistor
R2134	6-272-12	2700 Ω resistor
R2135	6-101-12	100 Ω resistor
R2136	6-392-12	3900 Ω resistor

CAPACITORS — TRIMMER

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C201	21-145	.001 μF ceramic feedthrough
C202	25-880	10 μF electrolytic
C203	25-880	10 μF electrolytic
C204	21-192	.1 μF ceramic
C205	21-145	.001 μF ceramic feedthrough
C206	21-145	.001 μF ceramic feedthrough
C207	31-83	5-25 pF ceramic trimmer
C208	21-140	.001 μF ceramic
C209	21-176	.01 μF, 100V ceramic
C210	Not used	
C211	21-722	330 pF ceramic
C212	21-6	27 pF ceramic
C213	21-192	.1 μF ceramic
C214	21-192	.1 μF ceramic
C215	21-140	.001 μF ceramic
C216	21-145	.001 μF ceramic feedthrough
C217	21-176	.01 μF, 100V ceramic
C218	21-722	330 pF ceramic
C219	20-159	39 pF mica
C220	Not used	
C221	21-192	.1 μF ceramic
C222	21-176	.01 μF, 100V ceramic
C223	21-140	.001 μF ceramic
C224	21-145	.001 μF ceramic feedthrough
C225	20-139	330 pF mica
C226	20-139	330 pF mica
C227	21-111	15 pF ceramic
C228	21-192	.1 μF ceramic
C229	21-176	.01 μF, 100V ceramic
C230	Not used	
C231	21-140	.001 μF ceramic
C232	21-145	.001 μF ceramic feedthrough
C233	21-32	47 pF ceramic
C234	21-32	47 pF ceramic
C235	21-157	5 pF, 5% ceramic
C236	21-192	.1 μF ceramic
C237	21-176	.01 μF, 100V ceramic
C238	21-140	.001 μF ceramic
C239	21-145	.001 μF ceramic feedthrough
C240	Not used	
C241	21-7	33 pF ceramic
C242	21-7	33 pF ceramic
C243	21-33	3.3 pF ceramic
C244	21-192	.1 μF ceramic
C245	21-176	.01 μF, 100V ceramic
C246	21-140	.001 μF ceramic
C247	29-5	1000 pF polystyrene

HEATH

Capacitors — Trimmers (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C248	29-42	2000 pF polystyrene
C249	29-5	1000 pF polystyrene
C250	Not used	
C251	21-145	.001 µF ceramic feedthrough
C252	25-880	10 µF electrolytic
C253	21-140	.001 µF ceramic
C254	21-176	.01 µF, 100V ceramic
C255	21-192	.1 µF ceramic
C256	21-140	.001 µF ceramic
C257	27-85	.22 µF Mylar
C258	21-176	.01 µF, 100V ceramic
C259	20-105	180 pF mica
C260	Not used	
C261	20-139	330 pF mica
C262	20-105	180 pF mica
C263	20-112	310 pF mica
C264	21-78	5 pF, 10% ceramic
C265	20-167	620 pF mica
C266	20-167	620 pF mica
C267	21-176	.01 µF, 100V ceramic
C268	21-176	.01 µF, 100V ceramic
C267	21-176	.01 µF, 100V ceramic
C270	Not used	
C271	20-167	620 pF mica
C272	20-167	620 pF mica
C273	21-176	.01 µF, 100V ceramic
C274	21-176	.01 µF, 100V ceramic
C275	21-176	.01 µF, 100V ceramic
C276	21-78	5 pF, 10% ceramic
C277	20-178	160 pF mica
C278	20-189	140 pF mica
C279	20-172	1000 pF mica
C280	Not used	
C281	21-145	.001 µF ceramic feedthrough
C282	25-880	10 µF electrolytic
C283	25-880	10 µF electrolytic
C284	21-176	.01 µF, 100V ceramic
C285	21-192	.1 µF ceramic
C286	21-192	.1 µF ceramic
C287	27-77	.1 µF Mylar
C288	27-129	.047 µF Mylar
C289	27-138	.033 µF Mylar
C290	Not used	
C291	27-136	.015 µF Mylar
C292	Not used	
C293	21-3	10 pF ceramic
C294	21-757	22 pF ceramic
C295	25-837	1.5 µF tantalum
C296	21-140	.001 µF ceramic
C297	21-140	.001 µF ceramic
C298	21-140	.001 µF ceramic
C299	21-192	.1 µF ceramic
C2001	21-176	.01 µF, 100V ceramic
C2002	21-192	.1 µF ceramic
C2003	21-145	.001 µF ceramic feedthrough
C2004	21-140	.001 µF ceramic
C2005	21-78	5 pF, 10% ceramic
C2006	21-176	.01 µF, 100V ceramic

Capacitors — Trimmers (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C2007	25-880	10 µF electrolytic
C2008	21-176	.01 µF, 100V ceramic
C2009	21-176	.01 µF, 100V ceramic
C2010	Not used	
C2011	21-32	47 pF ceramic
C2012	21-9	100 pF ceramic
C2013	21-176	.01 µF, 100V ceramic
C2014	21-176	.01 µF, 100V ceramic
C2015	21-32	47 pF ceramic
C2016	21-176	.01 µF, 100V ceramic
C2017	21-176	.01 µF, 100V ceramic
C2018	25-880	10 µF electrolytic
C2019	21-192	.1 µF ceramic
C2020	Not used	
C2021	21-176	.01 µF, 100V ceramic
C2022	25-900	1 µF electrolytic
C2023	21-56	470 pF ceramic
C2024	21-192	.1 µF ceramic
C2025	21-140	.001 µF ceramic
C2026	21-140	.001 µF ceramic
C2027	21-717	.01 µF, 50V ceramic
C2028	21-176	.01 µF, 100V ceramic
C2029	21-176	.01 µF, 100V ceramic
C2030	Not used	
C2031	21-176	.01 µF, 100V ceramic
C2032	21-176	.01 µF, 100V ceramic
C2033	21-176	.01 µF, 100V ceramic
C2034	20-107	680 pF mica
C2035	21-176	.01 µF, 100V ceramic
C2036	20-172	1000 pF mica
C2037	21-192	.1 µF ceramic
C2038	21-140	.001 µF ceramic
C2039	27-85	.22 µF Mylar
C2040	Not used	
C2041	25-880	10 µF electrolytic
C2042	20-189	140 pF mica
C2043	21-176	.01 µF, 100V ceramic
C2044	21-9	100 pF ceramic
C2045	21-176	.01 µF, 100V ceramic
C2046	21-176	.01 µF, 100V ceramic
C2047	21-176	.01 µF, 100V ceramic
C2048	21-176	.01 µF, 100V ceramic
C2049	20-707	470 pF mica
C2050	Not used	
C2051	21-192	.1 µF ceramic
C2052	21-176	.01 µF, 100V ceramic
C2053	21-176	.01 µF, 100V ceramic
C2054	21-176	.01 µF, 100V ceramic
C2055	21-176	.01 µF, 100V ceramic
C2056	21-176	.01 µF, 100 V ceramic
C2057	21-176	.01 µF, 100V ceramic
C2058	21-176	.01 µF, 100V ceramic
C2059	21-176	.01 µF, 100V ceramic
C2060	Not used	
C2061	21-176	.01 µF, 100V ceramic
C2062	21-176	.01 µF, 100V ceramic
C2063	21-192	.1 µF ceramic

Capacitors — Trimmers (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C2064	21-176	.01 μF, 100V ceramic
C2065	21-176	.01 μF, 100V ceramic
C2066	20-707	470 pF mica
C2067	21-176	.01 μF, 100V ceramic
C2068	21-145	.001 μF ceramic feedthrough
C2069	25-880	10 μF electrolytic
C2070	Not used	
C2071	21-192	.1 μF ceramic
C2072	21-192	.1 μF ceramic
C2073	25-880	10 μF electrolytic
C2074	21-176	.01 μF, 100V ceramic
C2075	20-107	680 pF mica
C2076	20-172	1000 pF mica
C2077	21-176	.01 μF, 100V ceramic
C2078	21-176	.01 μF, 100V ceramic
C2079	21-176	.01 μF, 100V ceramic
C2080	Not used	
C2081	25-880	10 μF electrolytic
C2082	20-707	470 pF mica
C2083	21-176	.01 μF, 100V ceramic
C2084	21-176	.01 μF, 100V ceramic
C2085	21-176	.01 μF, 100V ceramic
C2086	25-880	10 μF electrolytic
C2087	27-77	.1 μF Mylar
C2088	27-85	.22 μF Mylar
C2089	27-128	.022 μF Mylar
C2090	Not used	
C2091	21-6	27 pF ceramic
C2092	20-114	270 pF mica
C2093	21-32	47 pF ceramic
C2094	20-114	270 pF mica
C2095	20-106	390 pF mica
C2096	21-192	.1 μF ceramic
C2097	21-140	.001 μF ceramic
C2098	21-145	.001 μF ceramic feedthrough
C2099	21-176	.01 μF, 100V ceramic
C2100	Not used	
C2101	27-86	.47 μF Mylar
C2102	21-145	.001 μF ceramic feedthrough
C2103	21-176	.01 μF, 100V ceramic
C2104	21-176	.01 μF, 100V ceramic
C2105	21-176	.01 μF, 100V ceramic
C2106	25-880	10 μF electrolytic
C2107	21-145	.001 μF, 100V ceramic
C2108	27-138	.033 μF Mylar
C2109	25-880	10 μF electrolytic
C2110	Not used	
C2111	21-176	.01 μF, 100V ceramic
C2112	21-145	.001 μF ceramic feedthrough

DIODES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D201	56-56	1N4149
D202	56-56	1N4149
D203	56-648	MV109 varactor
D204	Not used	
D205	56-56	1N4149
D206	56-648	MV109 varactor
D207	Not used	
D208	56-56	1N4149
D209	56-648	MV109 varactor
D210	Not used	
D211	56-56	1N4149
D212	56-642	MV2107 varactor
D213	Not used	
D214	56-56	1N4149 diode
D215	56-648	MV109 varactor
D216	Not used	
D217	56-56	1N4149
D218	56-56	1N4149
D219	56-56	1N4149
D220	Not used	
D221	56-642	MV2107 varactor
D222	56-56	1N4149
D223	56-56	1N4149
D224	56-56	1N4149
D225	56-56	1N4149
D226	56-56	1N4149
D227	56-56	1N4149
D228	Not used	
D229	56-646	BA-244 PIN
D230	Not used	
D231	56-56	1N4149
D232	56-646	BA-244 PIN
D233	56-646	BA-244 PIN
D234	56-56	1N4149
D235	56-56	1N4149
D236	56-56	1N4149
D237	56-56	1N4149
D238	56-648	MV109 varactor
D239	56-56	1N4149
D240-D250	Not used	
D251	56-56	1N4149
D252	56-56	1N4149
D253	56-56	1N4149
D254	56-56	1N4149
D255	56-56	1N4149
D256	56-56	1N4149
D257-D260	Not used	
D261	56-648	MV109 varactor
D262	56-648	MV109 varactor
D263	56-648	MV109 varactor

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

TRANSISTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
Q201	417-134	MPS6520
Q202	417-169	MPF105
Q203	417-169	MPF105
Q204	417-169	MPF105
Q205	417-169	MPF105
Q206	417-169	MPF105
Q207	417-172	MPS6521
Q208	417-874	2N3906
Q209	417-874	2N3906
Q210	417-240	40673
Q211	417-240	40673
Q212	417-154	2N2369
Q213	417-240	40673
Q214	417-241	EL131
Q215	417-875	2N3904
Q216	Not used	
Q217	417-240	40673
Q218	417-240	40673
Q219	417-875	2N3904
Q220	Not used	
Q221	417-260	2N4258A
Q222	417-240	40673
Q223	417-240	40673
Q224	417-875	2N3904
Q225	417-875	2N3904
Q226	417-169	MPF105
Q227	417-875	2N3904
Q228	417-875	2N3904
Q229	417-875	2N3904
Q230	Not used	
Q231	417-169	MPF105
Q232	417-172	MPS6521
Q233	417-260	2N4258A
Q234	417-858	P1087E
Q235	417-874	2N3906
Q236	417-874	2N3906
Q237	417-875	2N3904
Q238	417-875	2N3904
Q239	417-875	2N3904
Q240	Not used	
Q241	417-875	2N3904
Q242	417-875	2N3904
Q243	417-875	2N3904
Q244-Q250	Not used	
Q251	417-875	2N3904

INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U201	442-603	78M05
U202	443-679	MC10131
U203	150-72	Double-balanced mixer
U204	443-701	MC14049CP
U205	442-603	78M05
U206	442-681	78L08
U207	443-679	MC10131
U208	150-72	Double-balanced mixer
U209	442-681	78L08
U210	442-55	MC1349P
U211	442-99	CD4016AE
U212	442-99	CD4016AE
U213	442-96	MC1496G
U214	442-55	MC1349P
U215	442-96	MC4016AE
U216	442-681	78L08
U217	443-701	MC14049CP
U218	443-695	CD4001AE

INDUCTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
L201	40-1990	.75 μH coil
L202	40-1991	.4 μH coil
L203	40-1992	.25 μH coil
L204	40-1993	.2 μH coil
L205	40-1993	.2 μH coil
L206	40-1855	6.5-turn variable coil
L207	40-2025	7.95 μH toroid coil
L208	40-1994	1.2 μH variable coil
L209	40-1994	1.2 μH variable coil
L210	40-1994	1.2 μH variable coil
L211	40-1994	1.2 μH variable coil
L212	40-1992	.25 μH variable coil
L213	45-39	4.65 μH choke
L214	40-1882	15.5 μH toroid coil
L215	52-177	10.7 MHz transformer
L216	40-486	100 μH peaking coil
L217	52-177	10.7 MHz transformer
L218	52-177	10.7 MHz transformer
L219	52-177	10.7 MHz transformer
L220	52-177	10.7 MHz transformer
L221	52-177	10.7 MHz transformer
L222	Not used	
L223	Not used	
L224	Not used	
L225	45-604	100 μH choke
L226	45-39	4.65 μH choke

MISCELLANEOUS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
FB	475-10	1.07 μH ferrite bead
FL201	404-283	3395 kHz crystal filter
FL202	404-620	3394.3 kHz crystal filter (narrow CW)
FL203	404-619	3394.3 kHz crystal filter (medium CW)
FL204	404-283	3395 kHz crystal filter

MAIN AUDIO CIRCUIT BOARD

RESISTORS — CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R301	6-103-12	10 kΩ resistor
R302	6-104-12	100 kΩ resistor
R303	6-152-12	1500 Ω resistor
R304	6-102-12	1000 Ω resistor
R305	6-104-12	100 kΩ resistor
R306	6-104-12	100 kΩ resistor
R307	6-101-12	100 Ω resistor
R308	6-222-12	2200 Ω resistor
R309	6-103-12	10 kΩ resistor
R310	Not used	
R311	6-183-12	18 kΩ resistor
R312	6-153-12	15 kΩ resistor
R313	6-103-12	10 kΩ resistor
R314	6-273-12	27 kΩ resistor
R315	6-751-12	150 Ω resistor
R316	6-471-12	470 Ω resistor
R317	6-271-12	270 Ω resistor
R318	6-273-12	27 kΩ resistor
R319	6-273-12	27 kΩ resistor
R320	Not used	
R321	6-101-12	100 Ω resistor
R322	6-221-12	220 Ω resistor
R323	6-101-12	100 Ω resistor
R324	6-334-12	330 kΩ resistor
R325	6-105-12	1 MΩ resistor
R326	6-474-12	470 kΩ resistor
R327	6-183-12	18 kΩ resistor
R328	6-105-12	1 MΩ resistor
R329	6-472-12	4700 Ω resistor
R330	Not used	
R331	6-474-12	470 kΩ resistor
R332	6-225-12	2.2 MΩ resistor
R333	10-390	20 kΩ control
R334	6-472-12	4700 Ω resistor
R335	6-104-12	100 kΩ resistor
R336	6-473-12	47 kΩ resistor
R337	6-103-12	10 kΩ resistor
R338	10-390	20 kΩ control
R339	6-472-12	4700 Ω resistor
R340	Not used	
R341	6-102-12	1000 Ω resistor
R342	6-274-12	270 kΩ resistor
R343	6-154-12	150 kΩ resistor
R344	6-153-12	15 kΩ resistor
R345	6-153-12	15 kΩ resistor
R346	6-472-12	4700 Ω resistor
R347	6-822-12	8200 Ω resistor
R348	6-102	1000 Ω, 1/2-watt resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R349	6-102	1000 Ω, 1/2-watt resistor
R350	Not used	
R351	6-279-12	2.7 Ω resistor
R352	6-273-12	27 kΩ resistor
R353	10-904	5000 Ω (5 kΩ) control
R354	6-472-12	4700 Ω resistor
R355	6-473-12	47 kΩ resistor
R356	6-473-12	47 kΩ resistor
R357	6-473-12	47 kΩ resistor
R358	10-904	5000 Ω (5 kΩ) control
R359	6-473-12	47 kΩ resistor
R360	Not used	
R361	6-102-12	1000 Ω resistor
R362	6-103-12	10 kΩ resistor
R363	6-124-12	120 kΩ resistor
R364	6-103-12	10 kΩ resistor
R365	10-390	20 kΩ control
R366	6-473-12	47 kΩ resistor
R367	6-563-12	56 kΩ resistor
R368	6-473-12	47 kΩ resistor
R369	6-222-12	2200 Ω resistor
R370	Not used	
R371	6-473-12	47 kΩ resistor
R372	6-563-12	56 kΩ resistor
R373	6-563-12	56 kΩ resistor
R374	6-273-12	27 kΩ resistor
R375	6-103-12	10 kΩ resistor
R376	6-471-12	470 Ω resistor
R377	10-941	100 kΩ control
R378	6-682-12	6800 Ω resistor
R379	6-103-12	10 kΩ resistor
R380	Not used	
R381	6-472-12	4700 Ω resistor
R382	6-274-12	270 kΩ resistor
R383	6-274-12	270 kΩ resistor
R384	6-222-12	2200 Ω resistor
R385	6-472-12	4700 Ω resistor
R386	6-683-12	68 kΩ resistor
R387	6-682-12	6800 Ω resistor
R388	6-222-12	2200 Ω resistor
R389	6-105-12	1 MΩ resistor
R390	Not used	
R391	6-124-12	120 kΩ resistor
R392	6-104-12	100 kΩ resistor
R393	6-222-12	2200 Ω resistor
R394	6-273-12	27 kΩ resistor
R395	10-1105	150 kΩ control
R396	6-103-12	10 kΩ resistor
R397	6-223-12	22 kΩ resistor
R398	6-102-12	1000 Ω resistor
R399	6-104-12	100 kΩ resistor
R3001	6-220-12	22 Ω resistor
R3002	6-103-12	10 kΩ resistor
R3003	6-104-12	100 kΩ resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R3004	6-103-12	10 kΩ resistor
R3005	6-274-12	270 kΩ resistor
R3006	6-103-12	10 kΩ resistor
R3007	6-104-12	100 kΩ resistor
R3008	6-103-12	10 kΩ resistor
R3009	6-274-12	270 kΩ resistor
R3010	Not used	
R3011	6-103-12	10 kΩ resistor
R3012	6-104-12	100 kΩ resistor
R3013	6-824-12	820 kΩ resistor
R3014	6-822-12	8200 Ω resistor
R3015	6-220-12	22 Ω resistor
R3016	6-220-12	22 Ω resistor
R3017	6-472-12	4700 Ω resistor
R3018	6-103-12	10 kΩ resistor
R3019	6-473-12	47 kΩ resistor
R3020	Not used	
R3021	6-105-12	1 MΩ resistor

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C301	25-900	1 μF electrolytic
C302	21-176	.01 μF ceramic
C303	27-62	.68 μF polyester
C304	21-176	.01 μF ceramic
C305	27-62	.68 μF polyester
C306	25-927	22 μF electrolytic
C307	27-85	.22 μF Mylar
C308	21-199	.1 μF ceramic
C309	21-199	.1 μF ceramic
C310	Not used	
C311	25-900	1 μF electrolytic
C312	27-98	.22 μF Mylar
C313	25-887	220 μF electrolytic
C314	25-880	10 μF electrolytic
C315	27-69	.0091 μF Mylar
C316	27-70	.0022 μF Mylar
C317	21-199	.1 μF ceramic
C318	27-69	.0091 μF Mylar
C319	21-140	.001 μF ceramic
C320	Not used	
C321	25-880	10 μF electrolytic
C322	25-875	1000 μF electrolytic
C323	25-837	1.5 μF tantalum
C324	25-901	220 μF electrolytic
C325	21-176	.01 μF ceramic
C326	27-70	.0022 μF Mylar
C327	27-70	.0022 μF Mylar
C328	27-69	.0091 μF Mylar
C329	21-143	.05 μF ceramic
C330	Not used	
C331	27-69	.0091 μF Mylar
C332	25-858	.33 μF electrolytic
C333	27-161	.01 μF Mylar
C334	25-900	1 μF electrolytic
C335	25-880	10 μF electrolytic
C336	25-900	1 μF electrolytic
C337	25-900	1 μF electrolytic
C338	21-143	.05 μF ceramic

Capacitors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C339	21-143	.05 μF ceramic
C340	Not used	
C341	21-140	.001 μF ceramic
C342	21-140	.001 μF ceramic
C343	21-143	.05 μF ceramic
C344	21-143	.05 μF ceramic
C345	25-880	10 μF electrolytic
C346	25-880	10 μF electrolytic
C347	21-199	.1 μF ceramic
C348	21-199	.1 μF ceramic
C249	21-176	.01 μF ceramic
C350	Not used	
C351	25-880	10 μF electrolytic
C352	21-176	.01 μF ceramic

DIODES

D301	56-56	1N4149
D302	56-56	1N4149
D303	56-56	1N4149
D304	56-56	1N4149
D305	56-56	1N4149
D306	56-56	1N4149
D307	56-56	1N4149
D308	56-56	1N4149
D309	56-56	1N4149
D310	56-56	1N4149
D311	56-56	1N4149
D312	56-56	1N4149
D313	56-56	1N4149
D314	56-56	1N4149
D315	56-56	1N4149
D316	56-56	1N4149
D317	56-56	1N4149
D318	Not used	
D319	Not used	
D320	Not used	
D321	Not used	
D322	56-56	1N4149
D323	56-56	1N4149

TRANSISTORS

Q301	Not used	
Q302	417-875	2N3904
Q303	417-806	TIS75
Q304	417-875	2N3904
Q305	417-875	2N3904
Q306	417-875	2N3904
Q307	417-875	2N3904
Q308	417-875	2N3904
Q309	417-874	2N3906
Q310	417-875	2N3904
Q311	417-875	2N3904
Q312	417-875	2N3904
Q313	417-875	2N3904
Q314	Not used	

Transistors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
Q315	Not used	
Q316	417-874	2N3906
Q317	Not used	
Q318	417-881	MPSA13
Q319	417-874	2N3906

INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U301	Not used	
U302	442-748	ULN2280B
U303	442-602	LM324N
U304	442-602	LM324N
U305	443-818	74LS05

Integrated Circuits (ICs) (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U306	443-701	MC14049CP
U307	442-681	78L08
U308	443-695	CD4001AE
U309	442-627	78L05
U310	442-602	LM324N
U311	Not used	
U312	Not used	
U313	443-701	MC14049CP

MISCELLEANEOUS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
L301	45-85	.16 mH hash filter

FRONT PANEL CIRCUIT BOARD

RESISTORS — CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R401	6-331-12	330 Ω resistor
R402	6-103-12	10 kΩ resistor
R403	6-103-12	10 kΩ resistor
R404	6-103-12	10 kΩ resistor
R405	6-331-12	330 Ω resistor
R406	6-331-12	330 Ω resistor
R407	6-331-12	330 Ω resistor
R408	6-331-12	330 Ω resistor
R409	6-473-12	470 Ω resistor
R410	Not used	
R411	6-222-12	2200 Ω resistor
R412	6-103-12	10 kΩ resistor
R413	6-151-12	150 Ω resistor
R414	6-472-12	4700 Ω resistor
R415	6-151-12	150 Ω resistor
R416	6-473-12	47 kΩ resistor
R417	6-222-12	2200 Ω resistor
R418	6-103-12	10 kΩ resistor
R419	6-151-12	150 Ω resistor
R420	Not used	
R421	6-472-12	4700 Ω resistor
R422	6-151-12	150 Ω resistor
R423	6-331-12	330 Ω resistor
R424	6-331-12	330 Ω resistor
R425	6-104-12	100 kΩ resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R426	6-104-12	100 kΩ resistor
R427	6-474-12	470 kΩ resistor
R428	6-681-12	680 Ω resistor
R429	6-681-12	680 Ω resistor
R430	Not used	
R431	6-681-12	680 Ω resistor
R432	6-104-12	100 kΩ resistor
R433	10-941	100 kΩ control
R434	10-941	100 kΩ control
R435	6-274-12	270 kΩ resistor
R436	6-100	10 Ω, 1/2-watt resistor

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C401	21-143	.05 μF ceramic
C402	25-200	.68 μF tantalum
C403	25-200	.68 μF tantalum
C404	25-880	10 μF electrolytic
C405	25-200	.68 μF tantalum
C406	21-199	.1 μF ceramic
C407	21-176	.01 μF ceramic

DIODES — LED s

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D401-D409	56-56	1N4149 diode
D410	Not used	
D411-D419	56-56	1N4149 diode
D420	Not used	
D421-D429	56-56	1N4149 diode
D430	Not used	

HEATH

Diodes — LEDs (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D431-D439	56-56	1N4149 diode
D440	Not used	
D441-D448	56-56	1N4149 diode
D449	412-628	MV5253 LED (large green)
D450	Not used	
D451	412-628	MV5253 LED (large green)
D452	412-640	LST5053 LED (large red)
D453	412-628	MV5253 LED (large green)
D454	412-628	MV5253 LED (large green)
D455	412-628	MV5253 LED (large green)
D456	412-642	SG405D LED (small green)
D457	412-642	SG405D LED (small green)
D458	412-79	TIL209 LED (small red)
D459	412-79	TIL209 LED (small red)
D460-D470	Not Used	
D471-D476	56-56	1N4149 diode

TRANSISTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
Q401	417-801	MPSA20
Q402	417-864	MPSA05
Q403	417-865	MPSA55
Q404	417-864	MPSA05
Q405	417-865	MPSA55
Q406	417-801	MPSA20
Q407	417-801	MPSA20
Q408	417-801	MPSA20
Q409	417-801	MPSA20

INTEGRATED CIRCUITS (ICs) — OPTICAL-COUPLERS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U401	443-623	SN74154N IC
U402	443-755	SN74LS04N IC
U403	443-755	SN74LS04N IC
U404	442-682	UDN6118A IC
U405	442-682	UDN6118A IC
U406	442-682	UDN6118A IC
U407	442-54	UA7805 IC
U408	442-691	78M08 IC
U409	443-607	MC14013AL IC
U410	443-701	MC14049CP IC
U411	443-701	MC14049CP IC
U412	443-607	MC14013AL IC
U413	443-695	CD4001AE IC
U414	442-99	CD4016AE IC
U415	150-74	OPB-813S optical coupler
U416	150-74	OPB-813S optical coupler

SWITCHES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
SW401	63-1354	6-position rotary switch (Passband Shift)
SW402	63-1362	8-position rotary switch (Mode)
SW403	60-621	8-section DIP switch
SW404	64-839	Momentary pushbutton switch (D → M)
SW405	64-839	Momentary pushbutton switch (D ↔ M)
SW406	64-839	Momentary pushbutton switch (D ↔ M)
SW407	64-839	Momentary pushbutton switch (T)
SW408	64-839	Momentary pushbutton switch (R)
SW409	64-839	Momentary pushbutton switch (△)
SW410	64-839	Momentary pushbutton switch (D → M)
SW411	64-839	Momentary pushbutton switch (▽)
SW412	64-840	Locking pushbutton switch (RIT)
SW413	64-840	Locking pushbutton switch (NB)
SW414	64-840	Locking pushbutton switch (Tune)
SW415	64-839	Momentary pushbutton switch (Meter)

MISCELLANEOUS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
V401	411-847	Display tube

PREAMP CIRCUIT BOARD

RESISTORS — CONTROL

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R501	6-681-12	680 Ω resistor
R502	6-470-12	47 Ω resistor
R503	6-4022-12	40.2 kΩ, 1% resistor
R504	6-121	120 Ω, 1/2-watt resistor
R505	6-680-12	68 Ω resistor
R506	6-102-12	1000 Ω resistor
R507	6-152-12	1500 Ω resistor
R508	6-103-12	10 kΩ resistor
R509	6-470-12	47 Ω resistor
R510	Not used	
R511	6-152-12	1500 Ω resistor
R512	6-272-12	2700 Ω resistor
R513	6-121-12	120 Ω resistor
R514	6-183-12	18 kΩ resistor
R515	6-220	22 Ω, 1/2-watt resistor
R516	6-151	150 Ω, 1/2-watt resistor
R517	6-151	150 Ω, 1/2-watt resistor
R518	6-159	1.5 Ω, 1/2-watt resistor
R519	6-181-12	180 Ω resistor
R520	Not used	
R521	6-332-12	3300 Ω resistor
R522	6-182-12	1800 Ω resistor
R523	6-332-12	3300 Ω resistor
R524	6-471-12	470 Ω resistor
R525	6-151-12	150 Ω resistor
R526	6-270-12	27 Ω resistor
R527	6-471-12	470 Ω resistor
R528	6-680	68 Ω, 1/2-watt resistor
R529	6-271-12	270 Ω resistor
R530	Not used	
R531	6-479-12	4.7 Ω resistor
R532	6-680	68 Ω, 1/2-watt resistor
R533	6-182-12	1800 Ω resistor
R534	6-181-12	180 Ω resistor
R535	6-151-12	150 Ω resistor
R536	6-225-12	2.2 MΩ resistor
R537	6-2201-12	2200 Ω, 1% resistor
R538	6-1801-12	1800 Ω, 1% resistor
R539	6-1132-12	11.3 kΩ, 1% resistor
R540	Not used	
R541	6-562-12	5600 Ω resistor
R542	6-3901-12	3900 Ω, 1% resistor
R543	6-473-12	47 kΩ resistor
R544	10-918	500 Ω control
R545	6-471-12	470 Ω resistor
R546	6-221-12	220 Ω resistor
R547	6-822-12	8200 Ω resistor
R548	6-101-12	100 Ω resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R549	6-821-12	820 Ω resistor
R550	Not used	
R551	6-224-12	220 kΩ resistor
R552	6-271-12	270 Ω resistor
R553	6-471-12	470 Ω resistor
R554	6-472-12	4700 Ω resistor
R555	6-102-12	1000 Ω resistor
R556	6-103-12	10 kΩ resistor
R557	6-103-12	10 kΩ resistor
R558	6-472-12	4700 Ω resistor
R559	6-224-12	220 kΩ resistor
R560	Not used	
R561	6-103-12	10 kΩ resistor
R562	6-472-12	4700 Ω resistor
R563	6-822-12	8200 Ω resistor
R564	6-103-12	10 kΩ resistor
R565	6-103-12	10 kΩ resistor
R566	6-104-12	100 kΩ resistor
R567	6-103-12	10 kΩ resistor
R568	6-103-12	10 kΩ resistor
R569	6-103-12	10 kΩ resistor
R570	Not used	
R571	6-102-12	1000 Ω resistor
R572	6-224-12	220 kΩ resistor
R573	6-272-12	2700 Ω resistor
R574	6-102-12	1000 Ω resistor
R575	6-181-12	180 Ω resistor
R576	6-101-12	100 Ω resistor
R577	6-182-12	1800 Ω resistor
R578	6-101-1	100 Ω resistor

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C501	21-143	.05 µF ceramic
C502	21-717	.01 µF ceramic
C503	21-192	.1 µF ceramic
C504	21-192	.1 µF ceramic
C505	21-140	.001 µF ceramic
C506	20-131	360 pF mica
C507	21-717	.01 µF ceramic
C508	21-717	.01 µF ceramic
C509	25-952	100 µF electrolytic
C510	Not used	
C511	21-717	.01 µF ceramic
C512	21-717	.01 µF ceramic
C513	21-717	.01 µF ceramic
C514	21-717	.01 µF ceramic
C515	21-143	.05 µF ceramic
C516	21-140	.001 µF ceramic
C517	21-717	.01 µF ceramic
C518	21-717	.01 µF ceramic
C519	21-140	.001 µF ceramic

HEATH

Capacitors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C520	Not used	
C521	21-192	.1 µF ceramic
C522	21-717	.01 µF ceramic
C523	21-717	.01 µF ceramic
C524	21-192	.1 µF ceramic
C525	21-192	.1 µF ceramic
C526	25-197	1 µF tantalum
C527	21-717	.01 µF ceramic
C528	21-143	.05 µF ceramic
C529	20-106	390 pF mica
C530	Not used	
C531	21-143	.05 µF ceramic
C532	25-883	47 µF electrolytic
C533	21-140	.001 µF ceramic
C534	21-140	.001 µF ceramic
C535	25-887	220 µF electrolytic
C536	21-717	.01 µF ceramic
C537	21-717	.01 µF ceramic
C538	25-883	47 µF electrolytic
C539	21-143	.05 µF ceramic
C540	Not used	
C541	21-717	.01 µF ceramic
C542	21-717	.01 µF ceramic
C543	25-200	.68 µF tantalum
C544	25-200	.68 µF tantalum
C545	21-192	.1 µF ceramic
C546	21-192	.1 µF ceramic
C547	21-192	.1 µF ceramic
C548	21-192	.1 µF ceramic
C549	25-880	10 µF electrolytic
C550	Not used	
C551	21-192	.1 µF ceramic
C552	Not used	
C553	21-143	.05 µF ceramic
C554	25-200	.68 µF tantalum
C555	25-200	.68 µF tantalum
C556	21-717	.01 µF ceramic
C557	21-717	.01 µF ceramic

DIODES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D501	56-656	BA-379
D502	56-656	BA-379
D503	57-27	1N2071
D504	56-56	1N4149
D505	56-621	1N4748A
D506	56-28	VS127
D507	56-656	BA-379
D508	56-28	VS127
D509	56-67	1N4740A zener
D510	Not used	
D511	56-56	1N4149
D512	56-56	1N4149
D513	57-27	1N2071
D514	57-27	1N2071

TRANSISTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
Q501	417-875	2N3904
Q502	417-874	2N3906
Q503	417-875	2N3904
Q504	417-880	2N4427
Q505	417-893	2N5109
Q506	417-880	2N4427
Q507	417-875	2N3904
Q508	417-874	2N3906
Q509	417-875	2N3904
Q510	Not used	
Q511	417-875	2N3904
Q512	417-874	2N3906
Q513	417-875	2N3904
Q514	417-818	MJE181
Q515	417-875	2N3904
Q516	417-875	2N3904
Q517	417-818	MJE181
Q518	417-875	2N3904

INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U501	442-602	LM324N
U502	442-681	78L08

INDUCTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
L501	45-74	.47 µH choke
L502	45-57	10 µH choke
L503	45-57	10 µH choke
L504	45-51	15 µH choke
L505	45-73	2.2 µH choke
L506	45-39	4.65 µH choke
L507	45-57	10 µH choke
L508	45-57	10 µH choke
L509	45-51	15 µH choke
RFC501	RF choke consists of:	
	475-17	*Ferrite core*
	344-163	*8" black wire (8 turns)*
RFC502	RF choke consists of:	
	475-17	*Ferrite core*
	344-163	*8" black wire (8 turns)*
RFC503	RF choke consists of:	
	475-17	*Ferrite core*
	344-163	*8" black wire (8 turns)*

MISCELLANEOUS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
FB	475-10	1.07 µH ferrite bead

POWER AMPLIFIER (PA) CIRCUIT BOARD

RESISTORS — CONTROL

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R601	6-181-12	180 Ω resistor
R602	6-102-12	1000 Ω resistor
R603	6-470-12	47 Ω resistor
R604	6-121-12	120 Ω resistor
R605	6-820-12	82 Ω resistor
R606	6-391-12	390 Ω resistor
R607	6-221	220 Ω, 1/2-watt resistor
R608	6-270-12	27 Ω resistor
R609	6-519-12	5.1 Ω resistor
R610	Not used	
R611	6-270-12	27 Ω resistor
R612	6-519-12	5.1 Ω resistor
R613	6-822-12	8200 Ω resistor
R614	6-104-12	100 kΩ resistor
R615	6-184-12	180 kΩ resistor
R616	6-823-12	82 kΩ resistor
R617	6-104-12	100 kΩ resistor
R618	6-104-12	100 kΩ resistor
R619	3-35-5	39 Ω, 5-watt, 10% wirewound resistor
R620	Not used	
R621	10-1154	10 kΩ control
R622	6-470-12	47 Ω resistor
R623	1-62	51 Ω, 1/2-watt resistor
R624	6-821-12	820 Ω resistor
R625	10-936	1000 Ω control
R626	6-222-12	2200 Ω resistor
R627	6-103-12	10 kΩ resistor
R628	1-197	3.3 Ω, 1/2-watt resistor
R629	1-197	3.3 Ω, 1/2-watt resistor
R630	Not used	
R631	1-197	3.3 Ω, 1/2-watt resistor
R632	1-197	3.3 Ω, 1/2-watt resistor
R633	3-35-5	20 Ω wirewound resistor
R634	6-470-12	47 Ω resistor
R635	1-134	3.9 Ω, 1/2-watt, 10% resistor
R636	1-134	3.9 Ω, 1/2-watt, 10% resistor
R637	1-134	3.9 Ω, 1/2-watt, 10% resistor
R638	1-134	3.9 Ω, 1/2-watt, 10% resistor
R639	6-104-12	100 kΩ resistor
R640	Not used	
R641	6-104-12	100 kΩ resistor
R642	6-184-12	180 kΩ resistor
R643	6-104-12	100 kΩ resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R644	6-104-12	100 kΩ resistor
R645	6-822-12	8200 Ω resistor
R646	6-103-12	10 kΩ resistor
R647	6-103-12	10 kΩ resistor
R648	10-1154	10 kΩ control
R649	6-102-12	1000 Ω resistor
R650	Not used	
R651	10-1153	1000 Ω control
R652	6-182-12	1800 Ω resistor
R653	6-103-12	10 kΩ resistor
R654	6-683-12	68 kΩ resistor
R655	6-102-12	1000 Ω resistor
R656	6-102-12	1000 Ω resistor
R657	6-470-12	47 Ω resistor

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C601	20-119	90 pF mica
C602	20-101	20 pF mica
C603	20-189	140 pF mica
C604	20-109	62 pF mica
C605	20-161	68 pF mica
C606	21-164	.0015 μF ceramic
C607	27-128	.022 μF Mylar
C608	29-5	1000 pF polystyrene
C609	27-96	.0082 μF Mylar
C610	Not used	
C611	21-164	.0015 μF ceramic
C612	21-184	750 pF ceramic
C613	27-151	.013 μF Mylar
C614	20-113	470 pF mica
C615	29-22	4700 pF polystyrene
C616	20-171	820 pF mica
C617	20-106	390 pF mica
C618	29-18	5600 pF polystyrene
C619	20-126	255 pF mica
C620	Not used	
C621	27-70	.0022 μF Mylar
C622	20-133	430 pF mica
C623	20-111	230 pF mica
C624	20-159	39 pF mica
C625	20-111	230 pF mica
C626	20-114	270 pF mica
C627	20-127	1300 pF mica
C628	20-120	220 pF mica
C629	20-126	255 pF mica
C630	Not used	
C631	20-114	270 pF mica
C632	20-171	820 pF mica
C633	20-171	820 pF mica
C634	20-108	100 pF mica
C635	27-141	.0027 μF Mylar

Capacitors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C636	20-177	125 pF mica
C637	29-5	1000 pF polystyrene
C638	20-120	220 pF mica
C639	20-103	150 pF mica
C640	Not used	
C641	20-137	1800 pF mica
C642	20-176	94 pF mica
C643	20-171	820 pF mica
C644	20-178	160 pF mica
C645	20-148	100 pF mica
C646	21-164	.0015 μF ceramic
C647	20-161	68 pF mica
C648	20-134	680 pF mica
C649	20-183	120 pF mica
C650	Not used	
C651	21-192	.1 μF ceramic
C652	21-192	.1 μF ceramic
C653	25-880	10 μF electrolytic
C654	25-200	.68 μF tantalum
C655	21-192	.1 μF ceramic
C656	21-192	.1 μF ceramic
C657	21-192	.1 μF ceramic
C658	21-192	.1 μF ceramic
C659	21-192	.1 μF ceramic
C660	Not used	
C661	21-140	.001 μF ceramic
C662	25-200	.68 μF tantalum
C663	21-772	.68 μF ceramic chip
C664	25-880	10 μF electrolytic
C665	20-97	50 pF mica
C666	21-772	.68 μF ceramic chip
C667	20-150	3300 pF mica
C668	21-192	.1 μF ceramic
C669	20-150	3300 pF mica
C670	Not used	
C671	21-192	.1 μF ceramic
C672	21-192	.1 μF ceramic
C673	25-200	.68 μF tantalum
C674	20-127	1300 pF mica
C675	20-127	1300 pF mica
C676	21-140	.001 μF ceramic
C677	20-171	820 pF mica
C678	25-896	2200 μF electrolytic
C679	21-192	.1 μF ceramic
C680	Not used	
C681	21-772	.68 μF ceramic chip
C682	21-771	1000 pF ceramic chip
C683	21-771	1000 pF ceramic chip
C684	21-771	1000 pF ceramic chip
C685	21-771	1000 pF ceramic chip
C686	25-896	2200 μF electrolytic
C687	21-192	.1 μF ceramic
C688	21-772	.68 μF ceramic chip
C689	21-771	1000 pF ceramic chip
C690	Not used	
C691	21-192	.1 μF ceramic
C692	25-200	.68 μF tantalum

Capacitors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C693	25-197	1 μF tantalum
C694	25-200	.68 μF tantalum
C695	21-192	.1 μF ceramic
C696	21-192	.1 μF ceramic
C697	21-192	.1 μF ceramic
C698	21-192	.1 μF ceramic
C699	21-192	.1 μF ceramic
C700	Not used	
C701	20-171	820 pF mica
C702	20-97	50 pF mica
C703	20-148	100 pF mica
C704	20-172	1000 pF mica
C705	20-172	1000 pF mica
C706	20-113	470 pF mica
C707	20-137	1800 pF mica
C708	20-106	390 pF mica
C709	20-167	620 pF mica
C710	Not used	
C711	20-167	620 pF mica
C712	20-109	62 pF mica
C713	20-127	1300 pF mica
C714	20-178	160 pF mica
C715	20-139	330 pF mica
C716	20-116	400 pF mica
C717	20-116	400 pF mica
C718	20-161	68 pF mica
C719	20-167	620 pF mica
C720	Not used	
C721	20-124	115 pF mica
C722	20-162	105 pF mica
C723	20-116	400 pF mica
C724	20-164	180 pF mica
C725	20-160	33 pF mica
C726	20-106	390 pF mica
C727	20-148	100 pF mica
C728	20-108	200 pF mica
C729	20-164	180 pF mica
C730	Not used	
C731	20-118	15 pF mica
C732	20-131	360 pF mica
C733	20-174	42 pF mica
C734	20-108	200 pF mica
C735	20-178	160 pF mica
C736	20-130	12 pF mica
C737	20-185	240 pF mica
C738	20-160	33 pF mica
C739	20-189	140 pF mica
C740	Not used	
C741	20-119	90 pF mica
C742	20-118	15 pF mica
C743	20-183	120 pF mica
C744	20-97	50 pF mica
C745	20-109	62 pF mica
C746	25-883	47 μF electrolytic
C747	21-772	.68 μF ceramic chip
C748	21-192	.1 μF ceramic

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

DIODES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D601	56-56	1N4149
D602	56-646	BA-244 PIN
D603	56-56	1N4149
D604	56-16	1N5231B zener
D605	56-56	1N4149
D606	56-56	1N4149
D607	57-27	1N2071
D608	56-656	BA-379 PIN
D609	56-646	BA-244 PIN

TRANSISTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
Q601	417-893	2N5109
Q602	417-893	2N5109
Q603	417-893	2N5109
Q604	417-175	2N5294
Q605	417-961	MRF455
Q606	417-818	MJE181
Q607	417-874	2N3906
Q608	417-175	2N5294
Q609	417-962	MRF421*
Q610	Not used	
Q611	417-962	MRF421*
Q612	417-818	MJE181

INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U601	442-728	LM2904N
U602	442-681	78L08
U603	442-728	LM2904N
U604	442-681	78L08
U605	442-681	78L08

INDUCTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
L601	40-1986	.188 μH toroid
L602	40-1855	Variable
L603	45-57	10 μH choke
L604	45-75	.68 μH choke
L605	40-1872	2.3 μH toroid
L606	40-1872	2.3 μH toroid
L607	40-2047	.975 μH coil
L608	40-2047	.975 μH coil
L609	45-75	.68 μH choke
L610	Not used	
L611	40-2048	.69 μH variable
L612	40-2049	1.27 μH variable
L613	40-2050	1.1 μH variable
L614	40-2051	.49 μH coil
L615	40-2052	.52 μH coil
L616	40-2053	.35 μH coil
L617	40-2054	.398 μH coil
L618	40-2055	.315 μH coil

*Transistors Q609 and Q611 are available as a matched set under Heath Part Number 117-15

Inductors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
L619	40-2056	.284 μH coil
L620	Not used	
L621	40-2040	4.56 μH toroid
L622	40-2041	4.4 μH toroid
L623	40-2042	3.68 μH toroid
L624	40-2007	2.44 μH toroid
L625	40-2008	2.14 μH toroid
L626	40-2009	1.34 μH toroid
L627	40-2003	1.17 μH toroid
L628	40-1964	.86 μH toroid
L629	40-1967	.66 μH toroid
L630	Not used	
L631	40-2010	.68 μH toroid
L632	40-2011	.59 μH toroid
L633	40-2012	.47 μH toroid
L634	40-2013	.41 μH toroid
L635	40-2085	.269 μH toroid
L636	40-2084	.184 μH toroid
T601	Input transformer consists of:	
	475-24	*Ferrite core*
	344-144	*1' blue wire*
	343-12	*6" braid*
T602	Interstage transformer consists of:	
	475-17	*Ferrite core (2)*
	475-26	*Ferrite core (4)*
	344-144	*1' blue wire*
	344-109	*6" white wire*
T603	Interstage transformer consists of:	
	475-24	*Ferrite core*
	344-144	*1' blue wire*
	343-12	*6" braid*
T604	Output transformer consists of:	
	475-28	*Ferrite core (6)*
	475-27	*Ferrite core (4)*
	343-25	*2' Shielded cable*
RFC601	RF choke consists of:	
	475-17	*Ferrite core*
	344-163	*8" black wire (8 turns)*
RFC602	RF choke consists of:	
	475-17	*Ferrite core*
	344-163	*8" black wire (8 turns)*
RFC603	RF choke consists of:	
	475-29	*Ferrite core*
	348-1	*6" enamaled wire (6 turns)*
RFC604	RF choke consists of:	
	475-29	*Ferrite core*
	348-1	*6" enamaled wire (6 turns)*

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
Inductors (Cont'd)		
RFC605	RF choke consists of:	
	475-27	*Ferrite core*
	438-5	*18" red enameled wire (6 turns)*
	438-6	*18" green enameled wire (6 turns)*

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
MISCELLANEOUS		
SW601A	63-1380	Switch section
SW601B	63-1380	Switch section
SW601C	63-1380	Switch section
SW601D	63-1380	Switch section
K601	69-99	Relay
FB	475-10	Small ferrite bead
FB	475-12	Large ferrite bead

CONTROLLER CIRCUIT BOARD

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R801	6-103-12	10 kΩ
R802	6-103-12	10 kΩ
R803	6-103-12	10 kΩ
R804	6-103-12	10 kΩ
R805	6-103-12	10 kΩ
R806	6-103-12	10 kΩ
R807	6-103-12	10 kΩ
R808	6-103-12	10 kΩ
R809	6-102-12	1000 Ω
R810	Not used	
R811	6-102-12	1000 Ω
R812	6-102-12	1000 Ω
R813	6-102-12	1000 Ω
R814	6-103-12	10 kΩ
R815	6-103-12	10 kΩ
R816	6-273-12	10 kΩ
R817	6-102-12	1000 Ω
R818	6-103-12	10 kΩ
R819	6-302-12	3000 Ω
R820	Not used	
R821	6-103-12	10 kΩ
R822	6-102-12	1000 Ω
R823	6-103-12	10 kΩ
R824	6-103-12	10 kΩ
R825	6-103-12	10 kΩ

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C801	21-143	.05 μF ceramic
C802	21-143	.05 μF ceramic
C803	25-900	1 μF electrolytic
C804	21-143	.05 μF ceramic
C805	21-143	.05 μF ceramic
C806	21-143	.05 μF ceramic
C807	21-143	.05 μF ceramic
C808	21-143	.05 μF ceramic
C809	21-143	.05 μF ceramic
C810	Not used	
C811	21-143	.05 μF ceramic
C812	21-143	.05 μF ceramic
C813	21-143	.05 μF ceramic
C814	21-143	.05 μF ceramic
C815	25-841	4.7 μF tantalum
C816	25-200	.68 μF tantalum
C817	21-143	.05 μF ceramic
C818	25-200	.68 μF tantalum
C819	25-200	.68 μF tantalum
C820	Not used	
C821	21-143	.05 μF ceramic
C822	21-722	330 pF ceramic
C823	21-722	330 pF ceramic
C824	21-722	330 pF ceramic
C825	21-143	.05 μF ceramic
C826	21-722	330 pF ceramic
C827	21-722	330 pF ceramic
C828	21-722	330 pF ceramic
C829	21-143	.05 μF ceramic
C830	Not used	
C831	21-722	330 pF ceramic
C832	21-143	.05 μF ceramic
C833	21-143	.05 μF ceramic

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

DIODES — TRANSISTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D801	56-56	1N4149 diode
D802	56-56	1N4149 diode
D803	56-56	1N4149 diode
D804	56-56	1N4149 diode
D805	Not used	
D806	56-56	1N4149 diode
Q801	417-801	MPSA20 transistor
Q802	417-865	MPSA55 transistor
Q803	417-801	MPSA20 transistor

INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U801	443-923	MK3853
U802	443-779	74LS02
U803	443-728	74LS00
U804	443-877	74LS138
U805	443-924	MK3871
U806	443-922	MK3850
U807	444-96	2316
U808	444-97	2316
U809	443-933	5101
U810	443-933	5101
U811	443-952	8250
U812	443-879	74LS174
U813	443-879	74LS174
U814	443-879	74LS174
U815	443-879	74LS174
U816	443-879	74LS174
U817	443-794	75188
U818	443-795	75189
U819	442-54	7805
U820	442-627	78L05

BANDPASS FILTER ASSEMBLY

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a 5% tolerance.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R901	6-101-12	100 Ω
R902	6-182-12	1800 Ω
R903	6-182-12	1800 Ω
R904	6-101-12	100 Ω
R905	6-182-12	1800 Ω
R906	6-182-12	1800 Ω
R907	6-101-12	100 Ω
R908	6-182-12	1800 Ω
R909	6-182-12	1800 Ω
R910	Not used	
R911	6-101-12	100 Ω
R912	6-182-12	1800 Ω
R913	6-182-12	1800 Ω
R914	6-101-12	100 Ω
R915	6-182-12	1800 Ω

Resistors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R916	6-182-12	1800 Ω
R917	6-101-12	100 Ω
R918	6-182-12	1800 Ω
R919	6-182-12	1800 Ω
R920	Not used	
R921	6-101-12	100 Ω
R922	6-182-12	1800 Ω
R923	6-182-12	1800 Ω
R924	6-101-12	100 Ω
R925	6-182-12	1800 Ω
R926	6-182-12	1800 Ω
R927	6-332-12	3300 Ω
R928	6-101-2	100 Ω
R929	6-182-12	1800Ω
R930	Not used	
R931	6-182-12	1800 Ω
R932	6-182-12	1800 Ω
R933	6-182-12	1800 Ω
R934	6-182-12	1800 Ω

HEATH

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C901	21-145	.001 µF ceramic feedthrough
C902	20-116	400 pF mica
C903	21-192	.1 µF ceramic
C904	29-6	1200 pF polystyrene
C905	20-116	400 pF mica
C906	21-145	.001 µF ceramic feedthrough
C907	31-85	5-25 pF ceramic trimmer
C908	20-183	120 pF mica
C909	21-192	.1 µF ceramic
C910	Not used	
C911	20-134	680 pF mica
C912	31-85	5-25 pF ceramic trimmer
C913	20-183	120 pF mica
C914	21-145	.001 µF ceramic feedthrough
C915	31-68	1-8 pF mica trimmer
C916	20-100	30 pF mica
C917	21-717	.01 µF ceramic
C918	20-116	400 pF mica
C919	31-68	1-8 pF mica trimmer
C920	Not used	
C921	20-100	30 pF mica
C922	21-145	.001 µF ceramic feedthrough
C923	20-77	24 pF mica
C924	31-85	5-25 pF ceramic trimmer
C925	20-160	33 pF mica
C926	21-717	.01 µF ceramic
C927	21-739	2.2 pF ceramic
C928	20-160	33 pF mica
C929	31-85	5-25 pF ceramic trimmer
C930	Not used	
C931	20-77	24 pF mica
C932	21-145	.001 µF ceramic feedthrough
C933	31-68	1-8 pF mica trimmer
C934	21-3	10 pF ceramic
C935	21-717	.01 µF ceramic
C936	20-108	200 pF mica
C937	31-68	1-8 pF mica trimmer
C938	21-3	10 pF ceramic
C939	20-104	130 pF mica
C940	Not used	
C941	20-124	115 pF trimmer
C942	21-167	39 pF ceramic
C943	20-124	115 pF mica
C944	21-192	.1 µF ceramic
C945	21-145	.001 µF ceramic feedthrough
C946	31-85	5-25 ceramic trimmer
C947	21-717	.01 µF ceramic
C948	20-105	180 pF mica
C949	31-85	5-25 pF ceramic trimmer
C950	Not used	
C951	21-145	.001 µF ceramic feedthrough

Capacitors (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C952	31-68	1-8 pF mica trimmer
C953	21-717	.01 µF ceramic
C954	21-11	150 pF ceramic
C955	31-68	1-8 pF mica trimmer
C956	21-145	.001 µF ceramic feedthrough
C957	31-85	5-25 pF ceramic trimmer
C958	21-717	.01 µF ceramic
C959	20-104	130 pF mica
C960	Not used	
C961	31-85	5-25 pF ceramic trimmer
C962	21-145	.001 µF ceramic feedthrough
C963	31-68	1-8 pF mica trimmer
C964	21-157	5 pF ceramic
C965	21-717	.01 µF ceramic
C966	20-124	115 pF mica
C967	31-68	1-8 pF mica trimmer
C968	21-157	5 pF ceramic
C969	21-192	.1 µF ceramic

DIODES

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
D901-D909	56-646	BA-244 PIN
D910	Not used	
D911-D920	56-646	BA-244 PIN

INDUCTORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
L901	40-1983	20 µH variable coil
L902	40-1983	20 µH variable coil
L903	40-1982	15.5 µH toroid
L904	40-1982	15.5 µH toroid
L905	40-1982	15.5 µH toroid
L906	40-1982	15.5 µH toroid
L907	40-1984	3.1 µH toroid
L908	40-1984	3.1 µH toroid
L909	40-1726	7 µH toroid
L910	Not used	
L911	40-1726	7 µH toroid
L912	40-1985	.375 µH coil
L913	40-1987	.083 µH coil
L914	40-1985	.375 µH coil
L915	40-1986	.188 µH variable coil
L916	40-1726	7 µH toroid
L917	40-1726	7 µH toroid
L918	40-1726	7 µH toroid
L919	40-1726	7 µH toroid
L920	Not used	
L921	40-1984	3.1 µH toroid
L922	40-1984	3.1 µH toroid
L923	40-1984	3.1 µH toroid
L924	40-1984	3.1 µH toroid

EXTERNAL ALC CIRCUIT BOARD

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R975	10-393	5 MΩ control
R976	10-904	5000 Ω (5 kΩ) control
C975	27-85	.22 μF Mylar
C976	21-717	.01 μF ceramic
Q975	417-241	EL131 transistor
RFC975	RF choke consists of:	
	475-17	*Ferrite core*
	344-163	*8" black wire (8 turns)*
S975	434-146	Phono socket

INVERTER ASSEMBLY

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

R1001	6-102-12	1000 Ω
R1002	6-223-12	22 kΩ
R1003	6-271-12	270 Ω
R1004	6-102-12	1000 Ω
R1005	6-102-12	1000 Ω
R1006	6-271-12	270 Ω
R1007	6-471	470 Ω, 1/2-watt
R1008	6-561	560 Ω, 1/2-watt

CAPACITORS

C1001	25-866	22 μF, 25V electrolytic
C1002	21-48	.05 μF ceramic
C1003	21-145	.001 μF ceramic feedthrough
C1004	25-220	10 μF tantalum
C1005	21-140	.001 μF ceramic
C1006	21-176	.01 μF ceramic
C1007	25-276	4.7 μF tantalum
C1008	25-220	10 μF tantalum
C1009	25-276	4.7 μF tantalum
C1010	Not used	
C1011	25-200	.68 μF tantalum
C1012	21-145	.001 μF ceramic feedthrough
C1013	25-867	22 μF, 50V electrolytic
C1014	21-48	.05 μF ceramic
C1015	25-276	4.7 μF tantalum
C1016	25-220	10 μF tantalum
C1017	21-145	.001 μF ceramic feedthrough
C1018	25-866	22 μF, 25V electrolytic
C1019	21-48	.05 μF ceramic
C1020	Not used	

Capacitors (Cont'd)

C1021	25-220	10 μF tantalum
C1022	25-220	10 μF tantalum
C1023	25-220	10 μF tantalum
C1024	21-145	.001 μF ceramic feedthrough
C1025	25-866	22 μF, 25V electrolytic
C1026	21-48	.05 μF ceramic
C1027	21-145	.001 μF ceramic feedthrough
C1028	25-866	22 μF, 25V electrolytic
C1029	21-48	.05 μF ceramic

DIODES

D1001	56-93	FD-333
D1002	56-93	FD-333
D1003	56-93	FD-333
D1004	56-93	FD-333
D1005	56-93	FD-333
D1006	56-93	FD-333

TRANSISTORS — INTEGRATED CIRCUITS (ICs)

Q1001	417-819	MJE-171 transistor
Q1002	417-818	MJE-181 transistor
U1001	442-53	NE-555 IC
U1002	442-663	78M12 IC
U1003	442-644	78L12 IC
U1004	442-665	79L05 IC

MISCELLANEOUS

L1001	45-98	Hash filter choke
FB	475-17	Ferrite bead
	75-204	Transistor heat sink
	432-753	Large spring connector
	432-821	Connector shell

POWER INTERFACE CIRCUIT BOARD

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1201	6-471	470 Ω, 1/2-watt
R1202	6-272-12	2700 Ω
R1203	6-102-12	1000 Ω
R1204	6-563-12	56 kΩ
R1205	6-393-12	39 kΩ
R1206	6-101-12	100 Ω
R1207	6-391-12	390 Ω
R1208	6-332-12	3300 Ω
R1209	6-681-12	680 Ω
R1210	Not used	
R1211	6-681-12	680 Ω
R1212	6-151-12	150 Ω
R1213	6-393-12	39 kΩ
R1214	6-392-12	3900 Ω
R1215	6-392-12	3900 Ω
R1216	6-103-12	10 kΩ
R1217	6-392-12	3900 Ω
R1218	6-392-12	3900 Ω
R1219	6-122-12	1200 Ω
R1220	Not used	
R1221	6-122-12	1200 Ω

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
CAPACITOR		
C1201	21-143	.05 μF ceramic
DIODES		
D1201	57-27	1N2071
D1202	56-36	16.1-volt zener
D1203	57-27	1N2071
D1204	56-617	1N5277B, 160-volt zener
D1205	57-27	1N2071
D1206	56-617	1N5277B, 160-volt zener
D1207	57-27	1N2071
TRANSISTORS		
Q1201	417-874	2N3906
Q1202	417-874	2N3906
Q1203	417-875	2N3904
Q1204	417-927	MPSA93
Q1205	417-195	MJE340
Q1206	417-195	MJE340
Q1207	417-875	2N3904
Q1208	417-875	2N3904
Q1209	417-875	2N3904
Q1210	Not used	
Q1211	417-875	2N3904
Q1212	417-195	MJE340

MOTOR DRIVER CIRCUIT BOARD

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5%.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1401	6-103-12	10 kΩ
R1402	6-332-12	3300 Ω
R1403	6-101-12	100 Ω
R1404	6-102-12	1000 Ω
R1405	Not used	
R1406	6-224-12	220 kΩ
R1407	6-224-12	220 kΩ
R1408	6-681-12	680 Ω

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
CAPACITORS		
C1401	25-864	10 μF electrolytic
C1402	25-276	4.7 μF electrolytic
C1403	25-200	.68 μF tantalum
C1404	25-200	.68 μF tantalum
MISCELLANEOUS		
D1401	57-27	1N2071 diode
D1402	56-16	1N5231B diode
M1401	420-606	Stepper motor
Q1401	417-865	MPSA55 transistor
Q1402	417-818	MJE181 transistor
Q1403	417-139	40411 transistor
Q1404	417-881	MPSA13 transistor

TRANSMIT AUDIO CIRCUIT BOARD

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1501	6-273-12	27 kΩ
R1502	6-104-12	100 kΩ
R1503	6-103-12	10 kΩ
R1504	6-473-12	47 kΩ
R1505	6-103-12	10 kΩ
R1506	6-223-12	22 kΩ
R1507	6-225-12	2.2 MΩ
R1508	6-222-12	2200 Ω
R1509	6-470-12	47 Ω
R1510	Not used	
R1511	6-470-12	47 Ω
R1512	6-103-12	10 kΩ
R1513	6-470-12	47 Ω
R1514	6-822-12	8200 Ω
R1515	6-222-12	2200 Ω
R1516	6-103-12	10 kΩ
R1517	6-473-12	47 kΩ
R1518	6-472-12	4700 Ω

CAPACITORS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C1501	21-176	.01 μF ceramic
C1502	21-176	.01 μF ceramic
C1503	21-176	.01 μF ceramic
C1504	21-140	.001 μF ceramic
C1505	21-176	.01 μF ceramic
C1506	21-140	.001 μF ceramic
C1507	21-60	18 pF ceramic
C1508	21-199	.1 μF ceramic
C1509	21-176	.01 μF ceramic
C1510	Not used	
C1511	25-800	10 μF electrolytic
C1512	21-176	.01 μF ceramic
C1513	25-800	10 μF electrolytic
C1514	25-800	10 μF electrolytic
C1515	21-140	.001 μF ceramic

INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
U1501	442-681	78L08
U1502	442-99	CD1416AE
U1503	442-602	LM324N

ALC CIRCUIT BOARD

RESISTORS — CONTROL

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1901	6-103-12	10 kΩ resistor
R1902	6-104-12	100 kΩ resistor
R1903	6-560-12	56 Ω resistor
R1904	6-560-12	56 Ω resistor
R1905	6-563-12	56 kΩ resistor
R1906	6-223-12	22 kΩ resistor
R1907	6-103-12	10 kΩ resistor

Resistors — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R1908	6-183-12	18 kΩ resistor
R1909	10-1137	2000 Ω control
R1910	Not used	
R1911	6-103-12	10 kΩ resistor
R1912	6-104-12	100 kΩ resistor
R1913	6-104-12	100 kΩ resistor
R1914	6-103-12	10 kΩ resistor
R1915	6-101-12	100 Ω resistor
R1916	6-682-12	6800 Ω resistor
R1917	6-393-12	39 kΩ resistor

HEATH

CAPACITORS

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
C1901	31-57	3-20 pF trimmer
C1902	21-140	.001 μF ceramic
C1903	21-140	.001 μF ceramic
C1904	21-9	100 pF ceramic
C1905	21-717	.01 μF ceramic
C1906	21-717	.01 μF ceramic
C1907	21-162	180 pF ceramic
C1908	21-162	180 pF ceramic
C1909	21-192	.1 μF ceramic
C1910	Not used	
C1911	25-197	1 μF tantalum
C1912	25-197	1 μF tantalum
C1913	21-717	.01 μF ceramic
C1914	21-717	.01 μF ceramic
C1915	21-717	.01 μF ceramic

DIODES

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
D1901	56-20	1N295A
D1902	56-20	1N295A
D1903	56-20	1N295A

TRANSISTORS
INTEGRATED CIRCUITS (ICs)

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
Q1901	417-874	2N3906 transistor
Q1902	417-874	2N3906 transistor
U1901	442-681	78L08 IC

MISCELLANEOUS

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
L1901	40-1011	30 μH toroid coil
P1901	432-1044	7-pin plug (one pin cut off)

COMPONENT LOCATIONS

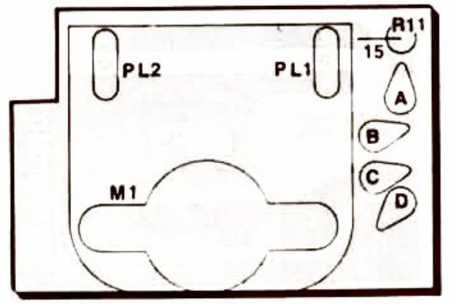
NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the corresponding circuit board X-Ray View, Photograph, or on the Schematic Diagram.

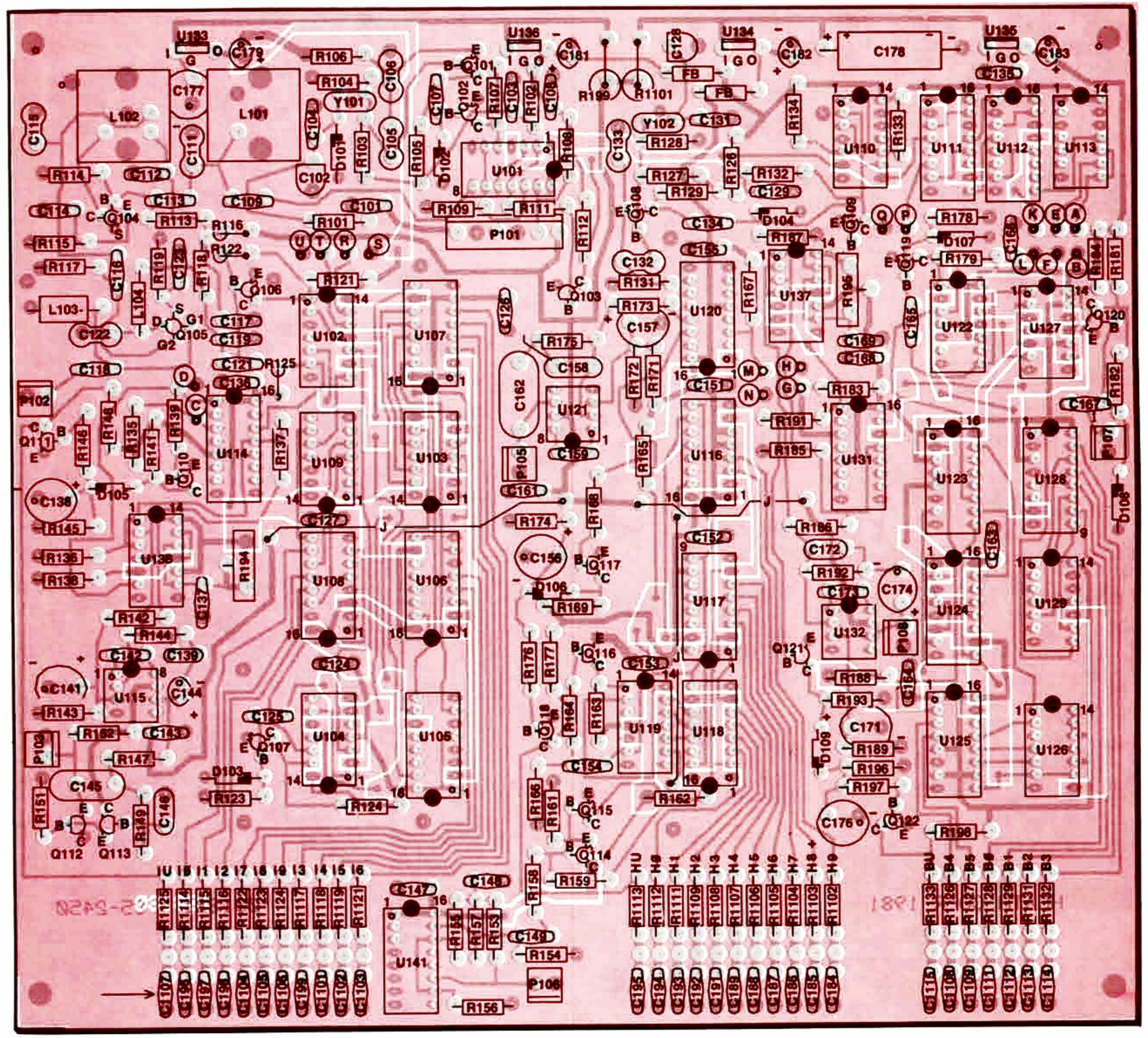
B. Locate this same number in the "Circuit Component Number" column of the "Replacement Parts List" section of this Manual.

C. Adjacent to the circuit component number, you will find the PART NUMBER and a brief DESCRIPTION which you must supply when you order a replacement part.

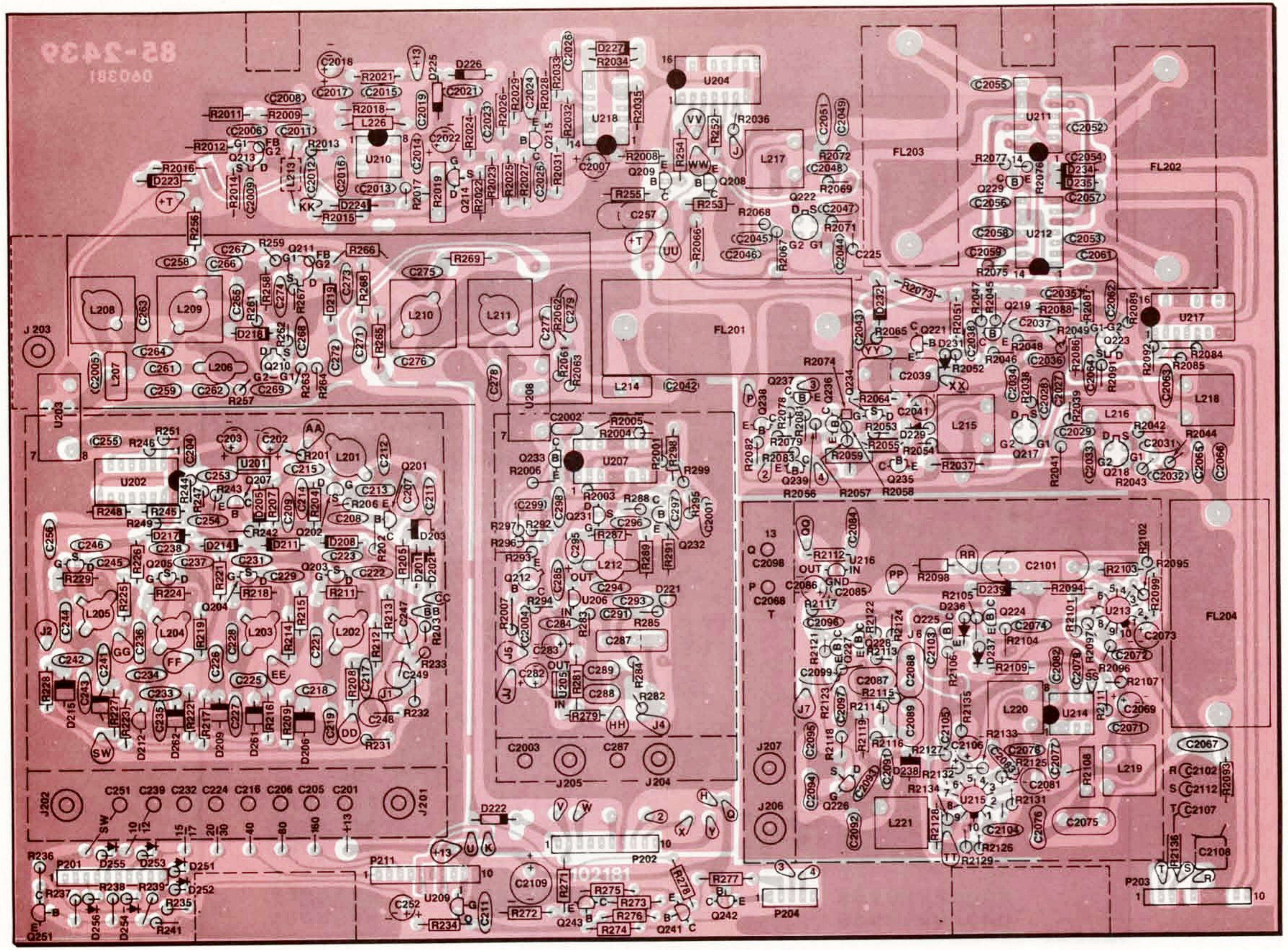
X-RAY VIEWS



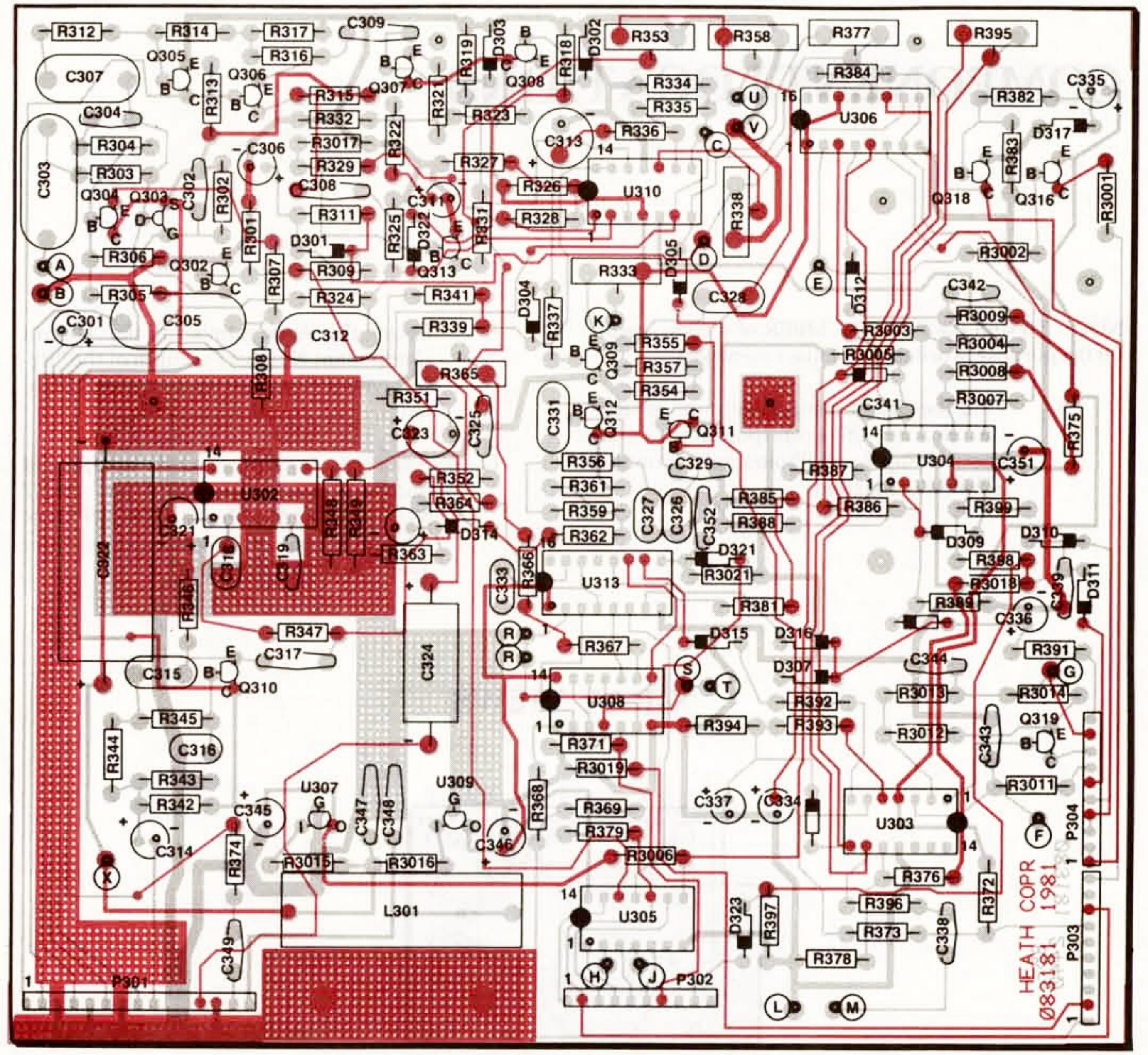
METER CIRCUIT BOARD
(Shown from the component side.)



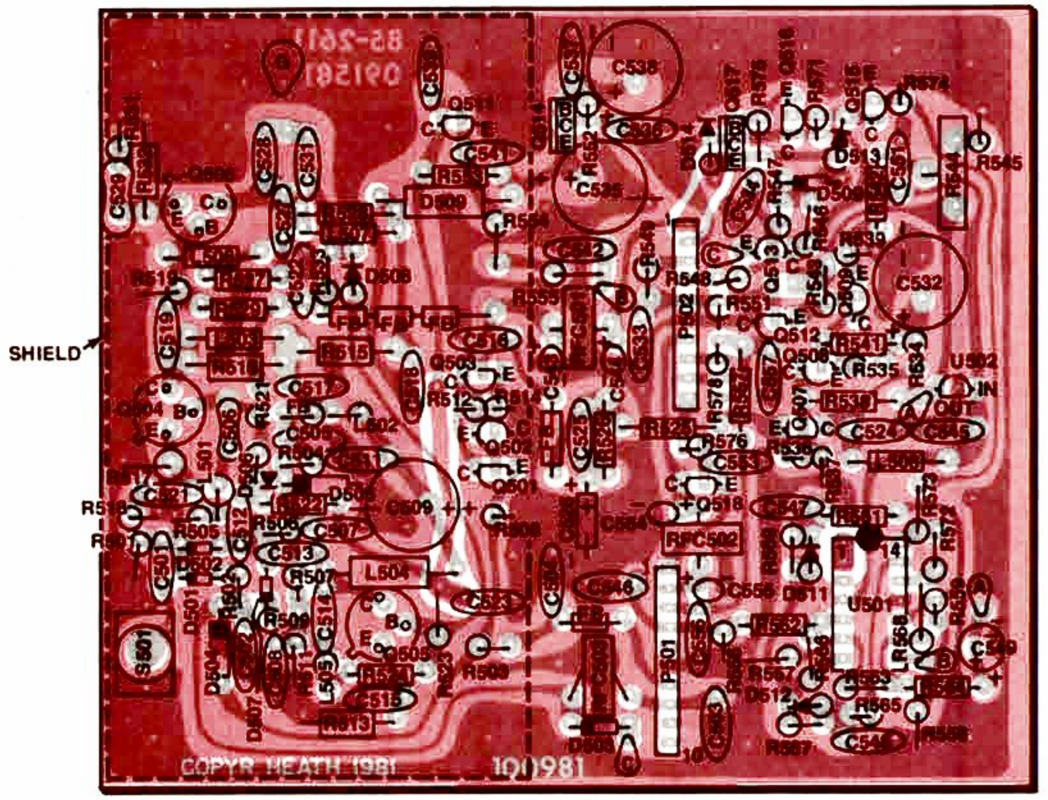
SYNTHESIZER CIRCUIT BOARD
(Shown from the component side. The foil on the component side is shown in red.)



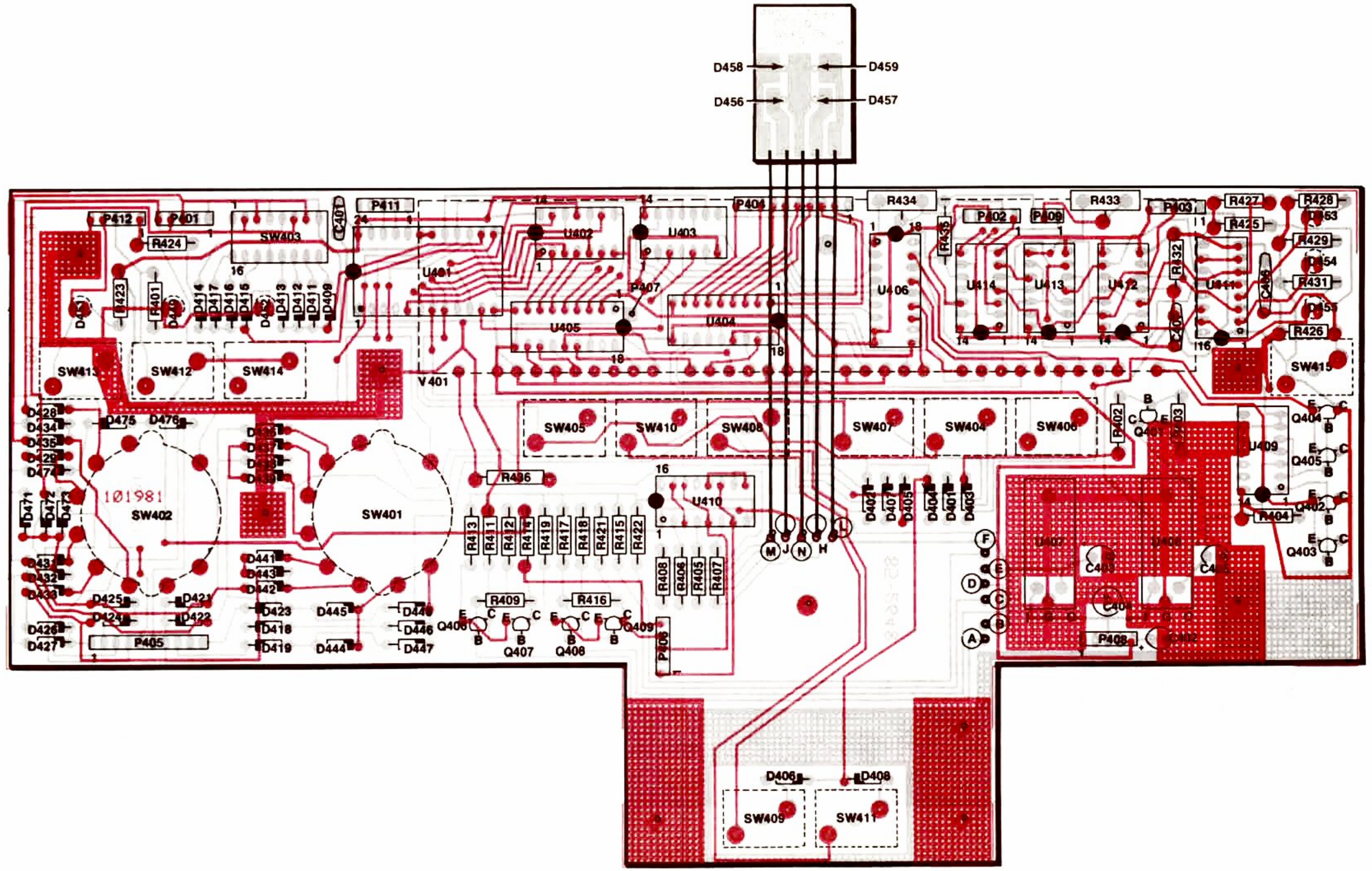
TRANSMIT/RECEIVE CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



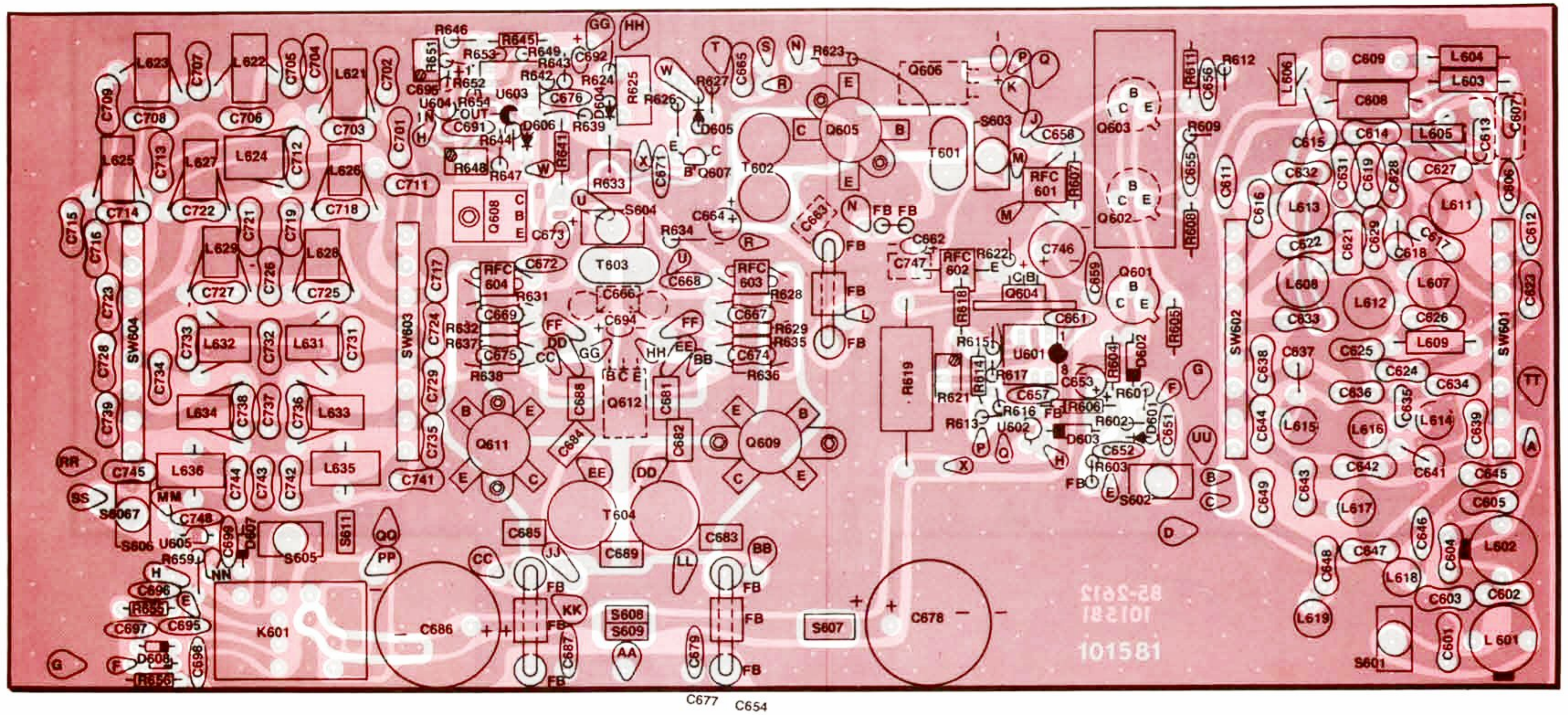
MAIN AUDIO CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



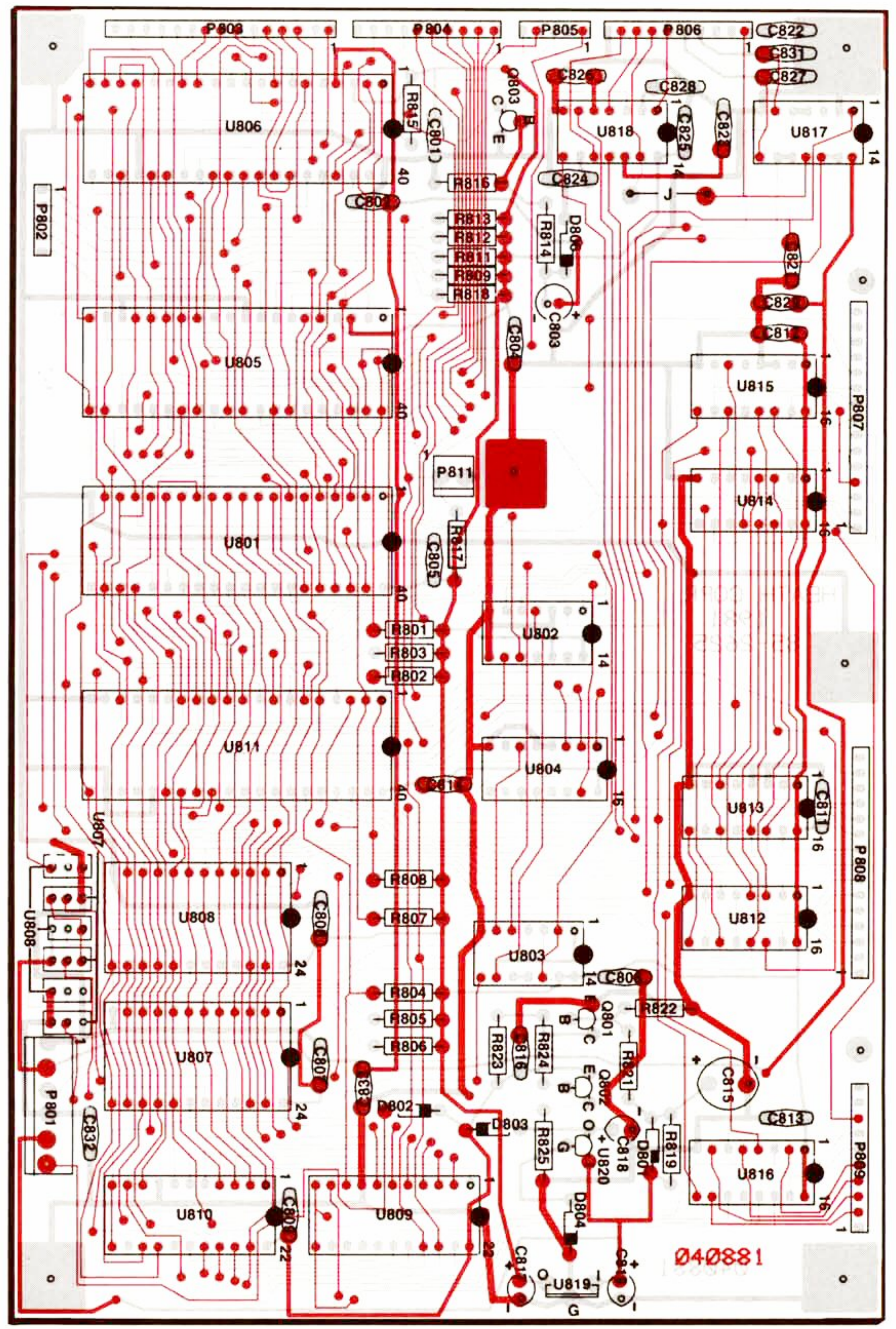
PREAMP CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



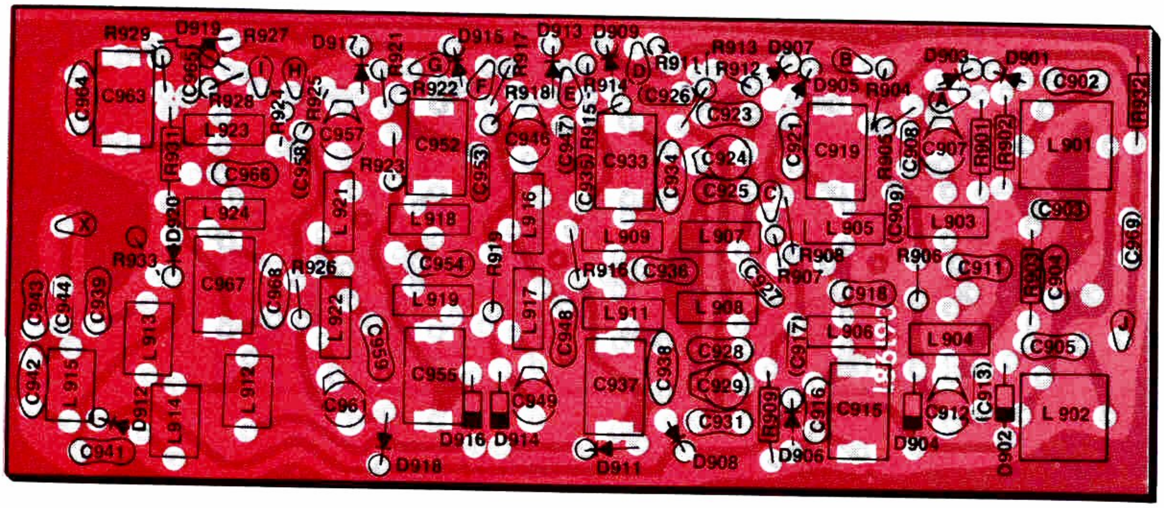
FRONT PANEL CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



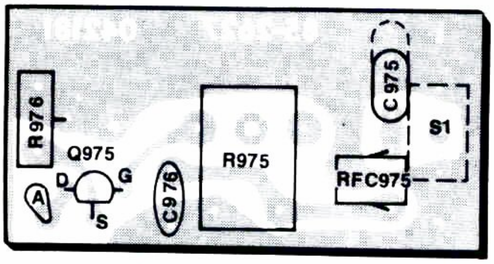
POWER AMPLIFIER (PA) CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



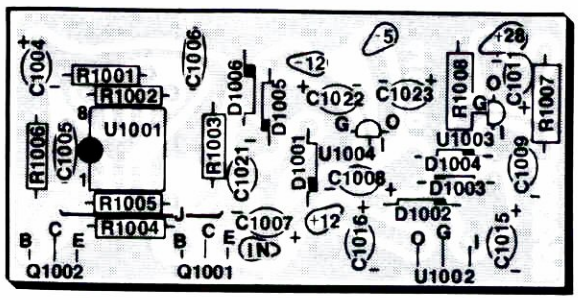
CONTROLLER CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



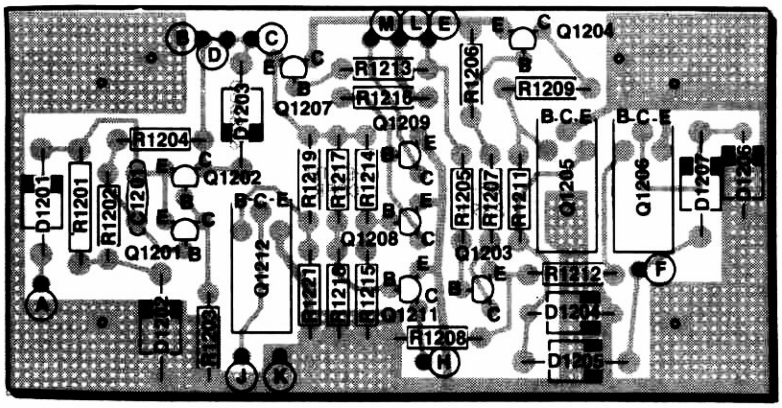
BANDPASS FILTER CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)



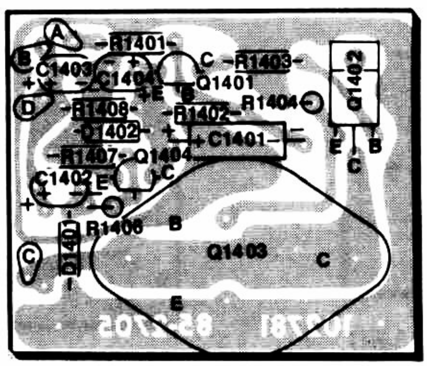
EXTERNAL ALC CIRCUIT BOARD
(Shown from the component side.)



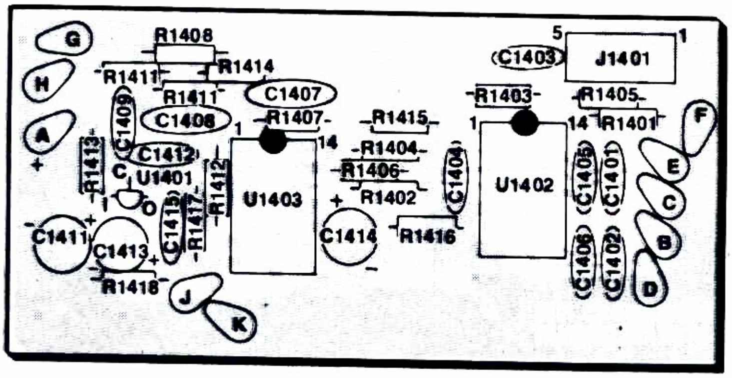
INVERTER CIRCUIT BOARD
(Shown from the component side.)



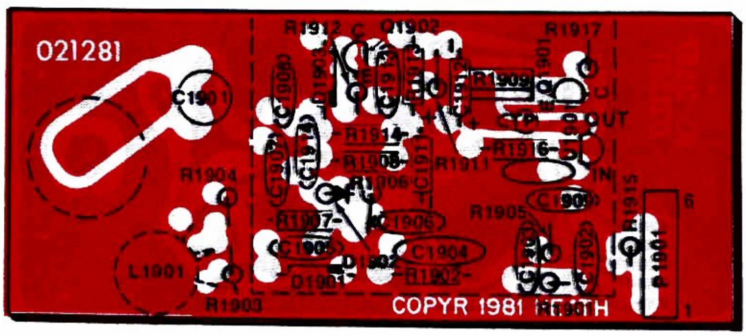
POWER INTERFACE CIRCUIT BOARD
(Shown from the component side.)



MOTOR DRIVER CIRCUIT BOARD
(Shown from the component side.)

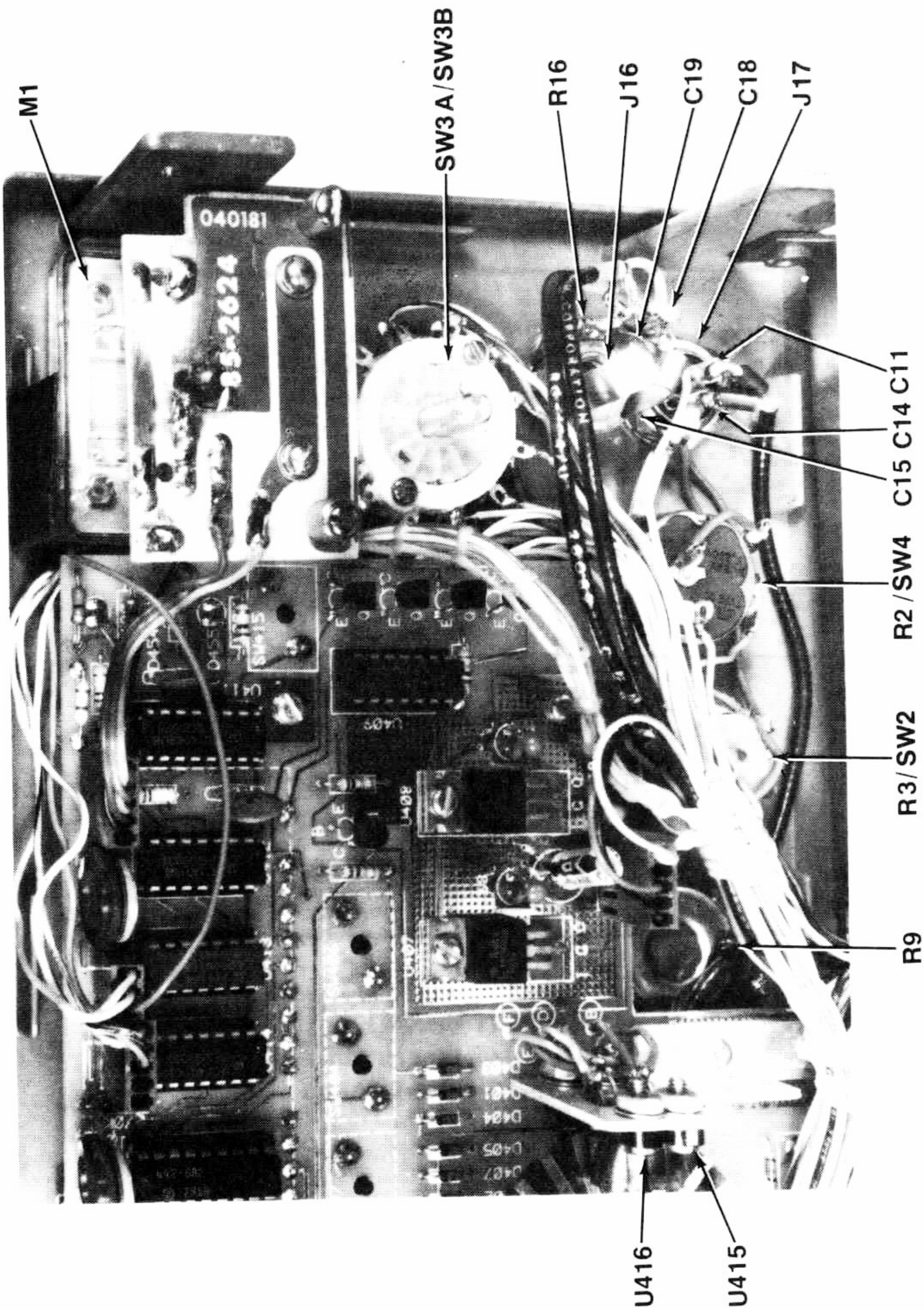


TRANSMIT AUDIO CIRCUIT BOARD
(Shown from the component side.)

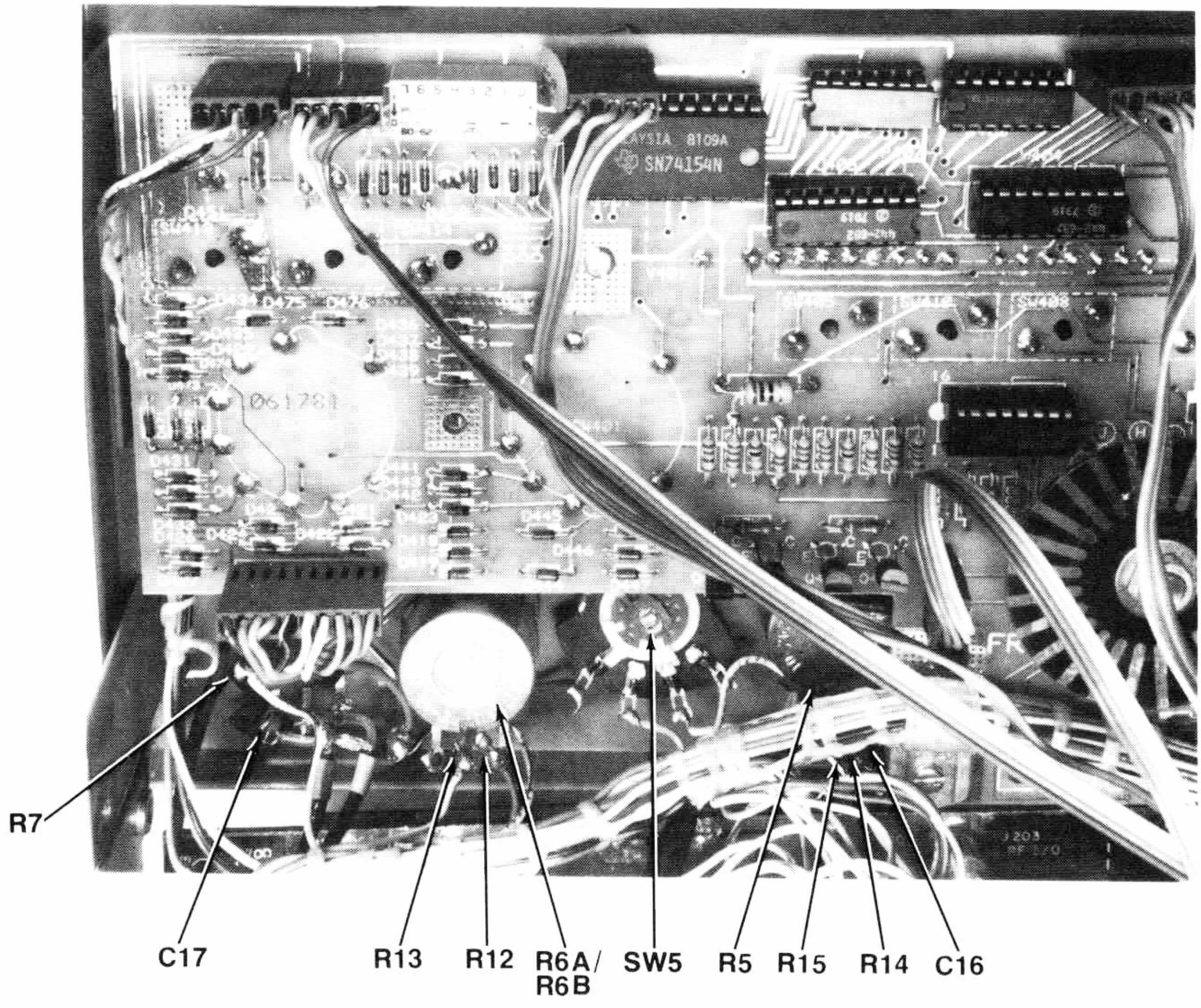


ALC CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is
shown in red.)

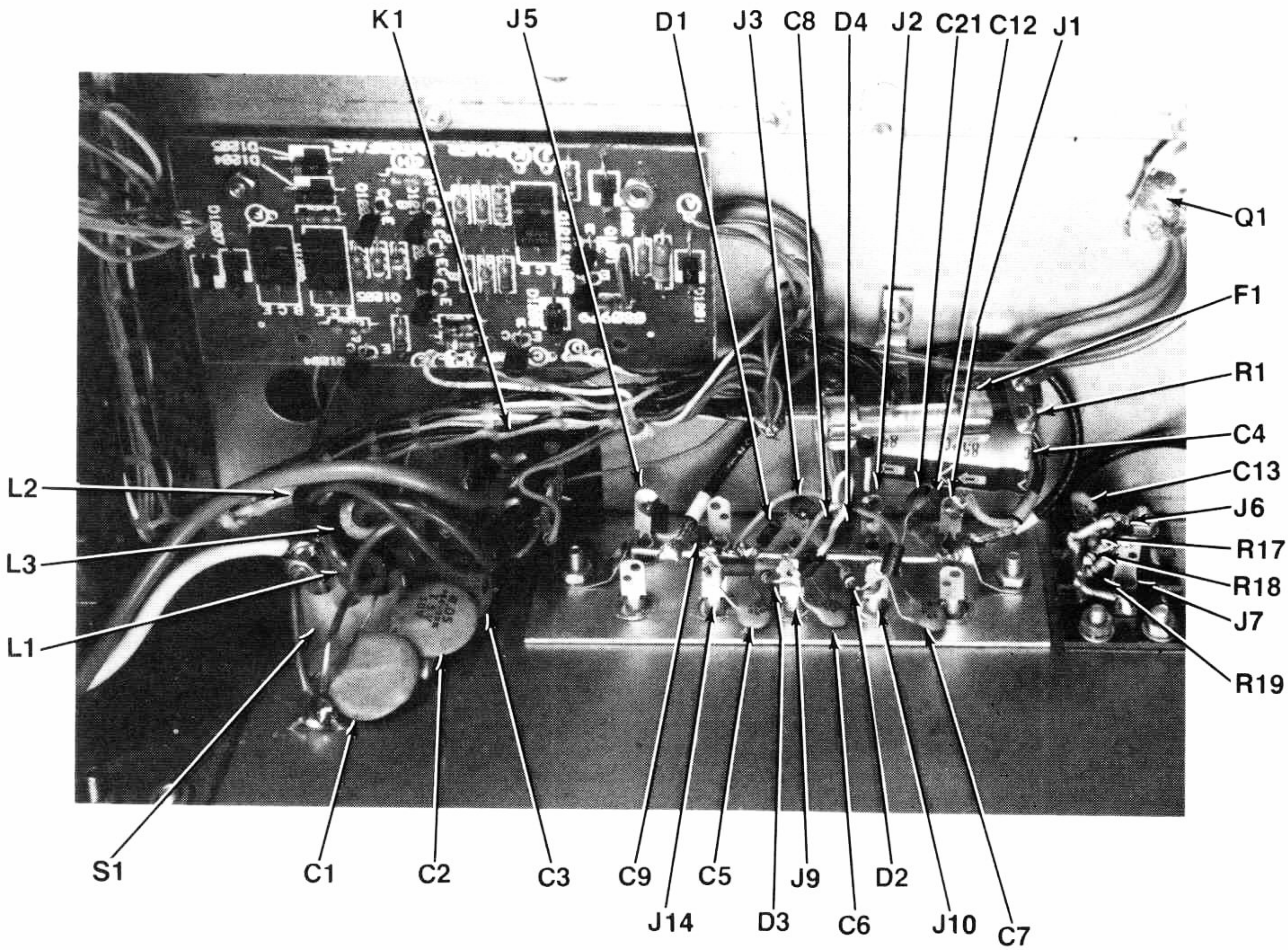
PHOTOGRAPHS



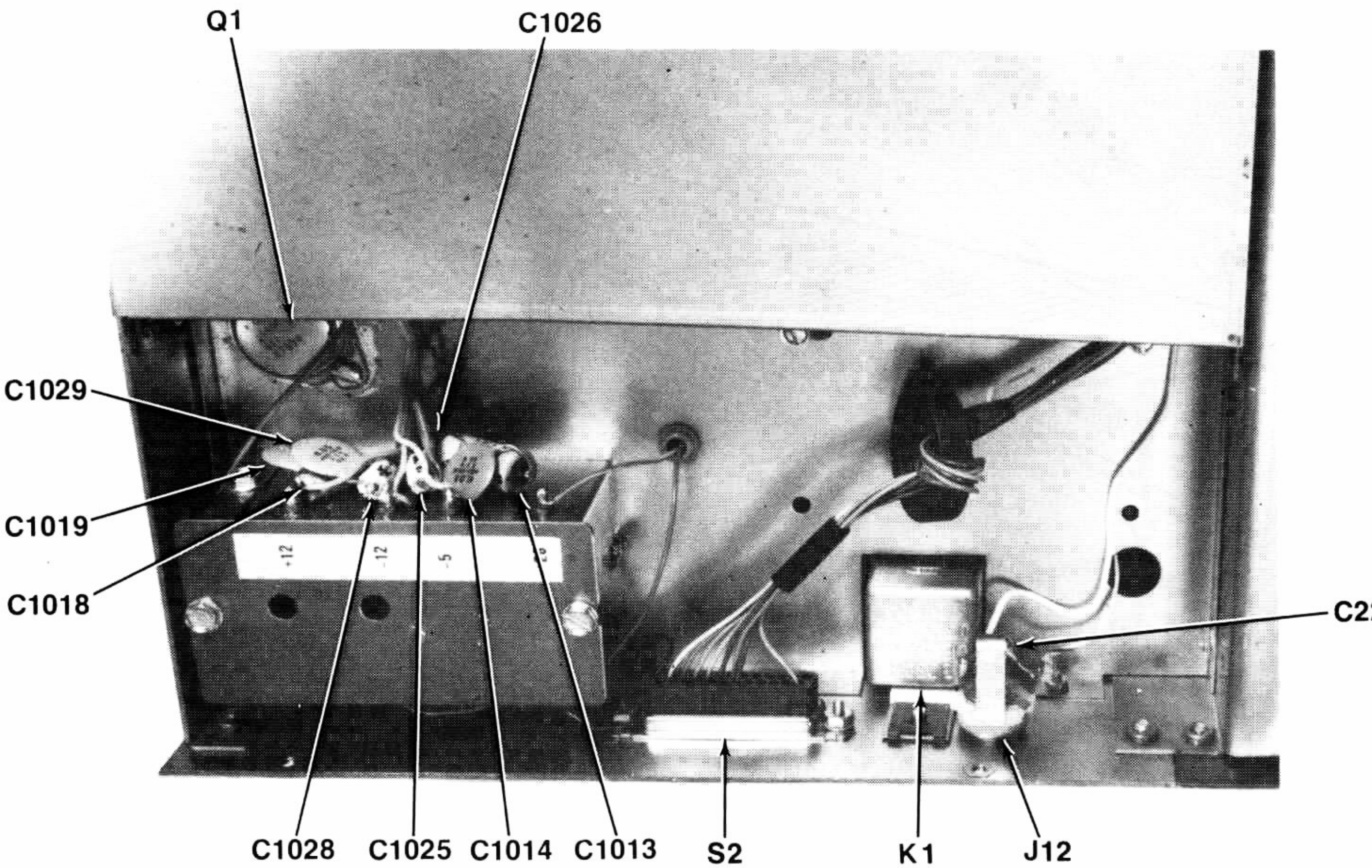
INSIDE FRONT PANEL (LOWER RIGHT AREA)



INSIDE FRONT PANEL (LOWER LEFT AREA)



BOTTOM REAR CHASSIS (UNDER T/R CIRCUIT BOARD)



TOP REAR CHASSIS

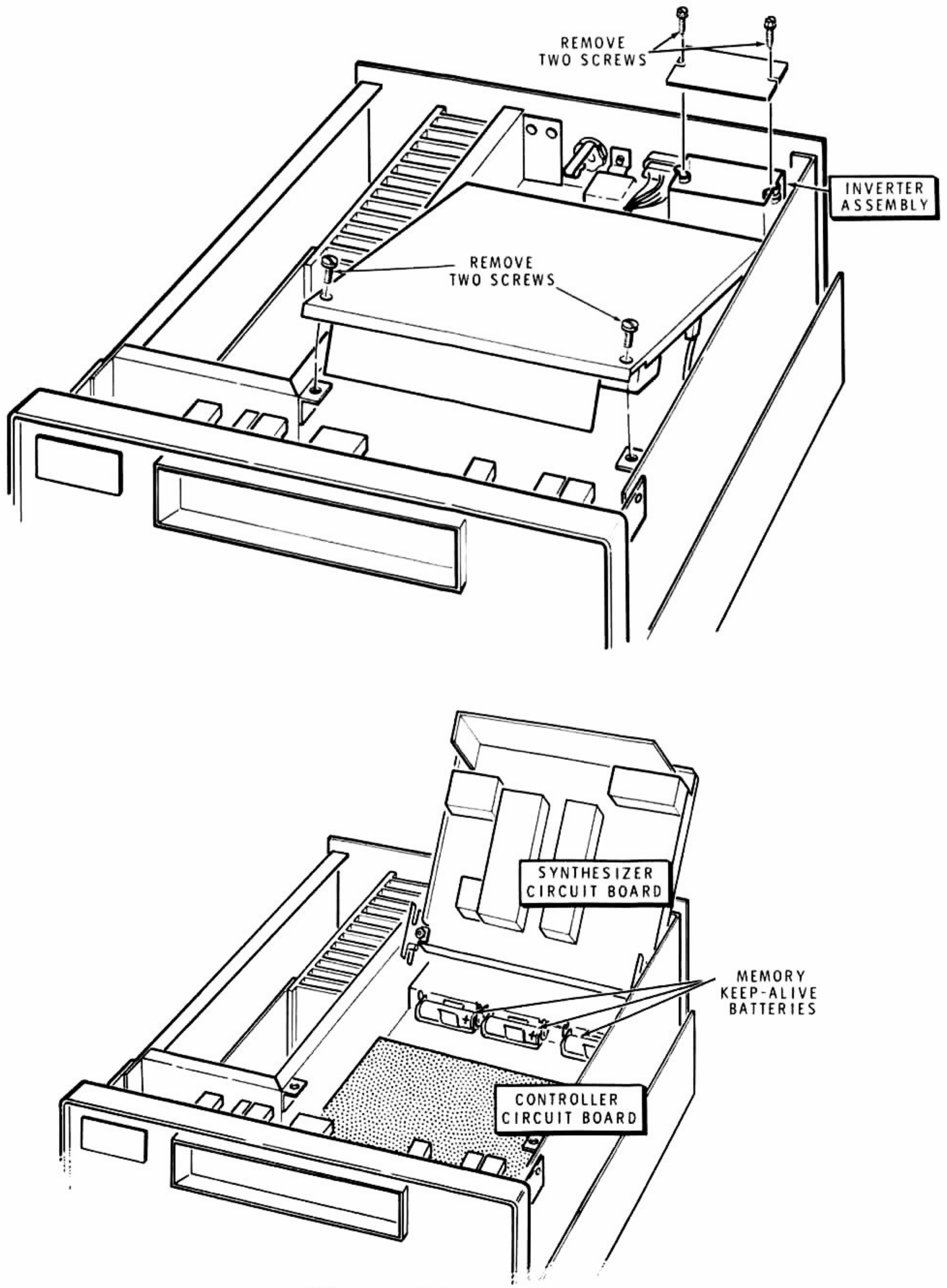


Figure 4-2

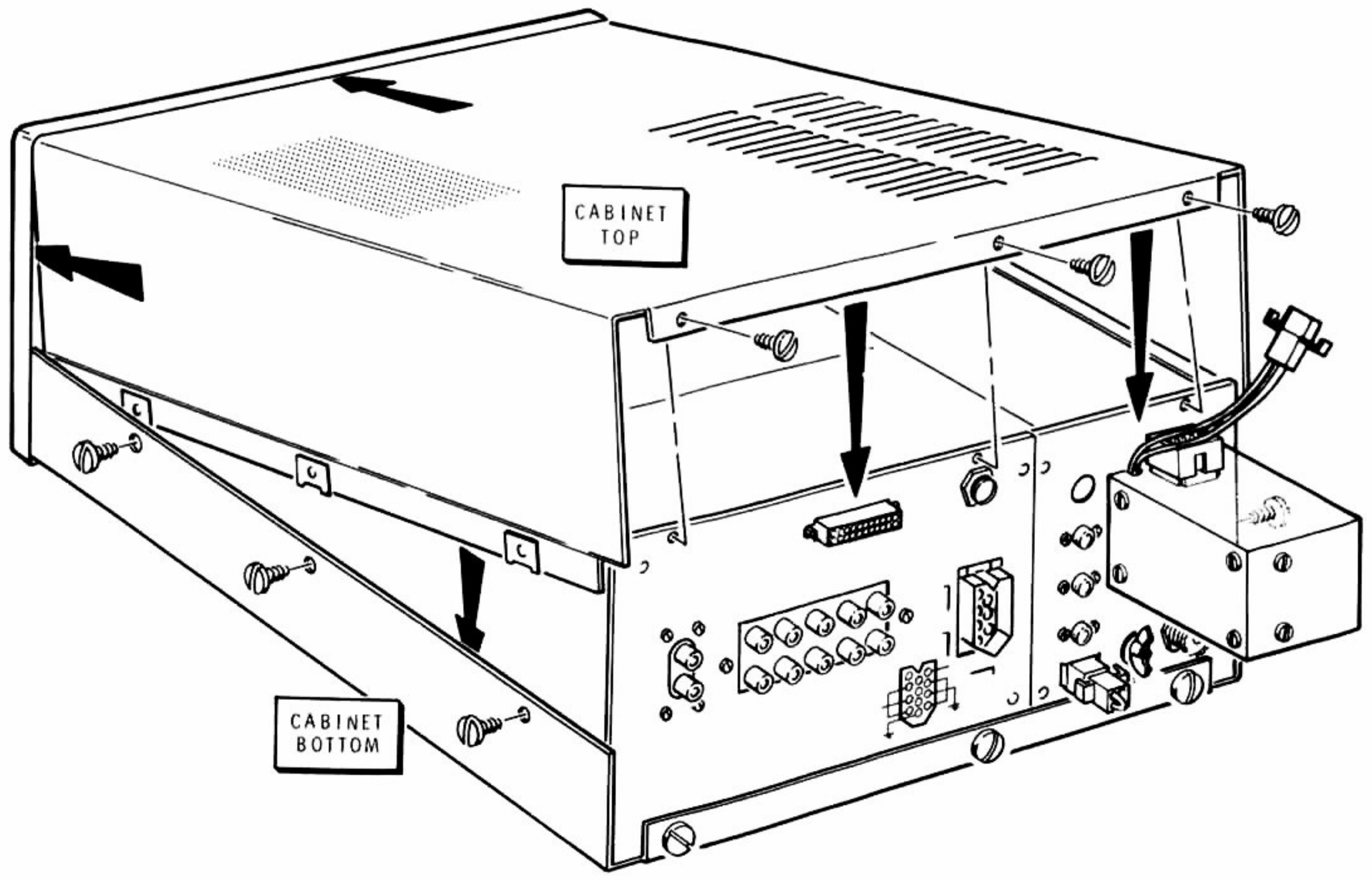


Figure 4-1

DISASSEMBLY

This section of the Manual shows you how to gain access to the various circuit boards, assemblies, and components that are mounted on the chassis.

CABINET REMOVAL

Refer to Figure 4-1 (fold-out from Page 108) as you perform the following steps.

1. Position the Transceiver right-side-up as shown in the Figure.

2. Remove the three screws on each side of the cabinet and the three screws along the top rear edge of the cabinet. Then remove the cabinet top.

3. Remove the three screws along the bottom rear edge of the cabinet. Then remove the cabinet bottom.

TOP CHASSIS CIRCUIT BOARDS AND ASSEMBLIES

Refer to Figure 4-2 (fold-out from Page 108) as you perform the following steps.

1. Position the chassis right-side-up as shown in the Figure.

2. Remove the two screws from the front corners of the synthesizer circuit board assembly. Then raise up on the front edge of the assembly. You now have access to the components on the synthesizer and controller circuit boards. You also have access to the memory keep-alive batteries.

3. To gain access to the components inside the inverter assembly, remove the two screws from the top of the assembly and remove the cover.

BOTTOM CHASSIS CIRCUIT BOARDS AND ASSEMBLIES

Refer to Figure 4-3 (fold-out from Page 109) as you perform the following steps.

1. Position the chassis upside-down as shown in the Figure.

2. Remove the two screws from the indicated corners of the T/R circuit board. Then raise the edge of the circuit board. You now have access to many of the components on the T/R and main audio circuit boards.

3. Remove the four screws from the cover of the bandpass filter assembly. Then remove the cover. You now have access to the components on the filter circuit board.

4. Remove the two indicated screws from the main audio circuit board. Then raise up on the edge of the circuit board (nearest the side panel). You now have access to the transmit audio circuit board (mounted on the back of the main audio circuit board) and the power interface circuit board.

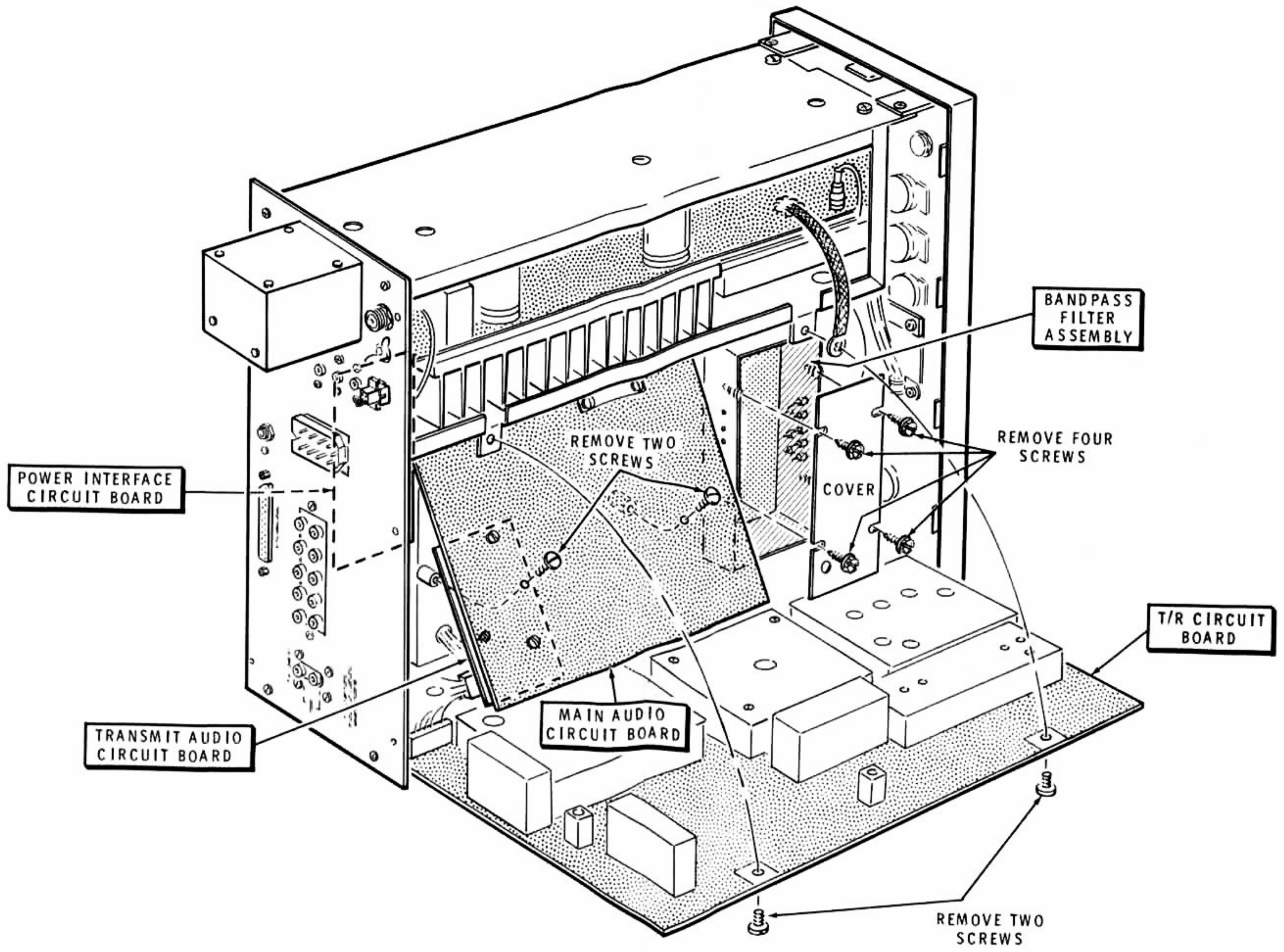


Figure 4-3

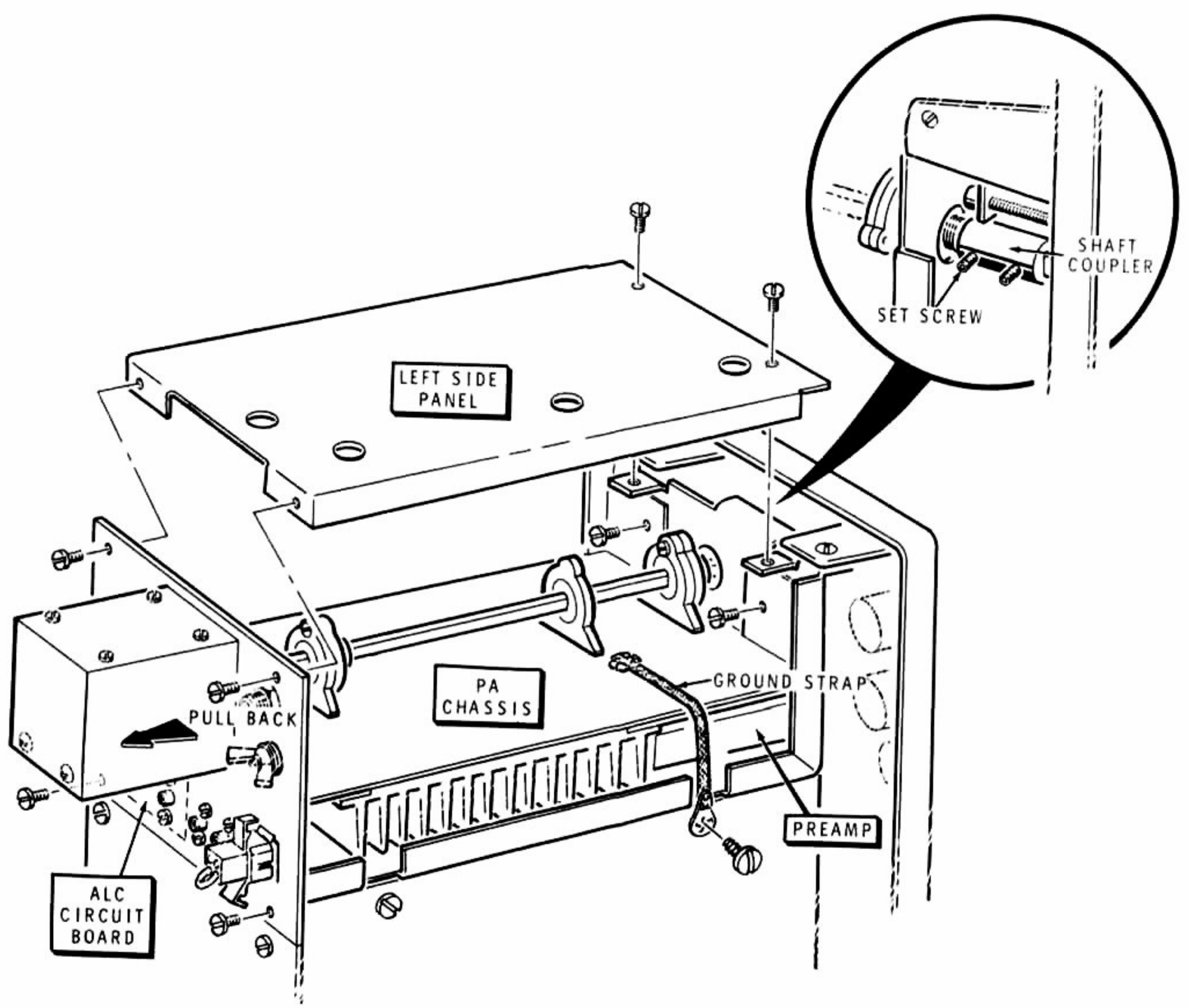


Figure 4-5

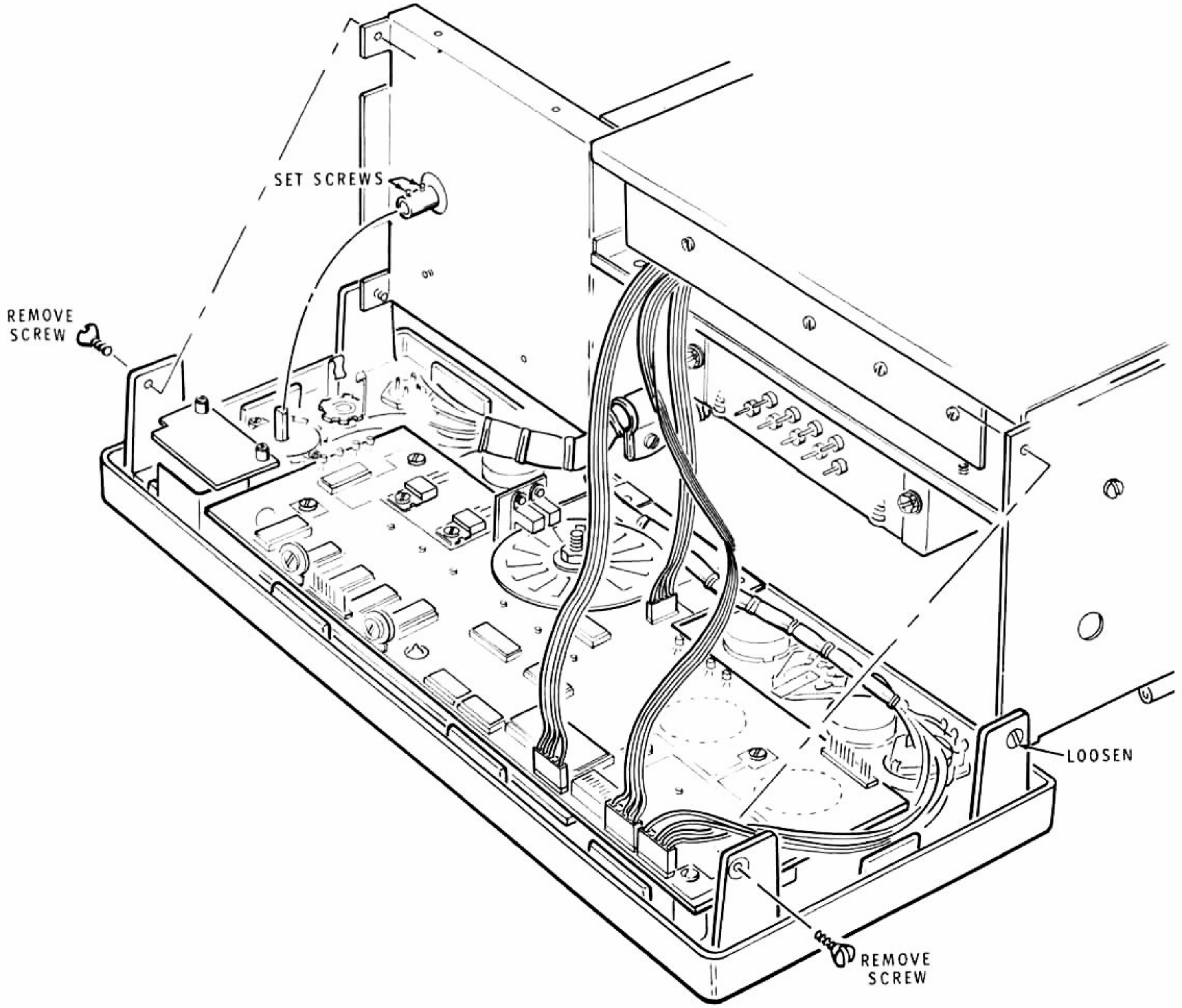


Figure 4-4

FRONT PANEL CIRCUIT BOARD

Refer to Figure 4-4 (fold-out from Page 110) as you perform the following steps.

1. Position the chassis right-side-up as shown in the Figure.

2. Turn the BAND switch to 160 meters. Then loosen the indicated setscrews in the shaft coupler. Do not turn the shaft or Band switch after you loosen these setscrews. Slide the coupler away from the shaft of the Band switch shaft.

3. Remove the top screw in each side of the front panel. Then loosen the bottom screw in each side of the front panel. Now lower the front panel to gain access to the components on the front panel circuit board. NOTE: You may find it easier to lower the front panel if you allow the front panel to extend over the edge of your work surface.

PA ASSEMBLY AND PREAMP CIRCUIT BOARD

Refer to Figure 4-5 (fold-out from Page 110) as you perform the following steps.

1. Position the chassis with the left side up as shown in the Figure.

2. Turn the BAND switch to 160 meters. Then loosen the indicated setscrew in the shaft coupler. Do not turn the shaft or Band switch after you loosen this setscrew.

3. Remove the two indicated screws from the rear panel and two screws from the front edge of the left side panel. Then remove the side panel. You now have access to the components on the PA circuit board.

NOTE: To remove the PA assembly from the chassis, so you can gain access to the preamp circuit board, perform the following steps:

4. Remove the indicated screw and ground strap from the T/R circuit board.

5. Remove the two screws from the front of the PA chassis and the two indicated screws from the rear panel.

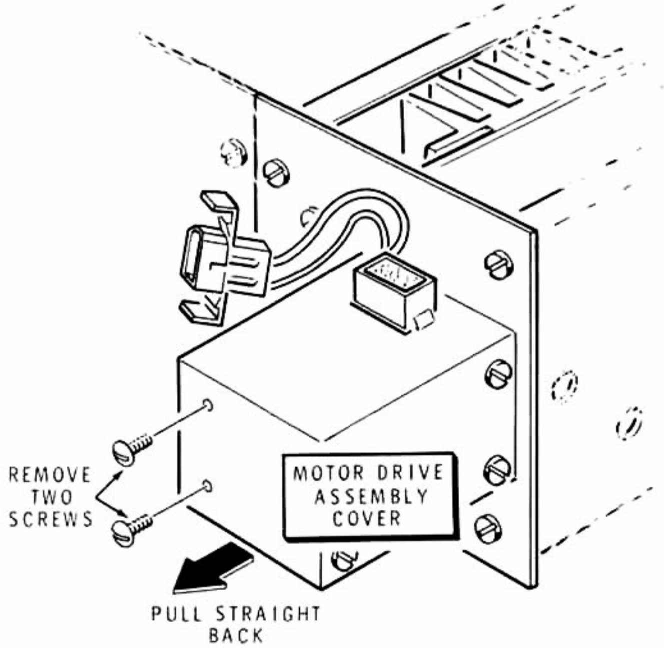
6. Pull back on the PA assembly to disengage the band switch shaft. Then lift the PA assembly out of the chassis. You now have access to many of the components on the preamp and external ALC circuit boards.

MOTOR DRIVE CIRCUIT BOARD

Refer to Figure 4-6 as you perform the following steps.

1. Position the chassis right-side-up as shown in the Figure.

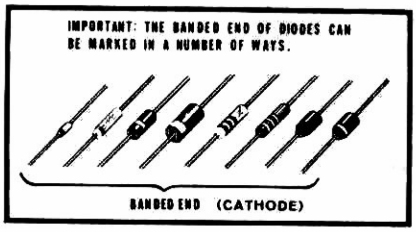
2. Remove the two screws from the back of the motor drive assembly cover. Then pull straight back on the cover. To remove the cover completely, work the socket out of the hole in the cover as you pull back on the cover.



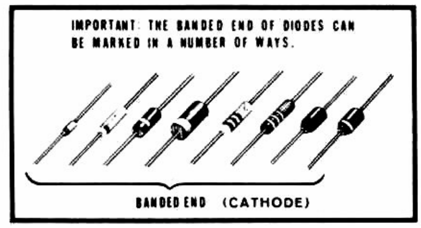
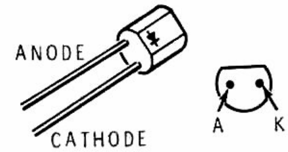
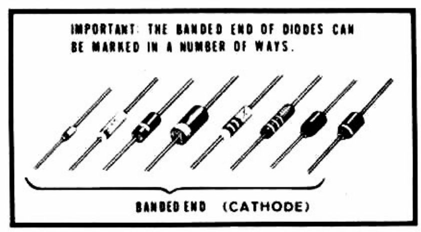
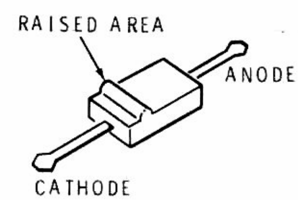
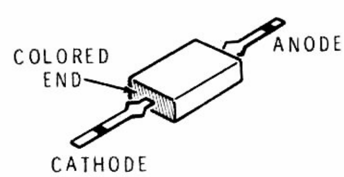
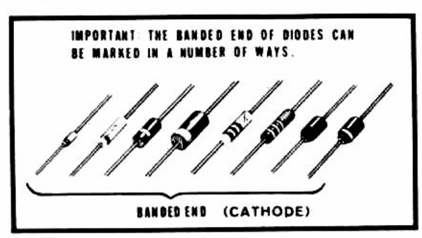
PICTORIAL 4-6

SEMICONDUCTOR IDENTIFICATION CHARTS

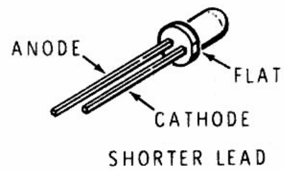
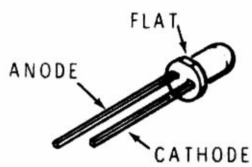
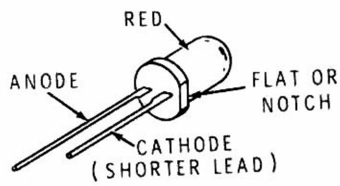
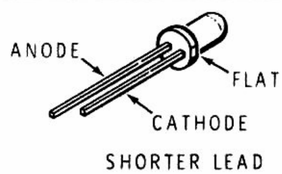
DIODES

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
56-16	1N5231B	D604,D1402	
56-20	1N295A	D1901,D1902,D1903	
56-26	1N191	D107,D108,D109	
56-28	S-127	D506,D508	
56-36	VR-16.1	D1202	
56-55	1N4753A	D1,D2	
56-56	1N4149	D102,D103,D104,D105, D106,D201,D202,D205, D208,D211,D214,D217, D218,D219,D222,D223, D224,D225,D226,D227, D231,D234,D235,D236, D237,D239,D240,D241, D242,D243,D244,D245, D246,D247,D248,D249, D250,D251,D252,D253, D254,D255,D256,D301, D302,D303,D304,D305, D306,D307,D308,D309, D310,D311,D312,D313, D314,D315,D316,D317, D322,D323,D401,D402, D403,D404,D405,D406,D407, D408,D409,D411,D412,D413, D414,D415,D416,D417,D418, D419,D421,D422,D423,D424, D425,D426,D427,D428,D429, D431,D432,D433,D434,D435, D436,D437,D438,D439,D441, D442,D443,D444,D445,D446, D447,D448,D471,D472,D473, D474,D475,D476,D504,D511, D512,D601,D603,D605,D606, D801,D802,D803,D804,D805, D806	

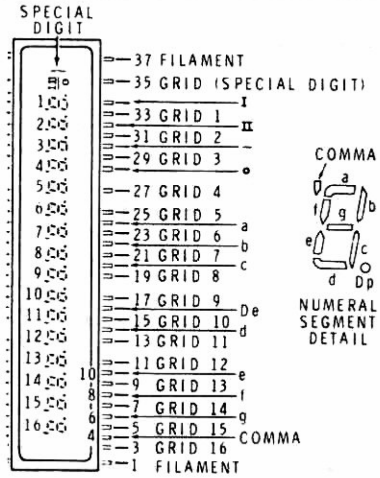
Diodes (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
56-67	1N4740A	D509	
56-77	FV1010	D101	
56-93	FD-333	D1001,D1002,D1003,D1004, D1005,D1006	
56-617	1N5277B	D1204,D1206	
56-621	1N4738A	D505	
56-642	MV2107	D212,D221	
56-646	BA-244	D229,D232,D233,D602, D609,D901,D902,D903, D904,D905,D906,D907, D908,D909,D911,D912, D913,D914,D915,D916, D917,D918,D919,D920	
56-648	MV109	D203,D206,D209,D215, D238,D261,D263	
56-656	BA-379	D501,D502,D507,D608	
57-27	1N2071	D503,D513,D514,D607, D1201,D1203,D1205,D1207, D1401	
57-65	1N4002	D3,D4	

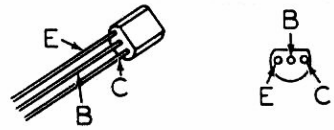
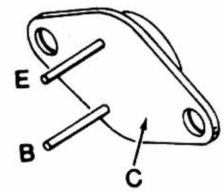
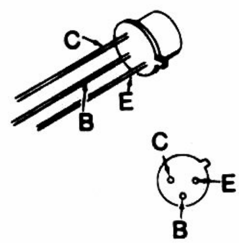
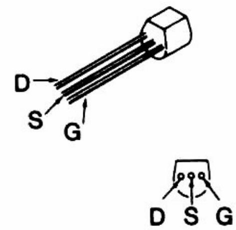
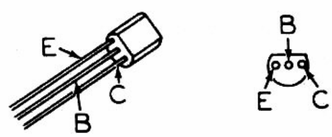
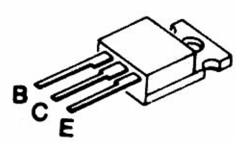
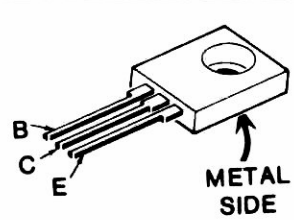
LIGHT – EMITTING DIODES (LEDs) – LAMPS

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
412-79	TIL209	D458,D459	
412-601	#2174	PL1,PL2	
412-628	MV5253	D449,D451,D453,D454, D455	
412-640	LST5053	D452	
412-642	SG405D	D456,D457	

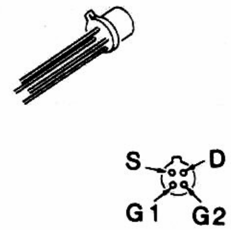
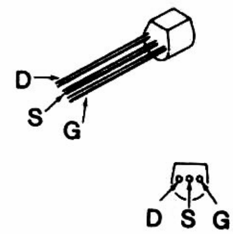
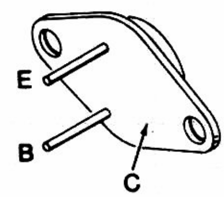
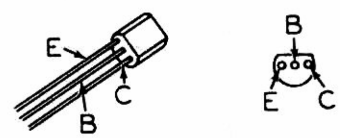
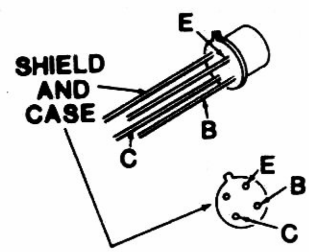
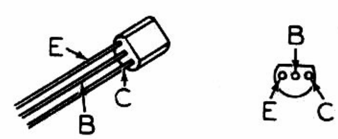
VACUUM TUBE DISPLAY

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
411-847	17MT34	V401	

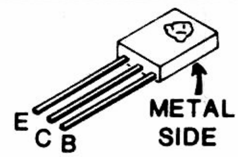
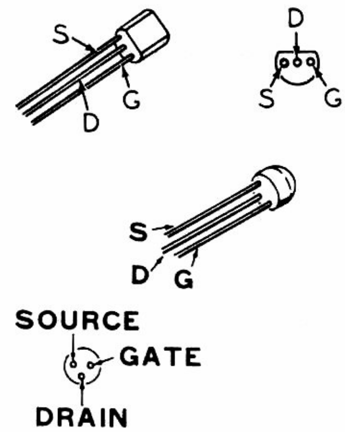
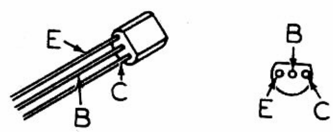
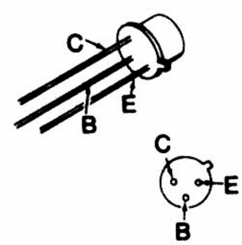
TRANSISTORS

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
417-134	MPS6520	Q201	
417-139	40411	Q1403	
417-154	2N2369	Q101,Q102,Q106,Q107,Q108, Q109,Q114,Q115,Q119,Q120, Q212	
417-169	MPF105	Q202,Q203,Q204,Q205,Q206, Q226,Q231	
417-172	MPS6521	Q207,Q232	
417-175	2N5294	Q604,Q608	
417-195	MJE340	Q1205,Q1206,Q1212	

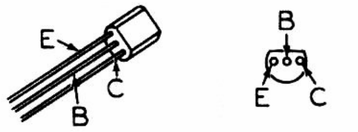
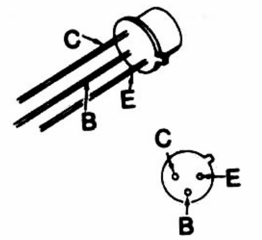
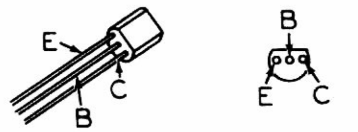
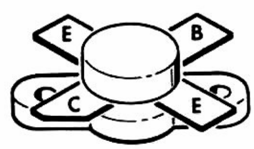
Transistors (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
417-240	40673	Q105,Q210,Q211,Q213, Q217,Q218,Q222,Q223	
417-241	EL131	Q214,Q975	
417-254	MJ802	Q1	
417-260	2N4258A	Q221,Q233	
417-290	MRF502	Q104	
417-801	MPSA20	Q103,Q110,Q111,Q112,Q116, Q117,Q118,Q121,Q122, Q401,Q406,Q407,Q408,Q409, Q801,Q803	
417-806	TIS75	Q303	

Transistors (Cont'd)

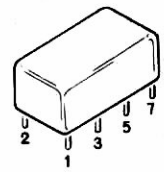
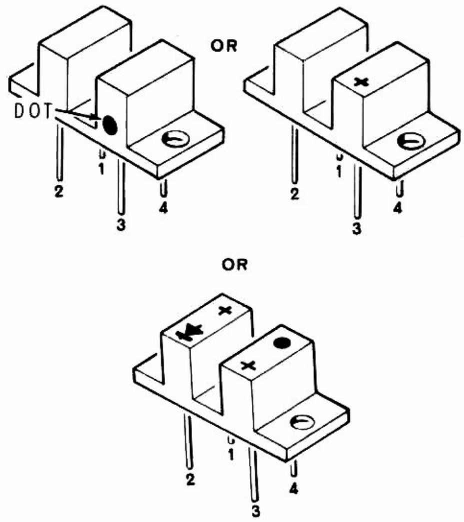
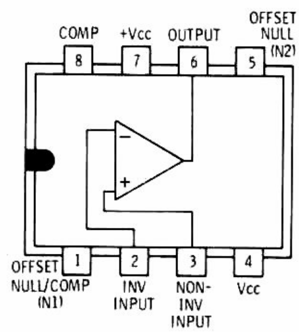
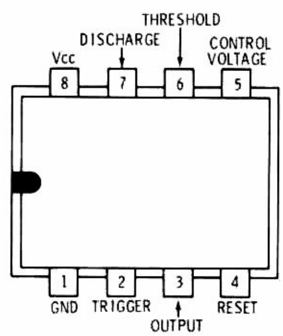
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
417-818	MJE181	Q514,Q517,Q606,Q612, Q1002,Q1402	
417-819	MJE171	Q1001	
417-858	P1087E	Q234	
417-864	MPSA05	Q402,Q404	
417-865	MPSA55	Q113,Q403,Q405,Q802, Q1401	
417-874	2N3906	Q208,Q209,Q235,Q236, Q309,Q316,Q319,Q502, Q508,Q512,Q607,Q1201, Q1202,Q1901,Q1902	
417-875	2N3904	Q215,Q219,Q224,Q225, Q227,Q228,Q229,Q237, Q238,Q239,Q241,Q242, Q243,Q251,Q302,Q304, Q305,Q306,Q307,Q308, Q310,Q311,Q312,Q313, Q501,Q503,Q507,Q509, Q511,Q513,Q515,Q516, Q518,Q1203,Q1207,Q1208, Q1209,Q1211	
417-880	2N4427	Q504,Q506	

Transistors (Cont'd)

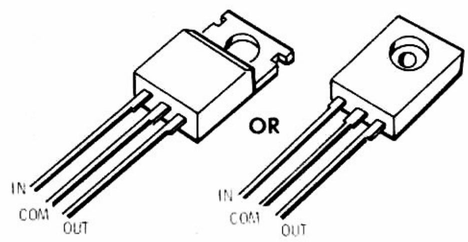
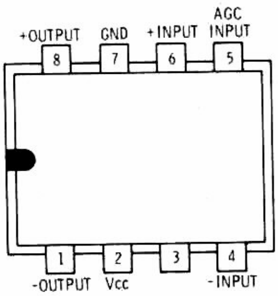
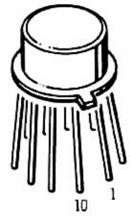
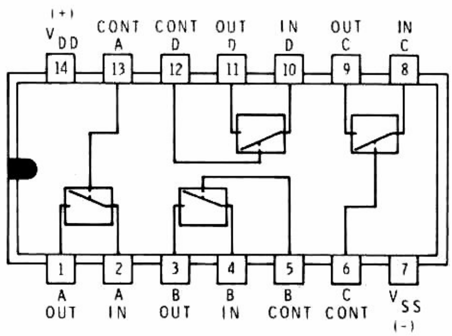
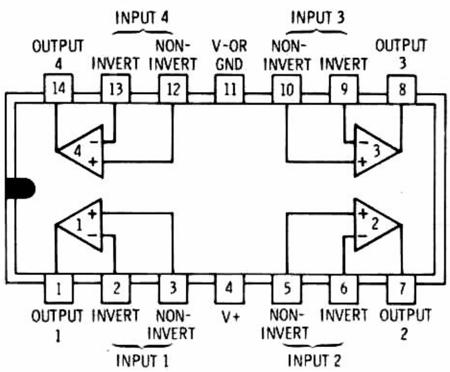
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
417-881	MPSA13	Q318,Q1404	
417-893	2N5109	Q505,Q601,Q602,Q603	
417-927	MPSA93	Q1204	
417-961	MRF455	Q605	
117—15*	MRF421	Q609,Q611	

*MATCHED PAIR

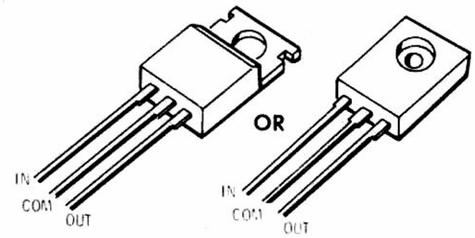
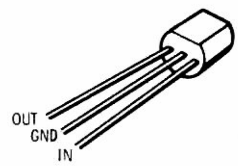
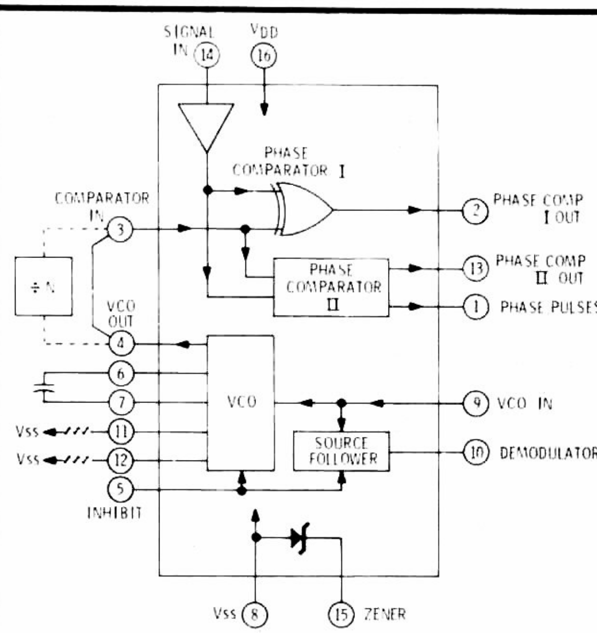
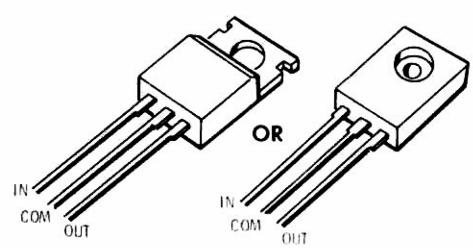
INTEGRATED CIRCUITS

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
150-72	Double-Balanced Mixer GK1133	U203,U208	
150-74	Optron Inc. OPB813, Spectronics Inc. SPX1874-1, HEI Inc., EOS-2A1	U415,U416	
442-39	LM301AN	U115,U121,U132	
442-53	NE555	U1001	

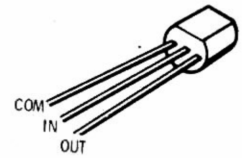
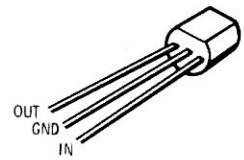
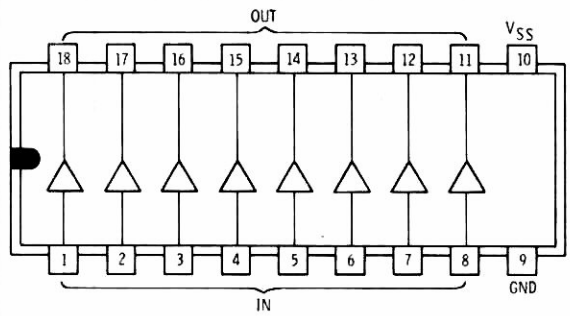
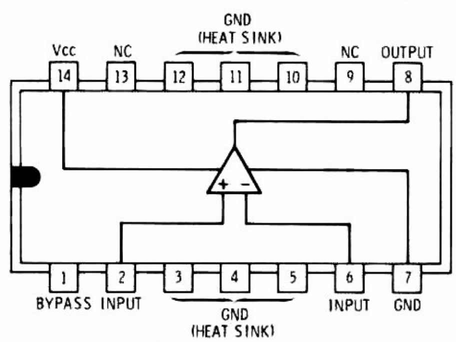
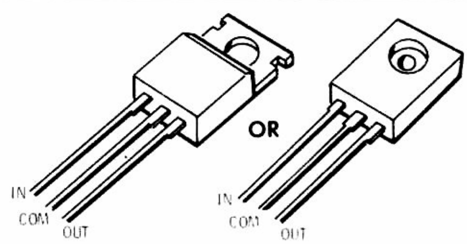
Integrated Circuits (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
442-54	UA7805	U133,U134,U135,U136, U407,U819	
442-55	MC1349P	U210,U214	
442-96	MC1496G	U213,U215	
442-99	CD4016AE	U211, U212, U414, U1502	
442-602	LM324N	U303,U304,U310,U501, U1503	

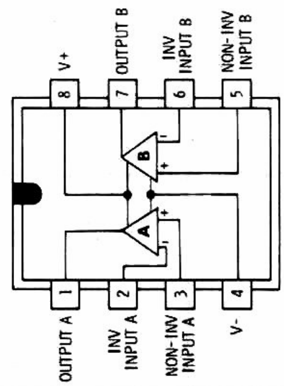
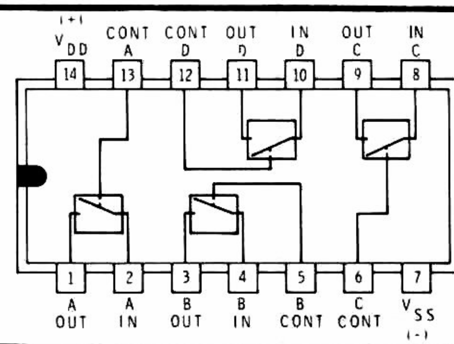
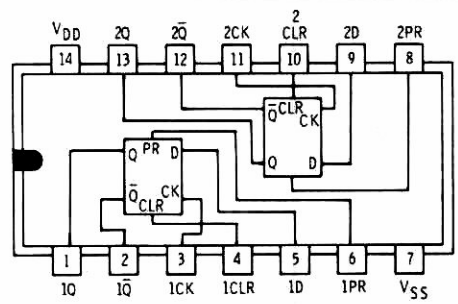
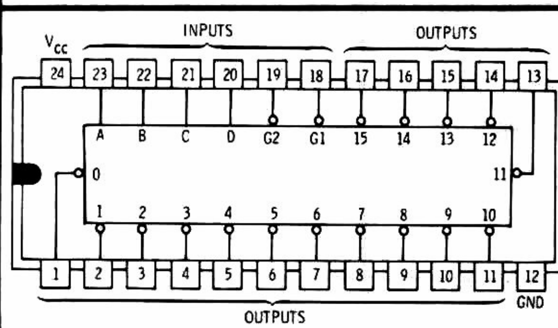
Integrated Circuits (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
442-603	78M05	U201,U205	
442-627	78L05	U309,U820	
442-644	78L12	U1003	
442-647	CD4046A	U114,U120,U131	
442-663	78M12	U1002	

Integrated Circuits (Cont'd)

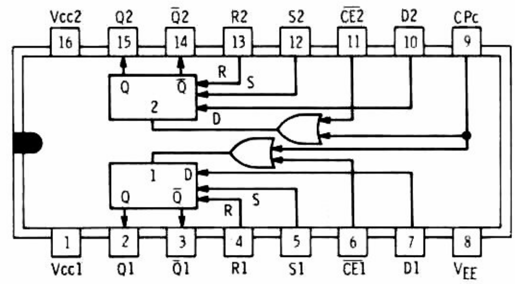
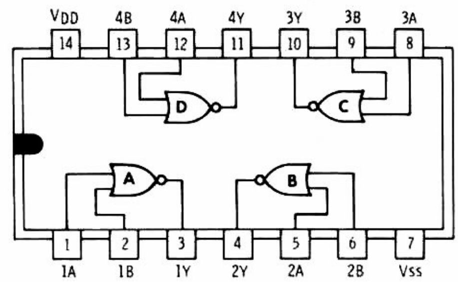
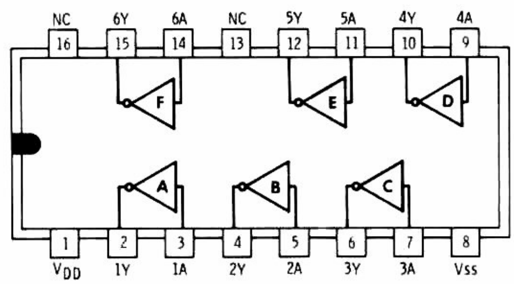
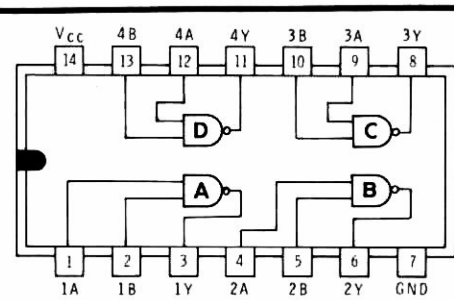
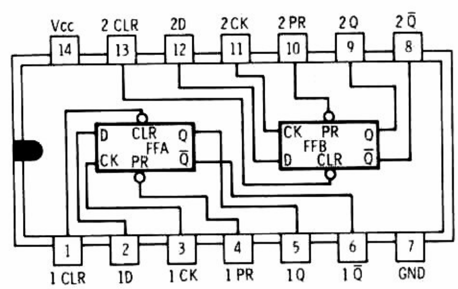
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
442-665	79L05	U1004	
442-681	78L08	U206,U209,U216,U307, U502,U602,U604,U605, U1501,U1901	
442-682	UDN6118A	U404,U405,U406	
442-748	ULN2280B	U302	
442-691	78M08	U408	

Integrated Circuits (Cont'd)

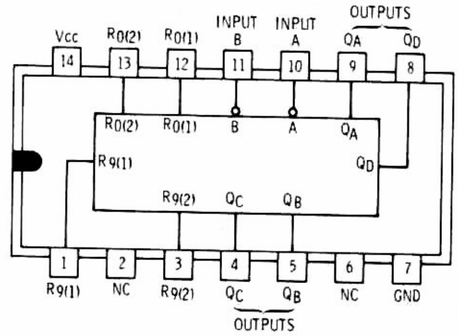
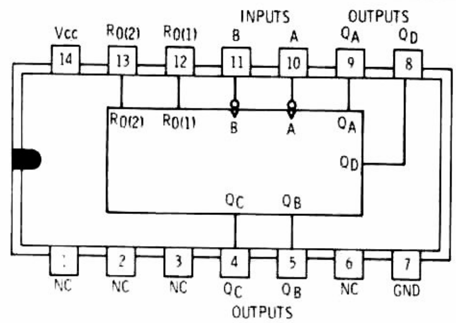
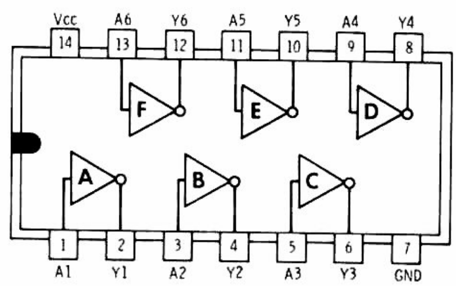
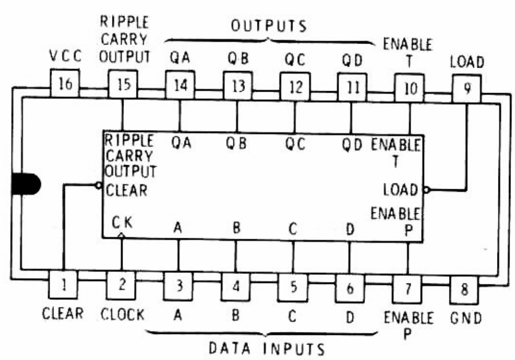
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
442-728	LM2904N	U601,U603	
442-747	CD4016	U137, U138	
443-607	MC14013AL	U409,U412	
443-623	SN74154N	U401	

HEATH

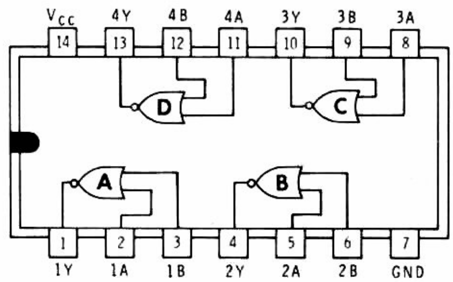
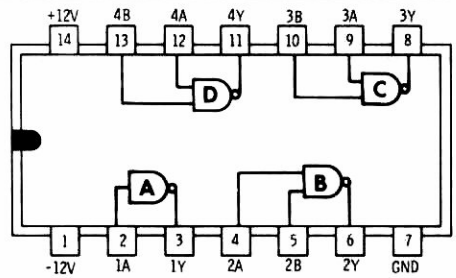
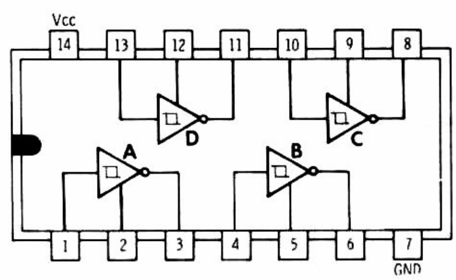
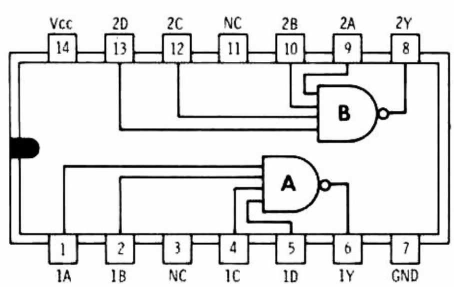
Integrated Circuits (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
443-679	MC10131	U141,U202,U207	
443-695	CD4001AE	U218,U308,U413	
443-701	MC14049CP	U204,U217,U306,U313, U410,U411	
443-728	74LS00	U101,U127,U803	
443-730	74LS74	U104,U122	

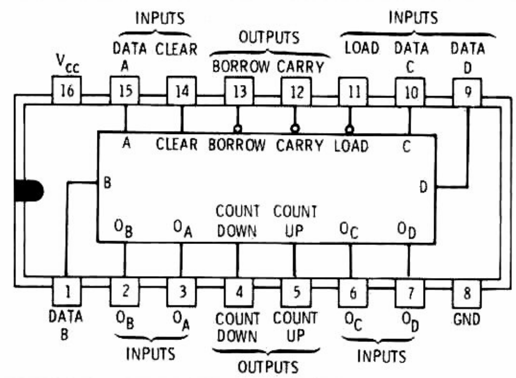
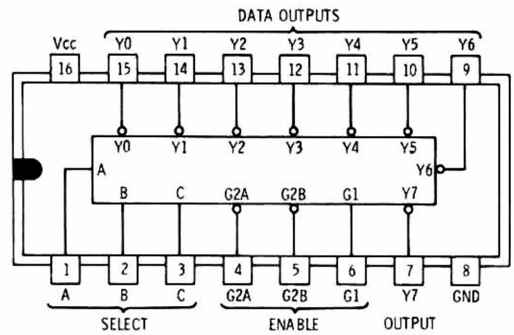
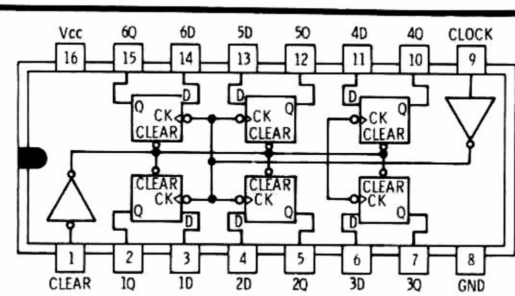
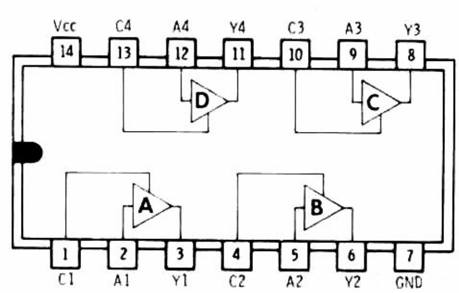
Integrated Circuits (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
443-731	74LS290	U113	
443-733	74LS293	U111,U112	
443-755	74LS04	U102,U402,U403	
443-757	74LS161	U105,U106,U107,U116, U117,U123,U124,U125	

Integrated Circuits (Cont'd)

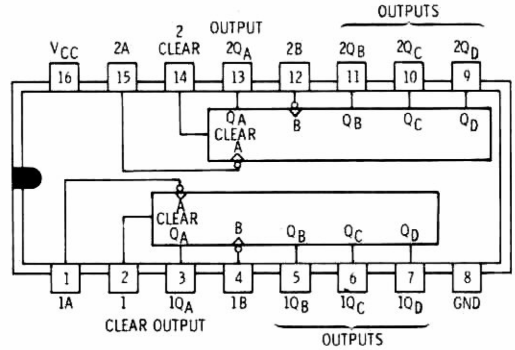
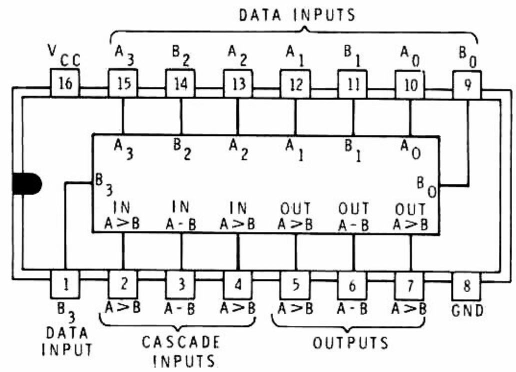
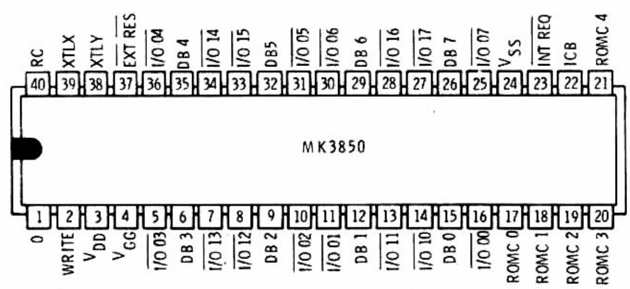
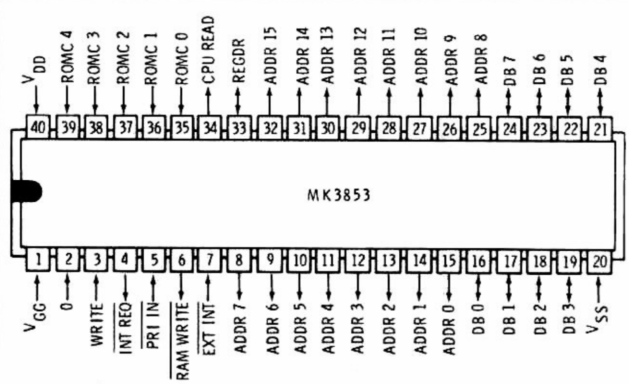
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
443-779	74LS02	U802	
443-794	75188	U817	
443-795	75189	U818	
443-798	74LS20	U103,U119,U126	

Integrated Circuits (Cont'd)

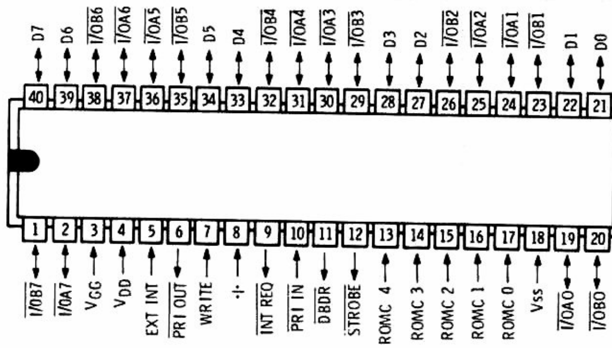
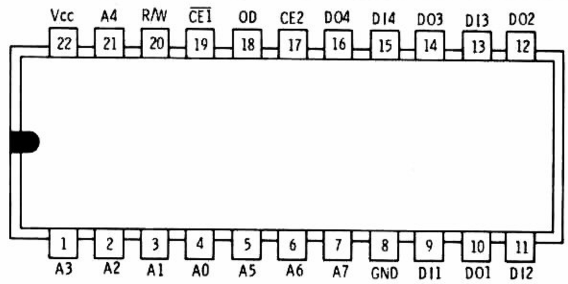
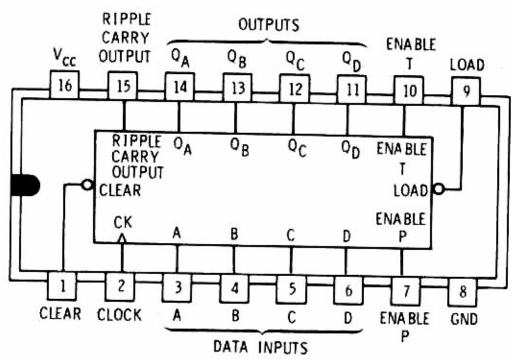
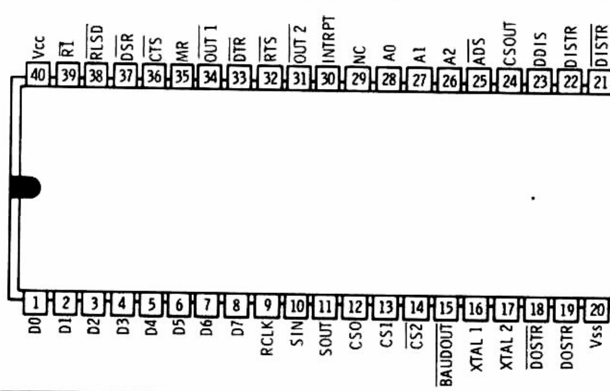
<table>
<tr><th>HEATH PART NUMBER</th><th>MAY BE REPLACED WITH</th><th>COMPONENT NUMBER</th><th>IDENTIFICATION</th></tr>
<tr><td>443-818</td><td>74LS05</td><td>U305</td><td>
</td></tr>
<tr><td>443-877</td><td>74LS138</td><td>U804</td><td>
</td></tr>
<tr><td>443-879</td><td>74LS174</td><td>U812,U813,U814,U815, U816</td><td>
</td></tr>
<tr><td>443-919</td><td>74LS126</td><td>U110</td><td>

FUNCTION TABLE
<table>
<tr><th colspan="2">INPUTS</th><th>OUTPUT</th></tr>
<tr><td>A</td><td>C</td><td>Y</td></tr>
<tr><td>H</td><td>H</td><td>H</td></tr>
<tr><td>L</td><td>H</td><td>L</td></tr>
<tr><td>X</td><td>L</td><td>Hi - Z</td></tr>
</table>
Y = A   Hi - Z = HIGH IMPEDANCE</td></tr>
</table>

Integrated Circuits (Cont'd)

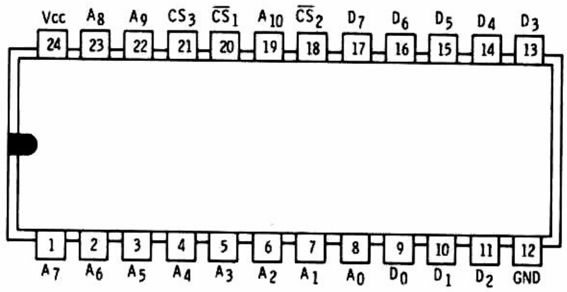
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
443-920	74LS85	U108,U128	
443-921	74LS390	U111,U112	
443-922	MK3850	U806	
443-923	MK3853	U801	

Integrated Circuits (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
443-924	MK3871	U805	
443-933	5101	U809,U810	
443-934	74S163	U118	
443-952	8250	U811	

HEATH

Integrated Circuits (Cont'd)

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
444-96	2316*	U807	
444-97	2316*	U808	

*Custom IC; replace with Heath replacement part only.

POWER SUPPLY (MODEL PS-9000)

INTRODUCTION

The Model PS-9000 Power Supply/Speaker/Dual Clock is an AC-operated power supply in a matching cabinet. This Power Supply also contains a built-in dual clock for displaying both local and UTC times and a speaker.

SPECIFICATIONS

GENERAL

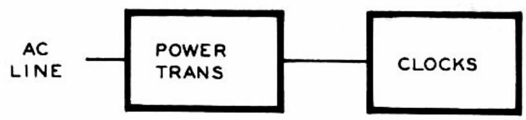
Output Voltage	13.8 VDC, regulated.
Maximum Output Current	25 amperes intermittant (50% duty cycle, 10 minutes on-off); 15 amperes continuous.
Power Requirements	110 to 130 VAC at 6 amperes, 50/60 Hz. Can be wired for 220 to 260 VAC at 3 amperes.
Regulation	Less than 4% from no load to 25 amperes.
Ripple	Less than 2% at 25 amperes.
Circuit Breaker	20 amperes for 110 to 130 VAC primary; 10 amperes for 220 to 260 VAC primary.
Current Limiting	Over-current protected (set typically for 28 amperes).
Thermal Protection	Automatic shutdown with over-temperature sensing on the heat sink.
Cabinet Dimensions	6-1/8" high × 9-5/8" wide × 13-3/4" deep (15.6 × 24.4 × 34.9 cm)
Weight	33 lbs (15 kg).

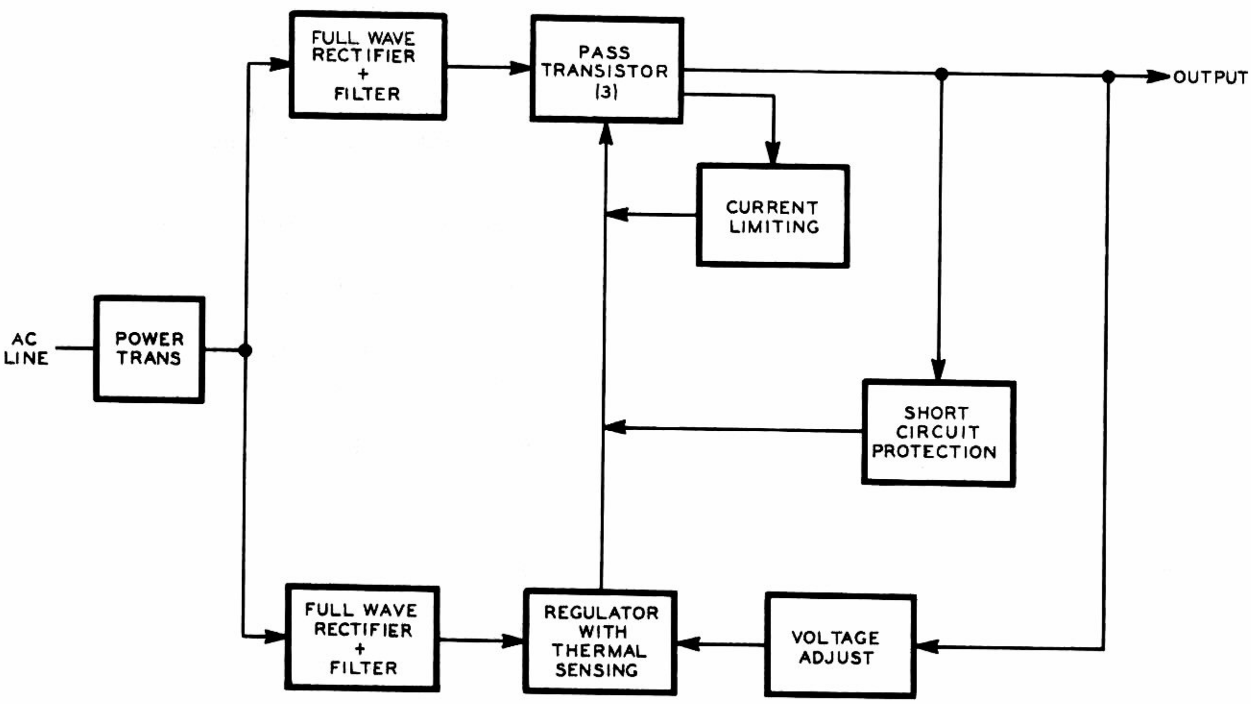
DUAL CLOCK

Display	Two independent vacuum fluorescent readout tubes. Each contains four digits and a colon.
Clock Format	12- or 24-hour display (each clock). Supplied with 24-hour format (see "Operation" section).
Accuracy	Determined by the line frequency.
Power Requirements	120 VAC, 50 or 60 Hz, 3.5 watts. Can be wired for 240 VAC.

*Specifications apply when the Power Supply is used with the Model SS-9000 Transceiver.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.





POWER SUPPLY BLOCK DIAGRAM

CIRCUIT DESCRIPTION

Refer to the "Power Supply Block Diagram" (on Page 132) and the "Power Supply Schematic" (large fold-in) as you read the following description. The component numbers are arranged in the following groups to help you locate specific parts on the Schematic, circuit boards, and chassis:

1-99	Parts mounted on the chassis.
101-199	Parts mounted on the power supply circuit board.
201-299	Parts mounted on the clock circuit board.

The Model PS-9000 Power Supply provides all of the power required by the Model SS-9000 Transceiver.

Transformer T2, a dual-primary power transformer, supplies voltage to rectifier BR1, pass transistors Q102, Q103, and Q104, as well as to the voltage regulation and protection circuits (U101, Q101, Q105, Q106, and Q107).

The output from the rectifier is filtered by C2, and then applied to three pass transistors, which are controlled by the voltage adjust and regulator circuits.

A common heat sink is used for the regulator and pass transistors to allow high temperature protection. If the heat sink temperature exceeds the safe operating limit for the pass transistors, regulator U101 begins to shut down. This rebiases the pass transistors and reduces their output. If this should happen, a period of time is required for the heat sink temperature to reduce before full output is again provided.

The surge current protection circuit (Q107) monitors the base-to-emitter current of the pass transistors. If this surge current exceeds the safe current-handling capability of the pass transistors, the circuit rebiases the transistors for the duration of the current surge.

A short-protection circuit, Q105, monitors the output voltage line and provides a dual function. First, it provides remote sensing of the output voltage at the Transceiver. Second, the transistor turns on and fires SCR Q101 if the output voltage drops due to a short circuit or excessive current drain. This pulls the output of regulator U101 to ground and rebiases the pass transistors. If this happens, you must turn the Power Supply On-Off switch Off and then On again to reset the SCR.

Since only the current through resistors R105 through R109 and R111 is used by the sensing circuit, transistor Q102 is selected so it has the highest gain of Q102, Q103, and Q104.

DUAL CLOCK

Fuse F1, transformer T1, rectifier diode D1, and capacitor C1 form the power supply for the clock circuitry, and provide half-wave rectified power.

For the left-most display, transistor Q201, control R204, and resistor R201 provide brightness control of tube V201 by controlling the filament-to-grid voltage differential. Transistor Q202 and control R208, together with resistor R201, provide brightness control of display tube V202 in the same way.

NOTE: In the next two paragraphs, the first component numbers are for the left display. The numbers in parentheses are for the right display.

The line frequency pulse is routed to the clock portion of integrated circuit U201 (U202) through resistor R205 (R209) and capacitor C201 (C202). The timekeeping functions of U201 (U202) are controlled by jumper wires to produce either 12- or 24-hour operation on either 50 or 60 Hz input, depending upon which jumpers you install.

Integrated circuit U201 (U202) provides all of the timekeeping and encoding operations to drive display tube V201 (V202) directly. Diodes D201 and D202 (D203 and D204) are used for isolation of the segments in the tens-of-hours digit in V201 (V202).

ADJUSTMENTS

Readjustment of the Power Supply circuits is not normally necessary. The following information is provided in the event that the Power Supply has been serviced and readjustment is required. Refer to "Component Locations" on Page 139 for the locations of the controls and connection points referred to in this section.

POWER SUPPLY

Use the following procedure to set the output voltage of the Power Supply:

1. Connect the negative lead of a DC voltmeter (that can measure 13.8 volts DC) to either of the GND terminals on the barrier strip that is located along the right edge of the power supply circuit board. Connect the positive lead of the voltmeter to the B+ terminal on this barrier strip.

2. Turn the Power Supply on. NOTE: Do not connect the Power Supply to the Transceiver for the following adjustment.

3. Adjust VOLTAGE ADJUST control R131 on the power supply circuit board until the voltmeter indicates exactly 13.8 volts DC.

4. Turn the Power Supply off and disconnect the voltmeter.

Use of the following procedure to set the short-protection circuit of the Power Supply:

1. Connect a constant 28-ampere load (must be very accurate) to the output of the Power Supply. Also connect a DC voltmeter (that can measure 13.8 volts DC) to the output of the Power Supply.

2. Turn the Power Supply on. Then adjust OVER–CURRENT ADJUST control R129 on the power supply circuit board to the point where SCR Q101 just fires (output voltage drops to zero). NOTE: You will have to turn the Power Supply off and then back on again to reset the SCR once it fires.

3. Turn the Power Supply off and disconnect the voltmeter and load.

DUAL CLOCK

Jumper wires are factory installed in the clock circuit board so that both clocks indicate in 24-hour formats. The clocks may be individually changed to 12-hour formats by simply cutting these jumpers. Refer to the Power Supply Schematic (large fold-in) for more information.

You can individually adjust the brightness of the two clocks. This allows you to raise or lower the intensity of the clocks as well as balance them so they are the same, or match the intensity of the display on the Transceiver.

Adjust control R204 on the clock circuit board for the desired intensity of the left clock. Use control R208 to set the intensity of the right clock.

IN CASE OF DIFFICULTY

You may also wish to refer to the "Power Supply Schematic" and the "Circuit Description" section of this Manual as you troubleshoot your Power Supply.

The component numbers are arranged in the following groups to help you locate specific components on the Schematic, circuit boards, photographs, and the chassis:

1-99	Parts mounted on the chassis.
101-199	Parts mounted on the power supply circuit board.
201-299	Parts mounted on the clock circuit board.

POWER SUPPLY PROBLEMS

The following chart lists some problems that you could experience with your Power Supply.

CONDITION	POSSIBLE CAUSE
No output voltage at point C.	1. Circuit breaker CB1 or CB2. 2. Output shorted.
Circuit breakers CB1 or CB2 blow.	1. Rectifier BR1. 2. Capacitor C2. 3. Diodes D101 or D102. 4. Capacitor C107.
No output voltage at B + or cable end.	1. Output shorted. 2. Integrated circuit U101. 3. Transistor Q105. 4. Transistor Q101. 5. Transistor Q102, Q103, Q104, Q106, or Q107.
Output voltage drops to zero whenever a load (Transceiver) is connected.	1. Transistor Q101. 2. Excessive load (keydown). 3. Transistor Q105.
Unable to obtain + 13.8 VDC with the Voltage Adjust control (R131).	1. Integrated circuit U101. 2. Resistor R131, R132, R133, or R134.
Voltage drops significantly when you key the transmitter.	1. Integrated circuit U101. 2. Transistor Q102, Q103, or Q104. 3. Transistor Q106 or Q107. 4. Diode D103 or D104.

CLOCK PROBLEMS

The following chart lists some problems that you could experience with the clock in your Power Supply:

CONDITION	POSSIBLE CAUSE
Display does not light.	1. Control R204 or R208 are set too low. 2. Fuse F1. 3. Diode D1. 4. Capacitor C1.
Display is very dim.	1. Control R204 or R208 are set too low.
Incorrect display segments light.	1. Circuit board jumpers. 2. Integrated circuit U201 or U202. 3. Display tube V201 or V202.
Clock gains or loses about 12 minutes per hour.	1. Clock is wired for the wrong frequency line voltage (50 or 60 Hz).
Clock cannot be set.	1. Switch SW201, SW202, SW203, or SW204. 2. Integrated circuit U201 or U202.
The "1" digit at the left of the display flashes on and off.	1. Power to the clock has been interrupted; reset the clock.

REPLACEMENT PARTS LIST

CHASSIS

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
BR1	57-88	MDA990-2 bridge rectifier (contains 4 diodes)
C1	25-876	1000 μF electrolytic capacitor
C2	25-847	39,000 μF electrolytic capacitor
C3	21-72	.005 μF ceramic capacitor
C4	21-72	.005 μF ceramic capacitor
C5	21-72	.005 μF ceramic capacitor
CB1	65-28	Circuit breaker
CB2	65-28	Circuit breaker
D1	57-27	1N2071 diode
F1	421-13	1/2-ampere, 3AG fuse
SP1	401-167	Speaker
SW1	60-619	Rocker switch
T1	54-972	Clock power transformer
T2	54-971	Main power transformer

POWER SUPPLY CIRCUIT BOARD

Resistors — Controls

NOTE: The following resistors are rated at 1/2-watt and have a tolerance of 5% unless otherwise listed.

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R101	3-31-5	500 Ω, 5-watt, 10% wirewound resistor
R102	3-14-2	.15 Ω, 2-watt wirewound resistor
R103	1-14-2	1500 Ω, 2-watt, 10% resistor
R104	6-390	39 Ω resistor
R105	3-1-3	.4997 Ω, 3-watt, 1% wirewound resistor
R106	3-1-3	.4997 Ω, 3-watt, 1% wirewound resistor
R107	3-1-3	.4997 Ω, 3-watt, 1% wirewound resistor
R108	3-1-3	.4997 Ω, 3-watt, 1% wirewound resistor
R109	3-1-3	.4997 Ω, 3-watt, 1% wirewound resistor
R110	Not used	
R111	3-1-3	.4997 Ω, 3-watt, 1% wirewound resistor

Resistor — Controls (Cont'd)

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
R112	6-390	39 Ω resistor
R113	3-11-5	.33 Ω, 5-watt resistor
R114	3-11-5	.33 Ω, 5-watt resistor
R115	3-11-5	.33 Ω, 5-watt resistor
R116	3-11-5	.33 Ω, 5-watt resistor
R117	6-390	39 Ω resistor
R118	3-11-5	.33 Ω, 5-watt resistor
R119	3-11-5	.33 Ω, 5-watt resistor
R120	Not used	
R121	3-11-5	.33 Ω, 5-watt resistor
R122	3-11-5	.33 Ω, 5-watt resistor
R123	6-102	1000 Ω resistor
R124	6-151	150 Ω resistor
R125	6-151	150 Ω resistor
R126	2-167	4 Ω, 1% wirewound resistor
R127	6-1000-12	100 Ω, 1/4-watt, 1% resistor
R128	6-271	270 Ω resistor
R129	10-1103	2000 Ω control
R130	Not used	
R131	10-390	20 kΩ control
R132	6-5110-12	511 Ω, 1/4-watt, 1% resistor
R133	6-271	270 Ω resistor
R134	6-9090-12	909 Ω, 1/4-watt, 1% resistor
R135	6-391	390 Ω resistor

Capacitors

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION
C101	25-220	10 μF tantalum
C102	25-220	10 μF tantalum
C103	25-220	10 μF tantalum
C104	21-176	.01 μF ceramic
C105	21-176	.01 μF ceramic
C106	25-220	10 μF tantalum
C107	25-878	2200 μF electrolytic
C108	27-121	.33 μF Mylar
C109	25-887	220 μF electrolytic

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

Diodes

D101	57-42	3A1
D102	57-42	3A1
D103	57-27	1N2071
D104	57-27	1N2071
D105	56-56	1N4149
D106	57-27	1N2071
D107	57-27	1N2071
D108	57-27	1N2071

Transistors

Q101	57-622	HS106 SCR
Q102	417-254	MJ802
Q103	417-254	MJ802
Q104	417-254	MJ802
Q105	417-874	2N3906
Q106	417-819	MJE171
Q107	417-298	TIP41B

Integrated Circuit (IC)

U101	442-685	UA78G

CLOCK CIRCUIT BOARD

CIRCUIT Comp. No.	HEATH Part. No.	DESCRIPTION

Electronic Components

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise noted.

R201	3-24-10	125 Ω, 10-watt wirewound resistor
R202	6-103-12	10 kΩ resistor
R203	6-103-12	10 kΩ resistor
R204	10-386	10 kΩ control
R205	6-104-12	100 kΩ resistor
R206	6-103-12	10 kΩ resistor
R207	6-103-12	10 kΩ resistor
R208	10-386	10 kΩ control
R209	6-104-12	100 kΩ resistor
C201	21-176	.01 μF ceramic capacitor
C202	21-176	.01 μF ceramic capacitor
D201	56-56	1N4149 diode
D202	56-56	1N4149 diode
D203	56-56	1N4149 diode
D204	56-56	1N4149 diode
Q201	417-801	MPSA20 transistor
Q202	417-801	MPSA20 transistor
SW201	64-839	Pushbutton switch
SW202	64-839	Pushbutton switch
SW203	64-839	Pushbutton switch
SW204	64-839	Pushbutton switch
U201	443-848	EA5316 IC
U202	443-848	EA5316 IC
V201	411-836	Display tube
V202	411-836	Display tube

COMPONENT LOCATIONS

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

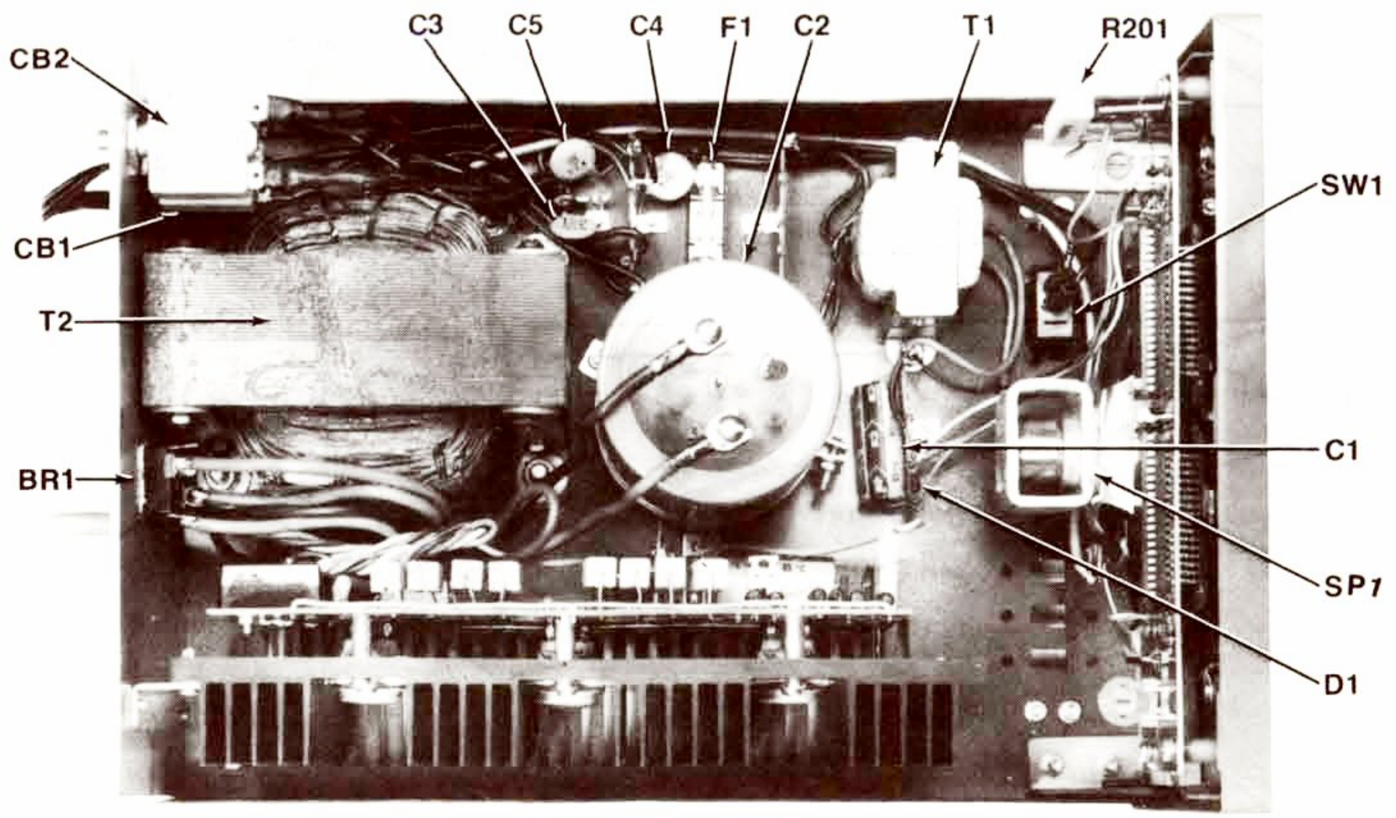
A. Find the circuit component number (R5, C3, etc.) on the corresponding circuit board X-Ray View, Photograph, or on the Schematic Diagram.

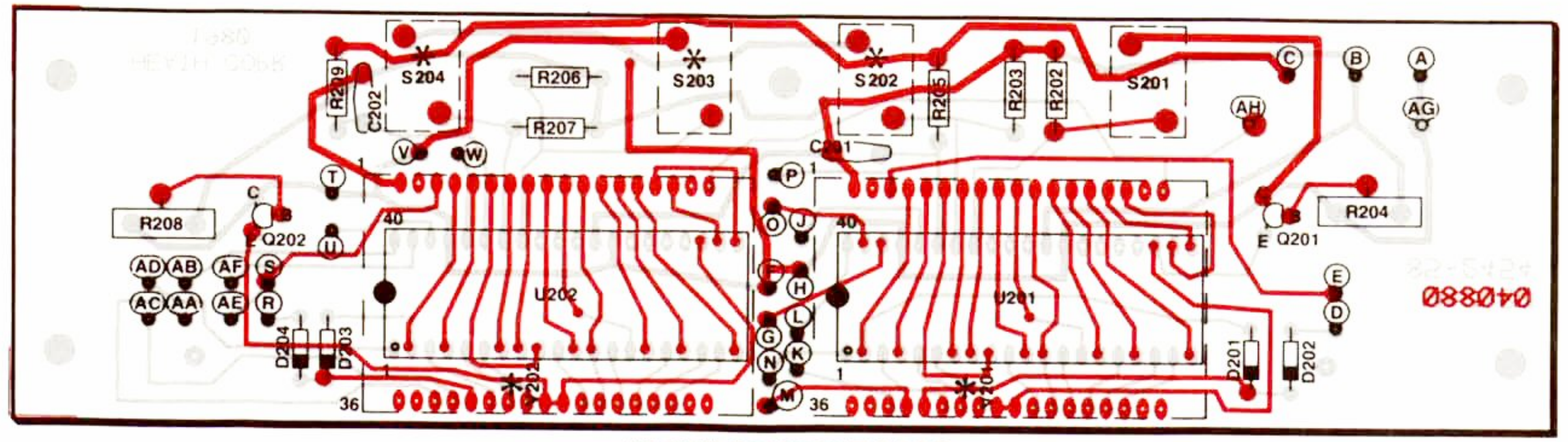
B. Locate this same number in the "Circuit Component Number" column of the "Replacement Parts List" section of this Manual.

C. Adjacent to the circuit component number, you will find the PART NUMBER and a brief DESCRIPTION, which you must supply when you order a replacement part.

X-Ray Views
on F.O. from this page.

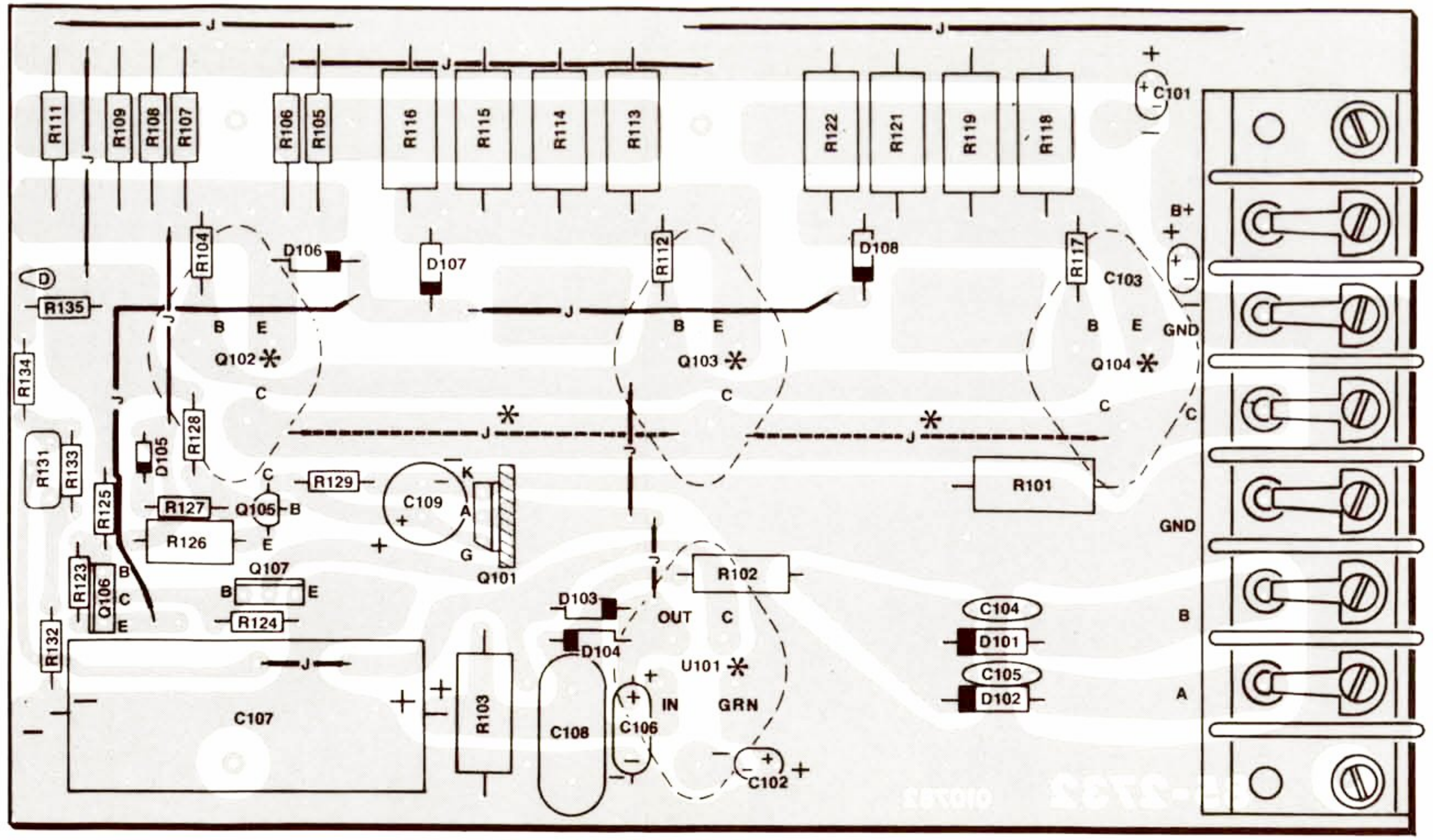
Photograph





CLOCK CIRCUIT BOARD
(Shown from the component side.
The foil on the component side is shown in red.)

*These items are mounted on the foil side of the circuit board.



POWER SUPPLY CIRCUIT BOARD
(Shown from the component side.)

*These components are mounted on the foil side of the circuit board.

DISASSEMBLY

NOTE: The following steps show you how to remove the top cover on your Power Supply.

> WARNING: When the line cords are connected to an AC outlet, AC voltage is present at several places on the chassis. Be careful you do not contact this voltage, or you could receive a dangerous electrical shock. We recommend that you unplug both line cords before you remove the cabinet top.

Refer to Figure 5-1 as you perform the following steps.

1. Position the Power Supply right-side-up as shown in the Figure.

2. Remove the three screws on each side of the cabinet and the three screws along the top rear edge of the cabinet. Then remove the cabinet top.

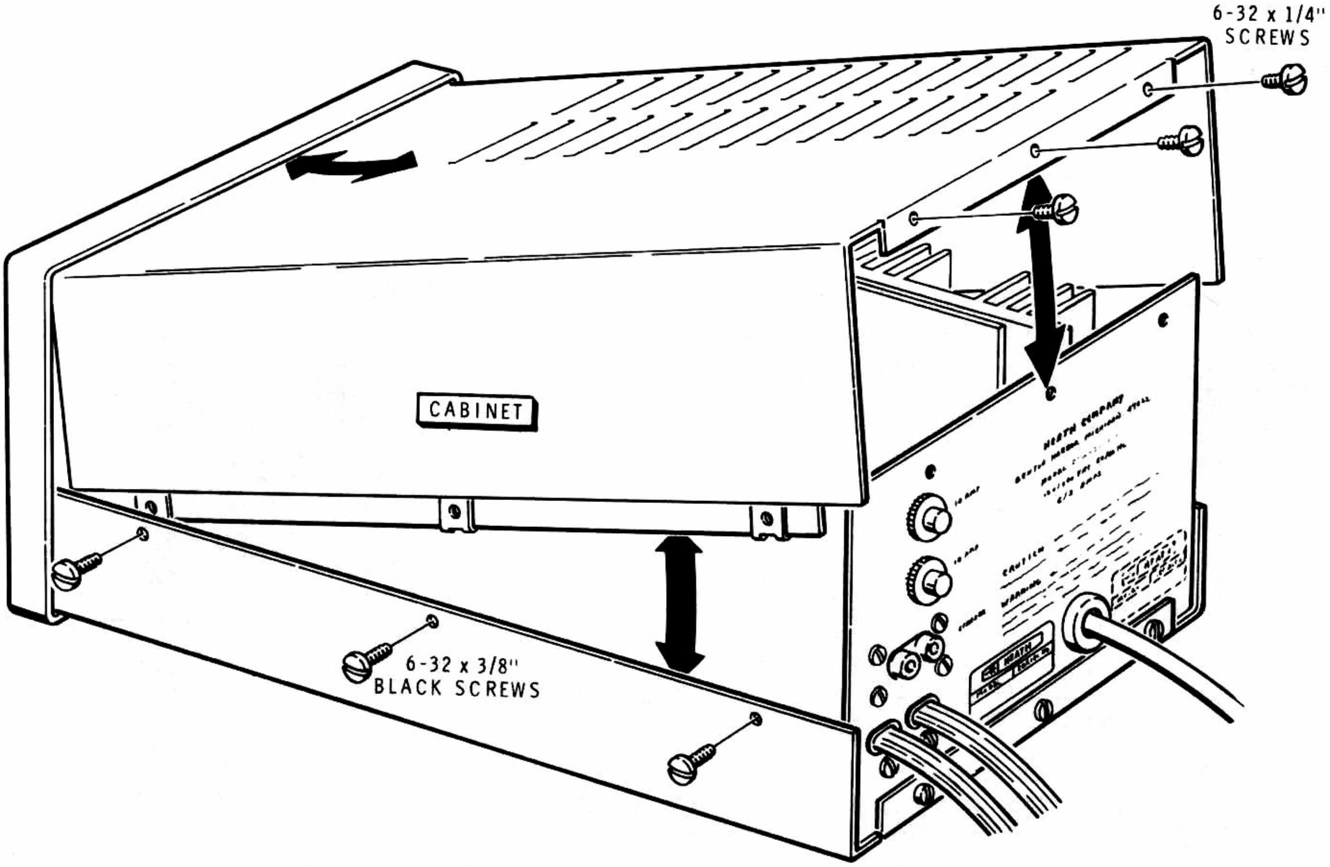
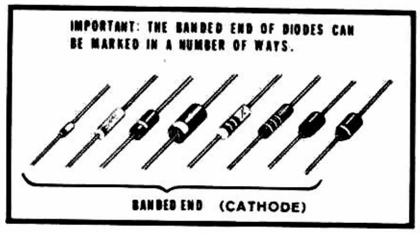
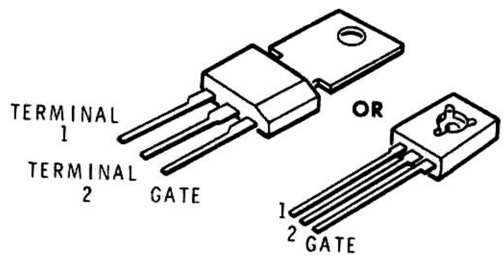
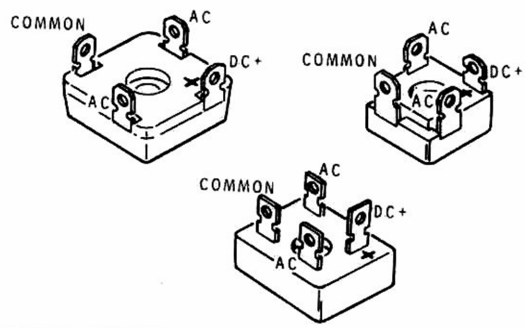


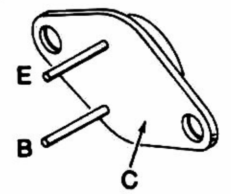
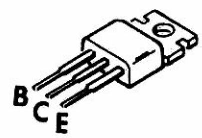
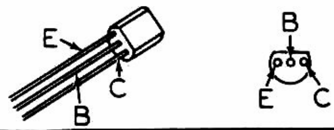
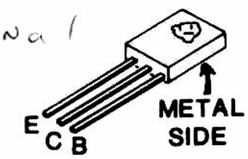
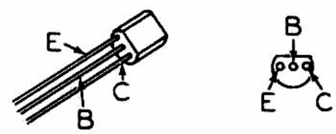
Figure 5-1

SEMICONDUCTOR IDENTIFICATION CHARTS

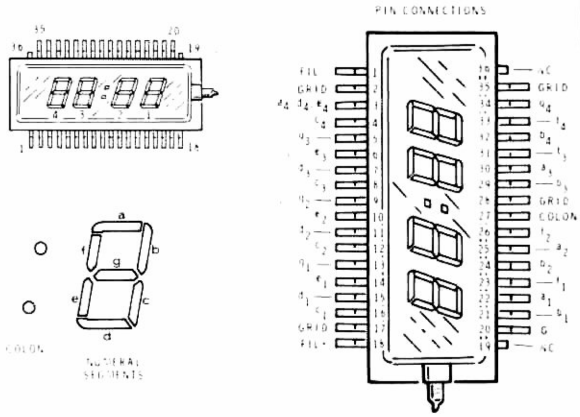
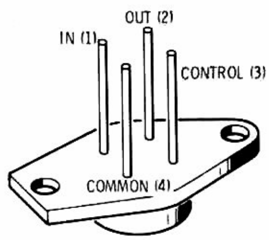
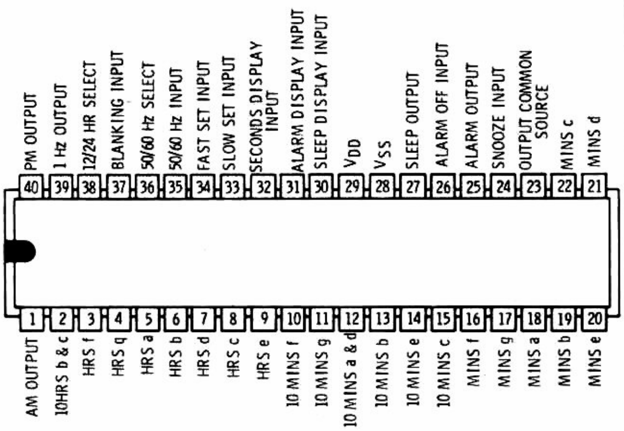
DIODES

HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
56-56	1N4149	D105,D201,D202,D203, D204	
57-27	1N2071	D103,D104,D106,D107, D108	
57-42	3A1	D101,D102	
57-622	HS106 SCR	Q101	
57-88	200PRV 40A MDA990-2 ECG5340	BR1	

TRANSISTORS

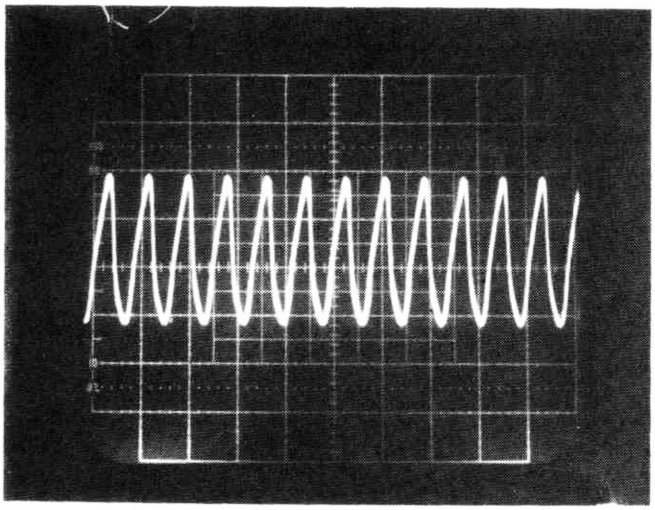
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
417-254	MJ802	Q102,Q103,Q104	Motorola 
417-298	TIP41B	Q107	Ti 
417-801	MPSA20	Q201,Q202	
417-819	MJE171	Q106	National 
417-874	2N3906	Q105	

DISPLAY & INTEGRATED CIRCUIT (IC)

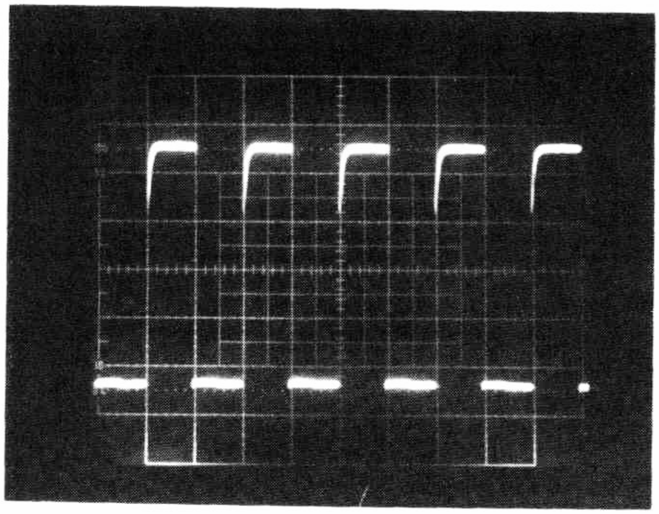
HEATH PART NUMBER	MAY BE REPLACED WITH	COMPONENT NUMBER	IDENTIFICATION
411-836	4BT-04	V201,V202	
442-685	UA78G	U101	
443-848	EA5316	U201,U202	

WAVEFORMS

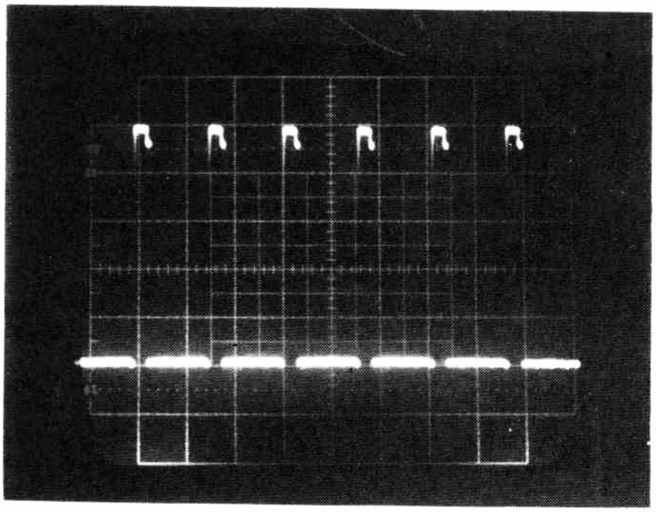
#1 1V/Div.
.1 µs/Div.
Collector of Q115



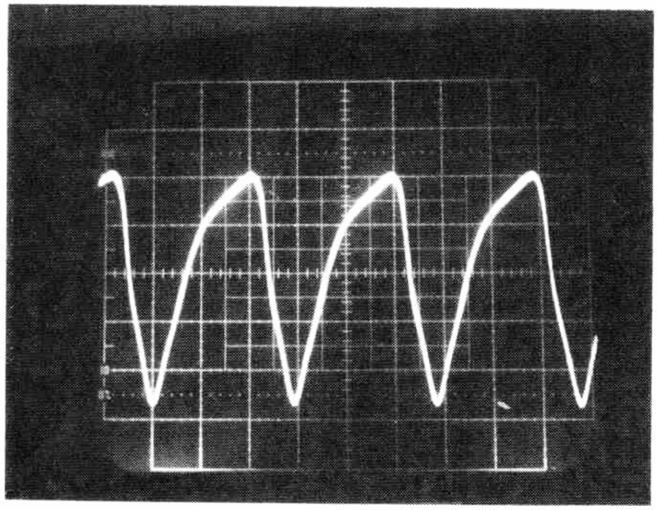
#2 1V/Div.
20 µs/Div.
U120 pin 3



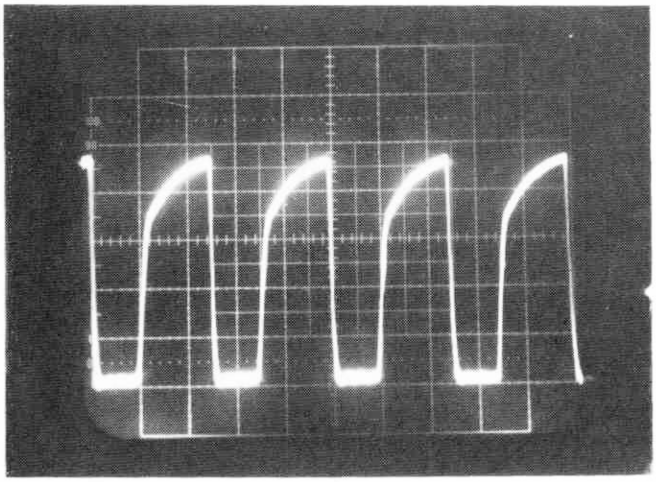
#3 1V/Div.
.2 ms/Div.
U114 pin 3



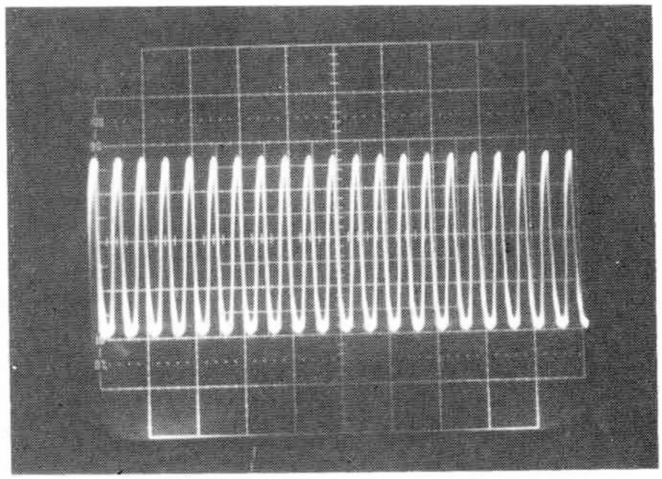
#4 1V/Div.
.1 µs/Div.
Collector of Q120



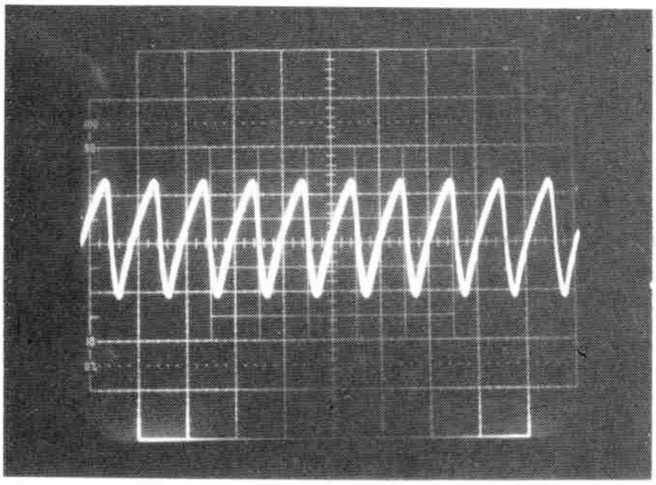
#5 1V/Div.
.2 μs/Div.
U102 pin 12



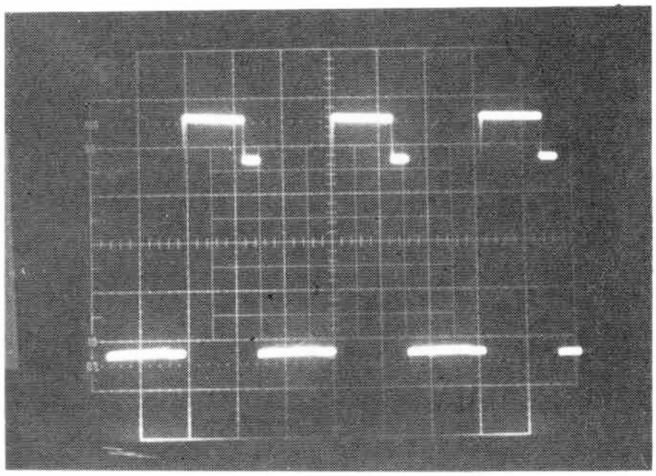
#6 1V/Div.
.2 μs/Div.
U101 pin 1



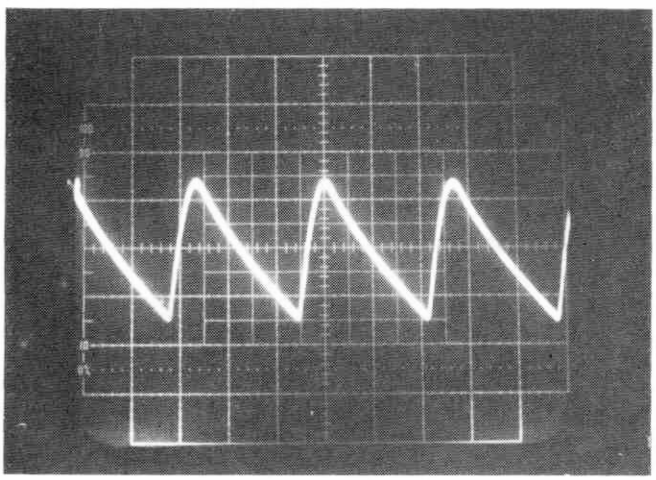
#7 1V/Div.
.1 μs/Div.
Collector of Q106



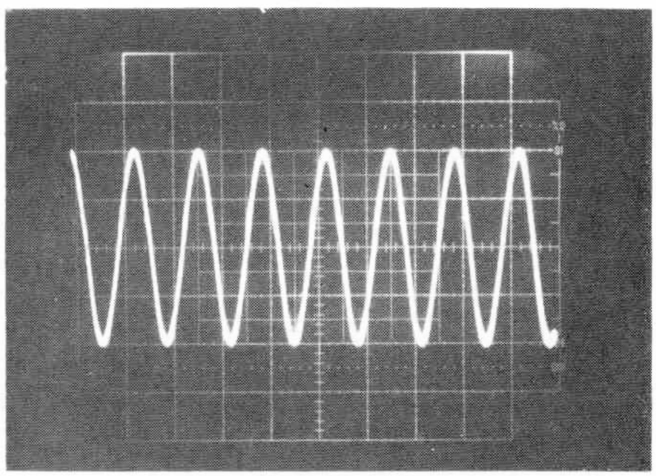
#8 1V/Div.
.2 ms/Div.
U131 pin 3



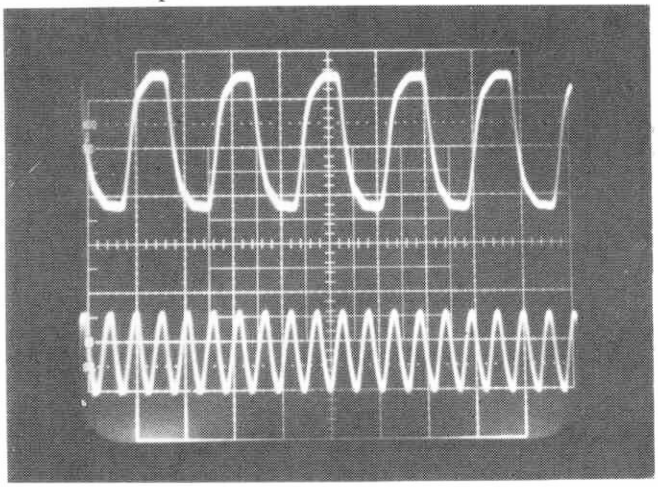
#9 .5V/Div.
.5 ms/Div.
Banded end of D308



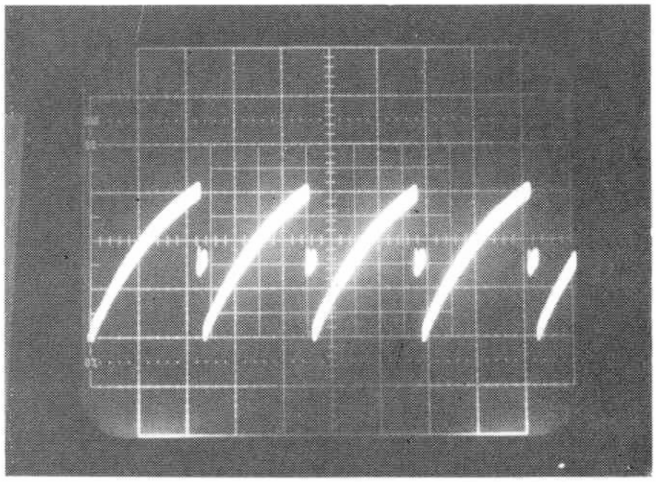
#10 .1V/Div.
1 ms/Div.
P203 pin 5



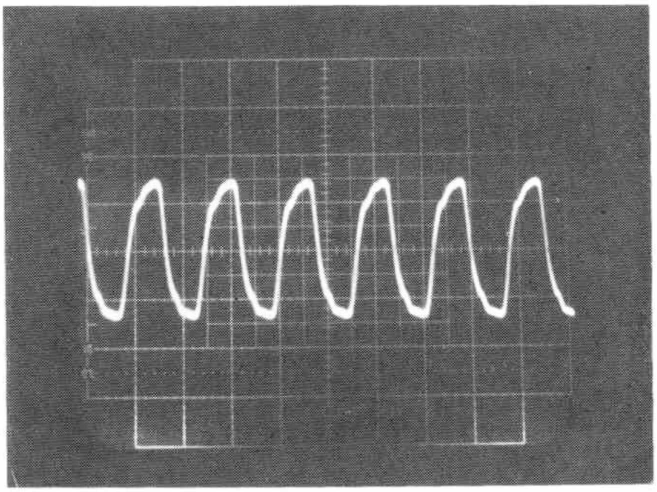
#11 .2V/Div.
.05 μs/Div.
U202 pin 10



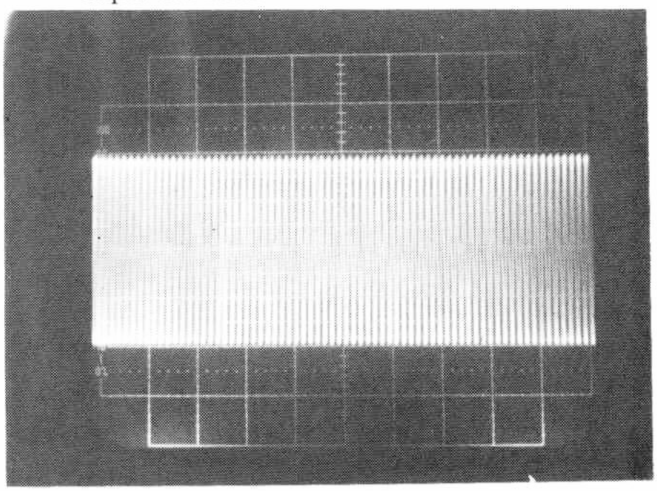
#12 50 mV/Div.
2 ms/Div.
Anode of D226



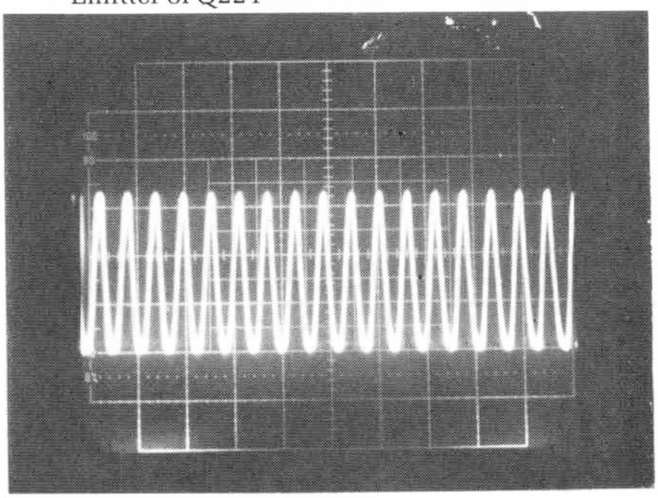
#13 .2V/Div.
.05 μs/Div.
U207 pin 15



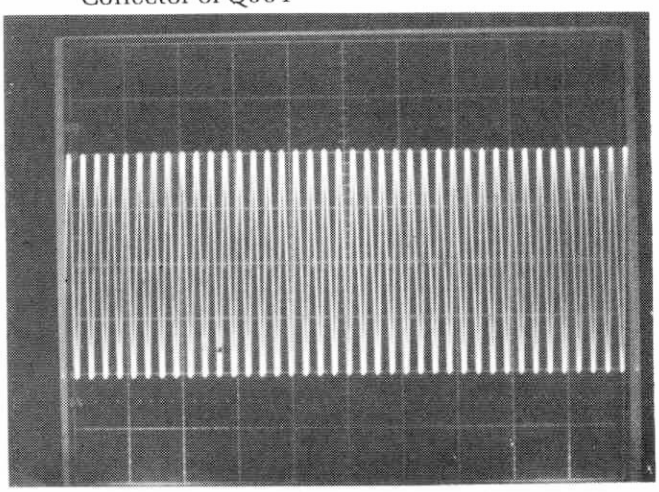
#14 .2V/Div.
2 μs/Div.
Input of FL201



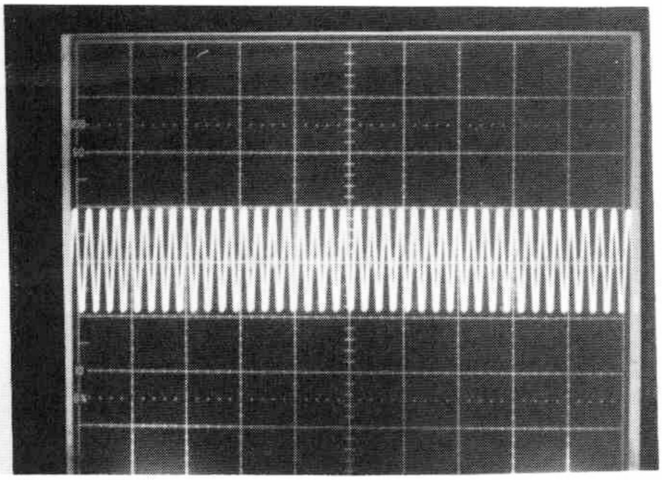
#15 .1V/Div.
.5 μs/Div.
Emitter of Q224



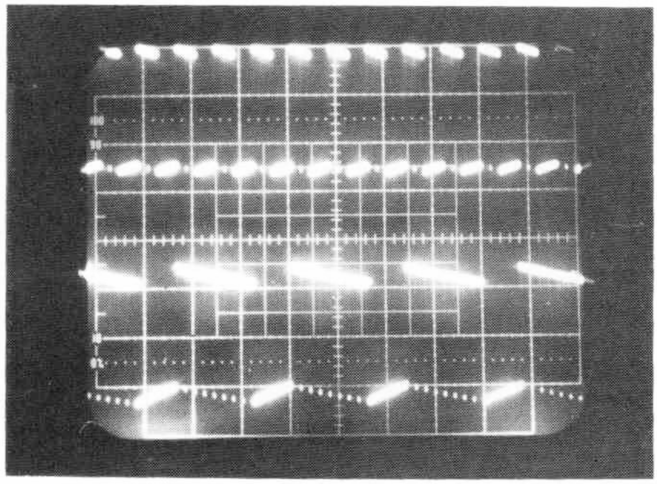
#16 .2V/Div.
2 ms/Div.
Collector of Q504



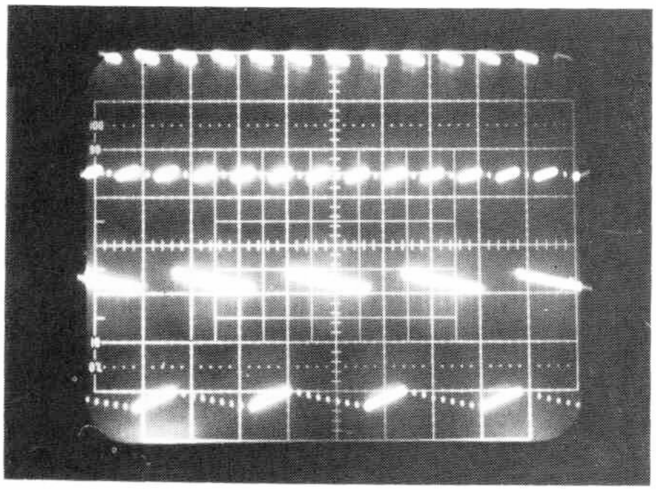
#17 .2V/Div.
2 ms/Div.
Collector of Q506



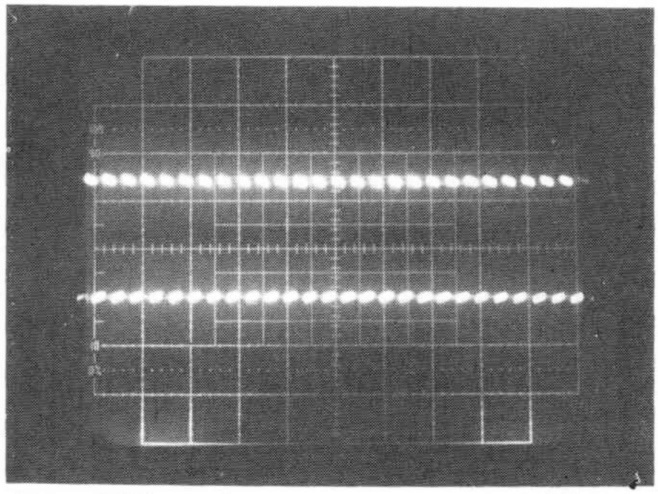
#18 2V/Div.
5 ms/Div.
P411 pin 1



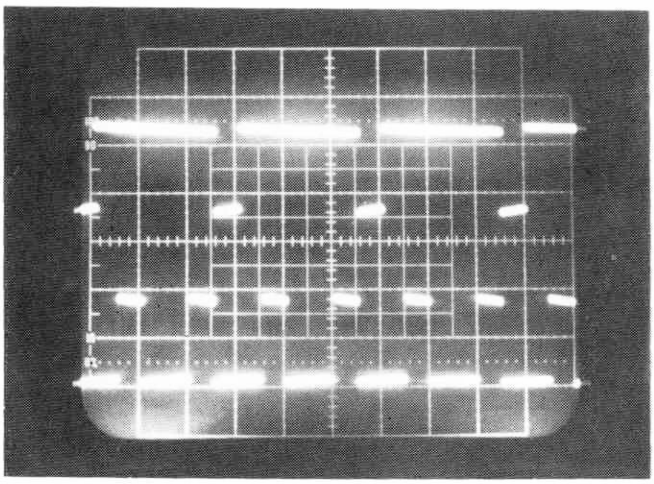
#19 2V/Div.
5 ms/Div.
P411 pin 3



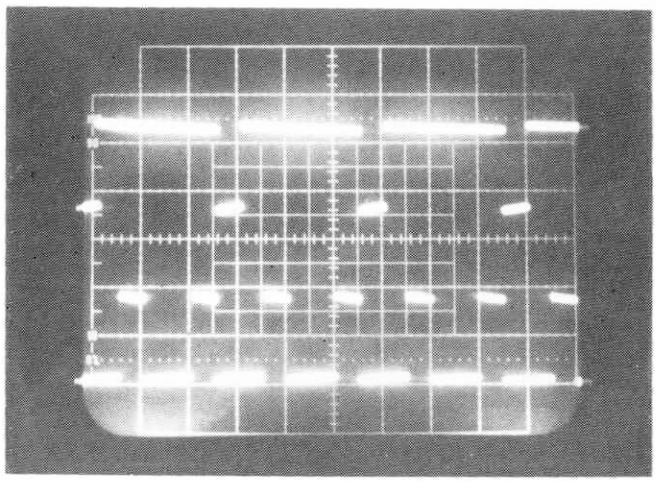
#20 2V/Div.
5 ms/Div.
P411 pin 5



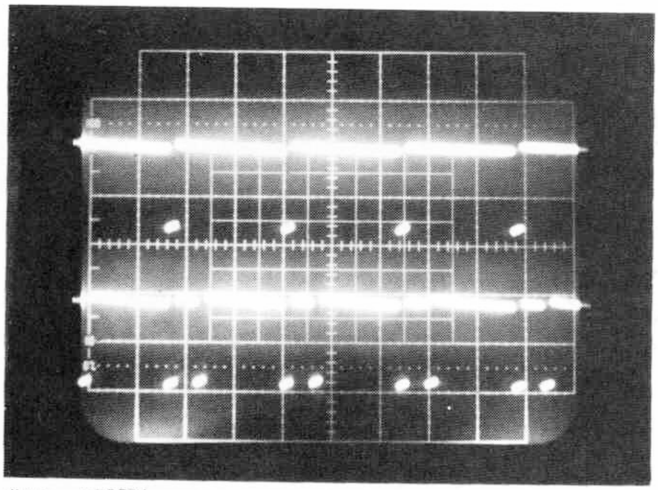
#21 2V/Div.
2 ms/Div.
P404 pin 2



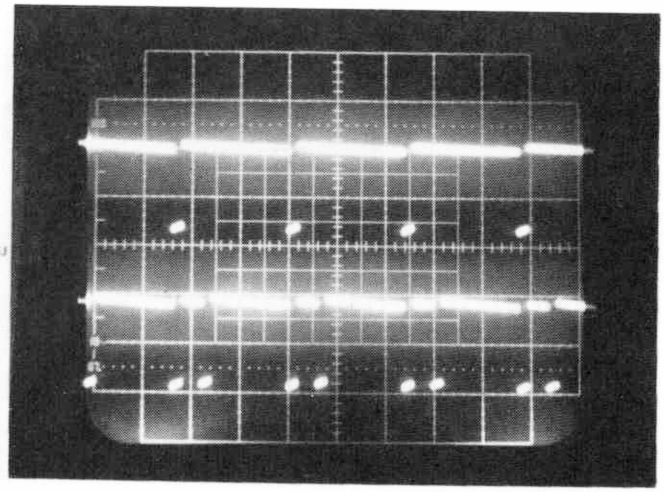
#22 2V/Div.
2 ms/Div.
P404 pin 3



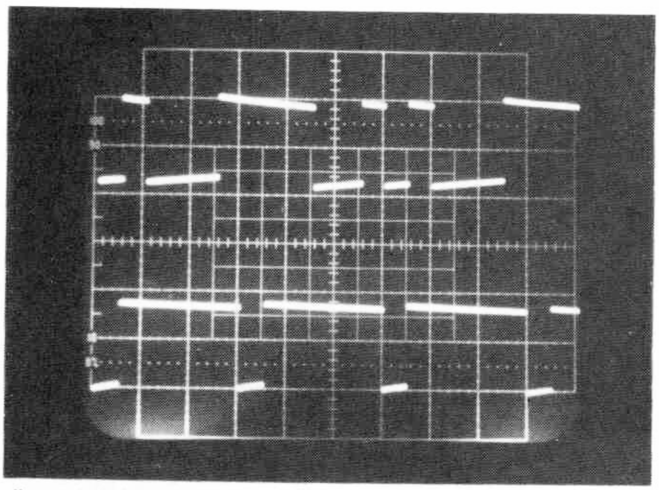
#23 2V/Div.
5 μs/Div.
P404 pin 4



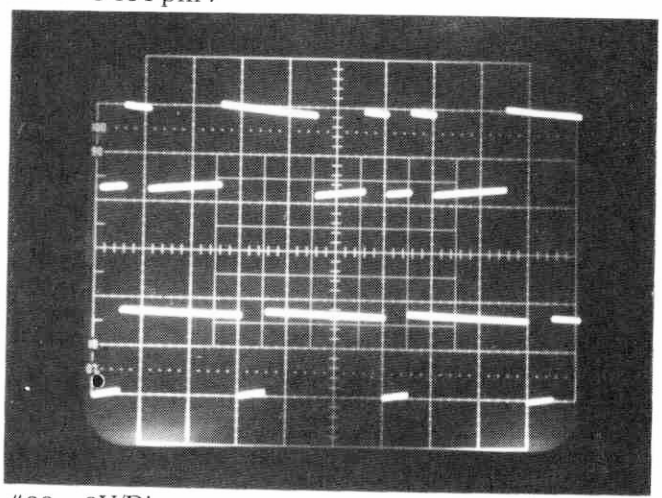
#24 2V/Div.
5 μs/Div.
P404 pin 5



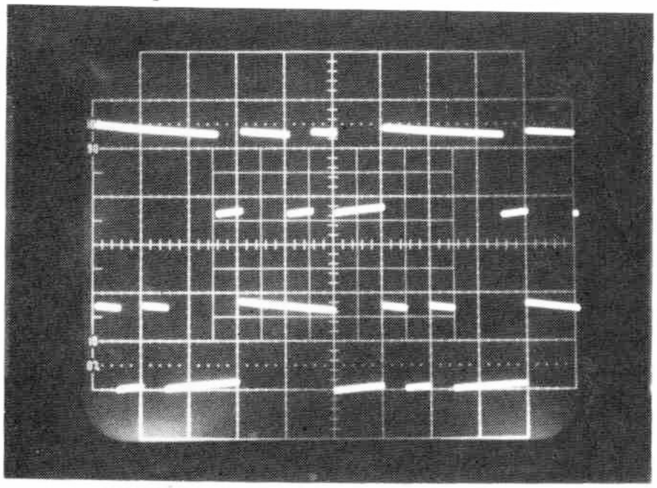
#25 2V/Div.
2 μs/Div.
P404 pin 6



#26 2V/Div.
2 ms/Div.
P404 pin 7



#27 2V/Div.
2 ms/Div.
P404 pin 8



#28 2V/Div.
2 ms/Div.
P404-10