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Colin Hinson
In the village of Blunham, Bedfordshire.

TCS-5

OPERATING AND SERVICE MANUAL

TCS-5 CHIRPSOUNDER® TRANSMITTER

BR Communications

TCS-5

OPERATING AND SERVICE MANUAL

MODEL TCS-5

CHIRPSOUNDER® TRANSMITTER

(P/N 1220-1500)

BR COMMUNICATIONS
222 Caspian Drive
Sunnyvale, California 94089-1014

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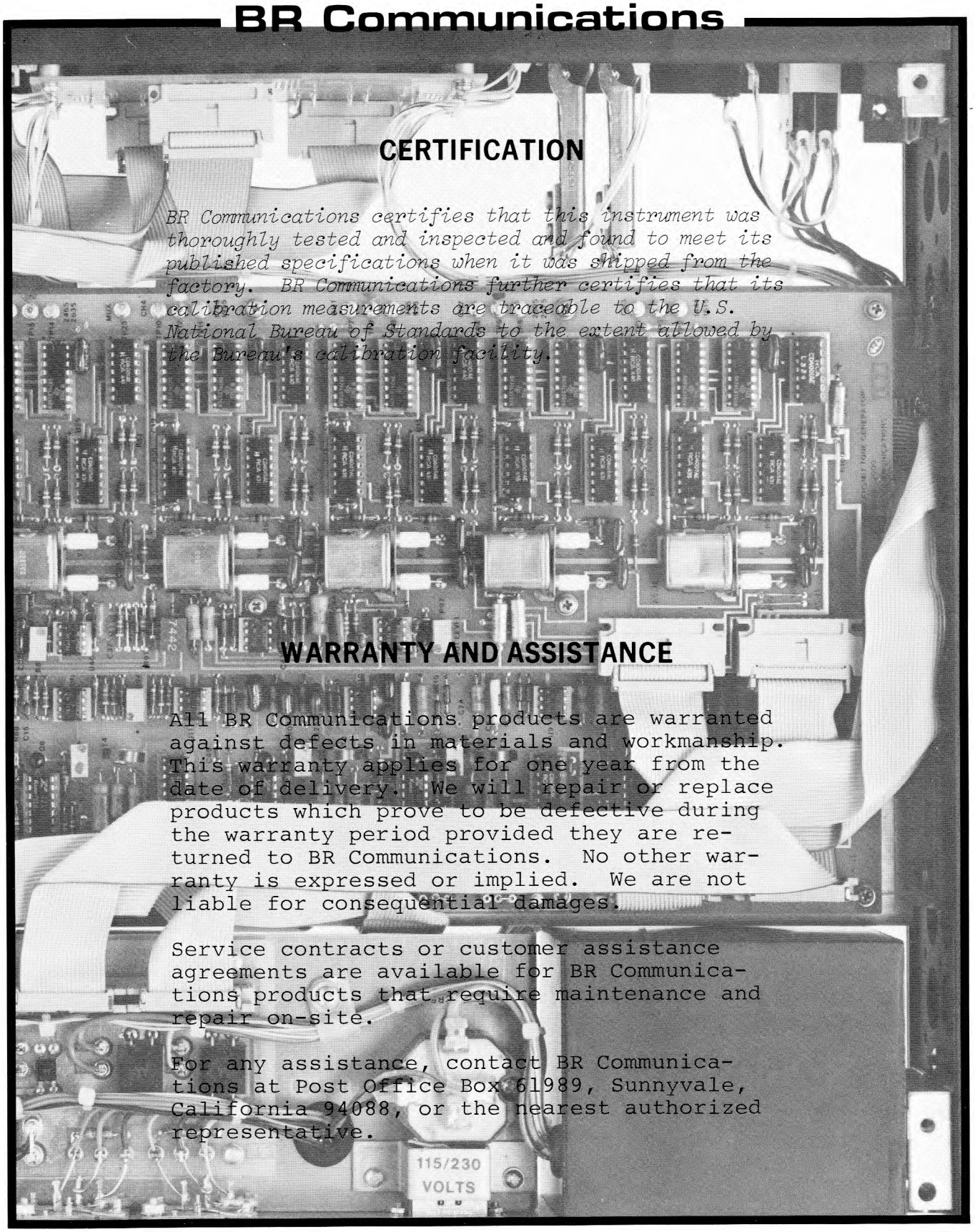
3-9	Note added
3-9	3-3.2c
3-10	3-3.2d

BR Communications



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BR Communications certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. BR Communications further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

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WARNING

THIS EQUIPMENT IS DESIGNED FOR OPERATION WITH A 3-WIRE (LINE, NEUTRAL, SAFETY GROUND) A.C. LINE POWER CONNECTION. DO NOT USE WITH SAFETY GROUND (GREEN WIRE) DISCONNECTED. IF A 3-WIRE SAFETY GROUNDED A.C. POWER RECEPTACLE IS NOT AVAILABLE, A SEPARATE GROUND WIRE MUST BE INSTALLED BETWEEN THE EQUIPMENT FRAME AND THE BEST AVAILABLE "EARTH" GROUND. DO NOT USE ANTENNA FEEDLINE OR SIGNAL CABLE SHIELDS FOR GROUNDING.

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FO-4	PCB Assembly, Synthesizer	2840-2006	FP-7
FO-5	Down Converter/Audio Modulator Assembly	1220-1004	FP-9
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FO-13	PCB Assembly, Programmer (5 Sheets)	1220-2002	FP-45
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Power Supply Foldouts

FO-No.	Description	BR Part No.	Foldout Page No.
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SAFETY SUMMARY

Operating personnel must at all times observe safety regulations. The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

If possible, do not reach inside the equipment while power is applied. Make the test connections, remove your hands from inside the equipment, and reconnect or restore power to observe the test results. Under certain conditions, dangerous potentials may exist in the power supplies when the power control is in the off position. To avoid casualties, always remove power and discharge and ground a circuit before touching it. When it is absolutely necessary to reach inside the equipment with power on, use only one hand; keep the rest of your body well insulated from ground or other power sources.

DO NOT SERVICE OR ADJUST ALONE

Do not work alone on energized circuits. Keep a partner with you who knows the emergency turn-off procedures and first-aid for electrical shock.

TEST EQUIPMENT

Always use the recommended or equivalent test equipment. Be sure that the test equipment is properly grounded while in use.

RESUSCITATION - FIRST AID

Each person engaged in electrical operations will be trained in first aid, particularly in the technique of mouth to mouth resuscitation and closed chest heart massage. Ref. AFR 127-101.

SAFETY SUMMARY (Continued)

The following warnings appear in the Operating and Service Manual, and are repeated here for emphasis.

WARNING

This equipment is designed for operation with a 3- wire (line, neutral, safety ground) A.C. line power connection. Do not use with safety ground (Green Wire) disconnected. If a 3-wire safety grounded A.C. power receptacle is not available, a separate ground wire must be installed between the equipment frame and the best available "earth" ground. Do not use antenna feedline or signal cable shield for grounding.

WARNING

Make sure that the frame is grounded by the three-wire, three-prong power cord or a separate ground strap before operating. If not grounded, the frame and exterior panel could be at a potentially dangerous voltage level.

WARNING

In the performance of some maintenance procedures, it is necessary to have the equipment energized and dust covers removed. Extreme care must be exercised in making internal measurements or adjustments since potentially dangerous voltages are present.

WARNING

Use extreme care when making internal adjustments with power on. Dangerous voltages are present in the transmitter.

SECTION I
GENERAL INFORMATION

1-1 INTRODUCTION

1-1.1 This manual provides operating and service instructions for the TCS-5 Chirpsounder Transmitter. The information is presented in 6 sections. Section I provides a brief description of the equipment and operating specifications. Unpacking instructions, site requirements, cabling data and installation instructions are included in Section II. Section III provides information on operator controls and indicators and describes operating procedures. Functional descriptions of the circuits are in Section IV. Section V describes preventive and corrective maintenance procedures for the instrument and gives a performance verification checkout. Refer to Section VI for hardware options, configurations and firmware versions. Appendix A, TCS-5 Interface Control Documents, BR Drawing Number K11078 describes TCS-5 software protocol. Appendix B, K11103, is special instructions for remote control of Chirpcomm messages. These appendices are provided in this manual following Section VI. Oversize drawings, including block diagrams, schematics, and wiring diagram are grouped in the back of this volume as a foldout (FO) section. The parts lists, wire lists and assembly drawings are provided in Volume 2, the Illustrated Parts Breakdown (P/N 0040-1220-15002).

1-2 GENERAL DESCRIPTION

1-2.1 INTRODUCTION. The TCS-5 (Figure 1-1) is a complete Chirpsounder transmitter, Chirpcomm message modulator, and communications transmitter in one package. The TCS-5 is a sweeping transmitter which tunes through the HF spectrum between 2 and 16 MHz (at a rate of 50 kHz/second) or between 2 and 30 MHz (at a rate of 100 kHz/second). Synchronized with a BR Communication's Chirpsounder Receiver (RCS-4B, RCS-5, or RCS-6), located at a distant end of an HF circuit, the system (TCS and RCS) provides a measurement of HF operating parameters. These include received power, propagating modes, and extent of multipath vs. frequency for that path.

1-2.2 CHIRPCOMM MESSAGE. The TCS-5 also features the Chirpcomm transmit capability built into the unit. The Chirpcomm system allows an operator to send short emergency or priority messages (40 characters) concurrently with the transmitted linear FM/CW (Chirp) signal. The message is continuously transmitted (63 times) as the Chirp transmission progresses in its sweep throughout the HF spectrum (2-16 MHz or 2-30 MHz). Chirpcomm messages may be received on BR Communications' RCS-5 and RCS-6 Receivers or on RCS-4B Receivers equipped with 3060 Chirpcomm adapters. Redundancy of transmission throughout the frequency spectrum virtually ensures correct message reception. For remote entry of Chirpcomm messages, the TCS-5 provides for a Chirpcomm interface to the BR Communications model FMT-5A Frequency Management terminal. All TCS-5 operational functions are available via remote control.

1-2.3 COMM TRANSMITTER FUNCTION. In addition to Chirpsounding, the TCS-5 provides a standard HF SSB communications transmitter capability, producing 150 watts PEP output in the fixed-frequency SSB modes. An exciter output is also available for use with external RF power amplifiers. The TCS-5 is a fully synthesized, high stability (5 parts in 109) transmitter, tunable through the 1.6 to 30 MHz range in 10 Hz steps. The TCS-5 can be coupled with the RCS-5 Receiver to provide semi-duplex or simplex transreceiver operation in addition to the Chirpsounder function as shown in

The TCS-5 contains a channelized memory to provide up to 100 pre-defined channel allocations for commonly used frequencies. These channels can be manually entered from the keyboard, or remotely entered through a remote I/O data port. Morse keying CW is also available using the TCS-5 as a communications transmitter.

1-2.4 SELF-TESTS FEATURE. The TCS-5 provides menu-driven built-in test to support trouble shooting and operational maintenance of this equipment. Three LED alarms provide rapid indication of power amplifier overload, over temperature, and audio overdrive.

1-3 CHIRPSOUNDING CIRCUITS

1-3.1 INTRODUCTION. To understand the function and purpose of the TCS-5 Chirpsounder Transmitter, the following description of how the TCS-5 and the RCS-5 Chirpsounder Receiver work together is discussed in the following paragraphs. For further information on Chirpsounding, refer to Appendix A, "Frequency Management of HF Nets Using TFMS Equipment", in the RCS-5 Operating and Service Manual (0040-2540-15001).

1-3.2 CHIRPSOUNDING THEORY. The RCS-5 is a sweeping HF receiver that tunes through the HF spectrum at a 50 kHz per second or 100 kHz per second rate beginning at 2 MHz. When synchronized with a TCS series transmitter (which includes either the TCS-4 or TCS-5) located at the other end of an HF circuit, the receiver provides a measurement of ionospheric propagation conditions for that path.

a. The TCS transmitter at one end of the HF circuit emits a CW signal which starts at 2 MHz and sweeps upward in frequency at a constant linear rate (50 kHz/second for 2-16 MHz sweep; 100 kHz/second for a 2-30 MHz sweep). An internal clock in the RCS-5 receiver starts its sweep synchronously with the transmitter and precisely tracks the sweeping transmitter signal. Any radio energy that can propagate over the HF circuit is received by the RCS-5. The radio energy propagates by various modes (e.g. surface wave, one-hop, two-hop, etc.) which have different propagation delays, characteristics, and signatures. The time created by the travel of the RF signal from the transmitter to the ionosphere and back to the receiver causes the returned signal to arrive slightly behind the exact tuned frequency of the RCS-5 receiver. Assuming that the transmit and receive sweeps are started at exactly the same time, the receiver sweep will have advanced to a slightly higher frequency by the time the transmit signal arrives at the receiver. Thus, the receiver is tuned to a slightly higher frequency than the arriving transmit signal.

b. This received frequency difference is amplified in the receiver I. F. and converted to a "baseband audio" tone. A tone at zero hertz indicates no time delay. Tones of increasing audio frequency (up to 500 Hz) indicate increasing time delay of the ionospherically returned signal. In practice, multiple tones are present in the sounder's baseband audio output which represent the various delays caused by the different modes, or layers of the ionosphere. The multiple tones are processed by the RCS-5's 200 line real time spectrum analyzer to separate the tones into discrete components which identify corresponding ionospheric modes.

Figure 1-1. TCS-5 Chirpsounder Transmitter

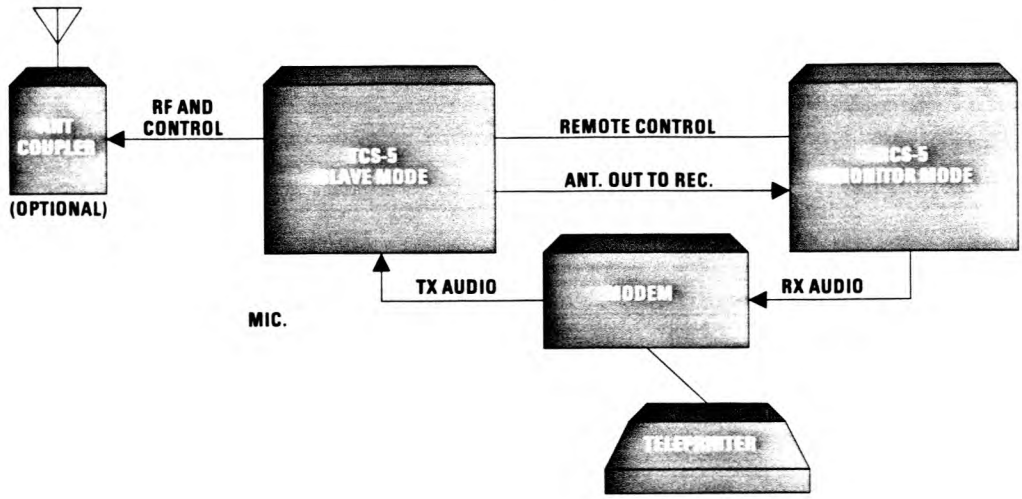


Figure 1-2. TCS-5/RCS-5 in Transreceiver Configuration (Comm Mode)

c. The output of the spectrum analyzer is then displayed on the CRT versus the RF sweep of the sounder. The CRT vertical axis indicates received signal time delay (ionospheric mode structure) versus the CRT horizontal axis of radio frequency; 2-16 or 2-30 MHz. The result is a display of propagating modes vs. frequency, referred to as a Chirpsounder Record as shown in Figure 1-3.

d. As radio energy at various levels is received, the receiver gain is automatically adjusted to provide a constant level output to the spectrum analyzer. The automatic gain control (AGC) voltage versus radio frequency provides a measure of the total received signal strength versus frequency, which is displayed as a bar graph on the CRT above the Chirpsounder Record at the top of the screen.

e. In addition to the AGC bar graph two other versions of the bar graph can be displayed. The SIGNAL STRENGTH bar graph subtracts the received background noise level from the total received signal strength of the AGC display, and is therefore a more accurate measure of the received strength of the actual transmitted signal. This bar graph is recommended for normal use. The SIGNAL QUALITY bar graph displays a communications quality rating based on signal strength and propagation mode characteristics. Thus, an RCS-5 receiver operating at one end of the radio circuit in association with a TCS-5 transmitter at the other end provides a real-time measurement of propagation conditions on that circuit.

1-3.3 CHIRPCOMM MESSAGE. Immediately above the bar graph, the Chirpcomm message is displayed (if transmitted) at the end of each sweep. The message, which may consist of up to 40 characters, is transmitted by the TCS-5 and decoded by the RCS-5 63 times during the sweep. This redundancy permits very accurate decoding of the message even in the case of poor propagation conditions.

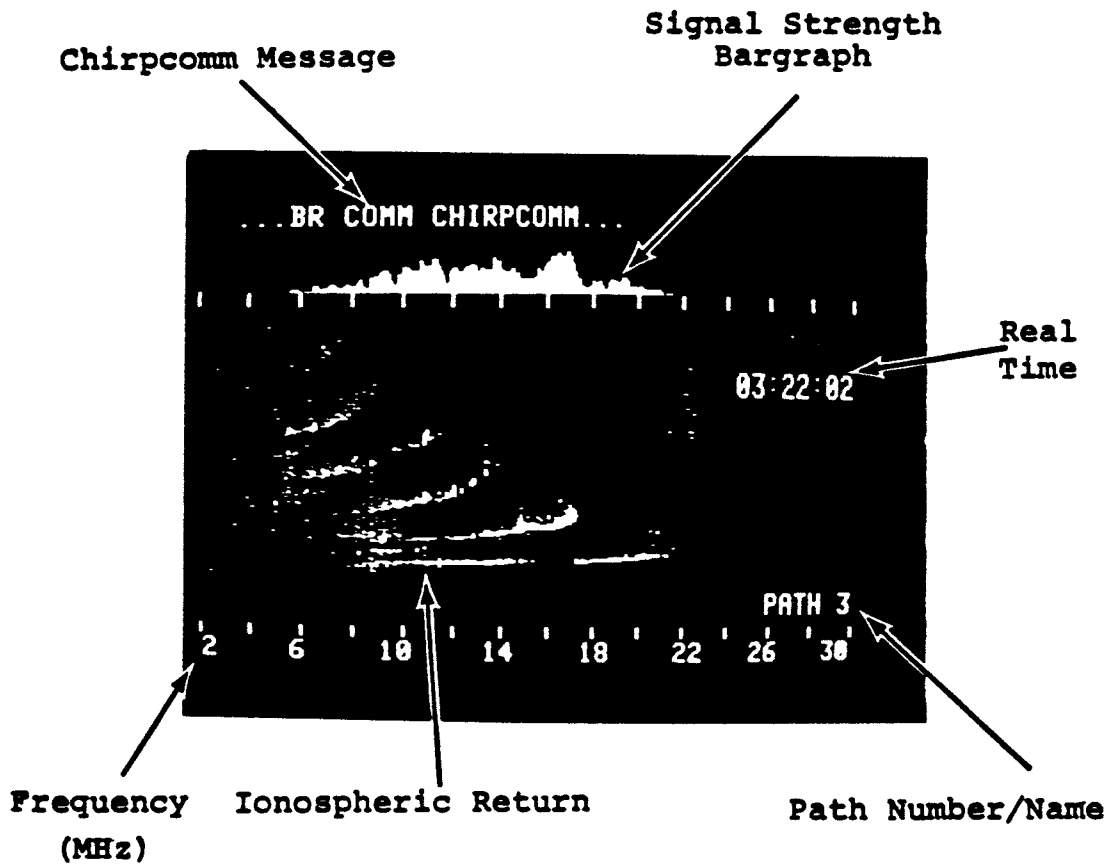


Figure 1-3. RCS-5 Chirpsounder Record Display

1-3.4 COMMUNICATIONS NETWORK. The receiver is designed to be synchronized with up to four different TCS transmitters located at different sites and can receive transmissions from one of the four every five minutes. The latest Chirpsounder record of each of the four paths is stored in memory and can be displayed at any time upon operator command. The RCS-5 Receiver is also equipped with single-sideband (SSB) monitoring capabilities. The radio is tunable from 2-30 MHz with 10 Hz resolution. USB or LSB monitoring is possible.

1-4 EQUIPMENT SUPPLIED

1-4.1 As supplied, the TCS-5 includes the following:

Name of instrument	Part Number
TCS-5 Chirpsounder Transmitter includes handset, mating connector/ cable assembly for J7 and J8, and power cord.	1220-1500

1-4.2 Refer to Section VI for instrument part numbers for various hardware configurations and firmware versions.

1-5 EQUIPMENT REQUIRED BUT NOT SUPPLIED

1-5.1 ANTENNA. The TCS-5 ideally requires an antenna capable of efficiently transmitting signals from 2 to 30 MHz. It is not absolutely necessary for the antenna to be well matched to the TCS-5 50 ohm output impedance over the complete 2-30 MHz range. No equipment damage will occur for any amount of mismatch, but the radiated power of the TCS-5 will be reduced in the frequency range of poor antenna match, or high VSWR. In general, satisfactory performance is obtained when the antenna VSWR is less than 4:1 over the frequency range of interest. Optimum performance is obtained with VSWR less than 2:1. If the VSWR is above 6:1 for a large portion of the frequency range of interest, performance will be significantly reduced and better antennas should be used.

1-5.2 OPTIONAL EQUIPMENT. Optional equipment (or external peripherals) can be used with the TCS-5 for special applications. Equipment such as the model 5040 Diplexers, Antenna Couplers, 2862 Cartridge Reader, 6202 Remote Control Modem, 7039 Relay, and the 6028 Time Diversity Modems are available for use with the TCS-5. Consult BR Communications for additional information on these items. Transreceiver cable kit (1220-1920) is an option to make a transreceiver system between RCS-5 and TCS-5.

1-6 SPECIFICATIONS

1-6.1 Table 1-1 lists the technical specifications and tested performance characteristics of the instrument.

1-7 PUBLICATIONS

1-7.1 REQUIRED PUBLICATIONS. Information in the following publications is required for the operation and service of the TCS-5.

Title	Manual No.
TCS-5 Chirpsounder Transmitter, Illustrated Parts Breakdown	0040-1220-15002

1-7.2 RELATED PUBLICATIONS. Information in the following publications is related to the operation and service of the TCS-5

Title	Manual No.
RCS-5 Chirpsounder Receiver, Operating and Service	0040-2540-15001
RCS-5A Chirpsounder Receiver, Operating and Service	0040-2541-15001
RCS-5B Chirpsounder Receiver, Operating and Service	0040-2542-15001
RCS-6 Chirpsounder Receivers, Operating Manuals**	0040-9181-15XX1
XCS-6 Chirpsounder Transceivers, Operating Manuals**	0040-9182-1XXX1
Cartridge Reader, Operating and Service	0040-2861-15001
FMT-5A Frequency Management Terminal, Operating and Service	0040-3044-15201
RSS-5 Spectrum Monitor, Operating and Service	0040-2710-15001
5040 Diplexer, Operating and Service	0040-5040-10001
RCS-4B Chirpsounder Receiver, Operating and Service	0040-9125-11001
6202 Dual Line Mode, Operating and Service	0040-6202-15001
7057 Antenna Coupler, Operating and Service/IPB	0040-7057-15001
7039 Antenna Relay, Operating and Service/IPB	0040-7039-15001

Different configurations of the RCS-6 and XCS-6 use separate operating manuals.

Table 1-1. Specifications

25. Antenna Selector/Antenna Coupler/ Interlock:	Rear panel connector (J8) for digital output to external antenna selector. Up to three antennas may be used. Serial data port for antenna coupler and coupler DC power. Interlock loop to disable transmission.
26. Comm Modulation:	LSB or USB.
*27. COMM Audio Bandwidth:	300-3000 Hz, 0 to -3 dB.
28. Comm Audio Input:	Line input (600 ohm balanced) on rear panel. Dynamic microphone on front panel.
*29. Audio Input Level:	LINE: 3 Position rear panel switch to select: -13 to -3 dBm -7 to +3 dBm 0 to +10 dBm MICROPHONE: 2mV
*30. Speech Compression:	Speech compression or full bandwidth audio selectable. Speech compression bandwidth 600-1500 Hz.
31. Microphone Gain:	Front panel control (microphone only).
32. Comm Transmit Key Line:	By contact closure (from +12V internal pull-up) to ground or by remote digital control.
33. Sidetone:	Transmit audio provided for handset.
34. Display:	4 Row by 40 Column liquid crystal display, with push button actuated back illumination.
35. Self Test:	Internal tests to verify system operation.
36. Standby Power (Battery):	Clock timing and synchronization are maintained through an AC line power interruption by a battery-powered standby power supply. The standby supply will typically operate for 5 hours (at 23°C ambient) from an internal rechargeable battery or for 48 hours from an optional external battery pack. A 12 Vdc input is also available to power the standby supply from a station or vehicle battery.

Table 1-1. Specifications

* 37. External Battery Input:	+ 11.0V to + 14.5 Vdc.
* 38. Remote Interface:	Full remote control of all major controls and setup functions. Serial I/O 75, 300, 1200, 9600 Baud.
39. Transreceiver Operation:	Interconnection between TCS-5 and RCS-5 for tuning, muting and other interoperable controls. Operates only if RCS-5 is in MONITOR mode.
40. Audio Output:	Front panel connection for handset audio from RCS-5 and transmit sidetone.
41. Chirpcomm Capability:	40 Character message (including first two character ID). Message sent on Chirp transmission. These messages may be decoded by BR RCS-5, RCS-6, and RCS-4B/ 3060 equipment.
42. Chirpcomm Message Input:	Local input by tuning knob/display. Remote input from FMT-5A or through remote I/O data port.
43. Chirpcomm Message Registers:	1 current register, 1 "waiting to send" register, and 1 storage register.
*44. Comm Transmit Preset:	100 Frequency registers for commonly used comm frequencies. Compatible with BR 2862 Cartridge Reader.
*45. Blanking of Chirp Transmission:	Up to 96 frequencies. Blanking ±10 kHz about each frequency.
*46. AC Power Input:	115/230V, ±15%, 47-440 Hz, 650 Watts maximum when transmitting. 200 Watts maximum in standby.
47. Chirp Standby:	Standby causes transmitter to key off if Chirp sweep is in progress. When system is taken out of standby, transmitter will key back on. If standby remains set on, no Chirp signals will be radiated, though programmer will run. Standby is accessible through the SET CHIRP mode or remote control.

Table 1-1. Specifications (cont.)

48.	Alarm LEDS:	Three LEDs located on the TCS-5 front panel indicating conditions that could cause damage to the instrument if left unchanged.
	RF OVLD:	Indicates RF power amplifier is in a near overload/high VSWR condition.
	OVTEMP:	Indicates of RF power amplifier over temperature condition.
	AUDIO OVLD:	Indicates excessive audio input signal.
		Note: RF overload or over temperature will cause the TCS-5 to operate at lower RF power output, but will not cause transmitter to shut off.
49.	Alarm Output:	"Electronic contact" (FET switch) closure to ground to indicate overload condition.
50.	Temperature:	0° to +50° C (-20° to +50° C with slightly degraded performance) operating; -40° to +71° C non-operating and storage.
*51.	Relative Humidity:	Up to 90% operating (non-condensing); Up to 95% non-operating and storage.
52.	Weight:	78 lbs (35.5 kg). With environmental case, 115 lbs (52.3 kg).
53.	Dimensions:	Standard 19" rack mounting, 25" deep including rear panel connectors, 8 3/4" high.

* NOTE:

Specifications marked with asterisks are for application information only and represent typical or design values. They are not individually tested under all operating conditions and are based on sample testing, and/or design analysis.

SECTION II
INSTALLATION

2-1 INTRODUCTION

2-1.1 This section contains instructions for installing the TCS-5 and for making all necessary cable interconnections before putting the system into use. Details on storage and reshipment are also included.

2-2 UNPACKING AND INSPECTION

2-2.1 SHIPMENT. The TCS-5 is shipped from the factory in a fully assembled condition. For shipment, it is enclosed in a moisture resistant barrier material with desiccant and humidity indicator and packed in a wooden box. Figure 2-2 illustrates the weights and dimensions of the standard rack mount TCS-5, and Figure 2-3 outlines the TCS-5 in its optional environmental case.

2-2.2 UNPACKING. To unpack the TCS-5, open the top and one side of the crate and lift the unit out of the box. The TCS-5 weighs 78 lbs. uncased and care should be exercised in lifting. Check all items against the packing list. The shipping container and associated packing material should be retained for possible use in reshipment or storage of the unit.

2-2.3 CLAIM FOR DAMAGE. If the TCS-5 is mechanically damaged or fails to meet specifications on receipt, notify the carrier and BR Communications. Retain the shipping carton and the padding material for the carrier's inspection.

2-3 INSTALLATION REQUIREMENTS

2-3.1 GENERAL. The TCS-5 operates satisfactorily within temperature limits of -20 ° to 50° C and up to 90% relative humidity. For long term operational stability, the equipment should not be exposed to excessive shocks (exceeding 15 g's), high dust levels, or extreme fluctuations in temperature. The TCS-5 has internally mounted cooling fans which exhaust through a hood on the front panel. Adequate clearance must be allowed for the free flow of air. Do not set the unit on a flat surface as this blocks the airflow exiting from the front exhaust hood.

2-3.2 RACK MOUNTING. The TCS-5 has a front panel designed for standard EIA 19-inch rack mounting. If the transmitter is not to be operated in its environmental case, care must be taken to adequately support the unit in the front and rear. This may be done with rack slides (Zero Corporation CTRN-1-20-E-94 or BR P/N 7102-0073) or support brackets. FO-37 is the envelope drawing for the rack mount TCS-5. FO-38 is an installation drawing in the optional environmental container.

2-3.3 BENCH MOUNTING. If the TCS-5 is bench mounted, the front of the unit must be elevated or some means provided to insure adequate clearance (approximately 2.5 inches) of the bottom opening of the front vent hood. An optional table top cabinet (option 11) is available that provides proper ventilation for permanent or semi-permanent table or bench top installation. Contact BR Communications for additional information.

2-3.4 ENVIRONMENTAL CASE. The TCS-5 may be supplied in an optional environmental case (as shown in Figure 1-1). This configuration is particularly suitable for shock or vibration prone environments. The container comes complete with four carrying handles for convenient local transportation. In addition, front and rear covers remove easily for access to equipment. To remove the covers, the pressure relief valves (screws) located on each side of the case should first be loosened. The front and rear panels can then be removed by turning the four handles located on each panel counterclockwise until the panel releases. Front and rear covers of environmental case must be removed to provide adequate ventilation when operating.

2-4 POWER CONNECTION

2-4.1 LINE VOLTAGE. The TCS-5 may be operated from either 115 or 230 volt (±15%), 47 to 440 Hz power lines. Rear panel slide switch S2 permits easy conversion to either voltage.

2-4.2 CIRCUIT BREAKER SWITCH. The power ON/OFF switch is a circuit breaker that will trip whenever AC line voltage exceeds approximately 120% of normal or AC line current exceeds approximately 150% of normal. The overcurrent trip point is automatically programmed to 15 amps for 115V operation and 7 amps for 230V operation by the voltage selector switch, S2. The circuit breaker provides an indication of an overvoltage or overcurrent condition by moving to the OFF position. The breaker will trip, however, even if the switch is forcibly held in the ON position.

2-4.3 POWER CABLE. The TCS-5 is provided with a detachable line cord (10 feet or 3 meters long) having a standard EIA 5-15P, 15 ampere plug (two blade with round grounding pin) at the supply end. Exposed portions of the equipment are grounded through the round pin of the plug for safety. A non-grounded, two blade receptacle should not be used without use of a grounding-type connector adapter.

Note: If molded power plug is replaced observe the following convention:

Brown Wire:	AC Line (HOT)	SKT A
Blue Wire:	AC Neutral	SKT C
Green Wire:	Safety (Earth) Ground	SKT E

If an extension power cord is used with the TCS-5, make sure that wire size and current rating is sufficient to handle the TCS-5 load. For 115V operation, the extension cords should be 3 conductor cable with a minimum wire size of 14 AWG (2 mm). For 230 volt operation the minimum wire size should be 16 AWG (1 mm).

2-5 CABLES AND CONNECTORS

2-5.1 GENERAL. The rear panel connectors are illustrated in Figure 2-4 and explained in Table 2-5. The following paragraphs and tables describe the use and pinouts of the various rear panel connectors.

2-5.2 ANTENNA. The TCS-5 is a Chirpsounder Transmitter which generates RF power up to 150 Watts. The Chirp transmission sweeps 2 to 30 MHz, thus the antenna should be of a (50 ohm) broad band type and capable of handling the RF power. An optional antenna coupler is available for use with non-wideband antennas. An external BR 7039 Antenna relay may be used to select up to three separate antennas.

2-5.3 ANTENNA CONTROL OUTPUT-J8. Rear panel connector J8 controls the optional BR 7057 Antenna Tuner or the optional BR 7039 antenna relay. The BR 7057 Antenna Tuner provides fast antenna matching for Chirp as well as fixed frequency operation. The BR 7039 Antenna Relay provides separate antenna selection for different operating modes. The relay routes the TCS-5 output to one of three antennas. The antenna selected, 1, 2, or 3, is determined by program selection made in the "Set Chirp" and "Set Comm" modes. The "Interlock In" is provided for external safety control of the TCS-5. Pin 5 of J8 must be grounded before any RF transmission may proceed. A mating plug for J8 is provided. Alternately, BNC connector J11 can be grounded to complete the interlock circuit and enable transmissions. If no safety interlock is required, connect BNC terminator P11 to J11. NOTE: P11 is shipped from the factory attached to the TCS-5 rear panel. The interlock may be extended from either J8-5 or J11 to an external safety loop if desired. A wiring diagram of the interlock/antenna select plug is provided in Figure 2-1. The serial data port #4 is provided for 7057 antenna tuner control. The pin-out of J8 is shown in Table 2-1. The alarm driver and the three antenna select drivers are open-drain FET devices that can sink up to 200 mA to ground when selected (on) and withstand a maximum open circuit voltage of +40 volts when deselected (off). Note that external (user supplied) inductive transient clamp diodes are required when connecting relay coils to the FET drivers (e.g. 1N4002 diode shown in "typical application" antenna crossover relay in Figure 2-1). The mating cable plug for J8 is BR P/N 1253-0005, military part number MS-27473E12F35P (MIL-C-38999) which uses a cable clamp (BR P/N 1253-0025) Military Part Number MS-27506F12-2, both of which are included in the TCS-5 Accessory Kit.

Table 2-1. Rear Panel Connector J8 (Antenna Control Output) Pin Out

Pin No.	Function	Pin No.	Function
1	Circuit Gnd	12	+5 Vdc
2	Chassis Gnd	13	Chassis (Shield) Gnd
3	+12 Vdc	14	+28 Vdc
4	Not Connected	15	Out 4 Ref
5	Interlock In (Gnd for Operation)	16	Out 4 Sig Serial Data
6	Alarm Out	17	In 4 Ref
7	Ant 3	18	In 4 Sig Serial Data
8	Ant 2	19	+28 Vdc
9	Ant 1	20	Spare
10	1 PPS	21	Spare
11	Antenna Select (HI/LOW)	22	Spare

WARNING

THIS EQUIPMENT IS DESIGNED FOR OPERATION WITH A 3-WIRE (LINE, NEUTRAL, SAFETY GROUND) A.C. LINE POWER CONNECTION. DO NOT USE WITH SAFETY GROUND (GREEN WIRE) DISCONNECTED. IF A 3-WIRE SAFETY GROUNDED A.C. POWER RECEPTACLE IS NOT AVAILABLE, A SEPARATE GROUND WIRE MUST BE INSTALLED BETWEEN THE EQUIPMENT FRAME AND THE BEST AVAILABLE "EARTH" GROUND. DO NOT USE ANTENNA FEEDLINE OR SIGNAL CABLE SHIELDS FOR GROUNDING.

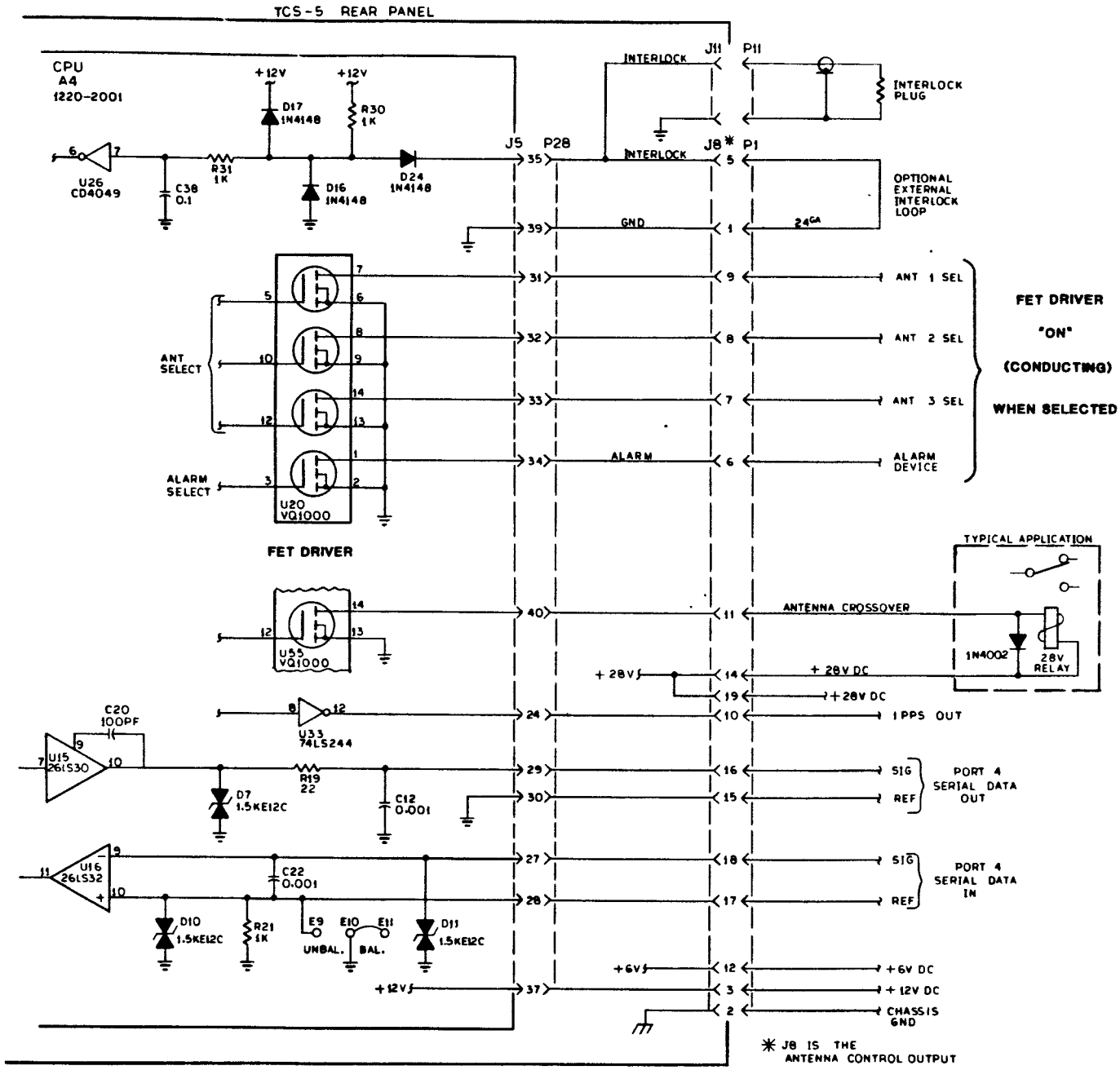


Figure 2-1. Antenna Control Output (J8) Wiring Diagram

2-5.4 REMOTE I/O-J7. J7 provides serial transfer of data via three I/O ports for remote control input and remote readout of Chirpsounder functions. Port I is typically used with the FMT-5A Frequency Management Terminal for control and setup of Chirpsounder operating parameters. FO-33 is the interconnect wiring diagram between the TCS-5 and the FMT-5A. Port 2 is typically used with the BR RCS-5A/B for transreceiver operation which requires an optional transreceiver connection cable kit (BR P/N 1220-1920). Port 3 is for optional uses. J7, serial data ports 1, 2, and 3, supply and accept unbalanced low level polar (MIL-STD-188-114, or EIA RS-423) signals. It is compatible with balanced (RS-422) signals. The pin out of J7 is shown in Table 2-2. The mating cable plug for J7 is BR P/N 1253-0019, military part number MS27473E14F35P (MIL-C-38999). For remote applications other than the FMT-5A, additional I/O information can be obtained by contacting BR Communications. Refer to FO-33 for FMT-5A connections using the BR 6202-1505 Modem.

2-5.5 TRANSRECEIVER INSTALLATION. Full co-located transreceiver operation of a TCS-5 and RCS-5A requires the use of the BR P/N 1220-1920 cable kit, which includes two BNC coaxial cables and one multiconductor data cable. The multiconductor cable must be connected between the TCS-5, J7 and the RCS-5A Remote I/O, J4. Audio for monitoring in the TCS-5 handset is provided by the BNC coaxial cable between the TCS-5 J4 and the RCS-5A Line audio out, J10. For common antenna operation, the second BNC coaxial cable must be connected between the TCS-5 J10 and the RCS-5A antenna input J1. This configuration is shown in Figure 1-2.

Table 2-2. Rear Panel Connector J7 (Remote I/O) Pin Out

Pin	Function	Pin	Function
1	IN 1 Signal Serial Data	14	+5 Vdc
2	+12 Vdc	15	OUT 2 REF
3	IN 1 REF	16	+5 Vdc
4	+12 Vdc	17	IN 3 Signal Serial Data
5	OUT 1 Signal Serial Data	18	IN 3 Ref
6	Circuit Ground	19	OUT 3 Signal Serial Data
7	OUT 1 REF	20	OUT 3 Ref
8	Circuit Ground	21	Not Connected
9	IN 2 Signal Serial Data	22	Spare OUT
10	-12 Vdc	23	Spare IN
11	IN 2 REF	26	Tx Key Status OUT (TTL HI=Key On)
12	-12 Vdc	27	Start of Sweep
13	OUT 2 Signal Serial Data	37	Chassis (Shield) Gnd

2-5.6 BATTERY INPUT-J2. The standby battery supply maintains critical timing and sweep parameters during primary power outages. J2 can be used for input of an external dc power supply for standby power in order to extend the standby power time limit beyond the 5 hours supplied by the internal standby battery supply. It is typically used with optional BR 6073 External Battery Pack. The battery pack will float charge while connected if battery switch (S4) on the rear panel is ON. It supplies standby power for approximately 48 hours. The pin out for J2 is shown in Table 2-3. The charger circuitry is designed for a 12V lead acid battery supply. Any user supplied external DC power source should supply

a nominal +12 Vdc (11.0 to 14.5 Vdc range is acceptable) to J8 pins A(+) and B(-). The mating cable plug for J2 is BR P/N 1251-0045, military part number MS3106A-14S-06S (MIL-C-5015) (with cable clamp BR P/N 1251-0014).

Table 2-3. Rear Panel J2 (Battery Input) Pin Out

Pin	Function
A	BATTERY +V IN
B	BATTERY-V IN
C	Charge Circuit Enable
D	Charge Enable (Gnd) Return
E	Spare
F	Spare

NOTE

Pins C and D are for use with BR P/N 6073 external battery pack only. A user-supplied +12 Vdc external battery or standby +12 Vdc supply may be connected to pins A (+) and B (-) only. The required standby power is 11.0 to 14.5 Vdc at approximately 200 mA. External battery -V must not be externally grounded, and must not be connected to the TCS-5 chassis.

2-5.7 MICROPHONE/HANDSET CONNECTOR. Front panel connector J1 allows the use of a microphone or handset. The mating cable connector is military part number U-229/U (MIL-C-55116). The pin out is shown in Table 2-4.

Table 2-4. Microphone/Handset Connector J1 Pin Out

A	Common (Ground)	D	Microphone
B	Receiver (ear phone)	E	Not Connected
C	Push-to-talk key		

2-5.8 LINE- AUDIO INPUT. Line-level audio from an audio source can be applied to the TCS-5 rear-panel terminal board TB1. The line audio will modulate the TCS-5 only when the LSB or USB communications mode is selected. The audio source must supply a nominal signal level between -13 and +10 dBm across 600 ohms to screw terminals A and B as follows:

a. For balanced audio sources, connect the two audio wires to terminals A and B. If a third (ground or shield) wire is used, connect it to the chassis ground terminal of TB1.

b. For unbalanced audio sources (one of the two audio wires grounded), connect the grounded line to terminal B, and the signal line to terminal A, of TB1.

c. Switch S3 should be set to the anticipated nominal audio signal level of the source.

2-5.9 EXTERNAL KEYLINE INPUT. The TCS-5 may be externally keyed in the communications mode by applying a transmit key signal to rear-panel terminal board TB1. The keyline input has no effect on Chirp sweep transmissions; only LSB, USB, or CW "comm" transmissions. The TCS-5 can be keyed from two sources:

a. Key (mechanical): connect the key contacts between the "Ext Key" and "Key Gnd" terminals of TB1. The transmitter is keyed on when the contacts are closed, i.e. when the "Ext Key" input is grounded.

b. Electronic: connect the key line to the "Ext Key" terminal, and the ground return line to the "Key Gnd" terminal, of TB1. To key the transmitter the keying source must provide a logic low (0.8V maximum) by sinking 12 ma from an internal 12-V (1k ohm) source. When not keyed, the external key line may be left open circuit or may be held at any voltage between 2.5 and 35 volts DC. If the external key line is left open circuit, the voltage will rise to approximately 12 volts DC. The external key input is compatible with keyers using the following digital logic devices: regular - and LS-type TTL; HC, HCT, AC and ACT type CMOS; and open collector discrete transistor logic. The external key input cannot be driven by regular CMOS logic, and must not be driven to a negative voltage by polar devices such as RS-423 line drivers or any other negative voltage source.

2-5.10 TRANSMIT INTERLOCK INPUT. The transmit interlock prevents inadvertent transmitter operation. Under no circumstances will the TCS-5 transmit when the transmit interlock circuit is open. (The interlock disables both the main RF output at J9 and the exciter output at J3.) Normal transmitter operation can be enabled in any of three ways:

a. Mechanical contact closure: connect the interlock line from an external interlock switch to either pin 5 of J8 or the center conductor J11. Connect the ground return line of the switch to either pin I of J8 or to the outer conductor of J11. Normal operation of the transmitter is allowed only when the contacts of the (external) mechanical interlock switch are closed, i.e. when the interlock is grounded.

b. Electronic: connect the interlock line to either pin 5 of J8 or the center conductor of J11. Connect the ground return line to either pin 1 of J8 or to the outer conductor of J11. To allow normal operation of the transmitter, the external interlock line must provide a logic low (0.8V maximum) by sinking 12 ma from an internal 12-V (1k ohm) source. To prevent transmissions under any circumstances, the external interlock line may be left open circuit or may be held at any voltage between 2.5 and 35 volts DC. If the external interlock line is left open circuit, the voltage will rise to approximately 12 volts DC. The external interlock input can be driven by the following digital logic devices: regular - and LS type TTL; HC, HCT, AC, and ACT type CMOS; and open collector discrete transistor logic. The external interlock input cannot be driven by regular CMOS logic, and must not be driven to a negative voltage by polar devices such as RS-423 line drivers, or any other negative voltage source.

c. Defeated: If the interlock function is not to be used, a BNC shorting plug (supplied and attached to the TCS-5 rear panel) may be left permanently connected to the connector J11.

2-5.11 EXTERNAL 5 MHz REFERENCE INPUT. The TCS-5 contains a precision internal 5-MHz oscillator as a timing and frequency reference. If TCS-5 timing is to be referenced to an external 5-MHz source (house standard), connect the external frequency standard to rear-panel connector J5. The external standard must provide a 5 MHz sine wave into a 50-ohm load. The TCS-5 will automatically use the externally applied frequency standard as long as the 5 MHz amplitude remains between 0.2 and 1.0 Vrms.

2-5.12 5 MHz REFERENCE OUTPUT. The TCS-5 outputs a precision 5-MHz timing and frequency reference from rear-panel connector J6. If no external reference is applied to connector J5, the reference will be derived from the TCS-5 internal crystal oscillator. If an external 5-MHz source (house standard) is connected to J5, the output will be derived from that source. The nominal output level is 0.5 Vrms into 50 ohms.

2-5.13 TRANSMIT EXCITER OUTPUT. The TCS-5 transmit exciter output can be used by an external RF power amplifier when rear-panel switch S5 is set to EXT. The exciter output signal which appears at rear-panel connector J3 is nominally +20 dBm in the high power setting (+10 dBm in the low power setting) and is 50 ohms unbalanced. When switch S5 is set to EXT, there will be no RF output from the main antenna connector J9. Connection of an external cable to the exciter output, J3, may cause certain transmitter self tests to fail. The preselector test may sense a failure if an unusual load is present in the circuit.

2-5.14 ANTENNA OUTPUT TO RECEIVER. In certain applications the TCS-5 will be operated with a companion HF receiver, sharing one antenna for alternating transmit and receive functions. In these configurations, the single antenna should be connected to the TCS-5 main antenna connector J9, and the receiver's antenna input connected to TCS-5 J10. When the transmitter is keyed, the TCS-5 RF power amplifier will automatically be connected through an internal T/R switch to the antenna connected to J9; J10 will be short-circuited to ground to protect the receiver. Whenever the TCS-5 is not transmitting, its power amplifier is disconnected and the antenna is connected to the receiver through J10.

2-5.15 OPTIONAL CARTRIDGE READER. A 2862 Cartridge Reader may be connected to the TCS-5 rear-panel remote I/O connector J7.

2-6 STANDBY BATTERY

2-6.1 A rechargeable standby battery supply contained within the TCS-5 is used to maintain Chirp synchronization during temporary AC line power outages. The battery is shipped from the factory installed in the unit and fully charged. In the event of AC line interruption, the real time clock and timing synchronization will be maintained for approximately 5 hours (at 23°C) by the internal standby battery pack, or 48 hours by the model 6073 optional external battery supply. Sounder transmission, however, will not occur during battery operation. It is recommended that the operator not rely on battery power for the first 12 hours of operation, as the battery pack may have self discharged during shipment and may need to be charged. Charging is automatic as soon as AC line power is turned on if the battery switch on the rear panel is ON. After a 24 hour charge the battery pack will provide approximately 75% standby capacity. Full battery capacity is not reached until the batteries have been charge/discharge cycled approximately three times with a 48 hour charging period. Refer to paragraph 3-15 for more information on use and shutdown procedures of the standby battery supply.

2-7 POST-INSTALLATION CHECKOUT

2-7.1 The electrical performance of the TCS-5 should be verified before being put into normal operation. The performance test described in Section V is performed as the post-installation checkout prior to operation.

2-8 STORAGE AND RESHIPMENT

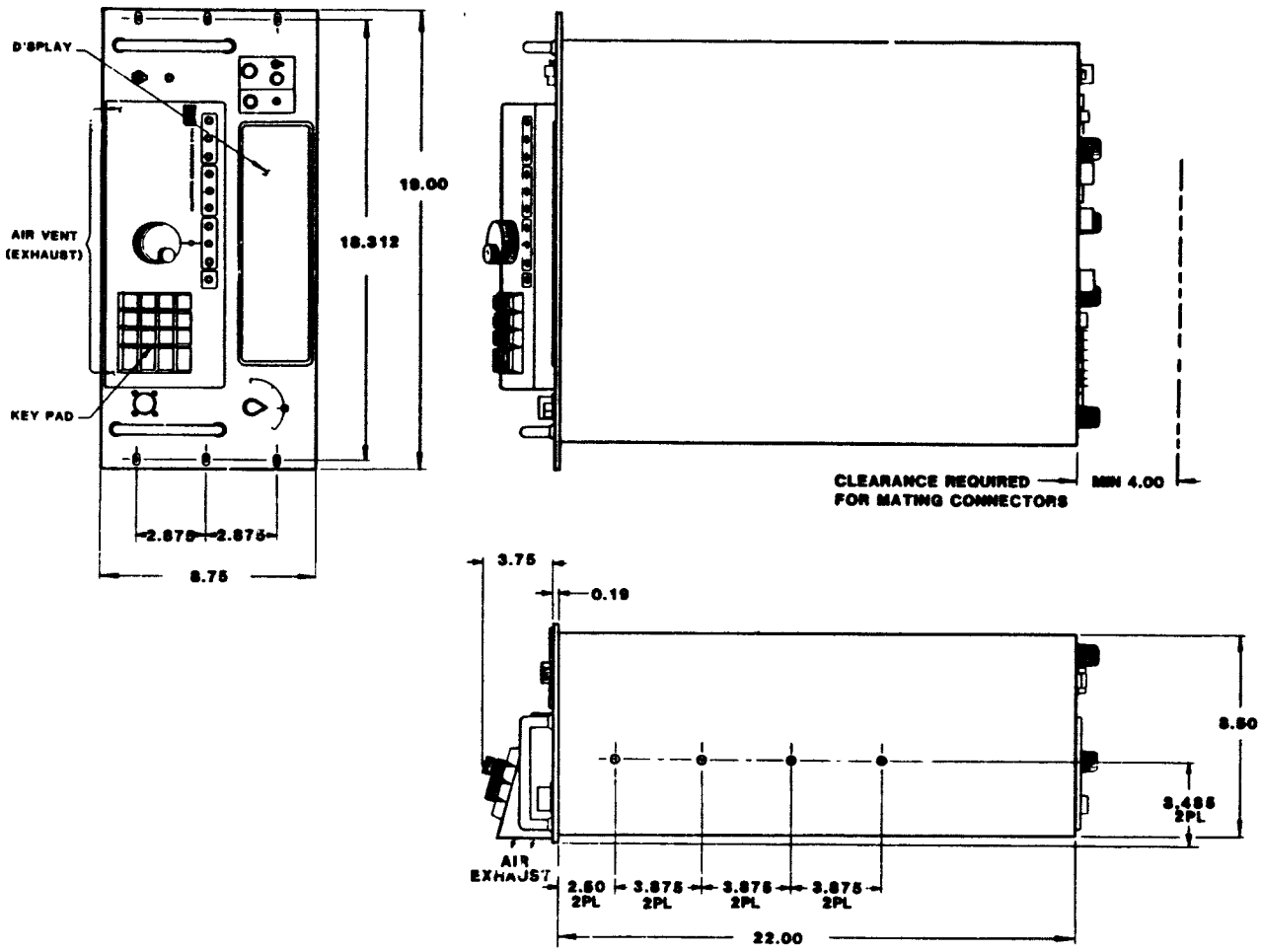
2-8.1 STORAGE. The maximum recommended storage environment should not exceed -40°C to +71°C temperature or 95% humidity. For long term storage, repackaging of the equipment and sealing of the cables into moisture proof bags is recommended. For storage exceeding 2 days the battery pack should be shutdown. See Section III for this procedure.

2-8.2 RESHIPMENT. The optional environmental case offers sufficient protection for reshipment of the TCS-5. If no case is available, the TCS-5 should be surrounded by high density foam and securely packed in a wooden crate for reshipment. The front and rear covers of the environmental case should be in place when moving the unit and extreme care should be taken to avoid damage to the instrument. To replace the front and rear panels, tighten the pressure relief valves (screws) located on each side of the case, and while pushing in, turn the handles on the front and rear panels clockwise until covers are secure. The rear panel is deeper and is equipped with a pouch for power cord storage. The front panel contains a slot for the operating manual.

2-9 CONNECTIONS TO COMPATIBLE INSTRUMENTS

2-9.1 The TCS-5 can be used with other instruments, including the FMT-5A Frequency Management Terminals, RCS-5A/B Chirpsounder Receivers, and external devices. These connections are illustrated as shown below.

Title	Figure No.
TCS-5 to RCS-5B (Slave Mode)	Figure 2-5
TCS-5 with 2862 Cartridge Reader to External Data Device	Figure 2-6
TCS-5 to FMT-5A (Versions -03, -04 and -05) for Tone Keying Data Transmission	Figure 2-7
TCS-5 to FMT-5A (Versions -03, -04 and -05) for Polar Data Transmission	Figure 2-8



WEIGHTS AND DIMENSIONS TCS-5 Rack Mount
(Refer to FO-37 for complete envelope drawing, including rear view)

WEIGHT: 78 lbs (35.5 kgs)

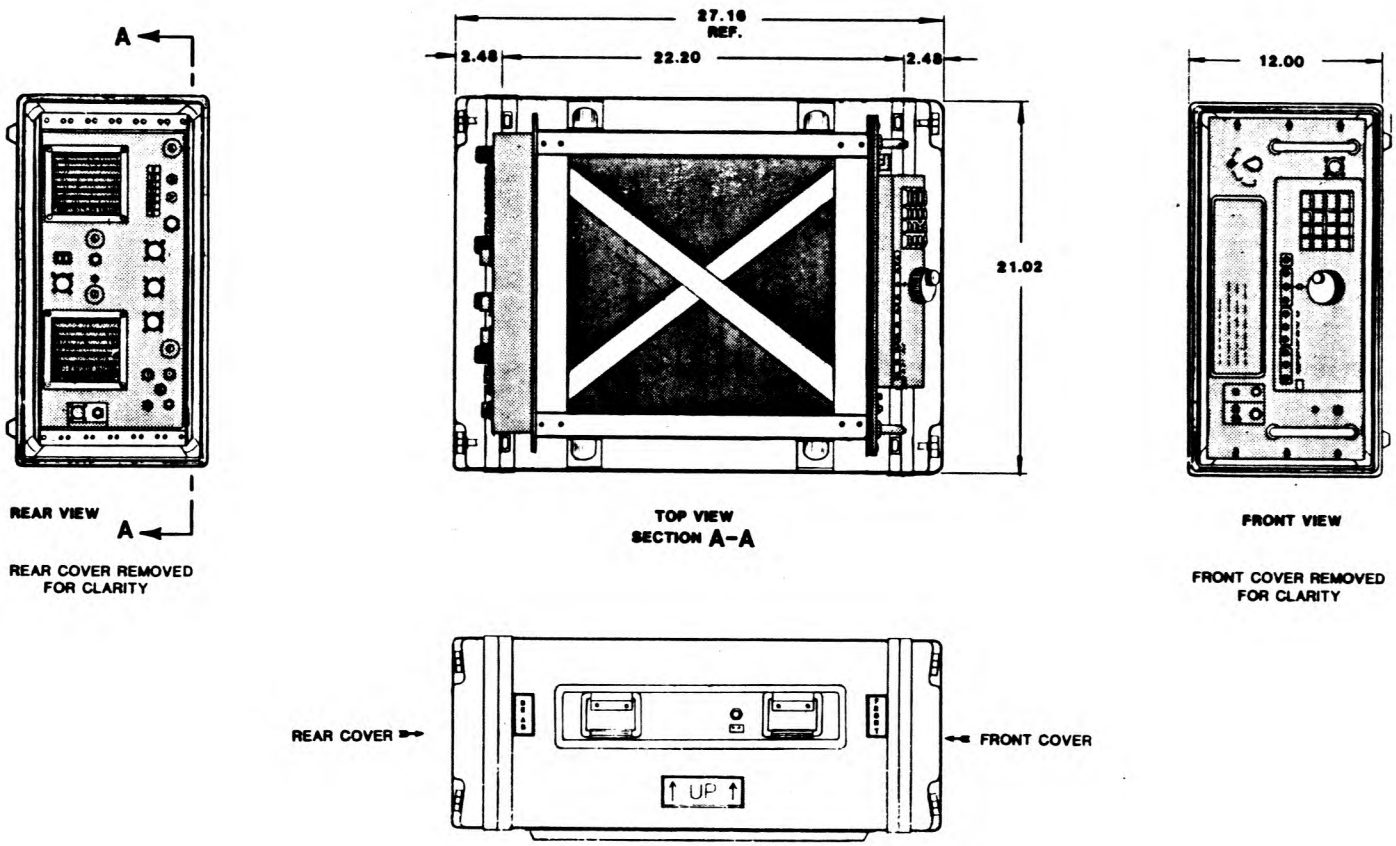
VOLUME: Approximately 2 cubic feet (.06 cubic meters)

DIMENSIONS

Width: 19 inches (48 cm) (with standard rack mount panels)
Depth: 22 inches (56 cm) (Behind front panel, not including connectors)
Height: 8.75 inches (22 cm)

SHIPPING WEIGHT: Approximately 155 lbs (70.5 kg)

Figure 2-2. TCS-5 Dimensions



WEIGHTS AND DIMENSIONS TCS-5 Environmental Case (Refer to FO-38 for complete envelope drawing)

WEIGHT: 115 lbs (52.3 kgs)

VOLUME: Approximately 3.8 cubic feet (.10 cubic meters)

DIMENSIONS

Width: 21.02 inches (53.3 cm)
Depth: 28.62 inches (71.1 cm)
Height: 12 inches (30.5 cm)

SHIPPING WEIGHT: Approximately 190 lbs (86.4 kg)

Figure 2-3. TCS-5 Dimensions in Optional Environmental Case

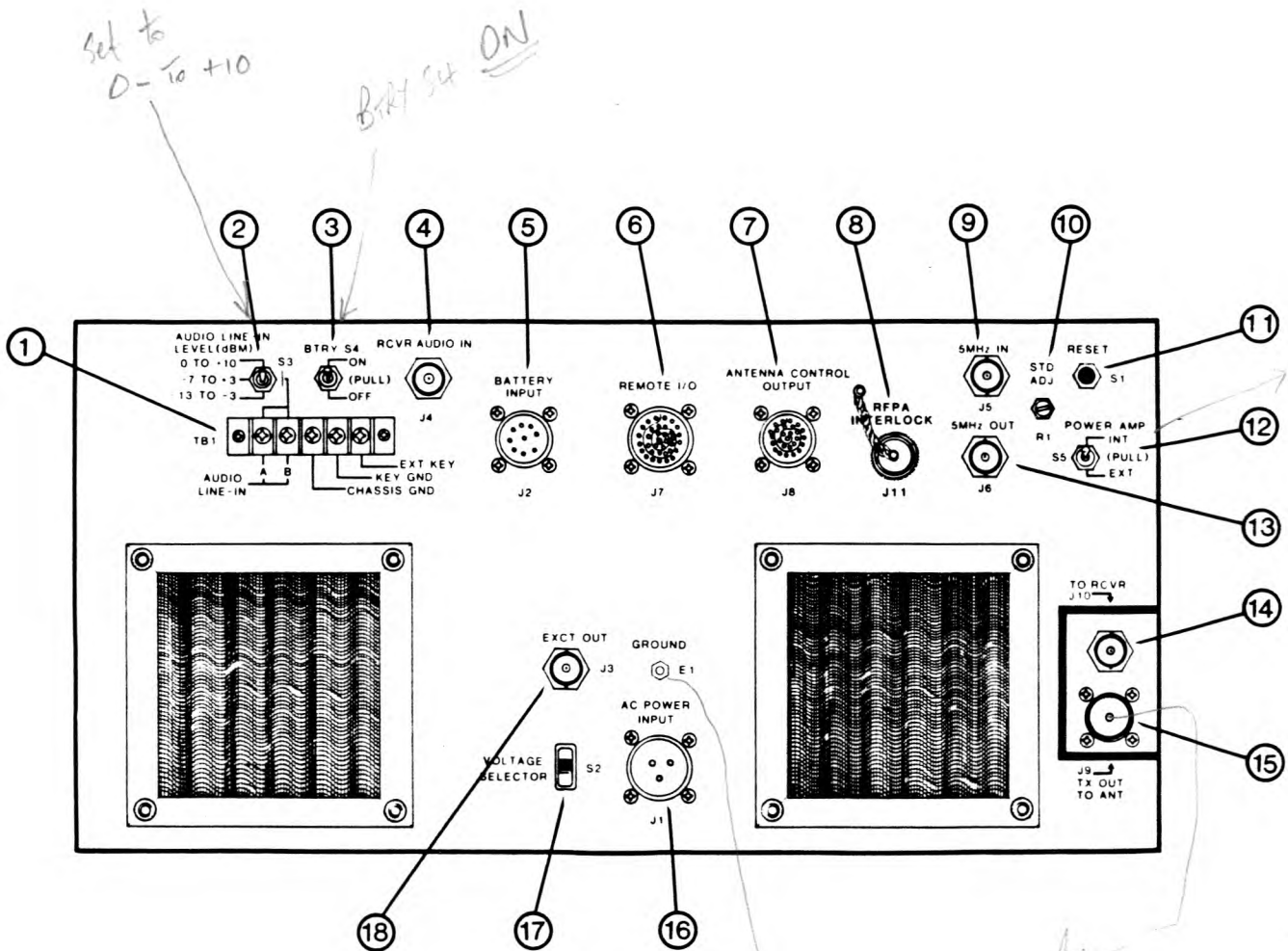


Figure 2-4. Rear Panel Controls and Connectors

Table 2-5. Rear Panel Controls and Connectors

Item	Control/Connector	Function
1.	LINE INPUT/EXT KEY (TB1):	A 5-way terminal board for audio input to the transmitter. The keyline is also located on this terminal board. The audio input is 600 ohms, balanced. Nominal level is set by S3. The keyline requires a contact closure to ground. Internal pull up to +12V is provided. Key line is in parallel with the front panel key and handset key. This allows Morse key CW operation.
2.	LINE AUDIO LEVEL (S3):	Three position switch to match the expected level of the line audio input. Switch will select one of three levels: -13 to -3 dBm; -7 to +3 dBm; 0 to +10 dBm
3.	BATTERY ON/OFF (S4):	A two position locking pull-to-switch toggle switch that disconnects the internal battery supply. Batteries should be disconnected prior to long term storage of the equipment.
4.	RECEIVER AUDIO IN (J4):	BNC connector for RCS-5 receiver audio input to the handset. The audio will appear in the handset receiver when the TCS-5 is not keyed. Input is 600 ohms unbalanced, nominal level of 0 dBm.
5.	EXT BATTERY (J2):	6 Pin, MIL-C-5015, MS3102A-14S-06P connector for connection of an external DC power to maintain clock and path timers. Input should be between 11.0 and 14.5 volts. External battery may be charged by jumpering certain pins.
6.	REMOTE CONTROL (J7):	Circular connector (37 pin MIL-C-38999, MS27508E14F35S) with three serial data ports. Port 1 is used for remote control. Slave control from the RCS-5A is on Port 2. Port 3 is a spare. Data is RS-423 ±5 volt, differential inputs. Power (+12V, -12V, +5V) for a BR 6202 Modem is available on this connector.

Table 2-5. Rear Panel Controls and Connectors (cont.)

Item	Control/Connector	Function
7.	ANTENNA CONTROL/ANTENNA COUPLER INTERLOCK (J8):	Circular connector (22 pin MIL-C-38999, MS27508E14F35S) providing serial data to BR model 7057 Antenna Coupler. Three control lines available for ANT 1, ANT 2, and ANT 3 for BR model 7039 Antenna Selector Relay. One additional control line output for control of an external low band/high band antenna crossover relay. An interlock line is provided for external control of the transmitter. This line must be grounded for transmitter operation. If the line is open, the transmitter cannot be keyed on.
8.	RFPA INTERLOCK (J11):	BNC coaxial connector allows remote control of transmitter interlock. Normal transmitter operation is allowed only when J11 is grounded. Transmitter operation is prevented when J11 is at a logic high or left open circuit.
9.	5 MHz IN (J5):	BNC connector for the input of an external 5 MHz frequency standard. When used, the TCS-5 becomes phase-locked to the external standard. For proper operation, the external standard must be spectrally clean, with phase noise less than -130 dB/Hz, and hum lines greater than -80 dBc. The required input waveform is a 5 MHz sine wave at 0.2 to 1.0 VRMS from a 50 ohm source.
10.	STANDARD ADJUST (R1):	Potentiometer to control the 5 MHz frequency standard.
11.	RESET (S1):	Push button used to reset the microprocessor system in the event of malfunction.
12.	INT/EXT PWR AMP (S5):	A two position locking pull-to-switch toggle switch. In the INT position, the internal RF power amplifier will operate. In the EXT position, the internal power amplifier is disabled and the RF signal at 100 mW (+20 dBm) level is available on the rear panel EXCIT OUT jack. The exciter signal may be used to drive an external RF power amplifier.

Table 2-5. Rear Panel Controls and Connectors (cont.)

Item	Control/Connector	Function
13.	5 MHz OUT (J6):	BNC connector provides 5 MHz sinewave output to another device. Output level is approximately 1/2 VRMS nominal into 50 ohms.
14.	ANT OUT to RECEIVER (J10):	Type BNC connector for the receiver antenna input. When the TCS-5 is in standby, this connector is connected to the transmit antenna. Thus, the transmit antenna may be used for receiving. When the TCS-5 is in transmit, the connector is disconnected from the antenna and shorted to ground.
15.	TRANSMIT OUT (J9):	Type N connector for the transmit power output. This connector also serves as the receive antenna input for transreceiver operation. Refer to item 14 above.
16.	AC LINE (J1):	Three conductor MS-3102A-16-10P (MIL-C-5015) connector for the attachment of the AC power cord. Mating plug is MS-3106A-16-10S.
17.	LINE VOLTAGE SELECTOR (S2):	Recessed, two position switch for selecting either 115 or 230 Volts AC line input to the main power supply. Overcurrent protection is provided by the front panel circuit breaker.
18.	EXCIT OUT (J3):	BNC Coaxial connector provides RF exciter output of TCS-5 for use by external RFPA when the INT/EXT switch is in the EXT position. The exciter signal will be at a nominal +20 dBm (100 mw) in the full power setting and will drop to a nominal +10 dBm level in the 1/10 power setting. Line impedance is 50 ohms unbalanced.

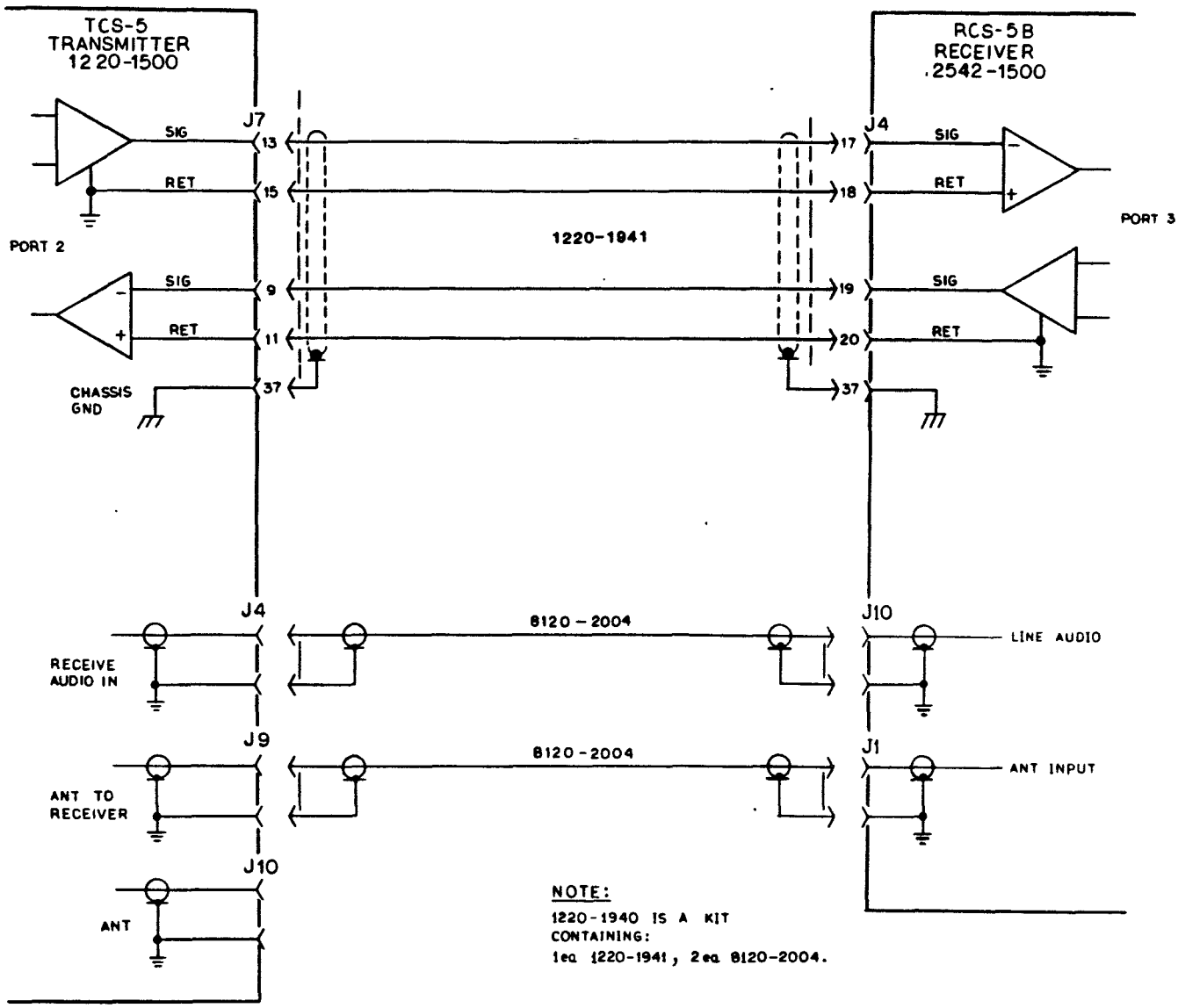


Figure 2-5. Interconnect Diagram, TCS-5 to RCS-5B (Slave Mode)
(BR Drawing No. 8999-4412)

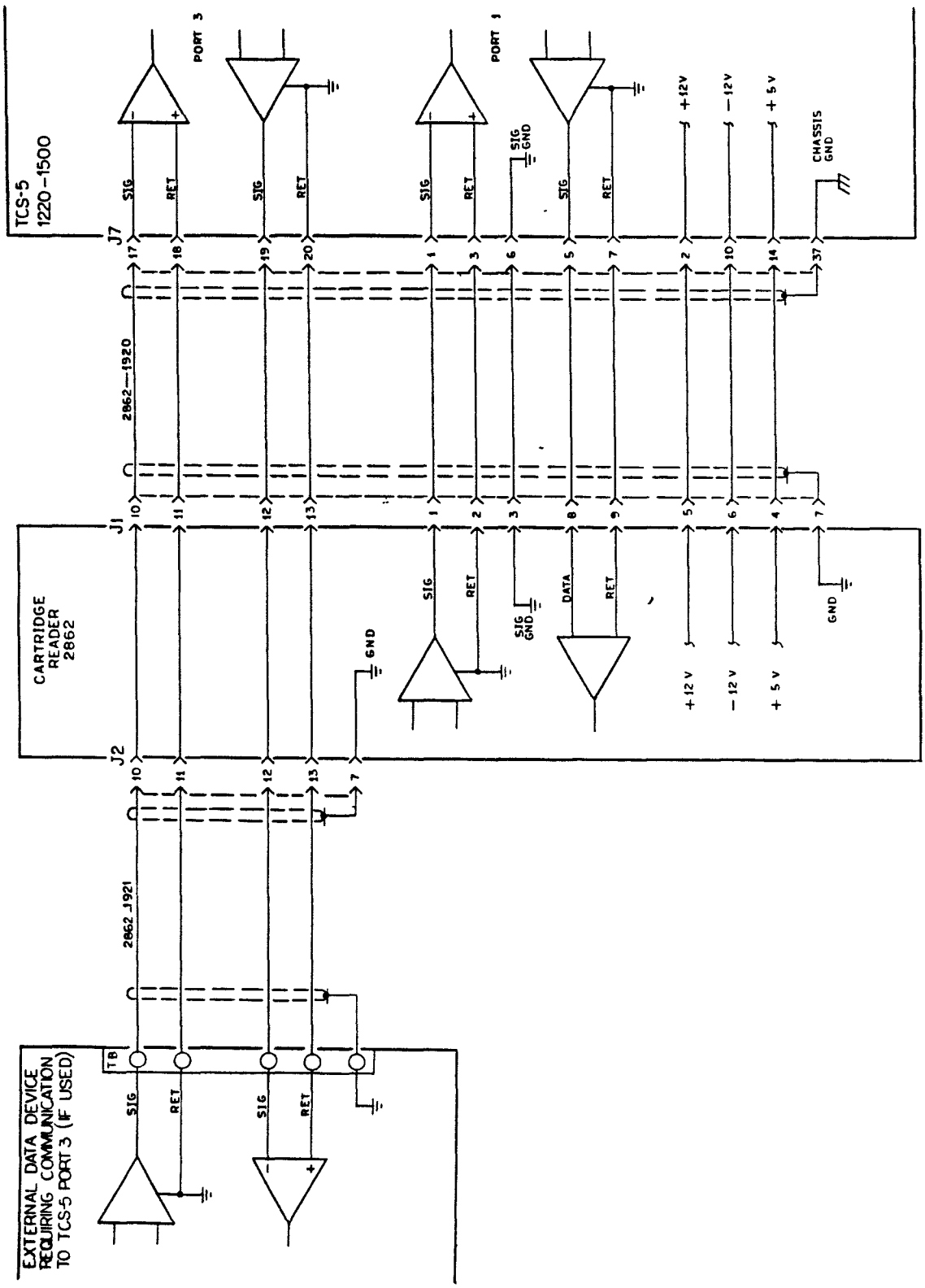


Figure 2-6. Interconnect Diagram, TCS-5 with 2862 Cartridge Reader to External Data Device (BR Drawing No. 8999-4411)

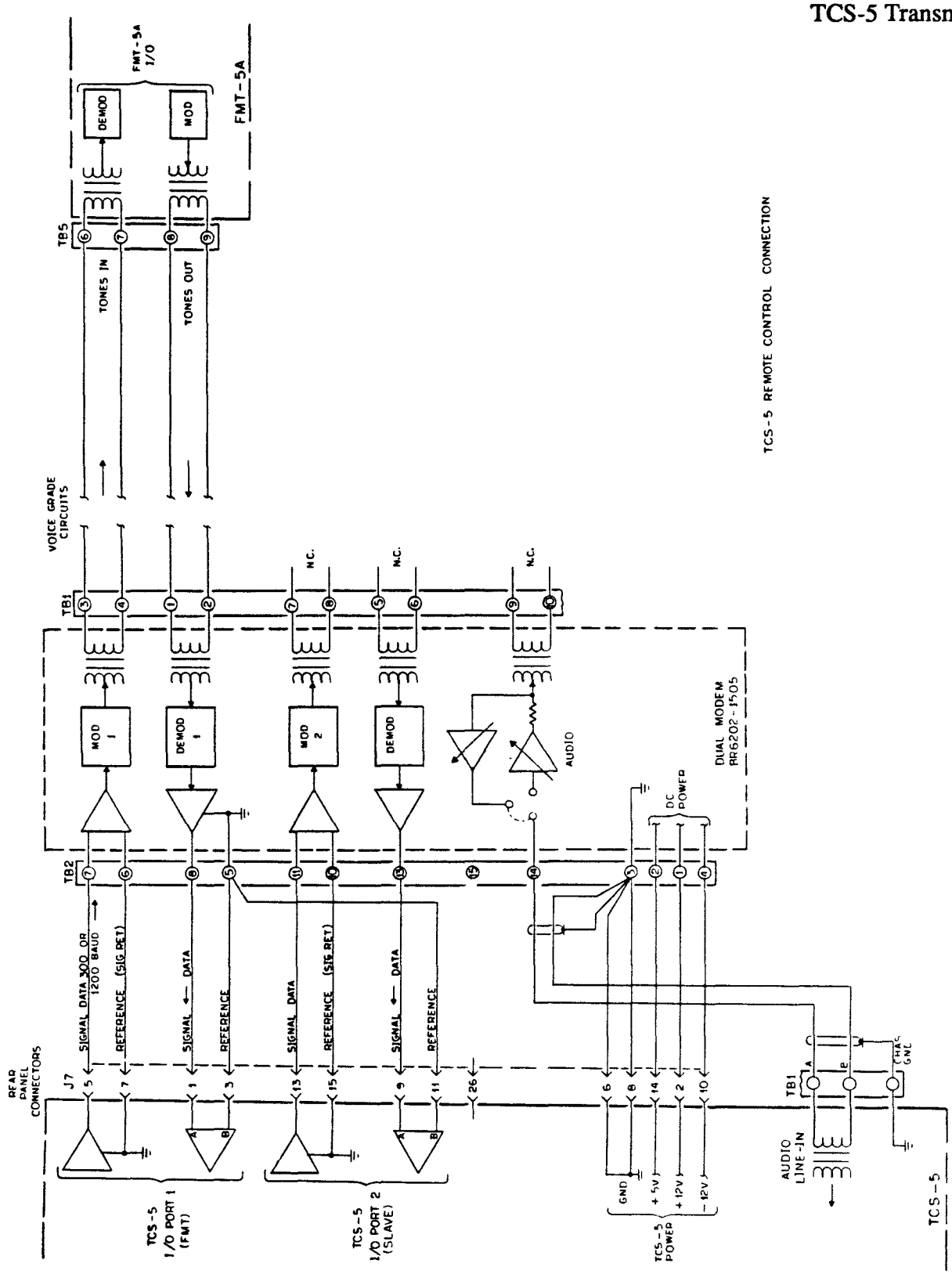


Figure 2-7. Interconnect Diagram, TCS-5 to FMT-5A (Versions -03, -04 and -05) for Tone Keying Data Transmission (BR Drawing No. 8999-4402)

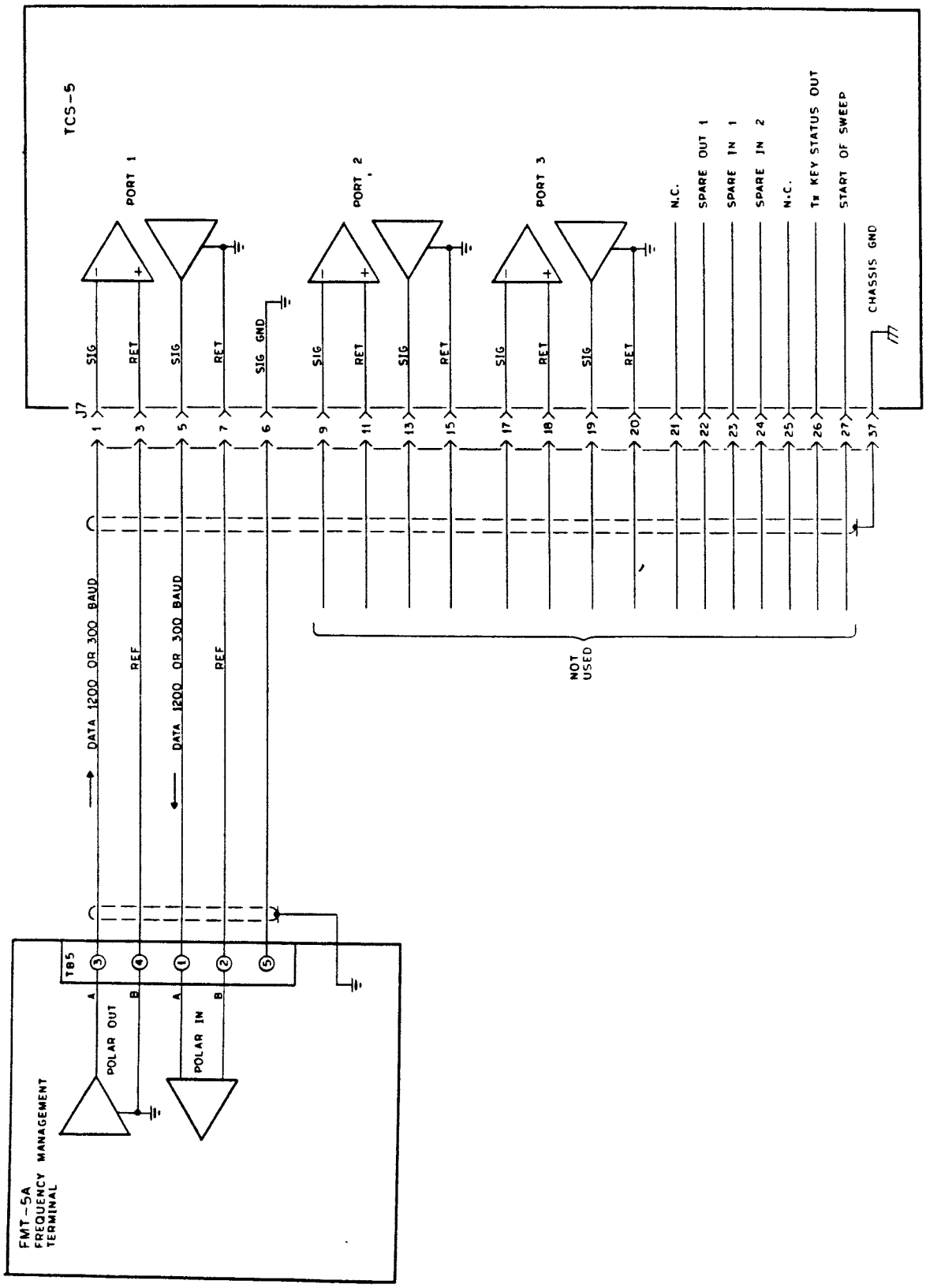


Figure 2-8. Interconnect Diagram, TCS-5 to FMT-5A (Versions -03, -04 and -05) for Polar Data Transmission (BR Drawing 8999-4413)

SECTION III
OPERATION

3-1 INTRODUCTION

3-1.1 GENERAL. The TCS-5 is a Chirpsounder Transmitter as well as a communications transmitter. The TCS-5 requires antenna(s) suitable for the intended task. For communications purposes, the audio source may be voice from the handset or tones from local or remote modems. If transreceiver operation is desired, a single antenna may be used for both transmission and reception.

WARNING

Make sure that the frame is grounded by the three-wire, three-prong power cord or a separate ground strap before operating. If not grounded, the frame and exterior panel could be at a potentially dangerous voltage level.

3-1.2 START UP PROCEDURES. Before proceeding, verify that the AC line voltage selector switch (S2) on the rear panel is set to match local AC line voltage. Insure that all necessary cable connections have been made as described in Section II, Installation. Move the power switch to the ON position. The display should activate and the clock start running. Adjust View Angle control until characters are shown on the display. Allow at least a twenty minute warm-up before proceeding.

3-1.3 SELF TESTS. If the TCS-5 has just been received or has been stored for a long period, perform the Self Tests. Allow a warm-up of twenty minutes, then place the MODE switch in the TEST position. Press "1" to select transmitter tests, and perform the following tests: preselector, post selector, full power, and sideband tests. Each test should pass. At the conclusion of each test, press "NEXT" to return to the transmitter test menu. Press 6 to return to the test menu and then perform the front panel, timer, and battery tests. If external control connections (remote control) are used, verify that the baud rate(s) are correct by using the baud rate setup selection on the Miscellaneous Utilities menu. Do not perform the CW test at this point. Refer to paragraph 5-5 for more detailed instructions on the Self Tests.

3-1.4 OPERATIONAL MODES. There are three major modes in the operation of the TCS-5 Transmitter. These are; initialization and check out mode, local operational mode, and remote mode. Front panel controls and indicators are described in Table 3-1 and illustrated in Figure 3-1.

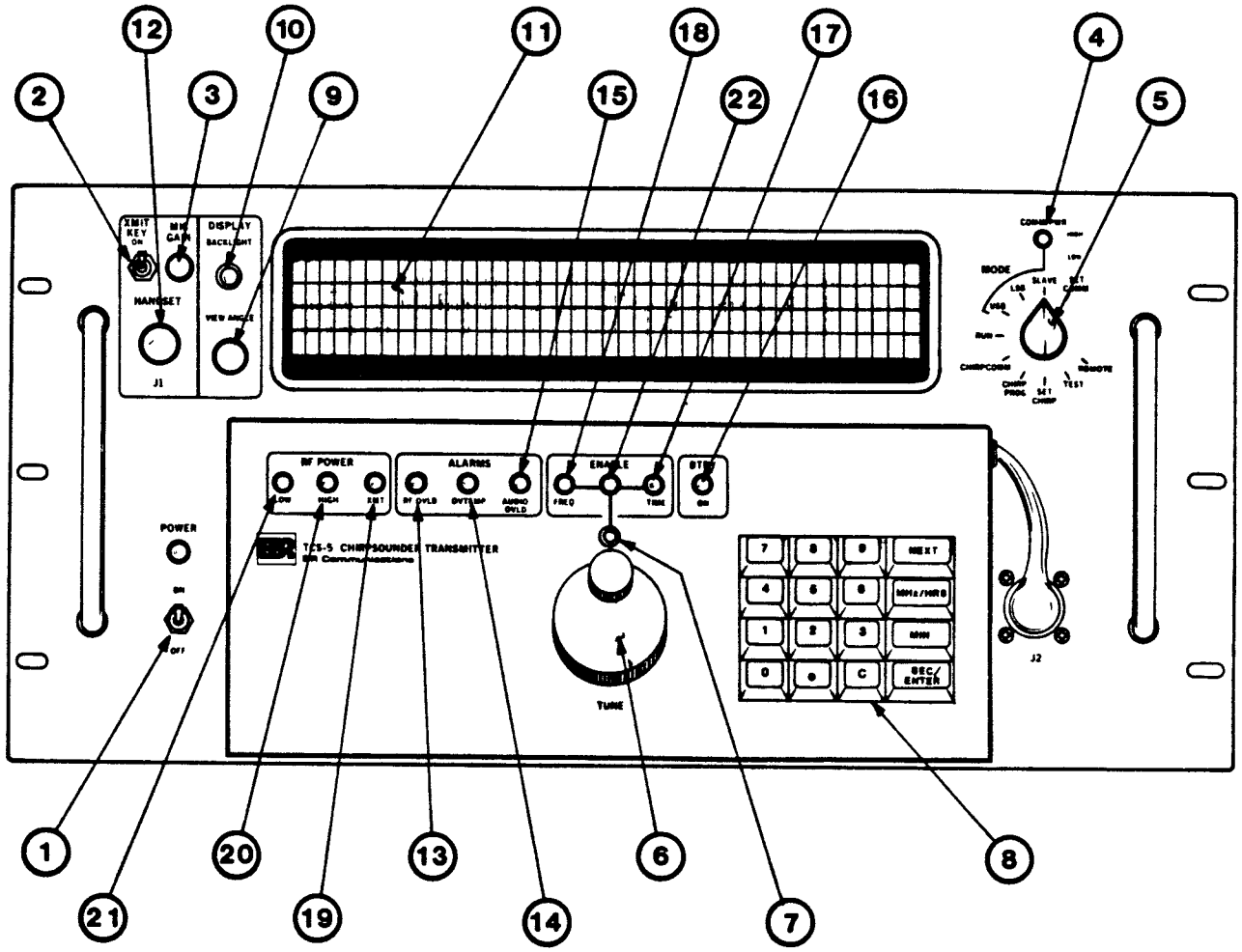


Figure 3-1. Controls and Indicators

Table 3-1. Front Panel Controls and Indicators

	Control/Indicator	Function
1.	POWER ON:	AC Line Power/Circuit Breaker Switch and green indicator lamp.
2.	XMIT KEY:	2-Position toggle switch. In ON position, transmitter keying logic is on. Actual transmission only initiated if MODE switch is in LSB, USB, or SLAVE position. If a frequency change is made when the transmitter is keyed on, the transmitter will key off and remain off until the key is cycled off and back on.
3.	MIC GAIN:	Potentiometer controls microphone input level. At full CCW position, no audio signal from the microphone will reach the modulator.
4.	COMM POWER: HIGH/LOW	3-Position toggle switch with momentary up and down positions. When MODE is USB, LSB, or SLAVE, pressing up enables HIGH for full power setting, pressing down enables LOW for 1/10 power setting. HIGH or LOW power LED (items 20 and 21) lights and remains illuminated until the switch is pressed in the other direction.
5.	MODE:	10-position rotary switch that selects the various modes of the TCS-5. The 10 modes are: SET COMM SLAVE LSB USB RUN CHIRPCOMM CHIRP PROG SET CHIRP TEST REMOTE
6.	TUNE:	Rotary tuning knob used to change frequency or time settings in a smooth manner. Operates only after ENABLE is pressed.

Table 3-1. Front Panel Controls and Indicators (Continued)

	Control/Indicator	Function
7.	ENABLE:	This button is a safety interlock for the TUNE knob. If the TIME LED or FREQ LED is on, the knob becomes enabled by pressing ENABLE.
8.	Keypad:	16 button keypad with numerals 0-9 and special TCS-5 operations.
9.	Display Viewing Angle Control:	Used to enhance the contrast for the operators particular viewing angle.
10.	Display Illumination:	Push button to activate the backlighting of the LCD. Illumination turns of automatically after about an eight minute timeout. Push and hold for 2 seconds or longer and release to turn off backlighting.
11.	LCD: (Liquid Crystal Display)	This 40 x 4 character LCD is used to display menu, modes, prompts, time, frequency, and other parameters of the TCS-5 transmitter.
12.	Handset Jack:	5-contact U-183/U (MIL-C-55116) connector for microphones or handsets. The connector provides contacts for the "push-to-talk" key and side tone.
Alarms		
13.	RFOVLD:	Red LED will light when the RF power amplifier detects an overload condition. This may be caused by high power into improper antenna loads, or excessive RF power injected into the transmitter output from adjacent RF sources.
14.	OVTEMP:	Red LED lights when the first level of over temperature occurs on the RF power amplifier (refer to paragraph 5-4.3b). At this time, the RF power will be reduced to a safe level. If the temperature continues to rise, a second over temperature thermostat will totally shut down the RF power amplifier. The amplifier will return to normal operation when its temperature has returned to normal.

Table 3-1. Front Panel Controls and Indicators (Continued)

Control/Indicator	Function
Alarms (Continued)	
15. AUDIO OVLD:	Red LED lights when excessive audio levels are input to the TCS-5. Reduce audio levels to prevent overload.
LED Indicators	
16. BTRY:	Green indicator lights when rear panel battery switch is on. When BTRY is on, an internal battery will maintain power to critical timing circuits during AC power failures, thereby maintaining synchronization.
17. TIME:	Yellow indicator flashes (1 second on, 1 second off) when tuning knob can be used to change time. However, ENABLE must be pressed before time can be changed by the knob.
18. FREQ:	Yellow indicator lights when tuning knob can be used to change frequency. However, ENABLE must be pressed before the frequency can be changed by the knob.
19. XMT:	Green indicator lights when the RF power amplifier is keyed on.
20. RF POWER/HIGH:	Yellow indicator lights when the RF power output level has been set to HIGH.
21. RF POWER/LOW:	Yellow indicator lights when the RF power output level has been set to LOW.
22. ENABLE:	Yellow indicator lights when tuning knob is active to adjust time or frequency after ENABLE push button is pressed. Pressing ENABLE push button again will disable knob and ENABLE LED will go out.

3-2 INITIALIZATION AND CHECK-OUT

3-2.1 INTRODUCTION. This paragraph describes in general terms the steps to set up the TCS-5 for operation. Specific instructions and displays follow in paragraphs 3-3 through 3-6. Initialization and check out mode is used when the unit is first turned on. Routines are available that establish operating parameters and unit check out. Modes available are SET CHIRP, CHIRP PROGRAM, CHIRPCOMM MESSAGE PROGRAM, and SET COMM. In addition, a TEST mode is explained in Section V.

3-2.2 PREPARATION. The Chirpsounder start (offset) time, the sweep times, and frequency limits must be determined when a Chirpsounder network is first set up. Once these have been established, the TCS-5 may be programmed.

3-2.3 SETTING THE REAL TIME CLOCK. To synchronize the Chirp transmitters with receivers, the real time must be set (on both units) as accurately as possible: see paragraph 3-3.2a, SET CLOCK. If possible, use an HF receiver to obtain time from an international time station. Allow the TCS-5 at least twenty minutes (preferably one hour) to warm-up before setting the clock. Turn on the rear panel battery switch at this time to prevent loss of time if there is an AC power loss. Synchronization of Chirpsounder receivers requires knowledge of transmission time to within ±1 second. The TCS-5 has a one second "tick" output for precise alignment of the clock. Once the clock has been set, do not change or reset it without notifying all Chirpsounder receiving locations that have synchronized to the transmission.

3-2.4 SETTING OFFSET TIME. The offset time determines when the Chirp will start with respect to each five-minute segment of the hour. See paragraph 3-3.2b and Figure 3-4 to enter the Chirp offset time that has been assigned for the transmitter location. For example, the transmitter may be programmed to operate four times per hour during the 5, 20, 35, and 50 minute time periods, with an offset of 1 minute, 40 seconds. The actual start times will then be 06:40, 21:40, 36:40, and 51:40. (Usually, integer seconds, without decimals, should be assigned to the transmitter, and the offset time should not exceed 4 minutes, 58 seconds.

3-2.5 SETTING CHIRP PROGRAM: SWEEP RANGE, POWER, AND ANTENNA. The sweep limits (2-16 or 2-30 MHz), transmit power (full or 0.1 power), and antenna must be specified for each of the twelve 5-minute intervals per hour. These parameters are part of the Chirp Program described in paragraph 3-4. If more than one antenna is used, a BR 7039 Antenna Relay must be used with the TCS-5.

3-2.6 FREQUENCY BLANKING. If specific frequencies are not to be swept, a 32 or 96 channel blanker may be programmed, depending on the firmware: see paragraph 3-3.2c, and Figures 3-5 through 3-6c. Typically, the frequencies of stations such as WWV (5, 10, 15, and 20 MHz) are blanked. Stations which are received locally are also usually blanked. The blanker, when enabled, will shut off the RF power ±30 kHz (32-channel blanking) or ±10 kHz (96-channel blanking) about each frequency. In addition, a wideband blanker is provided that blanks one or two bands defined by operator-programmable band edge frequencies.

3-2.7 NORM/STANDBY. When the TCS-5 SET CHIRP mode is in NORM, the Chirp program will operate as scheduled. The Chirp transmissions may be disabled by placing the system in STANDBY. This feature only inhibits Chirp RF emission. The Chirp transmission may be taken out of STANDBY at any time, including mid-sweep. Chirp transmissions are not disrupted when the rotary MODE switch is placed in any position as long as no switch or key is actuated.

3-2.8 Programming the TCS-5 is complete when all of the above parameters have been entered.

3-3 SET CHIRP

3-3.1 This mode may be used to set the clock, offset time, blanker frequencies, and run or standby mode. In addition, a Miscellaneous Utilities sub-menu allows setting of the remote I/O port baud rates, optional 7057 Antenna Coupler functions, and Antenna Crossover frequency. Figure 3-2 will be displayed when the MODE switch is set to SET CHIRP:

3-3.2 Press keypad 1, 2, or 3 to set the clock, (path) offset, or blanker (frequencies) respectively. Pressing keypad 4 turns the blanker on or off; pressing 5 places the system in NORMal or STANDBY mode.

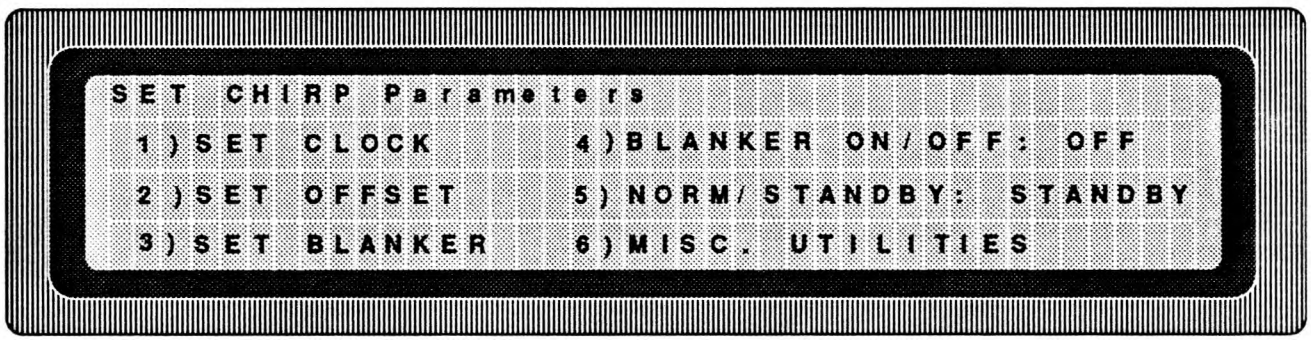


Figure 3-2. Set Chirp Parameters

a. SET CLOCK. Figure 3-3 is the Set Clock display. Current time may be entered by the keyboard by pressing the two-digit (00 to 23) hour and then "MHZ/HRS" key. Similarly, the minutes are entered by keying a two-digit minute (00 to 59) and pressing the "MIN" key. The seconds entry is similar, except the clock is not updated until key "SEC/ENTER" is released. The time-of-day will be continuously shown on the display in most of the operating modes. A rear panel (J8, pin 10) 1 second TTL "tick" is available for oscilloscope time comparison (where "time" is the rising edge of the 0.5 ms tick pulse). In SET CLOCK, the TIME LED will flash on/off: 1 second on, 1 second off. The moment the LED turns on or off indicates the exact start of a one second period, which coincides with the 1 second "tick" at the rear panel. The clock can be fine tuned by turning the tuning knob. To enable the tuning knob press the ENABLE button; the ENABLE LED will light. Then adjust the internal clock, 100 ms per knob revolution (CW to advance, CCW to retard). Pressing the ENABLE button again will disable the TUNE knob, and the ENABLE LED will go off. Press NEXT to return to the SET CHIRP parameters menu.

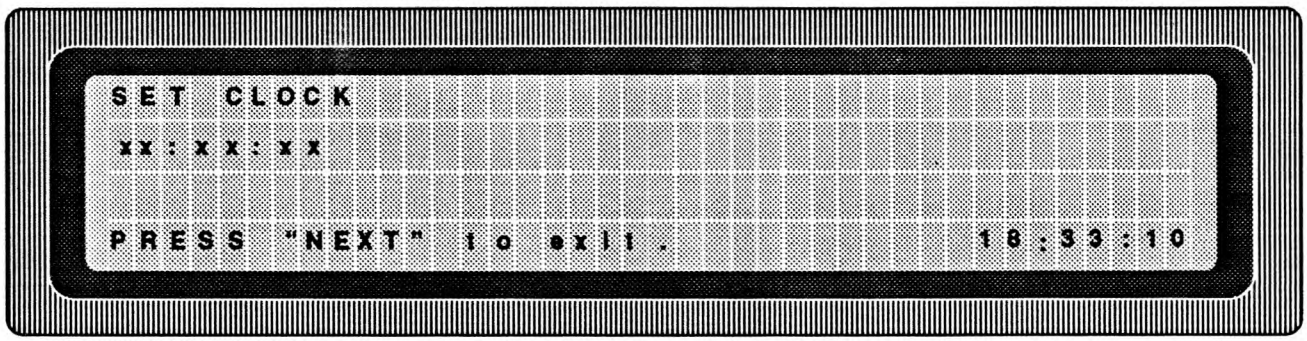


Figure 3-3. Set Clock

NOTE

The seconds digits, as they appear on the display, should not be used in making fine resolution adjustments (±1 second) to the clock. This is due to a delay (approximately 0.1 to 0.5 seconds) between the clock and the update of the display. Only the 1 second tick from the TIME LED or from the rear panel should be used in fine resolution time adjustments, as when synchronizing the internal clock to an external standard (WWV, Cesium Clock, etc.

b. SET OFFSET. Press the '2' key for the SET SWEEP START TIME OFFSET menu. The display will be as shown in Figure 3-4. The keypad may be used to enter a new start time offset. First, key in the 2-digit minutes offset (0-4), then press MIN. Second, key in the seconds offset (00.00000 to 58.99999), then press SEC/ENTER. (Usually, integer seconds, without decimals, will be assigned to the transmitter.) The seconds shown on the display will be rounded down to the nearest 0.0005 second. The tuning knob cannot be used to change the path offset time. Erroneous entries may be cleared by pressing CLEAR. Note that to be compatible with Chirpsounder receivers, the path offset time should not be set greater than 4 minutes 58.0000 seconds. Press NEXT to return to the SET CHIRP parameters.

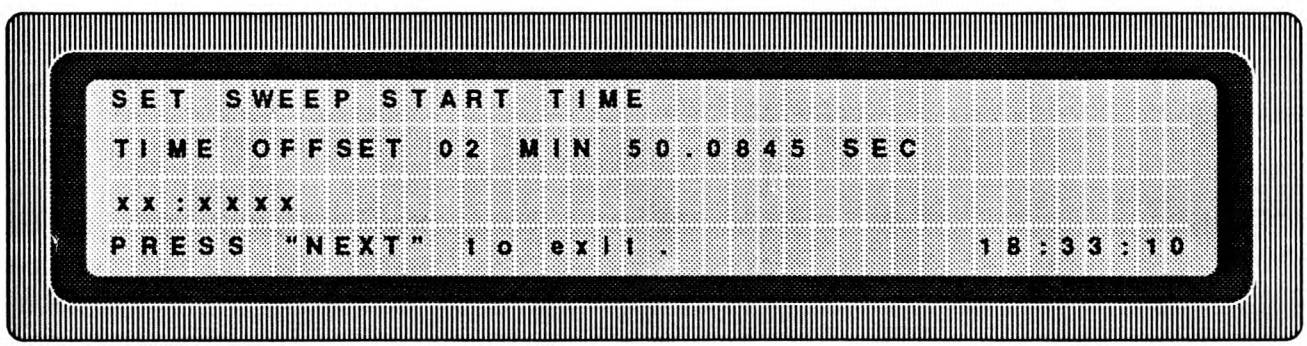


Figure 3-4. Set Offset

NOTE

There are two versions of the TCS-5 Blanker function currently in the field. A 32-channel Blanker was provided in TCS-5 models with CPU firmware release V06H and below. This firmware was originally supplied with units manufactured before June 1991, with Serial Numbers 91120 and lower. Units manufactured after June 1991 (with serial numbers 91121 and higher), feature a 96-channel blanker. The 96-channel Blanker can be identified by checking for CPU firmware version release V06J (or higher) shown in the upper right corner of the TEST menu display.

c. SET BLANKER. There are two choices for blanking frequencies. The first choice allows the blanking of 32 or 96 narrowband channelized frequencies with a blanking bandwidth of ±10 kHz; the other allows blanking of two bands with blanking bandwidth programmed by the operator ('Wideband Blanker'). Both types of frequency blanking may be selected and in use on the same sweep. Press '3' on the 'Set Chirp Parameters' menu (Figure 3-2) to set the blanker. Figure 3-5 is the Frequency Blanker selection menu for the blanker.

Figure 3-5. Blanker Frequency List Selection Menu

1. Narrowband Channelized Blanking. Press the '1' key for the menu to set narrowband blanking. The display will be shown as in Figure 3-6a. If the list is empty, the words BLANKER LIST EMPTY, will show at the top. FULL indicates that all 32 or 96 spaces are used. Figure 3-6b shows the display to enter/delete frequencies in the narrowband blanker frequency list. Follow the prompts to enter and delete frequencies. The blanked frequencies appear on the left side of the display, 4 at a time. The tuning knob can be used to scroll the list.
2. Wideband Blanking. Press the '2' key on the selection menu. Figure 3-6 shows the Wideband Blanking display. Follow the prompts to enter the frequency band. If a frequency is entered that is out of the 2-30 MHz range or if a range is entered with the highest frequency first, the prompt 'INVALID BLANKER RANGE' will appear for 1.5 seconds and the entered numbers will reset to 00.00. If no wideband blanking is desired, press CLR while moving cursor to each entry position (i.e. enter 00.0-00.0 MHz to disable).

d. BLANKER ON/OFF. Pressing "4" will enable or disable the operation of the blanker. If the blanker is enabled, the Chirpsounder transmitter will not transmit as it sweeps within either 10 kHz or 30 kHz depending on the blanking software in use, of any of the frequencies loaded in the blanker list or frequency band loaded with the 'wideband' function. The blanker does not affect the transmitter in the COMM mode.

e. NORM/STANDBY. Pressing "5" will toggle the NORMal or STANDBY modes. In standby, the Chirp RF power amplifier will be keyed off. If a Chirp transmission is in progress, the RF power will be cut off but the sweep will continue within the TCS-5. When standby is returned to normal, the RF power output will resume. If the system is left in STANDBY, no Chirp transmissions will occur, although the programmer will continue to operate. This allows shutting down a transmitter without having to program all "0s" (zeros) in the MODE menu positions. STANDBY does not affect the COMM mode.

f. MISCELLANEOUS UTILITIES. Pressing "6" allows setting of Baud Rates, control of the 7057 Antenna Coupler, and selection of the antenna crossover frequency. Refer to paragraphs 3-17, 3-18, and 3-19 for an explanation of functions available under Miscellaneous Utilities.

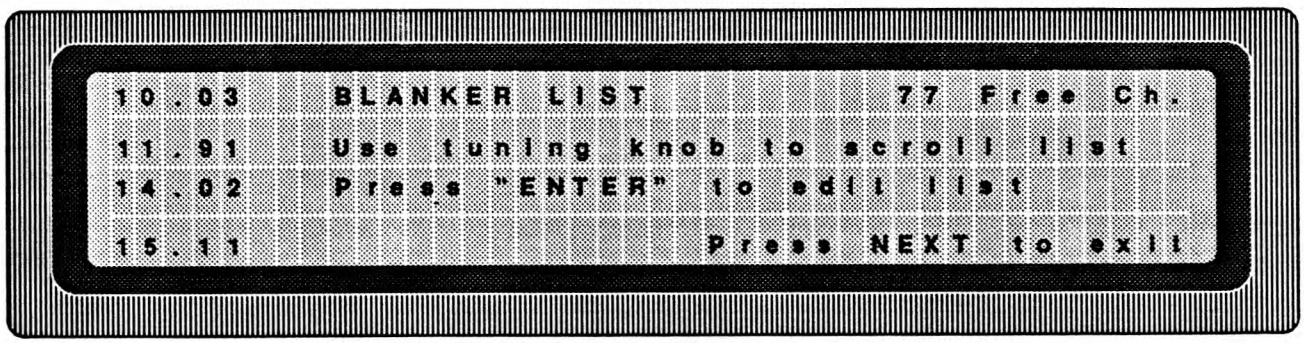


Figure 3-6a. Narrowband Blanker Frequency List

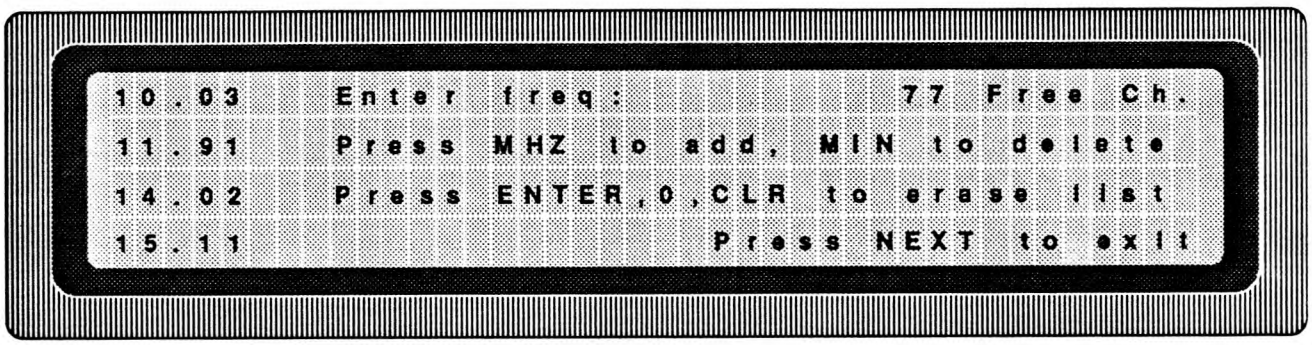


Figure 3-6b. Narrowband Frequency List, Entry Procedure

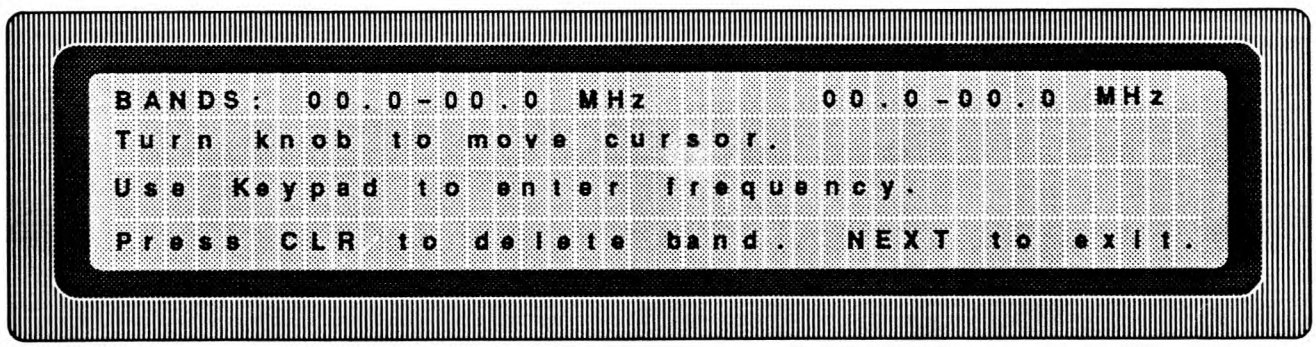


Figure 3-6c. Wideband Frequency Blanking Display

3-4 CHIRP PROGRAM

3-4.1 Place the mode switch to CHIRP PROG. This mode brings up the Chirp program display, Figure 3-7.

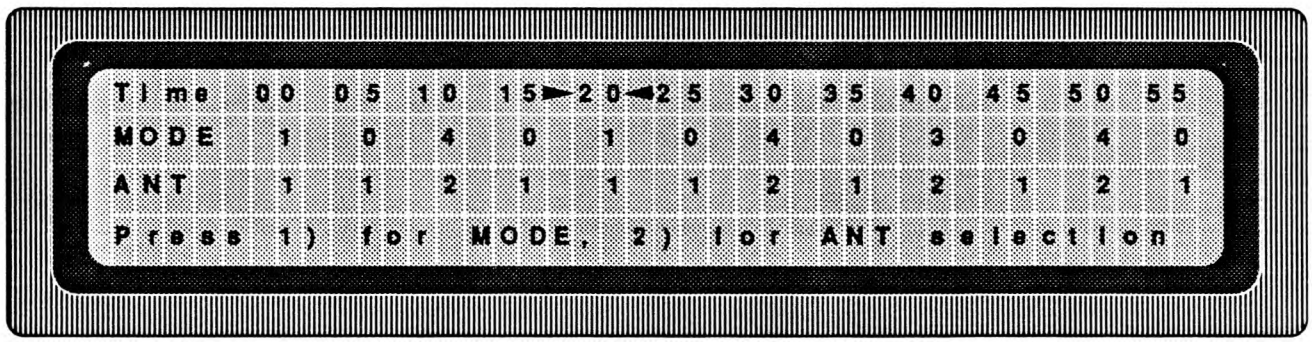


Figure 3-7. Chirp Program Display

3-4.2 The display will show the twelve 5-minute segments of the hour. Arrows indicate the current 5 minute segment. The MODE line shows a code representing the sweep range and output power level for each 5-minute segment, and the ANT line shows which antenna, 1, 2, or 3, is selected for each 5-minute segment. A Chirp sweep will start in the 5-minute segment at the programmed offset time only if mode 1, 2, 3 or 4 is programmed. If more than one antenna is used, a BR 7037 Antenna relay must be used with the TCS-5.

3-4.3 Pressing the "1" key (Figure 3-7) calls up Figure 3-8 and allows the setting of the sweep range and output power level. The code number to be changed blinks and is underlined by the cursor, which is moved by the TUNE knob. The sweep range and power level are set by keying 0-4 as follows:

0) No Sweep
1) 2-16 MHz, 1/10 Power
2) 2-30 MHz, 1/10 Power
3) 2-16 MHz, High Power
4) 2-30 MHz, High Power

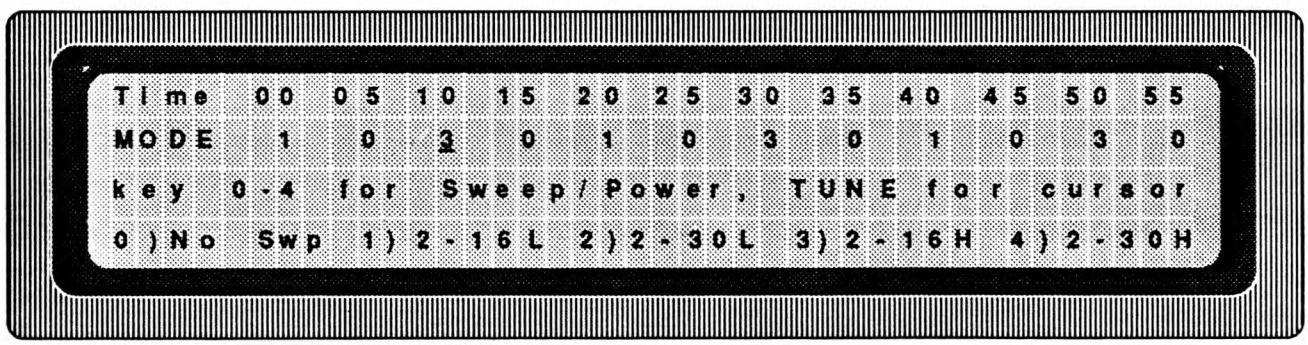


Figure 3-8. Sweep Range and Output Power Level Setting.

3-4.4 Press NEXT to return to Figure 3-7.

3-4.5 Pressing the '2' key in Figure 3-7 will call up Figure 3-9, which will allow antenna selection for each 5-minute segment. Note that the antenna program needs to be set only when multiple antennas and a BR 7039 Antenna Relay are used. The 7039 antenna relay will select the antenna programmed during the Chirp sweep. At the end of the sweep, the antenna relay will select the antenna programmed by the Comm Antenna Select (see paragraph 3-6.2). The antenna to be changed is underlined by the cursor, which is moved by the TUNE knob, and the antenna is selected by keying 1, 2, or 3. Pressing the NEXT key returns the display to the Chirp Program display, Figure 3-7.

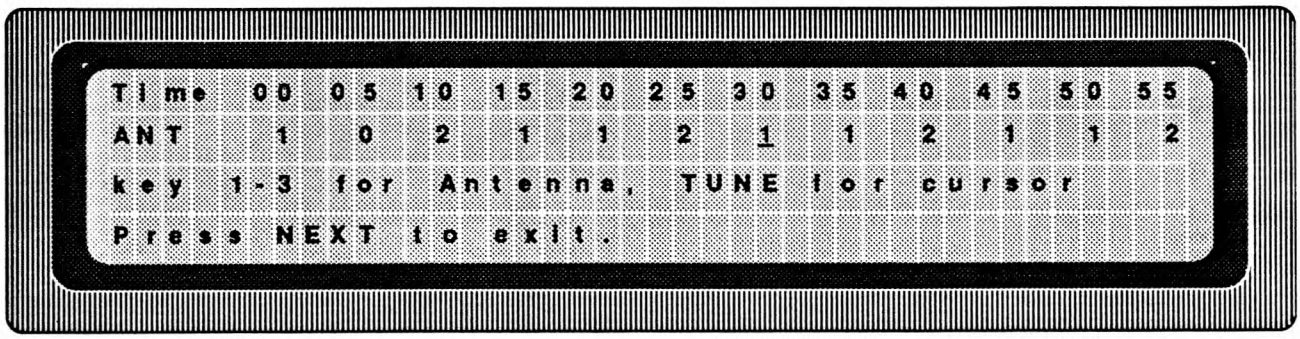


Figure 3-9. Antenna Selection (Chirpsounding)

3-5 CHIRPCOMM

3-5.1 INTRODUCTION. This selection allows for the entry of a Chirpcomm message as well as reviewing the current message.

3-5.2 CHIRPCOMM MENUS. Place the mode switch to CHIRPCOMM. This will cause the first of the Chirpcomm menus to appear on the LCD display. The keyboard will then be used to select secondary menus. The actual entry of a message will be by the tuning knob: a full alphabet will be shown on the display and the knob will be used to move a cursor.

3-5.3 CURRENT MESSAGE. Figure 3-10 appears when the MODE switch is first placed in CHIRPCOMM. It shows the Chirpcomm message that is currently being sent and provides a menu for further activities. The display alternates between one showing the message that is currently being sent,˘ ˜ and the one that is waiting to be sent.

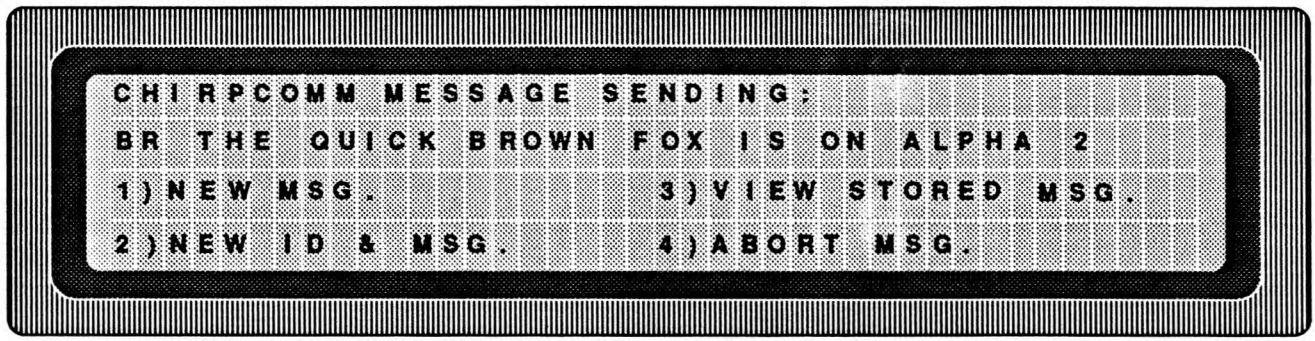


Figure 3-10. Chirpcomm Display I

3-5.4 CHIRPCOMM MESSAGE ENTRY. When either 1 or 2 is selected in Figure 3-10, Figure 3-11 (Chirpcomm Message Entry) is displayed. If the ID does not need to be changed, press "1", NEW MSG. If the ID must be changed, press "2", NEW ID & MSG. To type the message, turn the tuning knob until the cursor is on the desired character, then press ENTER. Select SP to enter spaces in the message, which are indicated by underlines. If an error is made, select BKSP to backspace and erase the previous character. (See paragraph 3-5.6 for use of the ALARM character).

1. NEW MSG. Begin typing in the new message. The first two characters showing the ID will not change. As the entry of the message progresses, it will replace the xxxx... shown in Figure 3-11.
2. NEW ID & MSG. Enter the new ID in the first two character spaces. Then type the new message. As the entry progress, it replaces the xxx... shown in Figure 3-11.
3. VIEW STORED MSG. This shows the message currently stored in memory, and allows it to be sent in several ways. Refer to paragraph 3-5.5 for a description of the "send" choices. Two other menu selections are available when the display alternates between CHIRPCOMM WAITING TO SEND and CHIRPCOMM MESSAGE SENDING:
4. ABORT MSG. Any message currently being sent will immediately be terminated and no future messages will be transmitted.
5. CLEAR MSG. Any message currently being sent will continue to the end of the current sweep, but no future messages will be transmitted.

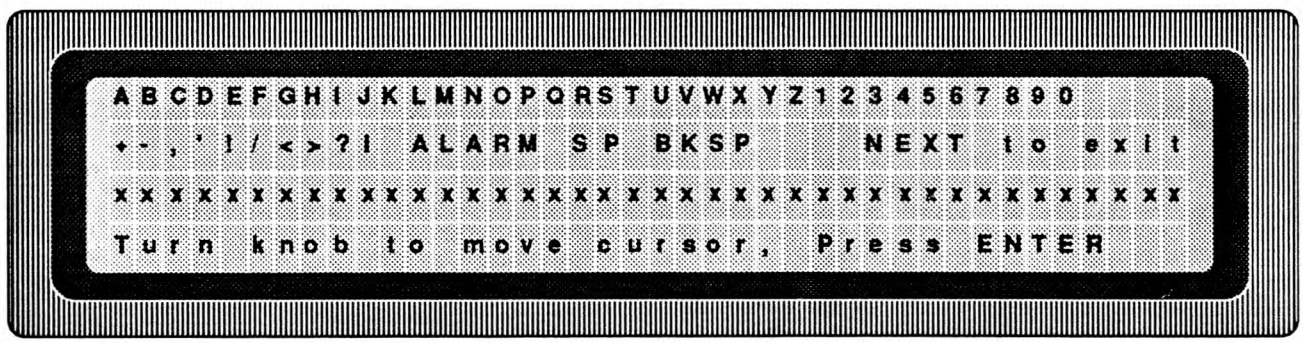


Figure 3-11. Chirpcomm Display II

3-5.5 CHIRPCOMM TRANSMISSION CHOICES. Figure 3-12 shows possible dispositions of the message after pressing 'NEXT' in Figure 3-11. This provides the operator with choices for transmission of the Chirpcomm Message. A ">" will appear to the left of the chosen selection(s) which will be executed when "6" is pressed and the display is exited. There are five choices:

a. SEND NOW. Removes any message currently being transmitted and immediately begins sending the new message for the remainder of the sweep in progress; sends message on all subsequent Chirp sweeps.

b. SEND CONTinuously. Sends the message at the beginning of all subsequent Chirp sweeps.

c. SEND TWICE. Sends the message twice, starting at the beginnings of the next two programmed Chirp sweeps.

d. SEND ONCE. Sends the message once, starting at the beginning of the next programmed Chirp sweep.

e. STORE MSG. The STORE MSG function allows a message to be prepared ahead of time and stored in non-volatile memory without being sent. The stored message can then be recalled at a later time by selecting VIEW STORED MSG (key 3) from Figure 3-10. Refer to paragraph 3-5.7 for additional information.

Pressing STORE MSG (key 1) is not required when sending a newly composed message. Any of the "SEND" functions (keys 2, 3, 4, 5) can be selected to send a new message without storing the message in the STORE MSG buffer.

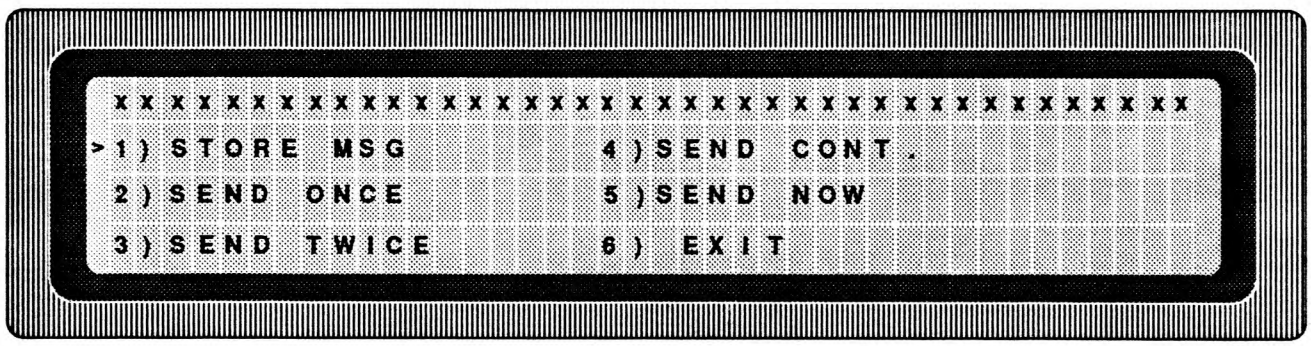


Figure 3-12. Chirpcomm Display III

NOTE

The stored message will appear as shown in Figure 3-13 after selecting "1" from Figure 3-12 or "3" from Figure 3-10. The xxx... represents the message in storage. The menu provides choices as the actions to be taken, as described in paragraphs 3-5.5a through 3-5.5d.

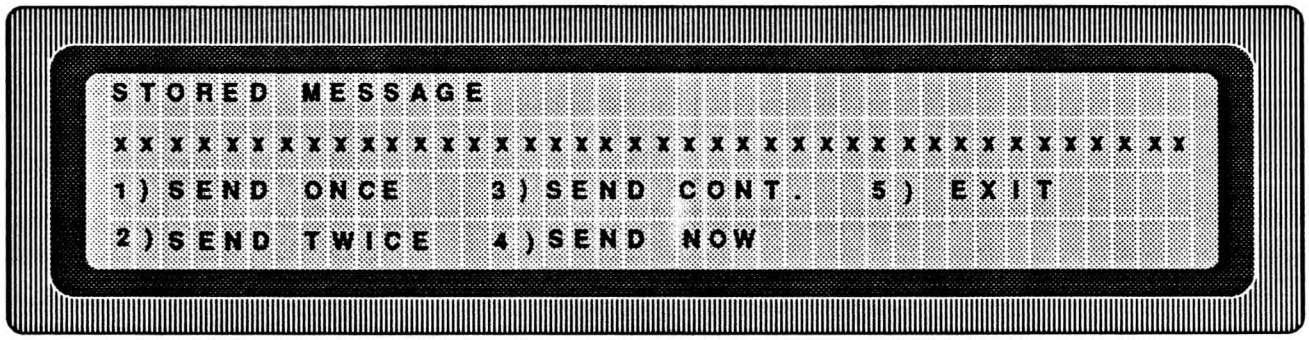


Figure 3-13. Chirpcomm Display IV

3-5.6 ALARM CHARACTER. The ALARM key may be used to send an alarm (bell) character to RCS-5 and RCS-6 Chirpsounder receivers and 3060 receive adapters. An audible alarm (RCS-5) or alarm LED (RCS-6) will activate at the receiver at the end of any Chirpcomm sweep in which an ALARM character (^) is detected. There are two types of alarm conditions:

a. General Alarm. To sound the alarm for all receivers synchronized to the Chirpcomm transmitter, enter the **ALARM** character in any one of the 38 positions of the Chirpcomm message field, except the 3rd position. (Typically, the ALARM character (^) is placed at the end of message for general alarms).

NOTE

Do not use the ALARM character for the third character of the 38-position message field (5th character of 40 positions) for a General Alarm.

b. Selective Calling Alarm. To sound the alarm on one particular Chirpsounder receiver (or a group of receivers with the same receive ID), the TCS-5 must send the intended receiver's ID along with the **ALARM** character as part of the message. This requires a fixed format message for the transmitter as follows:

TTRR^XXX....XX

Where:
- TT: is the transmitter ID (any two characters)
- RR: is the receiver's ID (any two numbers)
- ^: is the alarm character, which must always be located in the fifth position of the display.
- XX: is the message text of up to 35 characters.

3-5.7 CHIRPCOMM FOLLOWING PRIMARY POWER OUTAGES. When a primary power outage occurs, the Chirpcomm ID and message(s) may or may not be retained, depending upon the Chirpcomm function selected at the time of the outage.

a. The Chirpcomm ID and message in the STORE MSG buffer is stored in non-volatile memory and will not be lost during a primary power outage.

b. The Chirpcomm messages in the WAITING TO SEND and SENDING buffers are in volatile memory and will be lost if a primary power interruption occurs. However, if SEND CONT (key 4) or SEND NOW (key 5, Figure 3-12) was the last "send" function selected before a power interruption occurred, the TCS-5 will automatically recall the message stored in the STORE MSG buffer and transfer it to the WAITING TO SEND buffer for CONTinuous sending when primary power is restored. The automatic recall and sending of the STORE MSG buffer on power up does not occur if either the SEND ONCE (key 2) or SEND TWICE (key 3) function was selected.

c. If a Chirpcomm ID and/or message is to be sent continuously, even following a primary power interruption, the ID/message should first be placed in the STORE MSG buffer before selecting SEND CONTinuous or SEND NOW. If no Chirpcomm message transmission is desired following a power interruption of SEND CONTinuous operation, the STORED MSG buffer should be cleared by selecting either NEW MSG or NEW MSG & ID (Figure 3-10) and pressing 'NEXT' (Figure 3-11) without entering any message. If NEW MSG is selected when clearing the STORED MSG buffer, the 38-character message will be cleared and the 2-character ID will remain stored. To clear the entire 40-character field, select NEW MSG & ID. Be sure to clear the STORE MSG buffer of old messages when operational requirements change.

3-5.8 EFFECTS OF CHIRPCOMM MODULATION. When a Chirpcomm message is sent on a Chirp sweep, the TCS-5 modulates the linear FMCW sweep with the data from the Chirpcomm message. Chirpcomm generates a modulation that is similar to a 250 Hz FSK modulation of the linear sweep at a 55 bit per second rate. This modulation produces sidebands on the transmitted Chirp sweep which can be seen on the Chirpsounder record received by the Chirpsounder receiver at the far end of the HF path. The modulation sidebands appear as weak "Ghosts" or duplicates spurious images of the mode traces on the receiver CRT display. That is, Chirpcomm will produce a weak second copy of the Chirp trace in the upper half of the CRT display that is a copy (ghost) of the trace in the lower half of the display. The strength of the Chirpcomm induced ghost trace is a function of the message length; short messages produce very weak spurious ghosts, longer messages produce stronger ones. If the main purpose of the TCS-5 is to send Chirpcomm messages, these ghost traces can be ignored. (There is no degradation in Chirpcomm performance due to these ghost images.) However, if the TCS-5 is used primarily to transmit a Chirp sweep for frequency management purposes, the ghost Chirpcomm traces may make it more difficult to interpret the received Chirpsounder record for selection of optimum communication frequencies. In this case, Chirpcomm messages should be kept as short as possible. Ideally, only the Transmit ID should be sent repeatedly, sweep after sweep. This will minimize the extend of the spurious ghost Chirpcomm traces on the Chirpsounder record display. If the TCS-5 is used primarily for frequency management of an HF communications circuit, follow the instructions listed below to optimize the performance of the Chirpsounder system.

a. Text messages should be sent only when needed, since Chirpcomm messages degrade the quality of the records produced by the Chirpsounder receiver. The longer the message (that is, the greater the number of written characters in the message) the greater the degradation. If only the transmitter ID is sent (that is, characters in the first two positions of the 40 position field) followed by 38 'rubouts', there is virtually no degradation of the received Chirpsounder record. If the total number of characters sent is less than 10, there is very little degradation. If a 40 character message is sent, the received Chirpsounder record suffers about a 6 dB loss in signal-to-noise ratio and there is visible increase in spurious responses in the upper half of the received Chirpsounder record. Transmission of a two-character transmit ID followed by 38 rubouts is not the same as a two-character ID followed by 38 'spaces' (blank characters). There is no FSK modulation for a rubout while a space (blank) character is a modulated character similar to any other written character. Therefore, if Chirpcomm is used only to identify the Chirpsounder transmitter, make sure that the Transmit ID is entered only in the first two characters of the forty character field, and that only rubouts (no printable characters and no space/blank characters) are in the 38-character message field.

b. Note that the ABORT MSG or CLEAR MSG function can be used to insure that all 38 characters of the message field are filled with rubouts. The ABORT MSG/CLEAR MSG function only stops the Chirpcomm modulation of the 38-character message field. The Transmit ID (if any) will continue sending for the remainder of the sweep and on successive sweeps if Chirpcomm was programmed for Continuous (SEND CONT. or SEND NOW) operation. The Abort function simply replaces all 38 characters of the message field with rubouts which cause the TCS-5 to transmit an unmodulated Chirp sweep for the 38 characters. After selecting ABORT MSG, the sweep is Chirpcomm modulated only for the two Transmit ID characters; i.e. it is only modulated for approximately 0.22 seconds out of every 4.4 seconds of sweep.

c. If no Chirpcomm modulation of any kind is wanted (i.e. the entire sweep is a pure FMCW Chirp sweep with no Chirpcomm modulation whatsoever), then all 40 Chirpcomm characters must be rubouts. To clear all 40 characters, select NEW ID & MSG (press 2 on the main Chirpcomm menu), then press NEXT (without entering any ID or message) to select the Chirpcomm transmission ("send") menu. Now press SEND CONT or SEND NOW, then press 6 to exit. The main Chirpcomm menu will now indicate that Chirpcomm is sending only the 40 rubout characters (solid black squares in place of the alphanumeric Chirpcomm text).

3-6 SET COMM

3-6.1 MENU. To set the operating parameters for fixed-frequency communications, set the MODE switch to SET COMMunications (see Figure 3-14). The menu shows these choices:

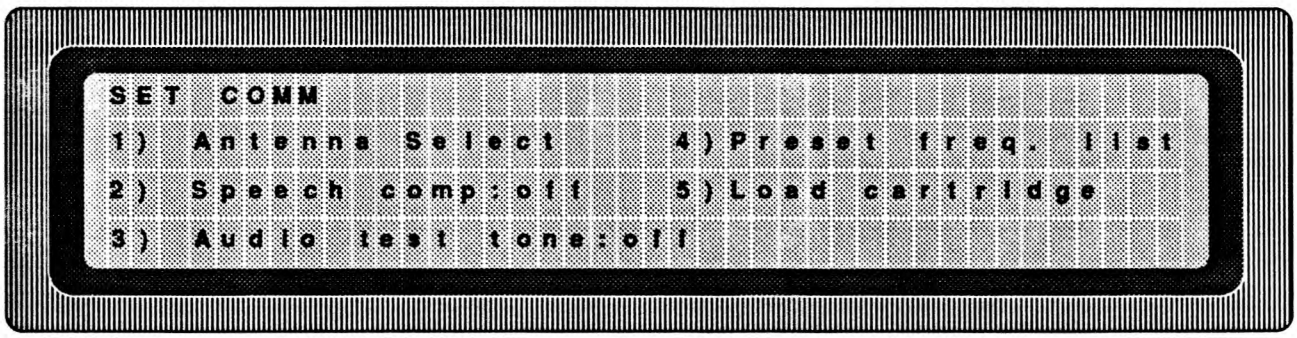


Figure 3-14. COMM Transmit Parameters

a. ANTENNA SELECT. This brings up another menu from which the comm antenna may be chosen. Refer to paragraph 3-6.2 and Figure 3-15.

b. SPEECH COMPRESSOR. Pressing "2" turns the speech compressor on and off, as indicated. Generally, the speech compressor should be on only when speech is being transmitted, and should not be used during digital (such as FSK) data transmissions. Because the compressor limits the audio bandwidth and clips high power transients, it will usually improve speech intelligibility, particularly on noisy circuits.

c. AUDIO TEST TONE. This transmits a continuous tone (approximately 1 kHz) for test purposes. This tone may be used during the communications system turn-on and check-out to test and adjust associated communications receivers. Pressing "3" turns the tone on and off. The tone is always turned off when the mode switch is turned past USB to RUN. The tone must be turned back on, if required, when the Comm Mode is reentered.

d. PRESET FREQ. LIST. The preset frequency list is a specified list of up to 100 frequencies that can be used in fixed-frequency communications, which includes USB and LSB modes. One 100-frequency list can be entered into TCS-5 memory either manually or from a properly connected Cartridge Reader. Paragraph 3-6.4 and Figure 3-16 describe the use of the Cartridge Reader with the TCS-5.

e. LOAD CARTRIDGE. This allows loading of preset frequency lists into the transmitter for fixed frequency communications.

3-6.2 COMM ANTENNA SELECT. The communications antenna select display (Figure 3-15) appears when "1" is pressed on Figure 3-14. The antenna selection feature is provided to control an external BR 7039 Antenna Switch when multiple antennas are used. To select the antenna to be used during comm transmissions, press 1, 2, or 3; the current selection is shown next to COMM ANT. If the external BR 7039 Antenna Switch is used, the comm antenna will be connected to the TCS-5 RF power amplifier during communications transmissions; during idle periods of no transmissions, the comm antenna will be connected to rear-panel receiver antenna connector J10. The antenna selection has no effect on the transmitter RF output on J9.

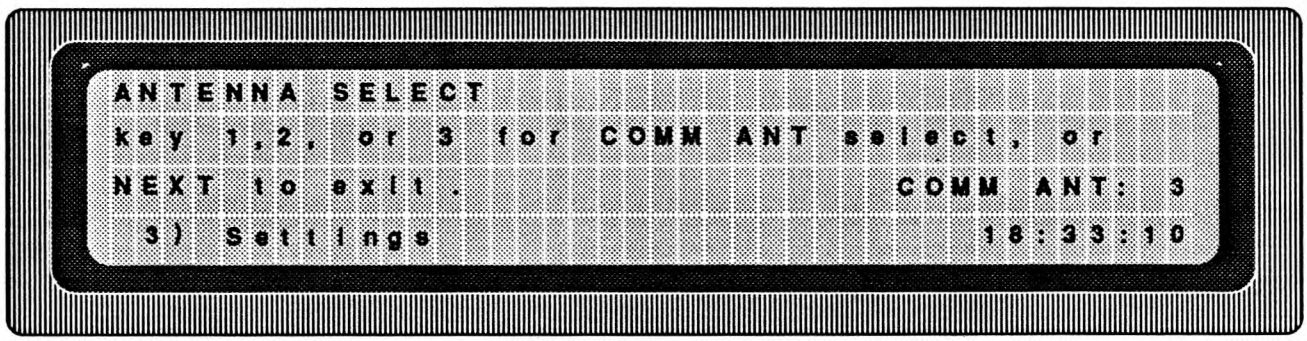


Figure 3-15. Antenna Select Display (Communications)

3-6.3 MANUAL ENTRY OF PRESET FREQUENCY LISTS. Selection 4 on the SET COMM menu (Figure 3-14) can be used to manually enter and use frequency lists for fixed frequency communications.

a. Press "4", Preset Frequency List. Figure 3-16 is displayed. The channels may be scrolled through by rotating the TUNE knob or by pressing two digits (00-99) on the keypad.

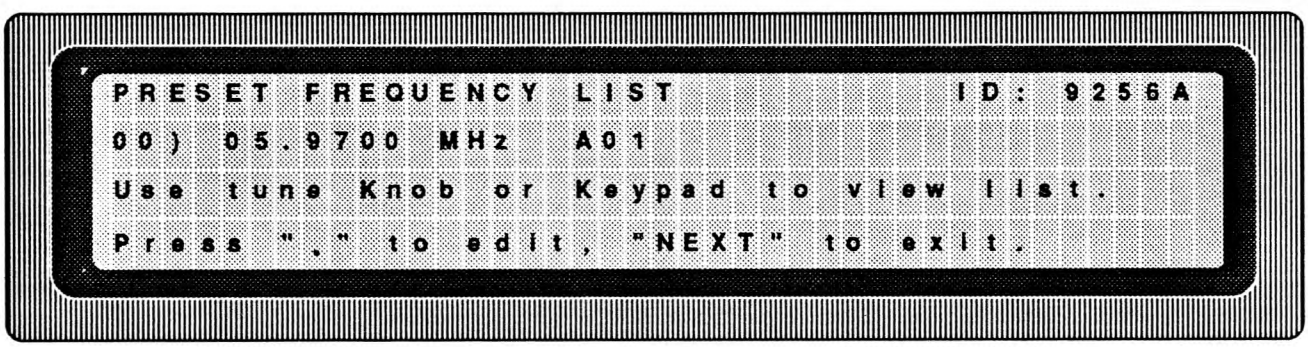


Figure 3-16. Preset Frequency List

b. Press "." to place the display into the edit mode. Figure 3-17 is displayed.

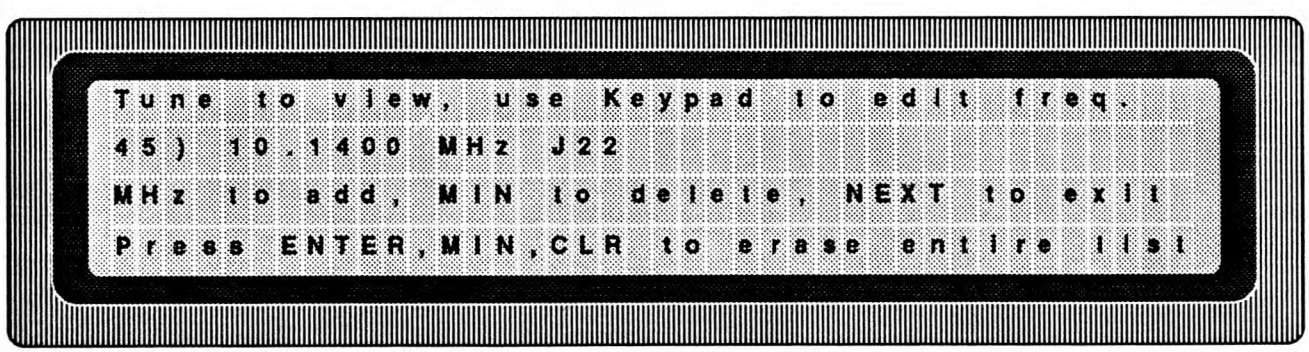


Figure 3-17. Edit Frequency List

c. Load frequencies by rotating the TUNE knob to the channel desired and type the frequency on the keypad using the decimal point if desired. The entry is displayed on the right side of line two as it is entered. It will not be placed into memory, however, until the MHz key is pressed. Note: the channel sequence begins at 00. The operator must use the TUNE knob to change channels, rather than entering the channel from the keypad.

d. Press MHz to load the frequency into memory and then rotate the TUNE knob to the next channel to be entered.

e. A manually entered frequency list will be identified as "0000", as indicated by the ID located on the far right side of line 1 of the LCD. Comments are normally located to the right of "MHz", but can only be entered using the Cartridge Reader (see paragraph 3-6.4).

3-6.4 ENTRY OF FREQUENCY LIST USING THE CARTRIDGE READER. Selections 4 and 5 on the SET COMM menu (Figure 3-14) can be used to enter and use preset frequency lists from a data cartridge for fixed frequency communications. To load and use a list, a Cartridge Reader must be properly connected to the TCS-5 (refer to section II, Installation).

a. Place the TCS-5 in SET COMM mode. The display will appear as in Figure 3-14.

b. Select item 5, Load Cartridge.

c. Install the cartridge into the reader. Turn the dial on the Cartridge Reader to the frequency list desired (A-F). Note the cartridge must be programmed by an FMT-5A Frequency Management Terminal.

d. Follow the prompts to load the list into the TCS-5. The load process takes about 13 seconds. The Cartridge Reader LED will change from green to red while the load is taking place. Do not disturb the cartridge or reader switch while the LED is red.

e. Select 4 on the SET COMM menu to view the preset list. It will appear as in Figure 3-16. The ID in the upper right is the identification of the list. Each cartridge should have the same first four digits, and the specific list identified by the final letter (A-F).

f. The second line of the display (Figure 3-16) shows the channel number, the frequency assigned to that channel, and comments. The channel number (00-99) can be scrolled through using the rotary tuning knob, or it can be entered by using the keypad. When using the keypad, a two-digit number must be entered. The channel selected appears immediately on the second line of the display.

g. Frequency lists entered by the cartridge can be edited by following the prompts on the display shown in Figure 3-17. If a frequency is changed, however, the comments remain the same, but the ID number of the list is automatically changed to "0000". No ID (other than 0000) can be given to a frequency list entered by the keypad.

3-7 OPERATIONAL MODES

3-7.1 Operational Modes include RUN, USB/LSB COMM, and SLAVE modes. These are used in the normal operation of the TCS-5.

3-8 RUN MODE

3-8.1 In this mode the TCS-5 will send Chirp transmissions according to the CHIRP PROG (paragraph 3-4). Only display and AC power controls will function. The display will show the Chirpcomm message and frequency of the transmission in progress, and the message and start time of the next transmission. A green RF POWER-XMT LED on the front panel will light whenever the transmitter is keyed on.

3-8.2 Figure 3-18 shows the display when the mode switch is placed in RUN and a Chirp transmission is in progress. This display will alternate with Figure 3-19, which shows the Chirpcomm message waiting to be sent and the antenna in use. BLKR ON indicates that the blanker is enabled. The time, shown immediately right of the @ symbol, is the start time of the next message. Forward and reflected power readings, ranging from 0 to 180 watts, are provided on the last line. Typical readings while sweeping (RUN mode) are 10W in LOW power setting and 100W in HIGH power setting. In COMM mode it can range from 18W (low) to 180 watts (high).

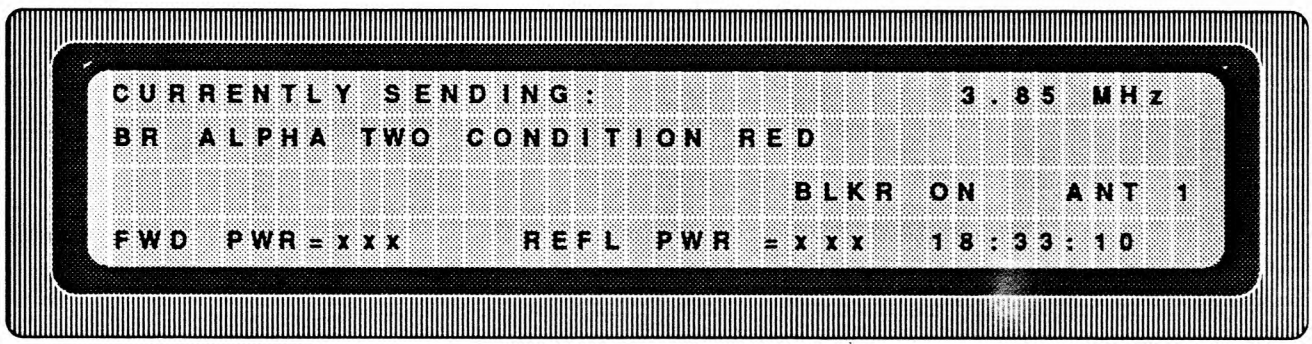


Figure 3-18. Current Chirp Frequency I

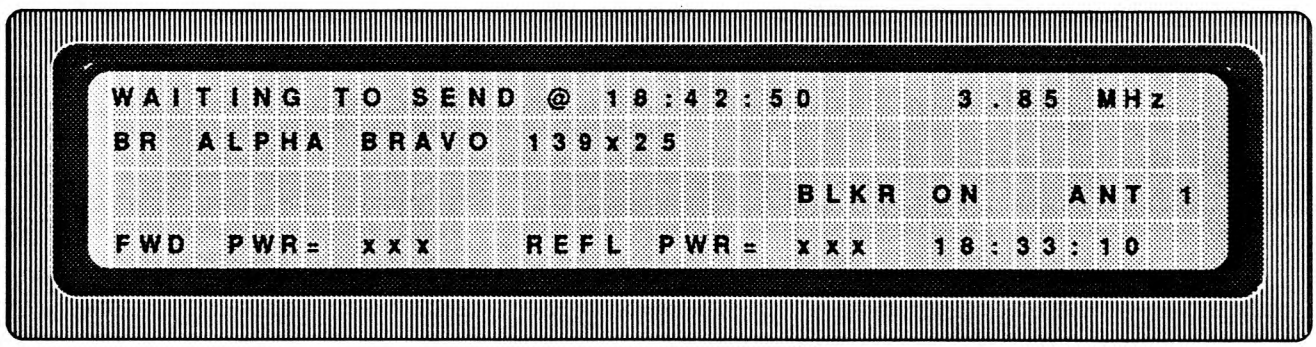


Figure 3-19. Current Chirp Frequency II

TB1 will key on the transmitter. Note that if either the frequency or MODE switch is changed, the transmitter will key off and will not automatically key back on; the XMIT KEY switch, push-to-talk switch, or external contact closure must be cycled through key off, back to key on, before the TCS-5 will again transmit.

3-9.7 The display will show the operating parameters at all times. SP COMP. ON indicates that the speech compressor is on. TONES ON indicates that the internally generated test tone is on, and ANT X indicates which antenna has been chosen for communications transmissions.

3-9.8 When the transmitter is keyed on, the display will be similar to Figure 3-23 and will include measurements of the forward and reflected powers, in watts, from the TCS-5. When the transmitter is connected to a properly matched antenna, the reflected power should be small compared with the forward power. A green RF POWER XMT indicator on the front panel lights whenever the transmitter is keyed on, either for communications or Chirpsounding, and an AUDIO OVLD indicator will light to signal overloading of the audio circuits. Should this occur, reduce the MIC GAIN control (if a microphone/ handset is used) or reset the rear panel line level input switch (if external audio is used). The audio level should be set such that the RF output power is maximized without over driving the audio circuits.

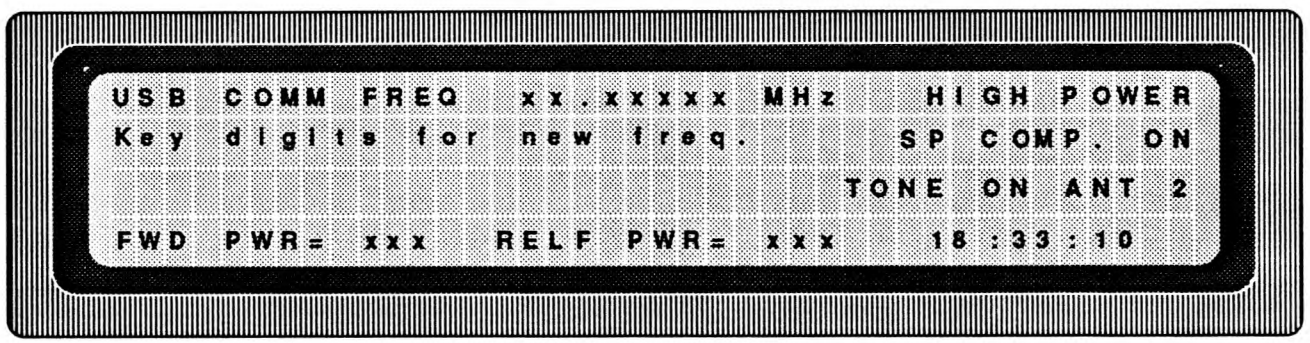


Figure 3-23. USB Comm Freq, Key On

3-9.9 If the internal circuitry of the TCS-5 detects a problem with the frequency synthesizer process, the prompt "SYNTH ALARM" will appear in the third row of the LCD in USB/LSB mode. The alarm turns off the RF, but continues the sweep to maintain internal timing. If the alarm occurs in either USB or LSB mode, the operator must re-key the transmitter to reset. That is, the transmitter must first be un-keyed by toggling the XMIT KEY off, then back to the ON position. This will reset the transmitter. However, if the same problem is detected, the alarm will occur again and the RF shut down. Refer to the paragraph 5-5.3c for troubleshooting the cause of the alarm.

3-10 TRANSRECEIVER OPERATION

3-10.1 INTRODUCTION. The TCS-5 can be connected to a BR Communications RCS-5 Chirpsounder Receiver to form a transreceiver, which can be configured to operate as a fixed-frequency communications transmitter and receiver in either simplex of semi-duplex mode.

3-10.2 SIMPLEX (SINGLE-FREQUENCY) OPERATION.

a. In the simplex (single-frequency) mode, the transreceiver transmits and receives on only one frequency. At any time, the system is either transmitting through the TCS-5, or receiving through the RCS-5. When transmitting, audio signal from a microphone or an external data source modulates the transmitter (see paragraph 3-9.2); when receiving, the audio signal from the RCS-5 receiver can be heard in the handset connected to the TCS-5, or can be sent to external equipment through the rear panel line output on the RCS-5. (See paragraph 2-5.4 for interconnections required between the RCS-5 and TCS-5.

b. Before operation in the transreceiver mode, the antenna must be selected (if multiple antennas and a BR 7039 Antenna Switch are used) and the speech compressor is turned on or off. In addition, a 1 kHz audio test tone must be turned on or off. These settings are made with the TCS-5 MODE switch set to SET COMM (see paragraph 3-6). When these settings have been made, front panel controls on the TCS-5 and RCS-5 must be set as follows:

TCS-5:	MODE Switch	SLAVE
	COMM PWR	HIGH/LOW (as required, see paragraph 3-9.4)
RCS-5:	MODE Switch	MONitor
	USB/LSB	As required
	FREQUENCY	As required

c. Note that the sideband and frequency for the entire transreceiver are set only on the RCS-5, and do not have to be set on the TCS-5.

d. After the transreceiver has been configured as above, and connected to an antenna, the transmitter can be keyed ON in any of three ways: the front panel XMIT KEY toggle switch, microphone/handset push-to-talk switch, or rear panel remote input control on connector TB-1. See paragraph 3-9.6. Whenever the transmitter is keyed ON, the receiver is muted, and no receiver audio will appear in the handset or RCS-5 speaker. Overall transmitter status (including the settings made above) will appear on the TCS-5 display as in Figure 3-24. To clear TCS-5 SLAVE mode, rotate MODE switch to RUN.

3-10.3 SEMI-DUPLEX (DUAL-FREQUENCY) OPERATION.

a. In the semi-duplex (dual-frequency) mode, the transreceiver transmits on one frequency and receives on another. At any time, the system is either transmitting through the TCS-5, or receiving through the RCS-5; the transmitter cannot transmit and receive simultaneously. When transmitting, audio signal from a microphone or an external data source modulates the transmitter (see paragraph 3-9.2); when receiving, the audio signal from the RCS-5 receiver can be heard in the handset connected to the TCS-5, or be sent to external equipment through the rear panel line output on the RCS-5. (See paragraph 2-5.4 for interconnections required between the RCS-5 and TCS-5.

3-8.3 If no Chirp transmission is in progress, the display will appear as in Figure 3-20 when the mode switch is in the RUN position. The time, shown to the right of the @ symbol, indicates the start time of the next message.

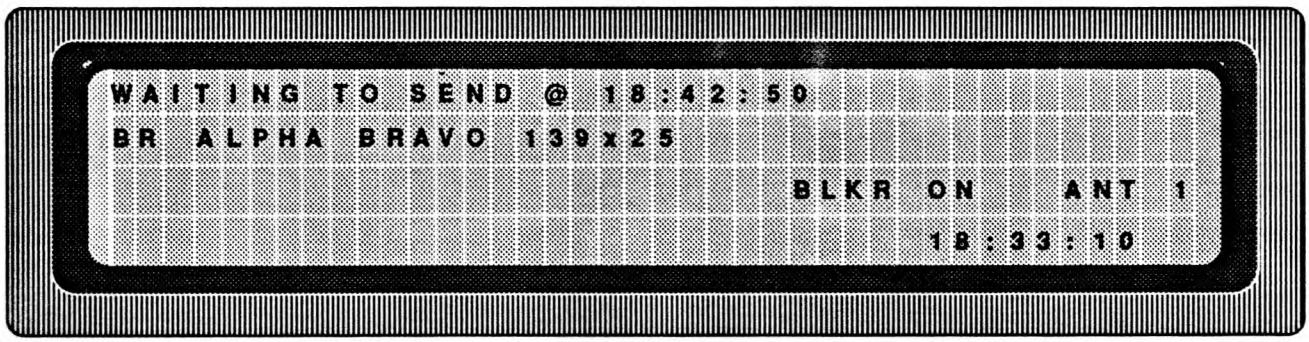


Figure 3-20. No Chirp Transmission

3-8.4 If the internal circuitry of the TCS-5 detects a problem with the frequency synthesizer process, the prompt "SYNTH ALARM" will appear on the third line of the LCD in RUN mode. The alarm turns off the RF, but continues the sweep to maintain internal timing. The transmitter will automatically reset itself at the beginning of the next sweep. However, if the circuitry detects the same internal problem at the start of sweep, the alarm will occur again and the RF turned off. If the Synth Alarm is still present on the next sweep, refer to the paragraph 5-5.3c for troubleshooting the cause of the alarm.

3-8.5 The TCS-5 checks the Reflected to Forward Power Ratio during a sweep when operating with the 7057 Antenna Coupler (see paragraph 3-18). If this power ratio exceeds 0.4 for approximately one-third of a Chirp sweep, the prompt "HIGH VSWR" will appear in the third row of the LCD in RUN mode display. The HIGH VSWR alarm can appear at any time during the sweep and will remain displayed after the sweep ends. This alarm alerts the operator to an antenna or 7057 coupler problem. After the problem is corrected, the operator can manually clear the High VSWR alarm by selecting (3) 'Learn New Antenna' in the Antenna Coupler Settings menu (Figure 3-29). The HIGH VSWR alarm will also clear automatically when two consecutive sweeps are completed without an alarm condition occurring.

3-9 COMMUNICATIONS TRANSMITTER OPERATION

3-9.1 The TCS-5 can be operated as a conventional fixed-frequency USB or LSB communications transmitter. It may be placed in the communications mode by moving the MODE switch to either the USB (upper sideband) or LSB (lower sideband) positions, then entering the operating frequency and power levels (see Figures 3-21 and 3-22). When the transmitter is keyed on, any Chirpsounding currently in progress will be terminated, and the transmitter will retune to the communications frequency for transmission of the audio signal. If a Chirpsounding has been interrupted by a communications transmission, it will not be resumed following the comm transmission.

3-9.2 The audio signal source can be either a microphone/handset connected to front panel connector J1, or external audio equipment providing a balanced line input to rear panel connector TB1.

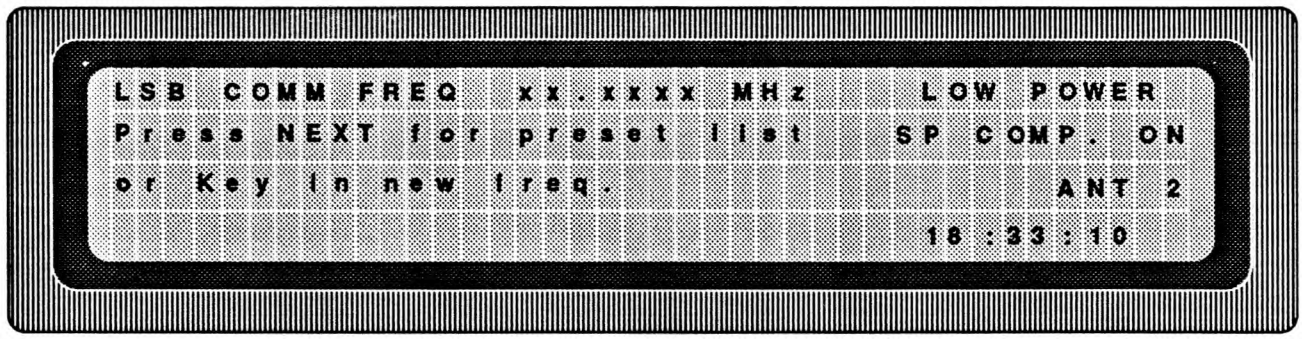


Figure 3-21. LSB Comm Freq.

3-9.3 To set the communications frequency, enter the desired frequency (in MHz) on the keypad, then press MHZ. As the frequency is entered, the second line of the display will change to the digits being entered, as shown in Figure 3-22. The tuning knob can be used at any time to make minor changes to the frequency: press ENABLE, above the knob, and turn the knob until the desired frequency is shown. (If the transmitter is keyed on when the frequency is changed, either through the keypad or by the tuning knob, the transmitter will key off and must be re-keyed on. See paragraph 3-9.6

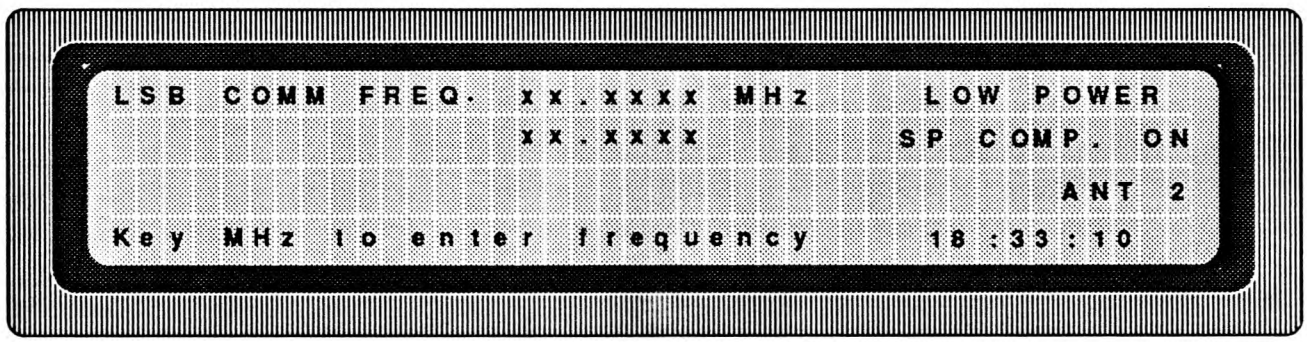


Figure 3-22. LSB Comm Freq.

3-9.4 Frequencies may also be entered using the preset frequency list which may be entered manually or from the cartridge reader as described in paragraph 3-6.4. If a preset list is desired in either USB or LSB, press NEXT. This displays the list that had previously been entered in the SET COMM mode. This list can then be used the same as frequencies entered manually be the keypad.

3-9.5 To set the power level, momentarily press the COMM PWR switch up or down for high or low power. The current power setting is shown in the display (as in Figure 3-22) and by two yellow front panel LEDs. The high power output is approximately 150W pep, and the low power output is one-tenth that level, approximately 15W pep.

3-9.6 The transmitter can be keyed on in three ways. First, a front panel XMIT KEY toggle switch may be left on at all times, keeping the transmitter constantly keyed on. Second, if a microphone/handset connected to front panel connector J1 is equipped with a push-to-talk switch, it can be pushed to key the transmitter on. Or third, a contact closure completing a circuit across two pins on rear panel connector

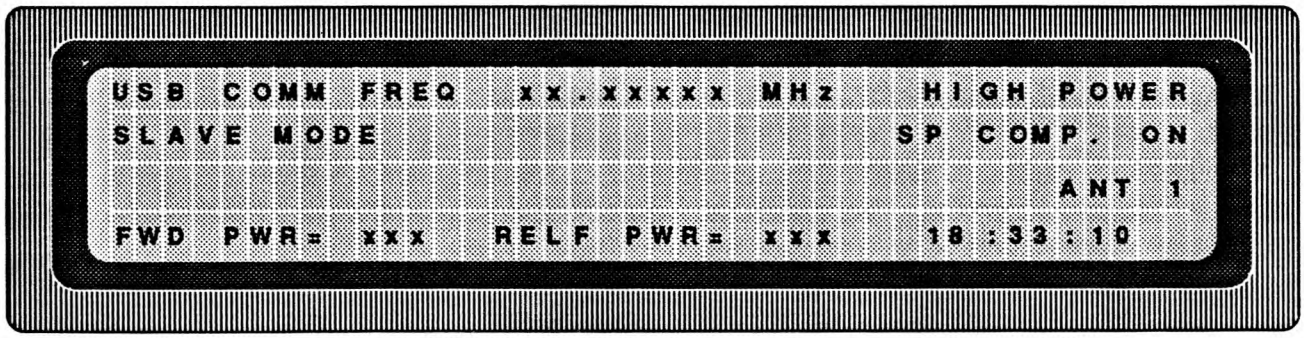


Figure 3-24. Transreceiver Mode

b. Before operating in the transreceiver mode, the antenna must be selected (if multiple antennas and a BR 7039 Antenna Switch are used) and the speech compressor must be turned on or off. In addition, a 1 kHz audio test tone must be turned on or off. These settings are made with the TCS-5 MODE switch set to SET COMM (see paragraph 3-6). When these settings have been made, front panel controls on the TCS-5 and RCS-5 must be set as follows:

TCS-5:	MODE Switch	USB/LSB (as required for transmitter)
	COMM PWR	HIGH/LOW (as required, see paragraph 3-9.5)
	FREQUENCY	As required for the transmitter (see paragraph 3-9.3)
RCS-5:	MODE Switch	MONitor
	USB/LSB	As required for the receiver
	FREQUENCY	As required for the receiver

c. Note that the sideband and frequency for the entire transceiver are set only on the RCS-5, and do not have to be set on the TCS-5.

d. After the transreceiver has been configured as above, and connected to an antenna, the transmitter can be keyed ON in any of three ways: the front panel XMIT KEY toggle switch, microphone/ handset push-to-talk switch, or rear panel remote input control on connector TB-1. See paragraph 3-9.6. Whenever the transmitter is keyed ON, the receiver is muted, and no receiver audio will appear in the handset or RCS-5 speaker. Overall transmitter status (including the settings made above) will appear on the TCS-5 display as in Figure 3-24.

3-10.4 SYNTH ALARM. If the internal circuitry of the TCS-5 detects a problem with the frequency synthesizer process, the prompt "Synth Alarm" will appear in the third row of the LCD in Transreceiver mode. The alarm turns off the RF, but continues the sweep to maintain internal timing. If the alarm occurs in transreceiver mode, the operator must exit the mode by rotating the mode switch to RUN. This will reset the transmitter. However, if the same problem is detected, the alarm will occur again and the RF will shut down. Refer to the paragraph 5-5.3c for troubleshooting the cause of the alarm.

3-11 REMOTE OPERATION

3-11.1 When the MODE switch is in the REMOTE position, the TCS-5 can be externally controlled through rear panel connector J7. Remote control may be required when the transmitter is located at an unattended location, or when the TCS-5 is to be used with BR Communications' FMT-5A Frequency Management Terminal or 3085 Propagation Analyzer. (See paragraph 2-5.4 for details of the electrical connections to the remote control connector.) A detailed description of the TCS-5 protocol is in BR document number K11078, provided as Appendix A in this manual.

a. Control Inputs. Most of the operating parameters of the TCS-5 can be remotely controlled. While under remote control, none of the operating parameters can be changed from the front panel. Chirp transmissions can be remotely disabled by the STANDBY control function, such that the internal path programmer will initiate Chirp transmissions, but no RF power will be transmitted. When STANDBY is returned to NORMAL, a Chirp transmission in progress will resume with normal RF power.

b. Audio Inputs. The audio signal source can be either a microphone/handset connected to front panel connector, J1, or external audio equipment providing a balanced line input to rear panel connector TB1.

c. Display and Outputs. Operating conditions of the TCS-5 such as alarms and RF power levels, will be indicated digitally on the rear panel remote control connector. Although the front panel RF POWER, ALARMS, and BTRY indicators will function normally, the display will show only REMOTE MODE and the current time.

3-12 USING KEYED CW (MORSE) WITH THE TCS-5

3-12.1 A Morse Key can be connected to the TCS-5 and used to transmit Morse code over a specific frequency using the following steps. Operation will be keyed CW at 10 or 100 watts. The CW Delay (or Semi-Break-In) timing is adjustable between x.x and y.y seconds. CW Delay controls the time that the transmitter remains in the transmit mode before switching back to the receive mode. An RCS-5 series receiver, connected to the TCS-5, will be muted while the transmitter is keyed and remain muted until the CW Delay terminates. The typical delay is 0.7 seconds and should be slightly longer than the typical word spacing delay. The delay should be adjusted to your keying speed so that the system does not switch back to receive between characters. Once the transmitted message ends, the delay times-out and reception is allowed.

a. Connect a Morse Key to TB1 on the rear panel of the TCS-5. Attach leads to "EXT KEY" and "KEY GND".

b. Place the TCS-5 mode switch to TEST Select Transmitter (Test 1), and select CW Calibration (Test 1).

c. Turn the XMIT KEY to the OFF position.

d. Select the Morse code transmit frequency on the keypad and press ENTER. This frequency should be the same as the receiver at the other end of the circuit.

e. Select the desired CW delay by pressing the MIN button. The delay is then adjustable by turning the TUNING knob. Exit back to the CW menu by pressing NEXT.

f. Key message using the Morse Key.

g. Exit the display by pressing NEXT.

NOTE
The Green Transmit Light will illuminate on the first keying and will remain on until the CW Delay times out.

3-13 ALARM INDICATORS

3-13.1 The TCS-5 has several alarms to indicate fault conditions. An alarm is indicated by red LEDs or a statement on the LCD. Table 3-2 discuss the source, cause, and effect of each alarm. The indicated alarm may be the result of one or more internal alarms. The internal alarms are explained in Table 5-2.

Table 3-2. Alarms

Name	Source/Cause	Effect on Operation/Corrections
OVTEMP Red LED	Overtemperature Alarm: Power amplifier is overheated.	RF Power will be automatically reduced (40 watts max) to reduce heat to RFPA. To correct, verify that cooling fans are running and vents and filters are clear so amplifier will return to normal temperature. If overtemperature continues to rise, amplifier may shut down, with no RF output. Normal operation will resume when the amplifier reaches normal temperatures.
RF OVLD Red LED	Overpower Alarm: Excessive RF power reflected back into amplifier or RF from external source injected into power amplifier.	Power will automatically be reduced to a safer level. Check antenna cable and antenna. If nearby transmitter is problem, moving the antenna may eliminate the problem.
AUDIO OVLD Red LED	Audio Overload: Excessive audio input.	Audio modulation may be distorted. Turn down microphone gain or level of external audio until alarm LED goes out.
SYNTH ALARM on LCD	Frequency Synthesis Alarm.	Alarm will key transmitter off if transmitting in RUN or COMM modes. RFPA will remain off until the start of next sweep or until manual key is released and then rekeyed. Cause may be a circuit failure. If alarm does not clear on next sweep or rekeying, maintenance is required.
INTERLOCK on LCD	Interlock	Open interlock will key transmitter off in any mode. Check interlock plug (J8) on rear panel and any external interlock circuits for break. Transmitter will remain off until interlock is restored.
ALARM OUT, J8-6	Overtemperature or Frequency Synthesis alarm.	Electronic closure for external alarm indication. If external alarm is connected and is on, one or both of the listed alarms is present.
HI VSWR ALARM on LCD	Reflected to Forward Power Ratio exceeds 0.4 for one-third of a Chirp sweep while operating with 7057 Antenna coupler.	Alerts operator to an antenna or 7057 problem. Alarm may be cleared after correction by selection (3) "Learn New Antenna" in Coupler Settings menu (Figure 3-29). HI VSWR clears automatically when two consecutive sweeps are completed without alarm condition reoccurring.

3-14 OPERATION UNDER ADVERSE CONDITIONS

3-14.1 GENERAL. The TCS-5 is a rugged instrument and can withstand adverse conditions. Follow recommended procedures described in the manual. Never operate the unit if it is not properly grounded as described in the Safety Warning page. There are certain procedures that should be followed to if the following conditions are encountered.

3-14.2 VIBRATION AND MOVEMENT. Any type of vehicular mounting of the instrument (within vessels, trucks, airplanes, etc.) may cause a combination of pitch, roll, and yaw and accompanying vibration. The TCS-5 is designed to operate through periods of such vibration and movement. The operator should take care, however, not to accidentally touch the front panel controls of the equipment as settings may be changed and synchronization lost.

3-14.3 ADVERSE ENVIRONMENTAL CONDITIONS. Adverse environmental conditions include high humidity, high temperature, excessively dusty and dirty environments, and periods of lightning from thunderstorms.

a. Humidity. The TCS-5 will operate in up to 90% humidity without degradation of performance. Prolonged exposure to moisture, as in an unprotected location in a rainy climate, may limit performance. Keep the unit in a dry place. In addition, problems can be caused when the unit is mounted in a shelter in which the air temperature is much cooler than outside. Condensation will tend to form on the unit if warm, moist outside air is permitted to contact a cold instrument. Avoid frequent and prolonged opening of the shelter door. If excessive condensation is observed on the TCS-5, turn the instrument off and allow it to dry.

b. Temperature. The specification for operation of the TCS-5 is between -20 and 50°C when operating. For maximum efficiency and long life, it is best if the unit is operated between 10° and 40°C If the unit has been stored at a temperature outside the specified operating range, allow the unit to reach room temperature before operating.

c. Dust/Dirt. In extremely dusty or dirty environments it is very important to keep the intake air filters as clean as possible. This may require cleaning the filters on a more frequent basis than described in the manual.

d. Lightning. To reduce risk of personal injury and equipment damage, it is best not to have the TCS-5 attached to an antenna during intense thunderstorms at times when it is likely that the antenna will receive a direct strike.

3-14.4 DAMAGED EQUIPMENT. In general, do not operate the equipment unless all conditions, including proper grounding as explained in the Safety Warning sheet, are met. Follow these procedures:

a. Do not operate the unit if the power cord is frayed, broken, or damaged in any way.

b. Do not operate the unit if the air filters are dirty or dusty. Inspect regularly.

c. Do not operate the unit if any interconnect cables between units are loose, broken, or have exposed connectors or conductors.

3-15 SHUTTING DOWN THE TCS-5

3-15.1 If timing synchronization is to be maintained and the TCS-5 is to be shut down for a short time (less than 5 hours), ensure that the battery switch on the rear panel is in the ON position. Then turn the front panel AC power OFF.

3-15.2 If the instrument is to be turned off with loss of timing, turn the battery switch to the OFF position. Turn power OFF on the front panel.

3-15.3 For long-term (less than one year) storage of the instrument, disconnect all cables, turn battery switch OFF, and store in a cool, dry place. The packaging that the TCS-5 came in is an ideal storage medium. Place desiccant in the container. The internal battery supply should be stored with the batteries fully charged. That is, turn off the battery switch and AC line power only after the batteries have been charged in a continuously operating TCS-5 for a minimum of 48 hours. This will maximize storage life time for the batteries. For very long term storage (greater than one year) of the transmitter, remove the battery supply from the instrument and store separately.

3-16 DATA SAVED IN NON-VOLATILE MEMORY

3-16.1 The parameters that are stored in non-volatile EEPROM memory are listed in Table 3-3. These settings will not be lost or changed when power is lost, the unit is shut down, or the standby battery power is lost. The parameters can only be cleared by intentionally writing new values in place of the old. In the table, references are made to appropriate paragraphs and figures where these functions are described.

Table 3-3. Data Stored in Non-Volatile Memory

Parameter	Paragraph	Figure
Sweep Start Time Offset	3-3.1(b)	Figure 3-4
Narrowband Frequency Blanker	3-3.1(c)1	Figure 3-6a, 3-6b
Wideband Frequency Blanker	3-3.1(c)2	Figure 3-6c
Blanker On/Off Status	3-3.1(d)	Figure 3-2
Standby On/Off Status	3-3.1(e)	Figure 3-2
Chirp Program Mode Selections	3-4	Figure 3-7, 3-8
Chirp Program Antenna Selections	3-4	Figure 3-7, 3-9
Chirpcomm Message Sending Status	3-5.5, 3-5.7	Figure 3-12
Chirpcomm Stored Message	3-5.5, 3-5.7	Figure 3-13
Comm Antenna Selection	3-6.2	Figure 3-15
Comm Preset Frequency List	3-6.3, 3-6.4	Figure 3-16
I/O Ports Baud Rate Selections	3-17	Figure 3-26
Antenna Coupler Connection	3-18.3	Figure 3-27
Antenna Coupler Settings	3-18.3(c)	Figure 3-28
Antenna Crossover Frequency	3-19	Figure 3-29

3-17 MISCELLANEOUS UTILITIES-BAUD RATE

3-17.1 INTRODUCTION. The miscellaneous utilities allow control of three functions of the TCS-5; the serial I/O port baud rates; control of the 7057 Antenna Coupler; and frequency selection of the antenna crossover feature. Figure 3-25 is the menu for the Miscellaneous Utilities feature.

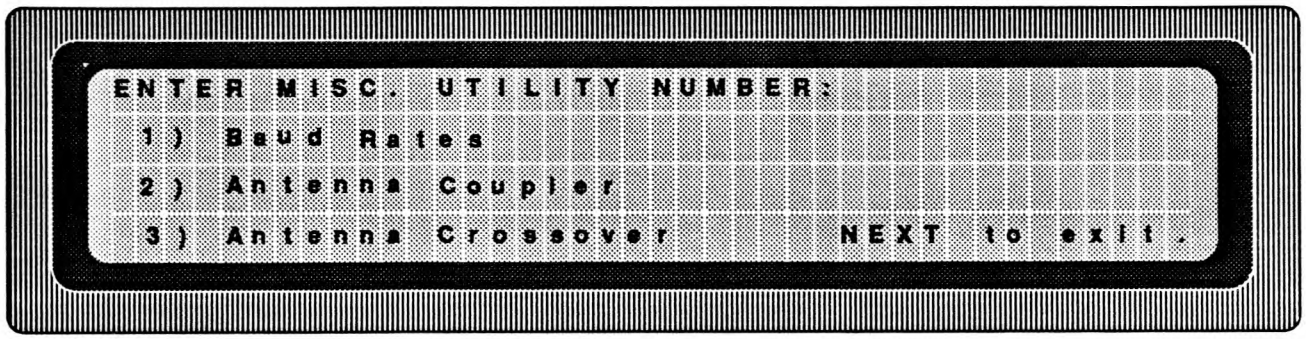


Figure 3-25. Miscellaneous Utilities Menu

3-17.2 BAUD RATE SELECTION. The baud rates of the 4 serial data ports are selected using this menu. From the SET CHIRP menu (Figure 3-2), press '6' for the Miscellaneous Utilities menu, then select '1' for baud rate selection. This displays (Figure 3-26) the current baud rate for each port. To change any port, press the port number on the keypad. This display, Figure 3-27, will again show the current baud rate and a selection of four baud rates: 75, 300, 1200, or 9600. To change the baud rate, press the selection number next to the baud rate. The new baud rate will now show at the top of the display. Press NEXT to exit. Verify that the baud rate selected for a port matches the baud rate of the device connected to the port. The baud rate of port 1 (FMT-5A) should be 300 baud. The baud rate for port 2, Slave operation of an RCS-5, should be 1200 baud. Port 4, used for the 7057 Antenna Coupler, is automatically set and locked to 1200 baud when 'CONNECTED' is chosen on the 7057 Coupler Menu (Figure 3-28).

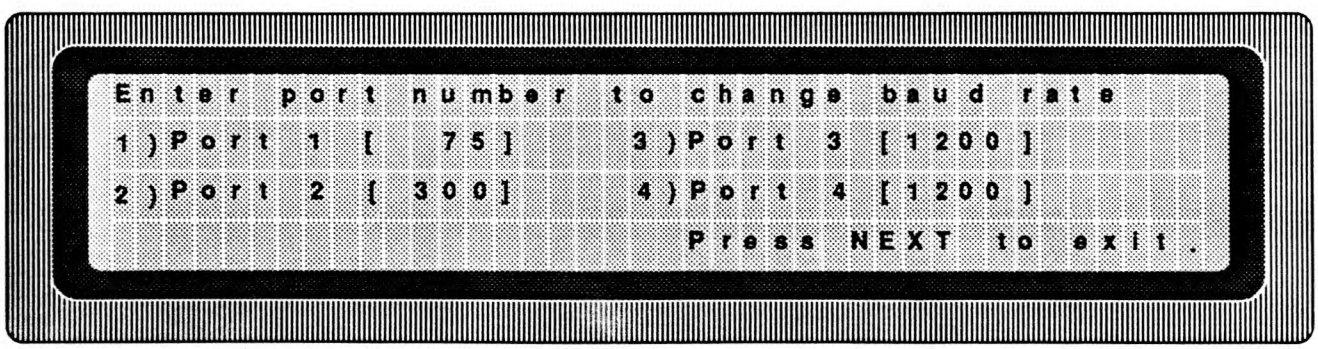


Figure 3-26. Baud Rate Display

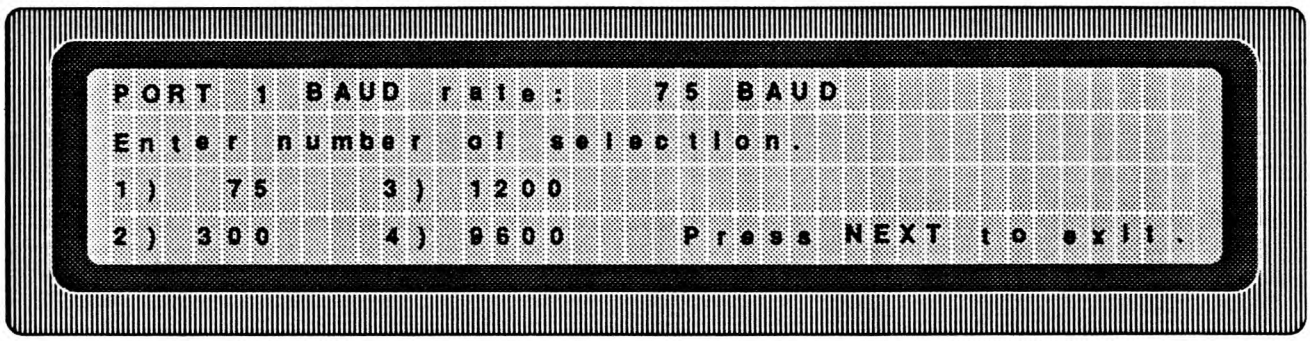


Figure 3-27. Baud Rate Selection Display

3-18 MISCELLANEOUS UTILITIES-7057 ANTENNA COUPLER

3-18.1 INTRODUCTION. The optional BR 7057 Automatic Antenna Coupler is an automatically tuned network that matches the output impedance of a 50-ohm transmitter to the input impedance of a non-broadband antenna such as a whip, dipole or long wire. The increase in efficiency provides greater radiated power than available from an unmatched antenna. The 7057 will automatically change the antenna settings according to conditions, such as ice loading, salt, or even antenna damage. The TCS-5 can control the 7057 from the Miscellaneous Utilities feature in Set Chirp Mode. For detailed information regarding the 7057, including schematic diagrams and parts lists, refer to the 7057 Antenna Coupler Manual (P/N 0040-7057-15001).

3-18.2 INITIAL STEPS. Connect the 7057 to the TCS-5 following the instructions in the 7057 manual. Place the ON/OFF switch on the 7057 Interface Module (P/N 7057-1105) to the ON position. Perform the following steps to gain access to the coupler control display.

a. Place the mode switch to SET CHIRP.

b. Select '6' for Miscellaneous Utility.

c. Select '2' for Antenna Coupler.

3-18.3 COUPLER CHOICES. When the Antenna Coupler display (Figure 3-28) is shown, three choices are available:

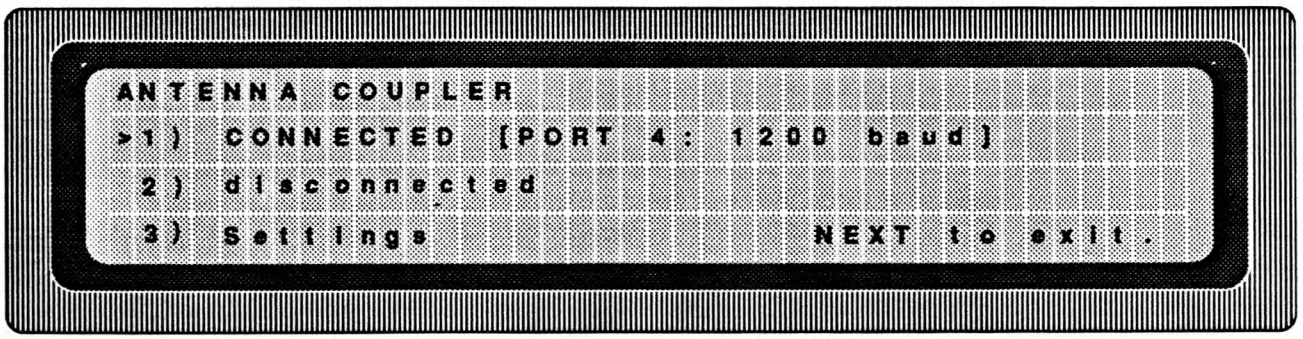


Figure 3-28. Antenna Coupler Display

a. CONNECTED. Select item '1' to tell the TCS-5 that the 7057 is connected. This tells the TCS-5 to send commands to the 7057. When selected, the word CONNECTED appears in all capital letters. TCS-5 serial data Port 4, used to control the 7057 will automatically be set to 1200 baud. Note that it is also necessary to physically turn the antenna coupler ON/OFF switch (located on the 7057 Interface) to ON to power the 7057.

b. DISCONNECTED. Item '2' is used to signal the TCS-5 that the 7057 is disconnected, or the 7057 Interface ON/OFF switch is off. When this is chosen, Port 4 can be set to any baud rate available. Note that when this is selected, the word DISCONNECTED appears in all capital letters and the 'High VSWR' alarm is disabled (see paragraph 3-8.5).

c. SETTINGS. Item '3' is used to set the 7057 and is only available if the 7057 is CONNECTED. Settings may be made for either Transmit (TX), on the left side of the display, or Receive (RX) on the right side. The selections are described below. Figure 3-29 show the settings that are available for the 7057.

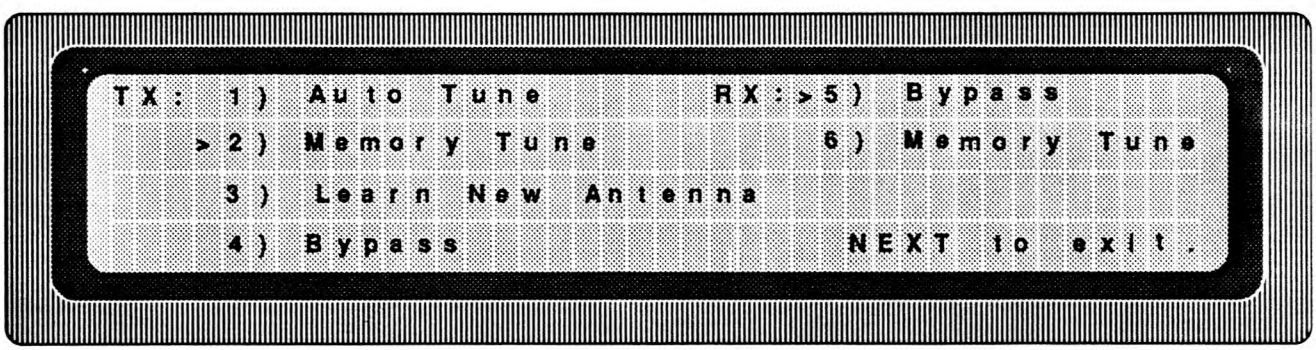


Figure 3-29. 7057 Antenna Coupler Settings

1. Auto Tune (TX). When (1) is selected, the 7057 automatically checks the antenna tune settings whenever the TCS-5 is transmitting, and changes them as required according to current conditions.
2. Memory Tune (TX). When (2) is selected, the 7057 uses tune settings that have been previously placed into memory (from Learn New Antenna or Auto Tune) and uses them, without regard to changing conditions.
3. Learn New Antenna (TX). When (3) is selected, the 7057 can 'learn' the tuning characteristics of an antenna for all frequencies from 2 to 30 MHz in one sweep of the TCS-5 transmitter. The tuner divides the range into bands as narrow as 50 kHz, then learns and stores the values of the required matching network for each band. If "Learn New Antenna" is selected while a sweep is already in progress, the coupler will start 'learning' immediately and finishing 'learning' in the next programmed sweep. However, if a 2-16 MHz sweep is in progress, the coupler will not relearn the full 2-30 MHz range if the next sweep is also in the 2-16 MHz range. It is recommended that the 'Learn New Antenna' function be selected at initial start-up of the TCS-5 and at the start of 2-30 MHz sweeps during mixed sweep range operations. Learn New Antenna must be co-selected with Auto Tune or Memory Tune. 'Learn New Antenna' is the only manual reset of the High VSWR alarm.
4. Bypass (TX). When '4' is selected, the transmitter RF output signal bypasses the 7057 tuning elements and is connected directly to the antenna. This is done by a bypass relay inside the 7057.
5. Bypass (RX). When '5' is selected the 7057 bypasses all tuning elements and connects directly to the antenna whenever the TCS-5 is not transmitting. This allows a receiver connected to the TCS-5 rear panel connector J10 direct access to the antenna (without tuning by the 7057 when the TCS-5 is not transmitting.
6. Memory Tune (RX). When '6' is selected, the TCS-5 will accept frequency tuning commands through remote I/O connector J7 (serial port 2) and transfer these commands to the 7057 when the TCS-5 is not transmitting. This feature allows a co-located receiver (such as an RCS-5) to remotely tune the 7057 (with the tune settings stored in the 7057 memory) instead of "bypassing" the 7057 tuning when the TCS-5 is not transmitting.

3-19 MISCELLANEOUS UTILITIES-ANTENNA CROSSOVER

3-19.1 In some applications of the TCS-5 it may be necessary to switch antennas during the 2-30 MHz sweep; for example, from a low band antenna to a high band. This can be done using the antenna crossover function and an external relay. Any frequency between 2.0 MHz and 29.9 MHz (100 kHz resolution) can be programmed for the antenna crossover frequency. When the operating frequency of the TCS-5 crosses the programmed antenna crossover frequency, the antenna crossover driver output (from FET driver U55) on rear panel connector J8 pin 11 will change state. The FET (field effect transistor) driver is suitable for driving RF relay coils powered from +12 or +28 Vdc. Refer to Figure 2-1 and drawing FO-30 for typical connections. The antenna crossover FET driver will be ON (conducting, relay energized) for frequencies below the crossover frequency, and OFF (open circuit, relay off) for frequencies at, or above the crossover frequency. Note that the antenna crossover relay is not provided as part of the TCS-5, only the FET driver for the external relay is provided. The external relay must operate on less than +40 Vdc power (+28 Vdc preferred) and must not require more than 200 mA of coil current to energize. A preferred relay operates from +28 Vdc and has a coil resistance

greater than 150 ohms. The relay must have a coil transient clamp diode installed across the coil. DC power (+28 Vdc) to operate the external relay is available on J8 pins 14 and 19. To program the antenna crossover frequency:

a. Select Miscellaneous Utilities (6) from the Set Chirp menu (Figure 3-2). Select Antenna Crossover (3) on the Miscellaneous Utilities menu, Figure 3-25. This brings up the Antenna Crossover Display, Figure 3-30.

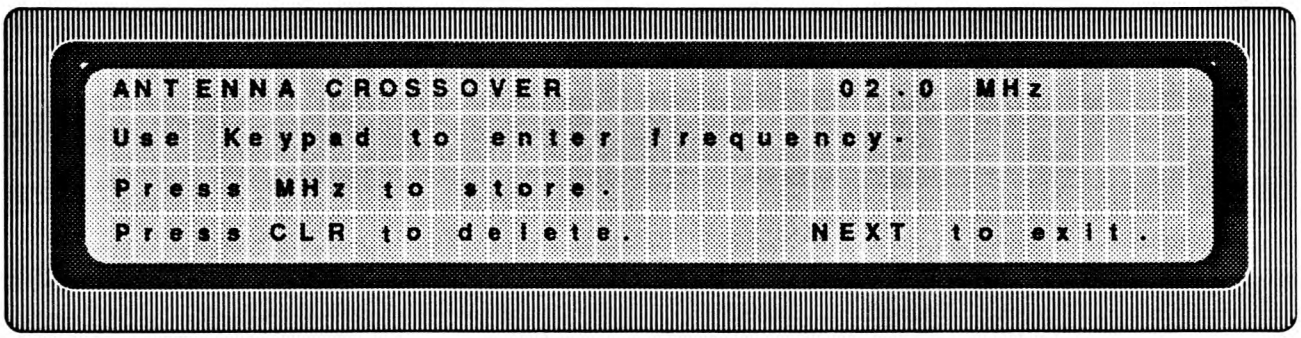


Figure 3-30. Antenna Crossover Display

b. Use the keypad to enter any frequency (to 100 kHz resolution) for the crossover frequency. The number will appear in the upper right corner of the first line. Press the MHz key to store or CLR (clear) to delete.

SECTION IV
THEORY OF OPERATION

4-1 INTRODUCTION

4-1.1 The TCS-5 Chirpsounder Transmitter is a complete Chirpsounder transmitter, Chirpcomm message modulator, and communications transmitter in one package. The TCS-5 employs completely synthesized RF generation and modulation, all solid state RF amplification with no mechanical tuning, and digital (microprocessor) CPU control of all functions.

4-1.2 RF signal generation begins at the synthesizer assembly (A6), which is driven by the programmer (A5) under control of the CPU (A4). The synthesizer frequency reference is obtained from a 5 MHz crystal frequency standard (A9). The 41.85-70.25 MHz output of the synthesizer is modulated and converted to the 1.6-30 MHz RF output by the downconverter/audio modulator (A7). The RF signal is then bandpass filtered in the preselector assembly (A8), amplified by the RF power amplifier (RFPA) assembly (A12), and lowpass filtered in the postselector assembly (A11). The RF output of the postselector (10 to 150W depending on TCS-5 operating mode) is fed to the rear panel RF output connector (J9) through the T/R switch A14.

4-1.3 RF modulation and conversion in the downconverter/audio modulator assembly starts in the single sideband (SSB) generator (A7A1). In this assembly, one of four signals is generated, depending on the selected TCS-5 operating mode:

1. A 250 kHz unmodulated CW carrier for Chirp mode;

2. A 250 kHz alternating with 250.250 kHz carrier for Chirpcomm modulation;

3. A 250 kHz suppressed carrier, audio modulated USB signal for Comm LSB mode (the sidebands are reversed in a later conversion step), and;

4. A 250 kHz suppressed carrier, audio modulated LSB signal for Comm USB mode.

4-1.4 In the upconverter, A7A2, the selected signal is mixed with 40 MHz and then filtered by a 40.25 MHz crystal filter. The crystal filter removes the unwanted 39.75 MHz mixer product and the 40 MHz carrier. The upconverter output amplifier gain is controlled by the automatic level control circuit. Further filtering of the 40.25 MHz signal occurs in the downconverter, A7A3, before the signal is mixed with the synthesizer output. The synthesizer covers 41.85 to 70.25 MHz, such that the downconverter mix produces the desired 1.6 to 30 MHz signal as well as an undesired 82.1 to 110.5 MHz signal. The undesired frequencies are removed by a 30 MHz low pass filter at the output of the downconverter. The signal level is +16 dBm at this point when the TCS-5 is operating in the 100 watt Chirp mode.

4-1.5 The synthesized (and modulated) carrier is passed through the preselector, A8, to remove broadband noise accumulated in the synthesizing, modulating and conversion processes. The preselector consists of 16, quarter octave-bandpass filters. The CPU selects the proper filter. The signal level at the output of the preselector is about +13 dBm.

4-1.6 The RF power amplifier, A12, is a three stage RF amplifier. The nominal +13 dBm signal from the preselector is amplified by 10 dB in the pre-driver section. The output of the predriver is fed to the RFPA driver or is switched to the rear panel exciter output (J3). The nominal full power exciter output level at J3 is +20 dBm. If the internal RFPA is used, the driver amp increases the signal level to approximately +34 dBm (approximately 3W) to drive the RFPA final. The final amplifies the signal another 16 dB to produce the 100/150 watt Chirp/SSB output of the TCS-5. Control circuitry in the power amplifier maintains maximum safe power output under all operating conditions. Power output is reduced, if required, to maintain a safe internal power dissipation for all VSWR and operating temperature conditions.

4-1.7 The postselector filter set, A11, follows the RF power amplifier at the 100/150 Watt level. This filter contains 8, half-octave low pass filters which track the transmitted frequency. Unwanted harmonics from the power amplifier are removed here. Again, the CPU selects the proper filter with pin diode switches driven from the controller/driver assembly (A15). The last unit in the RF signal path is the power detector and the T/R switch, A14. The T/R switch is a PIN diode "relay" that allows the antenna to be connected to a companion receiver when the TCS-5 is not transmitting. When the TCS-5 is keyed, the "relay" connects the antenna to the TCS-5. An RF directional coupler in this module provides forward and reflected power information to the CPU and the automatic level control (ALC) circuits in the upconverter (A7A2).

4-1.8 All control of the TCS-5 resides in the CPU. The CPU interprets front panel commands or remote control inputs to operate the system. Chirpsoundings are an automatic operation under program control. A separate clock/timer micro on the CPU board initiates the sweeps using the precision 5 MHz frequency standard for timing. This timing chain is maintained by the standby power battery system. The CPU keeps track of the required status of the system. When a transmission is required, the CPU passes the frequency (Comm) or start frequency (Chirp) to the programmer A5, keys the RF power amplifier, controls the RF modulation, and selects the proper pre- and post-selector filters. Controller/ driver A15, provides a logic level to 310V interface between the CPU, the postselector, and T/R switch pin diodes.

4-1.9 The programmer, A5, is the frequency programming interface between the CPU and the synthesizer. For Chirp transmissions, the programmer formats the start frequency to the synthesizer and then increments the frequency to generate the Chirp sweep. For SSB communications transmission, the programmer stores the carrier frequency information in the synthesizer format without change.

4-1.10 All timing and frequency generation is referenced to the 5 MHz frequency standard, A9. In the event of power loss, the standard is maintained for up to 5 hours by the standby battery. The 5 MHz clock is used by the Clock/Timer micro, programmer, and downconverter/audio modulator assembly, A7. A divider on the programmer supplies a 100 kHz reference clock required by the synthesizer. Downconverter/audio modulator A7, contains a 40 MHz phase-locked-loop and a 250 kHz generator referenced to the 5 MHz clock.

4-1.11 A switch-mode power supply, A13, provides all of the system DC power. The power supply and the RF power amplifier are fan cooled by temperature controlled fans.

4-1.12 The TCS-5 contains 12 major assemblies, including: CPU (A4), programmer (A5), synthesizer (A6), downconverter/audio modulator (A7), RF preselector (A8), postselector (A11), RF power amplifier (A12), T/R switch (A14), controller/driver (A15), power supply (A13), frequency standard (A9), and battery assembly (A10), which are described in paragraphs 4-2 through 4-13. The CPU software (firmware) is described in paragraph 4-14.

4-2 CPU (A4)

4-2.1 INTRODUCTION. The CPU board (1220-2001) consists of an 8085 microprocessor executing a program stored in EPROM which directs the control of all major TCS-5 processes. The CPU board communicates with other parts of the TCS-5 using I/O ports connected to the CPU buses. These I/O ports in turn are connected to ribbon cable connectors which carry the signals off board. Four UARTS's are included for external serial communications. A separate clock/timer micro (8748) keeps track of precise time and generates timing signals. A backup clock connected to a lithium battery maintains approximate time for emergencies. The CPU board interfaces with the operator through the use of keypad, switches, tuning knob, LEDs and LCD display. The CPU board has control of the synthesizer, and transmitter. An A/D converter is included to measure transmitter output power. A block diagram is provided in FO-2, and schematic is FO-12.

4-2.2 CPU. The CPU consists of an 8085 microprocessor (U21) running at 3 MHz. The CPU addresses memory and I/O ports using a 16 bit address bus. Data is passed back and forth over an 8 bit bidirectional data bus. Control signals which control the reading and writing to memory and I/O make up a third bus. U28 and U29 form a wait state generator which suspends CPU operation for one clock cycle when needed.

4-2.3 INTERRUPT CONTROLLER. U22 gets a 12.5 msec interrupt from the 5 MHz timing chain output, and a 1 PPS interrupt from the timer micro. These interrupts are recorded by U22 which causes the CPU to perform the interrupt service routine.

4-2.4 PROGRAM MEMORY. The program instructions which operate the TCS-5 are stored in a UV erasable programmable read only memory U10 (EPROM). The usable EPROM memory space is 48k bytes.

4-2.5 RAM. Data is stored in 8k bytes of static random access memory, U11.

4-2.6 NON-VOLATILE MEMORY. Data is saved when power is off in a 2k bytes of electrically erasable programmable read only memory (EEPROM). The CPU can write data to this memory at the rate of 1 byte every 10 msec.

4-2.7 COMMUNICATIONS INTERFACE. Dual universal asynchronous receiver transmitters (DUART) U13 and U14 provide serial data interface with external equipment. Each DUART consists of two UARTS, 2 baud rate generators, an input port, an output port, and a programmable timer. The UARTs communicate with remote equipment over serial polar data links. The I/O ports are used for miscellaneous signals between the programmer, front panel, and rear panel including parallel antenna control signals. One of the programmable timers is used to generate the 55 Hz Chirpcomm interrupt, which is derived by dividing the 5 MHz clock.

4-2.8 FRONT PANEL INTERFACE. Signals from the front panel switches and keypad are sampled through these I/O ports.

4-2.9 PROGRAMMER/SYNTHESIZER INTERFACE. The CPU can control the TCS-5 synthesizer by sending frequency and control signals to the programmer board.

4-2.10 TRANSMITTER INTERFACE. Signals to and from the downconverter, RF preselector, postselector, RF power amplifier, and T/R switch assemblies are interfaced to the CPU through I/O ports in the transmitter interface. The front panel tuning knob is also interfaced here through FIFO U43.

4-2.11 AUTO-RESET. This resettable CMOS counter presets to a programmed count and starts counting down to 0. An output pulse is issued at 0. This output pulse restarts the TCS-5 CPU and turns off the transmitter. The count down time is 6 seconds. During normal operation of the CPU program, a preset pulse will be issued by the CPU to the counter every few seconds. This restarts the count sequence so that it will not reach its final count (at 0) and restart the CPU. However, if the CPU halts or locks up in some undesired state, the auto reset counter will not get preset, and at the end of 6 seconds it will produce a system restart pulse to the CPU to re-initialize the system.

4-2.12 5 MHz DIVIDE CHAIN. The divider chain takes a 5 MHz reference clock and divides it by 625 to produce a 8 kHz signal for the clock/timer micro. A 12.5 msec period signal is also produced for the CPU for sampling the front panel switches and updating sweep parameters. A 2.5 MHz signal is sent to the Chirpcomm counter in DUART U14. The divide chain, up to the 8 kHz output, is powered by the standby (battery) supply.

4-2.13 TIMER MICRO. The timer micro is responsible for performing several functions for the TCS-5. These include updating the real-time clock, maintaining the mode programmer, maintaining the path offset, generating timing and sweep programmer signals.

1. Updating the real-time clock. The real time clock consists of 5 bytes each containing 2 BCD digits. These are organized in the following manner.

   Byte 0 contains the .1 msec and 1 msec digits.
   Byte 1 contains the 10 msec and 100 msec digits.
   Byte 2 contains the second digits (range 00-59).
   Byte 3 contains the minutes digits (range 00-59).
   Byte 4 contains the hours digits (range 00-23).

The real-time clock is updated every 500 µs. Therefore, the .1 msec digit alternates between 0 and 5. Every time the seconds byte increments, a 1 PPS signal is also generated. At the end of 24 hours the clock resets itself to 00:00:00.00.

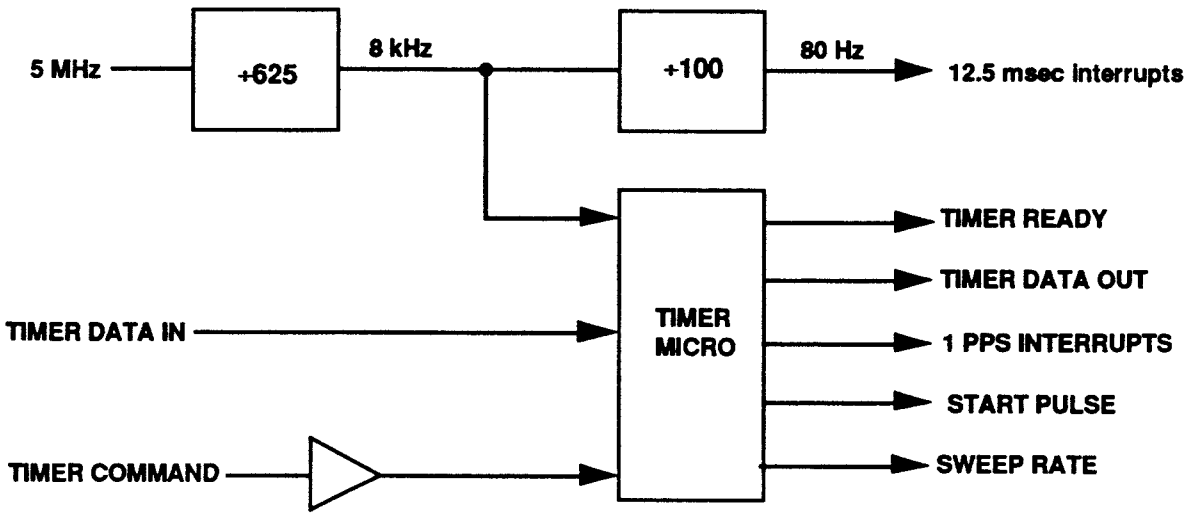


Figure 4-1. Timing Logic Block Diagram

2. Maintaining the Mode programmer. The mode programmer contains 16 entries. The first 12 entries (numbers 0-11) correspond to 5 minute intervals of the scan. Bits 0 and 1 of each entry indicate which mode should be activated during that interval (0-3). The modes are:

    0) 2-16 MHz, 1/10 power
    1) 2-30 MHz, 1/10 power
    2) 2-16 MHz, full power
    3) 2-30 MHz, full power

    Bit 2 is a 'don't care'. Bit 3 indicates whether the specified path is active (0=active, 1=inactive). The next two entries (numbers 12-13) are not used. The next entry (number 14) contains the frequency limits for each of the four modes. Each mode has a bit associated with it. A 0 (zero) in the bit position indicates 2-16 MHz, a 1 (one) indicates 2-30 MHz. The last entry (number 15) is used to indicate loss of power. The timer puts a 0 in this location upon power-on reset.

3. Path Offset. The path offset consists of 4 bytes, each containing 2 BCD digits. These are organized in the following manner:

    Byte 0 contains the 0.1 msec and 1 msec digits.
    Byte 1 contains the 10 msec and 100 msec digits.
    Byte 2 contains the seconds digits (range 00-59)
    Byte 3 contains the minutes digits (range 00-04).

    Offset values indicate how soon after the start of a five minute interval the path starts its sweep, if active as determined by the mode programmer.

4. Generating Timing Signals. The following is a list of the timing signals generated by the timer micro.

1 PPS:	A 500 µs wide, high-going pulse that occurs once every second.
START PULSE:	A 500 µs wide, high-going pulse that occurs whenever a sweep is supposed to start.
READY:	Level indicating whether the timer micro is ready to receive a new command. READY goes low when a new command is read and goes high when the command has been executed.
SWEEP RATE:	This line selects the sweep rate for the synthesizer. Zero indicates 2-16 MHz; one indicates 2-30 MHz.

5. Timer Interface. The timer micro responds to various 4-bit commands from the control CPU. These commands are:

0000	Set Clock
0001	Read Clock
0010	Advance Clock
0011	Retard Clock
01XX	Set Path Offset (XX)
10XX	Read Path Offset (XX)
1100	Set Path programmer
1101	Read Path programmer
1110	Not Used
1111	Not Used

An 8-bit input data bus and an 8-bit output data bus are provided for communications between the TCS-5 control CPU and the timer micro.

4-2.14 BACKUP CLOCK. The backup clock is a CMOS device powered by a Lithium battery. The clock's accuracy is controlled by a 32.768 kHz crystal and will maintain time within two seconds per week at room temperature (25°C). The lithium battery will power the backup clock for over five years. At the time of main power loss, the CPU writes the correct time with 10 millisecond resolution to the backup clock. When main power is restored, if the timer has lost standby (lead/acid) battery power, the CPU will read the current time from the backup clock.

4-2.15 A/D CONVERTER. The A/D converter allows the CPU to measure forward and reflected RF power. The power detector in the T/R switch (A14) provides the power level signal which is buffered by the downconverter (A7) and is sent to the CPU (A4).

4-2.16 LCD INTERFACE. A four line by 40 character liquid crystal display on the front panel is controlled by the CPU through this interface. Data and addressing information is transferred to the LCD.

4-3 PROGRAMMER ASSEMBLY (A5)

4-3.1 The programmer board (1220-2002) contains four independent circuit groups (block diagram FO-3, schematic diagram FO-13). The largest group is the programmer, an all digital circuit, which interfaces the CPU with the synthesizer. When Chirp sweeps are in progress, the programmer controls the frequency of the synthesizer by calculating the frequency increment rate needed to produce the sweep. The CPU, sends the programmer the start frequency and resets the programmer at the end of sweep. During comm transmissions the CPU frequency is stored in the programmer but not incremented. The frequency information stored in the programmer is continuously passed to the synthesizer, decade by decade, at a 10 microsecond frame rate.

4-3.2 The 8 decades of BCD frequency program data are stored in a parallel-in, serial-out, 4 X 8 storage register (PISO), U13, U22, U31, U36. The contents of this register are serially shifted out to the synthesizer by a burst of 8 clock pulses once every 10 μs frame. The serial data is simultaneously clocked through adder/subtracter U12 and back into the serial input of the PISO. If commanded to do so, the adder/subtracter can change the stored program frequency by selectively incrementing or decrernenting each decade as it is serially clocked through U12. To generate frequency sweeps, the adder/subtracter increments the 1 Hz decade (e.g. 1 Hz every 10 μs for 100 kHz/sec sweeps). To make larger frequency changes, such as when making frequency jumps, higher order decades are incremented or decremented. A string of increment/decrement commands on several decades can produce frequency jumps ahead or back of any size from 10 Hz to 999 kHz. The adder/subtracter and latch U2 process the carries and borrows between decades such that frequency jumps and frequency sweeps can be programmed simultaneously. For fixed frequency operation the adder/subtracter always adds zero. The initial synthesizer preset frequency (sweep low limit start frequency or fixed monitor frequency) is loaded by the CPU into the serial inputs of a SIPO (serial in, parallel out) storage register (U14, U23, U32, U49). Frequency preset information is entered on SD1 through SD4 one decade at a time starting with the most significant decade while the LOAD line is low. The contents of the SIPO (U14, U23, U32, U49) is then transferred directly to the PISO by a pulse derived from the synthesizer strobe. Information on which decade is to be incremented or decremented for frequency jumps is entered on SD1 through SD5 while the LOAD line is high.

4-3.3 Frequency data and control inputs from the CPU are clocked into latches (U8, U15, U17) with a strobe pulse. If the LOAD input is low, the frequency preset data is strobed directly into the SIPO by the clock pulse generated from the strobe. If the LOAD input is high when the STROBE input is pulsed, a decade will be incremented or decremented depending on whether the STEP +/- input is held low or high. The decade that is stepped is determined by which data line, SD1 through SD5 (10^1-10^5 Hz respectively), is low. Frequency sweeps are started by pulsing the STROBE input while holding one of the SWEEP RATE inputs low.

4-3.4 For data transmission, the synthesizer output frequency can be frequency shift keyed (FSK) by modifying the programmer output data. U11 performs a four-bit subtract with borrow on the data just before it is passed to the synthesizer.

4-3.5 The second function of this board is a 5 MHz power divider and a digital divider for the 100 kHz synthesizer reference. The 5 MHz sinewave from the frequency standard is split in an analog power divider. One sinewave output is passed off the board to the downconverter/audio modulator assembly (A7). The other output of the divider is digitally divided by 50, to 100 kHz and buffered for use by the synthesizer (A6).

4-3.6 The third section of this board is a battery charger and 5 volt switching supply. The charger maintains the six lead gel cells (assembly A10) at a constant float voltage under normal circumstances. When the batteries have been used and their terminal voltage is below a limit, the charger will charge the batteries at a constant current rate. When the proper terminal voltage is reached, the charger reverts to a constant voltage charge mode. The 12 volt output of the battery is used during power outage by the 5 MHz frequency standard (A9). The 5 volt switching supply efficiently converts the 12 volts to 5 volts for the 5 MHz divide chain and the timer micro.

4-3.7 The fourth section is a 30 volt power supply for the RF preselector. A free running oscillator, U28, through a FET and transistor switch, alternately apply -12 volts and +12 volts to capacitor, C30. The opposite end of C30 is either connected to -12 volts or capacitor C32. Effectively, C30, with a charge of 24 volts is pulled to -12 volts dumping a charge of -36 volts into C32. The resultant filtered -30 volts is used to bias the RF preselector PIN diodes to their off state.

4-4 SYNTHESIZER (A6)

4-4.1 Refer to block diagrams Figure 4-1, and FO-4. The 2840-2006 synthesizer circuit (schematic diagram FO-31) is a digitally programmed, phase-locked-loop synthesizer capable of generating any frequency between 40 and 70 MHz to I Hz resolution. It consists of a 40 - 70 MHz VCO, a programmable divider (÷N), a phase detector, loop amplifier, and control logic (phase register and timing generator). Figure 4-1 is a simplified diagram of the circuit. For more detailed information refer to Block Diagram, FO-4. This block diagram has been further subdivided into smaller functional sections, which refer to the respective sheets of the synthesizer schematic. Thus, the schematic illustrating the Residue Logic is found on Sheet 4 of schematic of FO-31.

4-4.2 The output frequency of the VCO (and the synthesizer) is determined by electrically tuning the VCO with a control voltage from the loop amplifier. The loop amplifier produces this control voltage by integrating (smoothing) the phase error signals generated by the phase detector. If there is no phase error, the output of the phase detector is zero and the loop amplifier will hold the VCO at its existing frequency. If there is a phase error the phase detector will drive the loop amplifier to change the VCO frequency until the error is corrected.

4-4.3 The synthesizer uses the phase detector to compare the output of the ÷N counter with a fixed 100 kHz reference signal. If the phase or frequency of these two signals do not match, the phase detector will drive the loop amplifier to adjust the VCO frequency until the ÷N output exactly matches the 100 kHz reference, thereby achieving phase lock.

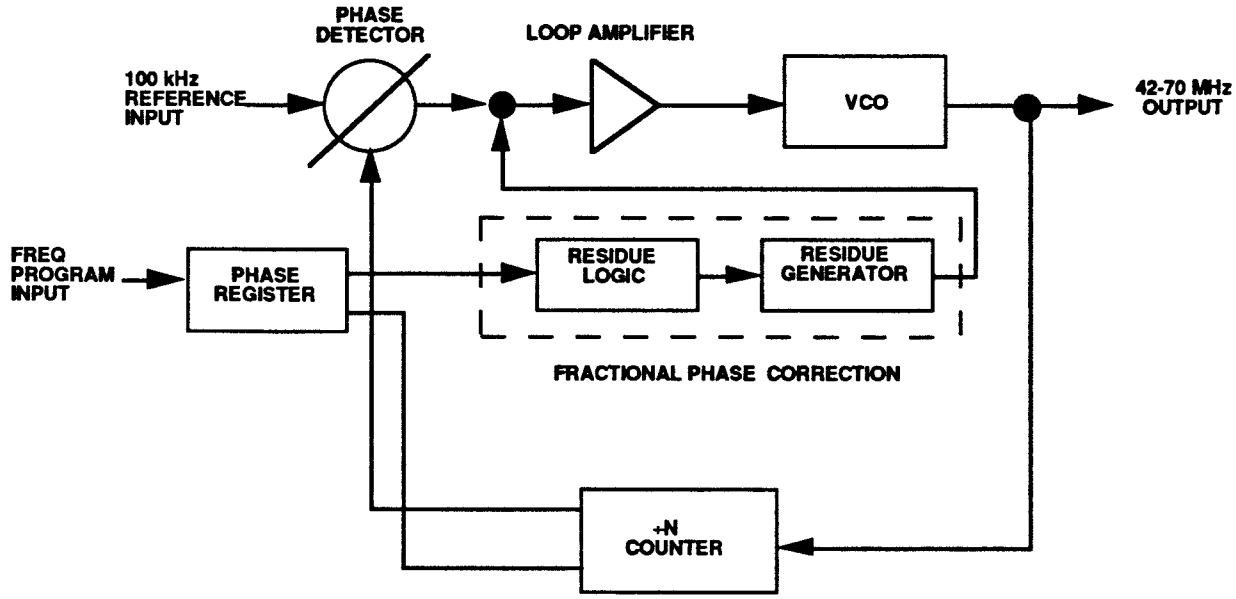


Figure 4-2. Simplified Block Diagram of Synthesizer

4-4.4 The VCO output frequency is always N times 100 kHz. There are N cycles of the VCO output for every one cycle of the 100 kHz reference. If N is an integer number, the VCO frequency will be an exact multiple of 100 kHz. However, if N is a number consisting of both integer and fractional components, intermediate frequencies between 100 kHz points may be synthesized. For example, to produce a 43.5 MHz output, the ÷N counter must divide by 435. If an output of 43.501 MHz is desired, the required divide ratio is 435.01. The ÷N counter, however, is a 3 decade counter only capable of dividing by integer numbers between 400 and 700. To divide by 435.01 the phase register circuitry programs the ÷N to divide by 435 for 99% of the time and divide by 436 for the remaining 1%. The resulting average divide number is:

$$\frac{(99 \times 435) + (1 \times 436)}{100} = 435.01$$

4-4.5 Because the synthesizer basic timing reference is 100 kHz, the ÷N counter completes a count sequence (frame) every 10 µs. In the above example the ÷N will count 435 VCO cycles (zero crossings) for ninety-nine 10 µs frames and 436 cycles for one frame. The phase detector and loop amplifier will then try to drive the VCO to operate at 43.50 MHz for 990 µs and at 43.60 MHz for 10 µs. The resulting VCO output is a phase modulated signal with an average center frequency of 43.501 MHz with 1 kHz sidebands. The 1 kHz sidebands result from the "jumps" in VCO frequency occurring every one millisecond (990 µs + 10 µs = 1 ms).

4-4.6 The amplitude of the sidebands can be reduced by smoothing the "jumps" in frequency such that the VCO remains steady at the average frequency and does not follow the loop back and forth between the two programmed frequencies. However, to reduce the sidebands to an acceptable level (-50 dBc) would require smoothing (slowing) the loop response to such an extent that the synthesizer would no longer be suitable for sweeps used in Chirpsounder applications.

4-4.7 These sidebands may be cancelled however, by using a fast loop and a fractional phase correction circuit operating in conjunction with the ÷N.

4-4.8 Note that the average frequency of the VCO is correct. Therefore the average value (or dc component) of the VCO control voltage from the loop amplifier is correct. The undesired 1 kHz sidebands are produced by the sudden phase errors generated when the ÷N counter "jumps" between the two programmed integer divide numbers. This produces a small momentary change in the VCO control voltage which modulates the VCO frequency resulting in sidebands. The fractional phase correction circuit cancels the VCO modulation by injecting a compensating correction signal into the loop amplifier to counteract the effect of the phase error jump when the ÷N skips from one divide ratio to another. The phase register keeps track of when to "skip" the ÷N from one divide ratio to the next and simultaneously programs the residue logic of the fractional phase correction circuits. The residue logic, in turn, drives the residue generator, which produces the residue fractional phase error correction signal. By careful alignment of the residue generator the synthesizer sidebands can be suppressed better than 50 dB below the fundamental frequency output level.

4-4.9 The ÷N counter consists of a VCO prescaler which typically divides the VCO output frequency by 2. The prescaler also contains a pulse skipper circuit that makes the 42 circuit skip one extra VCO clock pulse each time a skip command is given. This effectively turns the prescaler into a ÷3 circuit during a skip command. The output of the VCO prescaler drives the VCO divider. The combination of the VCO divider and the VCO prescaler is capable of dividing by any integer number between 400 and 700. For example, to divide by 437, the VCO counter down counts 430 times and the VCO prescaler skips 7 extra VCO clocks during the count sequence, yielding a total count of 437.

4-4.10 The phase register accepts binary-coded-decimal (BCD) frequency program data from the sweep programmer card (A5). All 7 decades of BCD data are transferred serially on a decade by decade basis every 10 μs. All timing signals needed by the synthesizer are produced by the timing generator circuit. The timing generator controls the timing of the transfer of frequency data input to the phase register and ÷N counter, and controls the timing of the fractional phase correction (residue) circuity.

4-5 DOWNCONVERTER/AUDIO MODULATOR ASSEMBLY (A7)

4-5.1 INTRODUCTION. The downconverter/audio modulator assembly (1220-1004, block diagram FO-5) consists of 3 circuit card assemblies: SSB generator (1220-2003), upconverter (1220-2004), and downconverter (1220-2005). The function of this assembly is to convert the synthesizer 41.85 to 70.25 MHz output to the 1.6 to 30 MHz carrier for amplification in the power amplifier. In the communications mode, the carrier is SSB modulated by these circuits.

4-5.2 SINGLE SIDE BAND (SSB) GENERATOR (A7A1). Refer to FO-14 for the schematic of the SSB generator.

a. Inputs from the MIC IN (front panel) and LINE IN (rear panel) are first preamplified by U1 and U5, respectively. Switch U2, which is controlled from the rear panel Gain Control switch, sets the proper preamplifier gain to correspond with the rear panel LINE IN signal level in order to provide the proper input level (100 mV min) for the audio ALC (automatic level control). The LINE IN, MIC IN, and a 1000 Hz test signal generated on the board are summed together at the input of the AUDIO ALC (U5, Q6, and Q1). The Audio ALC (U5, Q6, and Q1) also provides a reference for the Audio Overload Alarm to the CPU. The Audio ALC maintains the signal at a level of 600 mV peak.

b. Following the Audio ALC, the signal is filtered by a 300 Hz highpass filter if Speech Compression is off, or a 600 to 1500 Hz bandpass speech filter if Speech Compression is on. Speech Compression is selected by the CPU and implemented by U12 and switch U10. A 3 kHz lowpass filter is then used for further filtering. Sidetone amplifier, U11, allows monitoring of the signal transmitter or receiver audio in (from the rear panel) and outputs it to the front panel earphones jack. Selection is controlled by the CPU and switch U10.

c. Single sideband generation is done by the quadrature mix method. The audio 900 phase shifter provides the audio signal and its 90° phase-shifted complements to double balanced mixers U14 and U15. U16 and U17 comprise a 250 kHz divide-by-twenty circuit to provide 250 kHz from the 5 MHz standard. U18 selects the proper 250 kHz phase (±900 phase shift) for the mixers in order to select USB or LSB. The quadrature audio signals are then each mixed with one of the quadrature 250 kHz L.O. signals. The outputs of the mixers are then summed together, cancelling the unwanted sideband. The desired SSB signal is then amplified to -10 dBm and output to the upconverter. If a CW signal is desired the modulation on the U14 is disabled through U12 and CPU SSB control, and no SSB signal is obtained.

d. Chirpcomm frequency shift keying (FSK) modulation is accomplished in the SSB generator. The microprocessor, in the CPU, converts each Chirpcomm message character that is to be transmitted into a six-bit word. The forty six-bit characters (240 bits) are sent serially by the CPU to the SSB generator modulator, which shifts the frequency of the SSB Generator up by 250 Hz. Whenever the data bit is a zero or "space", the RF carrier is shifted down by 250 Hz; if the data bit is one or a "mark", it leaves the Chirpsounder RF sweep unchanged. Thus, on a message consisting of all marks (all ones) the modulator allows the 2 to 30 MHz Chirpsounder sweep to pass through the system unmodulated. However, a message of all spaces would cause the FSK modulator to shift the frequency of the 2 to 30 MHz sweep down by 250 Hz over the entire range of the sweep. Normal messages consist of a mixture of marks and spaces which cause the modulator to shift the Chirpsounder sweep back and forth between its normal sweep frequency for mark, and its sweep frequency minus 250 Hz for space. The output of the SSB generator for unmodulated Chirp transmission or CW is 250 kHz

4-5.3 UPCONVERTER (A7A2). Refer to FO-15 for the schematic of the upconverter. The upconverter phase-locks the internal 5 MHz frequency standard to an external 5 MHz by MXR1 and U1. Transistor Q3 and U1 sense the presence of an external 5 MHz and activate relay K1 to switch the internal 5 MHz standard control voltage into the phase locked loop. This 5 MHz reference is used by the 40 MHz synthesizer. The 40 MHz is mixed with the 250 kHz signal from the SSB generator to the

40.25 MHz I.F., filtered by crystal Y2, and amplified to a level of -9 dBm to be supplied to the downconverter. The alarm threshold circuitry (U2) senses the 40 MHz VCO control voltage and supplies it to the downconverter for the summary alarm to the CPU. ALC (automatic level control) from the downconverter regulates the 40.25 MHz SSB output level through U5 and U9.

4-5.4 DOWNCONVERTER (A7A3). The 40.25 MHz signal from the upconverter is first filtered by a 15 kHz bandwidth crystal filter. It is then mixed with the 41.85 to 70.25 MHz output of the synthesizer. After mixing, the signal is amplified and filtered through a 30 MHz low pass filter. The resulting 1.6 to 30 MHz SSB signal is then amplified to a level of +16 dBm for output to the preselector. FO-16 is the schematic diagram.

4-6 RF PRESELECTOR (A8)

4-6.1 The RF preselector (1220-2014) reduces the broadband thermal noise, present in the amplified output of the frequency synthesis circuits, before it reaches the RF power amplifier. FO-6 is the block diagram, and FO-23 is the schematic of the RF preselector.

4-6.2 The RF preselector contains 16, one-quarter octave, PIN diode switched, four-pole, band pass filters. The filters are arranged in four banks of four filters each, each bank containing every fourth filter (i.e., bank I contains filters 1, 5, 9, and 13, bank 2 contains 2, 6, 1 0, and 14, etc.). Therefore, adjacent frequency filters are always in another filter bank. This keeps the number of PIN diodes that must manage the full HF spectrum to a minimum.

4-6.3 The filters are selected by a 4-bit code from the CPU. This code is broken down into four bank select lines and 16 filter select lines. The select lines, in turn, control (20) transistor drivers. A TTL bank select line, when at a logic low, causes current from the +12 volt supply to forward bias a bank select switch diode. The other three bank select switch diodes are biased off by -30 volts. At the same time only one filter select line is at a TTL low. This selects one of the four filters in the select bank by placing +12 volts on the filter switch diode. This forward biases the filter switch diodes as well as forward biasing a diode shunt to ground. The shunt to ground reduces leakage through the non-selected filters.

4-7 POSTSELECTOR (A11)

4-7.1 The postselector filter set (1220-1104, block diagram FO-7) consists of eight sequentially enabled, half-octave, low pass filters which are used to attenuate harmonics generated by the 1220-1005 RF power amplifier. The filters are located on two circuit boards (A11A1 and A11A2) within the postselector assembly. The filters are designated LPF1-LPF7 and LPF9; LPF8 is a switchable bypass circuit that feeds the RF signal directly to LPF9. Filters LPF1-LPF4 are located on the A2 assembly (FO-25) and LPF5 through LPF9 are on the A1 assembly (FO-24).

4-7.2 The RF signal enters at J1 and is connected to PIN diode switches on the A1 and A2 assemblies. If the signal is between 1.6-2.8 MHz, LPF1 is enabled. This is accomplished by forward biasing the input (D10) and output (D12) diode. A +6 volt signal is connected to all of the input and output diode anodes. The controller/driver assembly (A15) grounds the select line of the one selected filter. The remaining seven pairs of diode gates are reverse-biased by a +310 volt potential also

provided by the controller/driver. As the RF sweep signal passes 2.8 MHz, D10 and D12 in LPF1 are reverse biased by +310 volts, thereby removing LPF1 from the RF circuit. Due to the permanent bias of approximately 300 volts at E9, D11 is now forward-biased, shunting to ground any RF that leaks through D10. As the RF signal sweeps up to 30 MHz, LPF2 through LPF8 are sequentially enabled in a similar manner. The following table indicates the frequency range during which each circuit is enabled.

Frequency (MHz)	Filter
1.6-2.8	LPF1
2.8-4.0	LPF2
4.0-5.8	LPF3
5.8-8.0	LPF4
8.0-11.0	LPF5
11.0-16.0	LPF6
16.0-23.0	LPF7
23.0-30.0	LPF8
1.6-30.0	LPF9

4-7.3 As indicated in the table, LPF9 is in the RF path for all transmitted frequencies. This filter further attenuates any harmonic frequencies above 30 MHz not removed by the selected fitter, LPF1-LPF8 When LPF8 is selected, the RF signal is fed directly to the LPF9. LPF8 contains no filtering elements but routs the signal to LPF9 which removes the unwanted harmonics for signals above 23 MHz. A transient suppressor is placed on the output line to ground for circuit protection.

4-8 RF POWER AMPLIFIER (A12)

4.8.1 RF POWER AMPLIFIERS IN USE IN THE FIELD. There are currently two power amplifier boards in the field in use for the TCS-5. The 1220-2007 board is used on TCS-5 units with serial number 90109 and lower, and the 2842-2006 board is used on units with serial number 90110 and higher.

4-8.2 RF POWER AMPLIFIER (1220-2007, units with serial number 90109 and lower)

a. The power amplifier board, 1220-2007, consists of 5 major blocks; the pre-driver stage, the driver stage, the final amplifier stage, the protection circuitry, and the control circuitry as shown in the block diagram FO-8 and schematic diagram, FO-18. The following description assumes operation of the RFPA at 100 watts CW output. For 150W PEP SSB output, the indicated levels will be slightly higher (approximately 2 dB).

b. The pre-driver is a single ended class "A" amplifier with approximately 7 dB of gain which brings the nominal +13 dBm of input drive to +20 dBm (100 mW). A relay K1 switches this signal either to the driver stage or to the external drive output.

c. Q3 and Q4 compose the driver stage. Configured as a class "A" push-pull amplifier, this stage provides 14 dB of gain to deliver 2.5 watts of RF power for the final amplifier stage.

d. The final stage uses 2 MOS power FETs in a class AB push-pull amplifier. The bias voltage is obtained by voltage regulator, U2, which is thermally compensated through Q6 to stabilize the FET quiescent current with temperature. The output of each FET is passed through a step up transformer and added to the other to provide 100 watts of RF power. The final amp is capable of 200W PEP output when driven to compression. The 1 dB attenuator at the input of the final amplifier helps assure amplifier stability of VHF frequencies.

e. Protection circuitry consists of a directional coupler, a DC current sense of the final amplifier stage, a summer/amplifier stage and a variable attenuator at the input of the pre-driver stage. Sensing the forward power, reflected power, and the DC current, the circuit determines the power dissipated in the final amplifier stages and if needed, reduces the drive (by adding attenuation) to keep the FETs in a safe operating region.

f. The control circuit switches the amplifier from its standby state to the operate state. This is done by switching the +12V supply through Q2 to the bias circuits of the driver amplifier and the final amplifier. A thermostat will force the amplifier to its standby mode if the heatsink temperature rises above a safe level. The amplifier is also placed into standby if the +54V supply fails.

4.8.3 RF POWER AMPLIFIER (2842-2006-02, units with serial number 90110 and higher)

a. The RF power amplifier PCB (2842-2006, schematic FO-19) amplifies the transmit signal generated by the IF assembly, A7, to develop the 100/150 watts of output power. The following description assumes operation of the RFPA at 100 watts CW output. For 150W PEP SSB output, the indicated levels will be slightly higher (approximately 2 dB). It consists of 5 major blocks: A pre-driver stage, a driver stage, a final amplifier stage, protection circuitry, and control circuitry. This amplifier is capable of delivering nearly 200 watts into a 50 ohm load, but this excess capability is used to overcome losses in the controller/driver PCB and to obtain greater VSWR tolerances.

b. The pre-driver is a singled ended class A amplifier with approximately 10 dB of gain which brings the nominal +10 dBm of input driver to +20 dBm (100mW). A relay, K1, switches this signal either to the driver stage or to the +20 dBm external drive output. The resistor and a diode level detector are used for the built in test functions of the system.

c. Transistors Q3 and Q4 compose the driver stage. Configured as a class "A" push-pull amplifier, this stage provides 14 dB of gain to deliver approximately 3 watts of RF power to the final amplifier.

d. The final amplifier stage used 2 MOS power FETs (Q8 and Q9) in a class AB push-pull configuration. The output of each FET is passed through a step up transformer and summer together to provide 100/150 watts of RF power. The final amplifier is capable of 200 Watt PEP when driven to compression. The transistor are biased through a voltage regulator, U2, which is thermally compensated through Q6 to stabilize the FET quiescent current with temperature.

e. The protection circuitry consists of a directional coupler, a DC current sense of the final amplifier stage, a thermistor connected to the RF power output transformer, a summer amplifier stage, and a variable attenuator at the input of the pre-driver stage. The circuit sense the forward power,

the reflected power, the DC current draw, and the transformer temperature and generates a composite protect signal (PA VSWR E20) which goes to the downconverter PCB (1220-2005). If for reasons of high antenna VSWR or extreme stress on the final amplifier components, the ALC circuit will cause the CPU summary alarm to indicate. The comparator, U3-7, also monitors the PA VSWR signal. If there is a failure in the IF ALC circuit, the comparator will protect the RF power amplifier by overriding the IF ALC circuit and attenuating the input signal at the pre-driver stage with PIN diodes D7 and D8.

f. The control circuit switches the amplifier from its standby state to the operate state. This is done by switching the +12 volts supply through Q2 to the bias circuit of the driver amplifier and the final amplifier. A thermostat will force the amplifier to its standby mode if the heatsink temperatures rise above a safe level. The amplifier is also placed into standby if the +54 volt power supply fails.

4-9 T/R SWITCH (A14)

4-9.1 The main function of the T/R switch (1220-1016) is to connect the antenna to the TCS-5 power amplifier during periods of transmit or to the receiver output connector during the standby periods. The switching is accomplished by two PIN diode switches D4 and D5. The 1 MHz high pass filter between the antenna and the PIN diode switches protect the diodes from strong LF and MF signals preventing them from generating unwanted IMD products in the HF spectrum. The output power of the TCS-5 is measured by the directional coupler for display, and for ALC of the TCS-5 output power level. FO-9 is the block diagram, and FO-20 is the schematic of the T/R switch.

4-9.2 Also included on the T/R switch PCB is the third PIN diode switch which connects a 10 watt 50 ohm, dummy load to the RF output during the TCS-5 transmitter Self Tests.

4-10 CONTROLLER/DRIVER (A15)

4-10.1 The controller/driver assembly performs two functions. The first function is to convert logic signals into high voltage signals for driving the postselector and T/R switch RF switches. The second function is to provide speed control for the RF power amplifier fan. FO-10 is the block diagram, and FO-22 is the schematic of the controller/driver.

4-10.2 The driver section contains 11 FET drivers. The drivers either place +310 volts at a low current on the output line or sink the output line to ground at a high current. Each driver consists of a pair of FETs (e.g. Q22, Q23). The FET with the grounded source (Q22) is driven directly by the 12 volt CMOS logic. The drain of Q22 is connected to the output line through diode D12, which can sink several hundred milliamps to ground when Q22 is on. When Q22 is off, Q23 pulls the output line to +310 volts through diode D34. Note that Q23 sources less than 10 milliamps at 31OV.

4-10.3 The eight postselector drivers are controlled by a 3-bit digital signal from the CPU. The 3-bit code is converted to a 1 of 8 code by U2 and then inverted by U3 and U4. The T/R drivers operate from the true and inverted T/R CPU signal. The dummy load driver operates from the inverted dummy load CPU signal. All CPU logic signals are +12 volt CMOS.

4-10.4 The fan controller is used to maintain the RF power amplifier cooling fan speed at the minimum required rate. The air temperature sensor, thermistor RT1, is mounted on the board such that it is in the exit air flow of the power amplifier. The servo amplifier, U1, drives transistor, Q1, which drives the output transistor, Q2. Zener diode, VR1, prevents the output voltage from dropping below about 15 volts. The result is about 13 volts minimum across the fan, thus the fan will run between about 13 volts (slow) to 28 volts (full speed) depending on the air temperature. This reduces the fan noise when the system is idle or operating at low power.

4-11 POWER SUPPLY (A13)

4-11.1 The main power supply (5060-1150-02) is a modular switching converter supply. It accepts 115 or 230 Vac, selectable, (±15%), 47 to 440 Hz line power. It outputs +6 Vdc (1.5 A nominal), +12 Vdc (3.3 A nominal), +28 Vdc (1.5 A nominal), +54 Vdc (6 A nominal), +310 Vdc (6 mA nominal), -12 Vdc (0.7 A nominal), and +5 Vdc (2.3 A nominal). It can withstand such problems as poor line voltage regulation including "brown outs", line surges, transients, and frequency variation. If the AC line drops below the specified value, the system will shut down or not turn on. The circuit breaker will trip if the AC line voltage exceeds 130% of nominal. All DC outputs are protected from overcurrent or short circuit loads. DC output overvoltages will trip the circuit breaker. All connections are made via terminal strips. The power supply has a TTL output for power failure warning, allowing the CPU time to shut down when a power failure is imminent. FO-35 is the block diagram and FO-36 is the manufacturer's (Resonant Power Technology) schematic of the assembly.

4-11.2 Power is applied to the power supply through circuit breaker CB1 on the TCS-5 front panel. CB1 will trip for currents exceeding 15 amps (115 Vac) and 7.5 amps (230 Vac). Rear panel voltage selector slide switch, S4, selects either the 115 or 230 Vac input to the power supply. Line disturbances and reflected noise are filtered through line filter L1. The AC line voltage is rectified by D1 and capacitors C9-C14. The input voltage detector (U15, Q45) senses the input voltage at turn on and trips the circuit breaker if this voltage is unacceptably high. The power fail detector (U14, and line undervoltage sensor (U14, also monitor the input voltage level. The power fail circuit provides a TTL level output to flag the CPU of an imminent loss of power. The CPU then has approximately 20 ms to shut down without data loss. The line undervoltage sensor holds the switching converters off until the input voltage is sufficiently high to allow all outputs to turn on within spec and remain in spec until power is turned off (i.e. either on and in spec or completely off). The housekeeping converter (U17, Q12, T12) provides +12V and +24V for internal use by the power supply. This converter also supplies the unregulated input voltage to the 3-terminal voltage regulator (VR1) that controls the -12V output. The 54V output is regulated by three parallel switching converters (U7-U10, Q1-Q16). Another switching converter (U4, U5, Q6, Q7) regulates the +28V output. The 16V switching converter (U2, U3, Q1, Q2) drives two buck regulators. One of these buck regulators (U12, Q29) regulates the +12V output. The +310V output is tapped from the +12V buck regulator through transformer T11. The +310V output follows the +12V regulation (only the +12V output is directly regulated). The other buck regulator (U11, Q28) regulates the +6V output. The +5V output is derived via the voltage drop across diode D22. The +5V and +6V outputs are regulated as one output. All output voltages are monitored by comparator U13. If an output overvoltage condition arises the circuit breaker relay trip coil is activated, shutting of f power to the supply. In addition, the 16V, 28V, and 54V switching converters are electronically shut down (independently) in the event of an output overvoltage condition. Output current is sensed and limited by the switching converters for the +28V and +54V outputs. The +12V

and +310V output currents are sensed independently and limited by their buck regulator. The +5V and +6V output currents are sensed and limited as one by their buck regulator. Thermal sensors on the heatsinks for the converter switching transistors are monitored by comparator U18, which activates the circuit breaker relay trip coil and shuts off the supply if overheating occurs.

4-12 FREQUENCY STANDARD (A9)

4-12.1 The frequency standard (0410-2540) is a self-contained unit supplying highly accurate 5 MHz outputs to the TCS-5. Refer to FO-21 for the schematic of the frequency standard filter. A 5 MHz TTL level (+0.4 to +3.5V) output on J1-I is fed to the CPU (A4) to generate a timing reference. The CPU, in turn, provides timing synchronization for the rest of the TCS-5 Transmitter. A 5 MHz sine wave output on J3 drives the programmer board (A5). This board provides frequency reference signals based on this 5 MHz to the downconverter/audio modulator (A7) to insure that all operations are coherent with the 5 MHz standard. The TCS-5 rear panel has a frequency standard adjustment potentiometer which may be used to adjust the standard. See Section V for details.

4-13 BATTERY ASSEMBLY (A10)

4-13.1 The standby battery supply (2540-1008) consists of six series connected 2.0 volt lead/acid rechargeable batteries contained in a box which is bolted to the chassis. The battery supply is activated in the event of AC line interruption and will maintain the timing circuitry for approximately 5 hours. Sounder transmission, however, is lost in the event of AC line shutoff. An automatic charging circuit located on the programmer assembly (A5) charges the battery supply when AC line power is on. The standby battery supply is shut down whenever its voltage falls below 10.8 volts to protect the batteries.

4-14 SOFTWARE

4-14.1 GENERAL. The performance of the TCS-5 is largely determined by software executed by the CPU. Software performs the operator interface by sampling front panel controls and setting indicators. Transmitter control is also under software control. The following descriptions are intended to describe the functions performed by the TCS-5's software without detailing the programs themselves. There are three major software categories:

a. Interrupt processing for handling time-critical situations in real time.

b. Operator interface processing for switches, keypad and tuning knob inputs.

c. Mode processing for the ten modes of operation of the TCS-5.

4.14.2 INTERRUPT PROCESSING. Some functions must be performed at specific times by the TCS-5. This is accomplished by the use of CPU interrupts. An interrupt is a signal that stops current software execution and begins the execution of the interrupt service software for the interrupt received. If a function needs to happen at a certain time, interrupts allow real time processing of the function without delaying until a later time. The thirteen interrupts in the TCS-5 can be categorized into five types:

1. Power Fail
2. Timing
3. Sweep Start
4. Chirpcomm (55 Hz)
5. UART Interface

a. Power Fail. The power fail interrupt from the power supply indicates that power failure is imminent. The CPU sets the backup clock to the correct time and sets an I/O bit to disable clock and timer microprocessor access.

b. Timing. There are two timing interrupts.
   1. The 1 PPS interrupt is generated by the timer micro, once per second, synchronously with an internal real time clock. The TCS-5 software responds by reading and displaying the time from the timer micro.
   2. The 12.5 millisecond interrupt is generated by a hardware divide chain synchronized to the beginning of each sweep. This interrupt is used to sample the front panel switches. Every eight interrupts or 100 msec, the sweep frequency is updated for control of the pre-selector and postselectors and for possible sweep termination. The sweep frequency is checked against tables of pre- and post-selector frequencies.

c. Sweep Start. The timer micro issues a sweep start interrupt at the beginning of each sweep. This causes the TCS-5 to start sweeping. The Chirpcomm timer is reset and its interrupt enabled.

d. Chirpcomm. The Chirpcomm interrupt occurs at a rate of 55 Hz. Upon reception of this interrupt, the CPU sends the next Chirpcomm message bit to the SSB generator board. This interrupt is produced by the Chirpcomm timer which is loaded with a value of 22727. When reset, it begins to count down this number to zero at a 2.5 MHz clock rate. It then reloads and counts down again. Upon termination of this second countdown, an interrupt is sent to the CPU. This happens at the 55 Hz Chirpcomm rate.

$$35.00066\ \text{Hz} = \frac{1}{2(22727) \times \dfrac{1}{(2.5 \times 10^6)}}$$

This rate is slightly fast with an error of 0.0012% per bit which would accumulate to an error of 18% by the last bit (the 15400th bit). To prevent this, the timer is reset every second by the 12.5 msec timing interrupt so that the error will not accumulate beyond .066%.

e. UART Interface. There are 8 UART interrupts. Four of these are transmit-buffer-empty interrupts from each of the four UARTS. The other four are receiver-ready interrupts from the four UARTS. These interrupts allow the UARTs to signal the CPU when they need data to transmit or when they have received data from a remote user.

4-14.3 OPERATOR INTERFACE PROCESSING. The TCS-5 monitors operator input functions every 12.5 msec using the 12.5 msec interrupt. These functions include keypad, switches, mode rotary switch, tuning knob, transmit key input, interlock, and the internal/external switch.

a. The keypad is in a matrix configuration. The matrix consists of four rows and four columns. Each row is strobed with a signal. While that row is being strobed, each column is sampled to see if the strobe signal is present. If a keypad switch is pressed in that row, the strobe signal will show up in the column for that switch. Thus, the switch pressed will be identified by the CPU.

b. The switches are sampled and processed according to their position.

c. The tuning knob rotates an encoder which clocks CW/CCW data into a 64 byte deep FIFO at a rate of 200 counts per revolution. The FIFO data is read by the CPU for tuning or scrolling applications.

4-14.4 MODE PROCESSING. The front panel rotary mode switch enables the various modes of the TCS-5. These are described below.

a. RUN MODE. This is the normal operating mode once the TCS-5 sweeps have been programmed. Changes in sounder parameters or system clock are inhibited in this mode making the front panel "safe" from inadvertent use. The TCS-5 will perform Chirp transmission under control of the timer microprocessor. The display will show the current Chirpcomm message transmission frequency, and a pending Chirpcomm message and start time of the next transmission. Only the mode switch is operable.

b. CHIRP PROGRAM MODE. The TCS-5 may be set up to sweep in a specified 5-minute interval of every hour in this mode using keypad entries. There are 5 modes which can be programmed to sweep in the TCS-5. These modes define the sweep range and output power level for each 5 minute segment.

Table 4-1. Mode Description

MODE	SWEEP RANGE/OUTPUT POWER
Mode 0	no sweep
Mode 1	2-16 MHz, 1/10 power
Mode 2	2-30 MHz, 1/10 power
Mode 3	2-16 MHz, full power
Mode 4	2-30 MHz, full power

The path timer in the timer micro is programmed with the mode program. The timer micro controls the sweep rate and start times. There are 3 antenna outputs which can be programmed for use during each 5 minute segment in this mode.

c. SET CHIRP. Such TCS-5 parameters as setting the clock, start time delay, and blanker frequencies can be changed in this mode.

1. CLOCK SET. The system real time clock, located in the timer micro may be set or adjusted. Keypad entries for hours, minutes, or seconds are sent to the clock after the appropriate unit key is pressed. The SEC key will freeze the clock at the specified seconds until the key is released. Pressing the ENABLE switch allows fine clock adjustment with the tuning knob at a rate of 100 msec per revolution.
2. SET OFFSET. Path start offset is the amount of time elapsed in a five minute program interval before a sweep begins. Keypad entries specifying path offset minutes, seconds, and fractional seconds are tested for limits and sent to the timer micro after a MIN or SEC unit key is pressed.
3. SET BLANKER. The blanker frequencies are listed and can be changed in this menu. Up to 32 frequencies may be entered using the 'Narrowband Channelized Blanking' menu, and two bands in the 'Wideband Blanking' menu. The list can be scrolled through using the tuning knob and changed using the keypad.
4. BLANKER ON/OFF. This allows blanker list to be implemented. When the blanker on/off is on, the transmitter will be turned off for ±30 kHz around each blanker frequency as it is encountered during the sweep.
5. NORM/STANDBY. In STANDBY, the Chirp transmitter emission will be keyed off. If a transmission is in progress, the RF power will be cut off, but the sweep will continue in the programmer/synthesizer. When standby is returned to normal, the RF power output will resume. If the system is left in STANDBY, no Chirp emissions will occur although the programmer will continue to operate. This allows shutting down a transmitter without having to reprogram all '0's (zeros) in the mode program.

4-14.5 CHIRPCOMM MESSAGE PROGRAM. Entry of the 40 character Chirpcomm message is done in this mode. The first two characters form the receiver ID code. This ID code can be changed or left the same. A new message can be stored, sent immediately, sent once, sent twice, or sent continuously. Also a current message can be aborted, or a waiting-to-send message can be cleared in this mode. The 40 character message is converted into 40 six bit characters of special Chirpcomm code which is weighted to reduce transmission disturbance. The message entry is menu driven and requires the keypad and tuning knob.

4-14.6 SET COMM. Set comm mode allows the comm mode antenna to be selected 1, 2, or 3. Speech compression can be turned on or off. The preset frequency list may be reviewed or changed in SET COMM mode. Frequencies can be added or deleted. Also the preset list can be read from an external cartridge over a serial data link.

4-14.7 USB AND LSB COMM MODE. In this mode the TCS-5 operates as a conventional communications transmitter with either a LSB or USB modulation. A frequency is entered by the keypad or from the preset frequency list. The frequency can then be modified by the tuning knob. If the mode switch is placed into the USB or LSB comm mode positions, a frequency must be entered before the COMM mode becomes active which terminates and disables sweeps. The CPU sends the selected frequency to the synthesizer and selects the appropriate preselector and postselector. When the transmit key switch is pressed and interlock is not on, the CPU switches the T/R switch to T, waits 1 msec for the switch to change, then turns on the transmitter. When the transmit key is released, the transmitter is turned off, and the T/R switch put back to R.

4-14.8 SLAVE MODE. This mode is used for transreceiver operation with the RCS-5. All frequency and sideband selection is controlled by the RCS-5. The TCS-5 will ask for the RCS-5 frequency and sideband every 100 msec. When the TCS-5 is about to turn on its power amp, it sends a mute command to the RCS-5. When the power amp goes off, a mute off command is sent to the RCS-5.

4-14.9 REMOTE MODE. In remote mode the TCS-5 can be fully remotely controlled by another instrument such as the FMT-5A. All front panel controls are disabled. Only the time is displayed. Control will come over a remote serial digital data link. Almost all TCS-5 functions will be available by remote control with the exception of forward/reflected power measurement, slave mode, and test mode. However there is one general test that a remote unit can perform which results in "TCS-5 working" or "TCS-5 not working" status.

4-14.10 TEST MODE. Several subsystems of the TCS-5 can be tested in the test mode. The front panel test checks switches, LED's, tuning knob, and keypad. There is a battery test, a battery charger test, timer micro test, and serial I/O port tests. A transmitter test includes the testing of the preselector, power amp, postselector, sideband generator, and synthesizer. These tests are done by setting control lines to the transmitter according to the test selected; turning on the dummy load, setting to a frequency if needed, generating a tone if needed, and monitoring power levels at the A/D converter. Power levels that can be measured are forward power, reflected power, and ALC levels. Several alarms can be monitored by the CPU, including synthesizer out-of-lock, up/down converter summary, over-temperature, audio and over-power alarms. Baud rates for the four serial 1/0 ports can be changed in a test mode menu.

SECTION V
MAINTENANCE

5-1 INTRODUCTION

5-1.1 This section provides maintenance and service information for the TCS-5 Chirpsounder Transmitter. This includes a table of recommended test equipment, a preventive maintenance schedule, corrective maintenance procedures, and performance verification data. An understanding of the theory of operation from Section IV is required for troubleshooting and repairing the equipment.

5-2 TEST EQUIPMENT

5-2.1 Recommended test equipment for performance tests and troubleshooting is listed in Table 5-1. Other test instruments may be used if their performance is equivalent to those listed. If a test measurement is made which is outside the acceptable range, operation of the test equipment should first be verified before assuming malfunction of equipment under test.

Table 5-1. Test Equipment Required

Item	Recommended Manufacturer and Type
Oscilloscope, 100 MHz, Dual Channel	Tektronix 2235 (same as AN/USM-488, NSN 6625-01-187-7847)
Frequency Counter, 100 MHz	HP 5315A
Multimeter AC/DC volts, Ohms	Simpson 460, Beckman 3020, or Fluke 77
Spectrum Analyzer 0-110 MHz	HP 141T
With IF Section	HP 8552B
With RF Section	HP 8553B
or Spectrum Analyzer	HP 71100XL
Attenuator, 100W, 30 dB, 50 ohm	Bird Model 8323
Attenuator, 20 dB, 50 ohm	Mini-Circuit Model NAT-20
RF Wattmeter	Bird Model 43
Wattmeter Elements	Bird 50W, 250W
Adapter N to BNC	Kings KN-99-35 or UG-201A/U

5-3 PREVENTIVE MAINTENANCE

5-3.1 GENERAL. Table 5-6 provides a list of recommended preventive maintenance procedures to assist in obtaining long-term trouble-free operation of the transmitter. The procedures should be followed as closely as possible. Marginal operation of any unit checked should be noted and carefully re-examined at the next maintenance period.

WARNING

In the performance of some maintenance procedures, it is necessary to have the equipment energized and dust covers removed. Extreme care must be exercised in making internal measurements or adjustments since potentially dangerous voltages are present.

5-3.2 CLEANING THE AIR FILTERS. The air filters should be cleaned with compressed air or water on the following schedule:

a. If in a clean, indoor environment, the filters should be cleaned monthly.

b. If in a dusty environment, the filters should be cleaned weekly.

c. If in a very dusty environment (i.e. in the field), clean filters daily.

d. Use the following procedures to remove the filters for cleaning.
   1. Remove the 4 nuts or screws holding each filter in place on the rear panel.
   2. Remove the filters from the rear panel.
   3. Clean filters and replace.

5-3.3 STANDBY BATTERY SUPPLY REMOVAL. The standby battery supply contains rechargeable, sealed, lead-acid batteries. Typical lifetime for these batteries is 2 to 5 years, depending on use. Continuous use of the receiver on AC line power where the batteries are always fully charged by the internal charger will maximize battery life. Frequent full discharge/full recharge cycles will reduce battery life somewhat, and storage of the unit (with AC line power off) with the batteries in the discharged state will greatly reduce battery life. If the TCS-5 is stored (non-operating) for more than 5 days but less than one year, the batteries may be safely left inside the unit if they are FULLY CHARGED and the rear panel battery switch (S4) is turned OFF before the AC line power is turned off for storage. Storage of the batteries for more than one week in a discharged condition can permanently damage the batteries. If the TCS-5 is stored for more than one year, the battery box should be removed from the unit. Replacement or spare battery supplies are available by ordering BR part number 2540-1008. Remove the standby battery supply (A10) as described on the following page.

NOTE

Battery supply should be fully charged before being removed from the unit for storage.

a. Unplug power cord and remove TCS-5 top cover.

b. Disconnect the 3-pin connector (A10J1) located on the battery supply leads. Refer to Figure 5-6 for battery supply location.

c. Remove (or replace) the battery Supply. Refer to paragraph 5-8.9.

5-3.4 REPLACEMENT OF THE 5 YEAR LITHIUM BATTERY. The Lithium battery is mounted on the battery board (1220-2021) which rests on the CPU board assembly (A4) (refer to the locator diagram, Figure 5-8). The battery has an expected lifetime of over 5 years. If the 24 hour backup clock fails to restart the TCS-5 real time clock upon AC line power turn on after an extended power outage, the lithium battery needs replacing. Do not replace the lithium battery if the Path Program and sweep start time offsets are lost during a power outage, as this data is maintained in the clock/timer micro by the rechargeable standby battery (A10). The Lithium powered backup clock only maintains approximate real time clock timing to make resetting of the TCS-5 clock easier or unnecessary after the regular standby battery supply has run down and the clock/timer micro has stopped. If the lithium battery is dead, the CPU battery assembly 1220-2021 can be returned to BR Communications to have the Lithium battery replaced. The battery can also be ordered from BR Communications (BR P/N 1420-0007) and replaced by qualified personnel only in the following manner:

NOTE

Use care when handling the PC board on which the battery is installed. Do not place board on any conductive surface which may short the battery or associated circuitry. Shorts may reduce the service life of the battery or cause battery failure.

The case of the battery is positive with respect to circuit ground and must not be used as a ground terminal during any circuit troubleshooting procedures. To do so may reduce the service life of the battery or cause battery failure.

a. Disconnect jumpers on CPU board marked BAT- and BAT+.

b. Remove two screws holding battery board to CPU board. Unsolder and remove old battery from battery board.

c. Unpack new battery, being careful not to short leads. Do not touch top lead (-) to battery case.

d. Form case leads (+) to fit flat on battery board, trim for proper fit, and lap solder to PC board.

e. Carefully remove tape from top lead.

f. Place 1/8" diameter by 7/8" long black sleeving over top lead (to insulate lead from case) and shrink to fit. Avoid heating battery case.

g. Form lead onto pad (-) on PC board, trim to fit, and solder. Be careful not to short battery while installing or soldering battery to board, as a shorted battery can explode.

h. Reinstall battery board onto CPU board. Reconnect jumpers, red to BAT+ and black to BAT-.

5-3.5 STATIC SENSITIVE DEVICES. Static sensitive devices, typically CMOS, MOSFET and similar devices, are indicated in the parts list with a "Y" following the 5 digit FSCM code in column 5. To protect static sensitive devices from damage, the following suggested precautions should be followed:

a. Keep all static sensitive devices or circuit assemblies containing these devices in their protective packaging until needed. This packaging is usually conductive and should provide adequate protection for the device. Storing or transporting static sensitive devices in conventional plastic containers could be destructive to the device.

b. Turn off power prior to insertion or extraction of sensitive devices. This also applies to printed circuit cards or plug-in modules containing sensitive devices.

c. Double check test equipment voltages and polarities prior to conducting any tests. Verify that no transient exists.

d. Use only soldering irons and tools that are properly grounded. Ungrounded soldering tips will destroy these devices. Soldering guns must never be used.

e. Avoid contact with the leads of the device. The component should always be handled carefully by the ends or the side opposite the leads.

f. Avoid contact between the printed circuit card or component leads and synthetic clothing while handling static sensitive devices or assemblies containing them.

CAUTION

Never use a soldering gun on any static sensitive device in this unit. The device can be permanently destroyed.

5-4 CORRECTIVE MAINTENANCE

5-4.1 GENERAL. The corrective maintenance data provided in this section consists of troubleshooting and adjustment procedures. Parts requiring removal during relevant adjustment operations are described and illustrated as necessary. The recommended maintenance approach for the TCS-5 is repair by replacement of assemblies. Faulty assemblies are returned to the depot or factory for repair to a component part level. Due to the circuit complexity of the transmitter, it is recommended that component level maintenance be performed only by personnel who have completed the factory/depot maintenance training.

5-4.2 TROUBLESHOOTING PROCEDURES. Table 5-7 provides a basic guide for troubleshooting the TCS-5. The table is not intended to be all inclusive but rather to provide indications of what unit or assembly is defective. One approach to fault isolation is to derive all possible information from the function or malfunction of operating controls and indicators and then, through systematic analysis of test and measurement data, along with the troubleshooting guides, localize a fault to a module or assembly. The malfunction is verified and corrected by replacing the faulty assembly with a known good assembly.

NOTE In order to perform troubleshooting and adjustment procedures, individual units must be removed from rack, and top access cover must be withdrawn, being careful to first disconnect interconnecting cables.

5-4.3 RF OVERLOAD AND OVERHEATING PROTECTION. Front panel LEDs on the TCS-5 indicate when RF overload or overtemperature conditions exist.

a. RF Overload Protection. The RF overload alarm LED (RF OVLD) on the TCS-5 front panel will light if an overload condition exists. The transmitter will automatically drop the RF power output to a lower level to prevent damage to the equipment. The circuit breaker will not trip if this occurs. When this alarm LED lights, the operator may continue operating, but should begin an immediate investigation to determine the cause of the overload. Overload conditions can occur when improper load (antenna) impedances are seen by the TCS-5 RFPA or excessive external RF power is induced into the antenna from other nearby HF transmitters.

b. Overheating Protection. The over temperature alarm LED (OVTEMP) on the front panel will light if an over temperature condition exists in the RFPA. The RFPA is protected by a 2 stage over temperature sensor. In the first stage, the transmitter will automatically drop the RF power output to a lower level to prevent damage to the equipment, but the circuit breaker will not trip. When the OVTEMP alarm LED is ON, the maximum power output of the TCS-5 is about 40 watts. The operator should begin an immediate investigation of the cause of the overheating, but there is no need to turn the TCS-5 off. The usual cause of this overheating will probably be impedance matching problems, clogged air filters, or blockage of the front panel exhaust hood. If the first stage of overheating protection is not successful in reducing RFPA heat and the RFPA temperature continues to rise, the second stage over temperature sensor will shut down the RFPA completely (no RF output). All other TCS-5 functions will continue and normal operation will resume as soon as the temperature returns to normal. The power supply assembly (A13) also contains an over temperature sensor. If the power supply overheats it will automatically shut down by tripping the front panel circuit breaker to protect itself and thereby remove DC power from all TCS-5 circuits except the battery powered standby supply. All TCS-5 functions will stop except for the clock/timer and frequency standard which will automatically switch over to the battery standby supply. When the main power supply cools sufficiently it can be restarted by resetting the front panel circuit breaker. Note that if a power supply overtemp trip occurred, it may take up to an hour for it to cool sufficiently to restart.

5-4.4 AUTOMATIC PROTECTION SHUTDOWN. The TCS-5 will automatically trip the front panel circuit breaker under any of the following conditions:

a. The AC line input voltage exceeds 135 volts on the 115V range or exceeds 270 volts in the 230 volt range.

b. Due to some malfunction, the power supply draws excessive current: 15 amps or 7.5 amps max for the 115V or 230V ranges, respectively.

c. The internal temperature of the power supply exceeds 90°C. This condition can occur if the unit is operated in an ambient temperature exceeding 55°C, if the rear panel air filter becomes clogged, or if the fan fails.

5-4.5 INTERNAL ALARMS. Table 5-2 explains the causes of internal alarms. It provides possible effects and course of action to return the unit to operational status.

Table 5-2. Internal Alarms

Name	Source/Cause	Possible Effect/Action Required
Synthesizer Alarms		
Synthesizer Out of Lock	A6: Synthesizer malfunction. Synthesizer Phase detector not in lock.	Synthesizer off frequency or excessive spurious output.
VFO	A7A3: Loss of VFO (41.85 to 70.25 MHz) injection to downconverter mixer.	Loss of RF Drive
Upconverter	A7A2: 40 MHz PLL out of lock.	Frequency error or spurious output.
Other Alarms:		
Overpower	A12: Excessive RF power level due to impedance mismatch or external RF induced into antenna.	Overheating of RF power amplifier. Output power reduced by RF power amplifier.
Overtemperature	A12: Power amplifier is over temperature.	ALC in A7A3 reduced RF output power to protect A12. If over temperature continues the RF amp is totally shutdown. Normal operation resumes when temperature is reduced to normal.
Audio Overload:	A7A1: Excessive audio input level.	Distorted Modulation.
Interlock	Rear Panel J8 loop. Safety interlock loop open.	Transmitter keyed off.
Summary Alarm	A7A3: Combined Overpower, Upconverter, and VFO alarms.	Output signal to CPU if any of the alarms are active.
High VSWR Alarm on LCD	Reflected-to-Forward Power Ratio exceeds 0.4 for one third of a Chirp sweep while operating with the 7057 Antenna Coupler.	Alerts operator to an antenna or 7057 problem. Alarm may be cleared after the problem is corrected by selecting (3) "Learn New Antenna" in Coupler Settings menu (Figure 3-29). High VSWR clears automatically when two consecutive sweeps are completed without alarm conditions occurring.

5-5 SELF TESTS

5-5.1 INTRODUCTION. The TEST mode provides a series of built-in test functions that can be used to troubleshoot the TCS-5. The Self-Tests should be done upon initial receipt of the instrument and at regular maintenance intervals.

5-5.2 SELF TEST MENU. When the TCS-5 mode switch is placed in the TEST position a menu will appear on the LCD display. A number of items may be selected by pressing a single digit on the keypad. Certain menu items may then call up a second menu, etc. Figure 5-1 is the Test Menu. The 4 characters in the top right corner show the software version number.

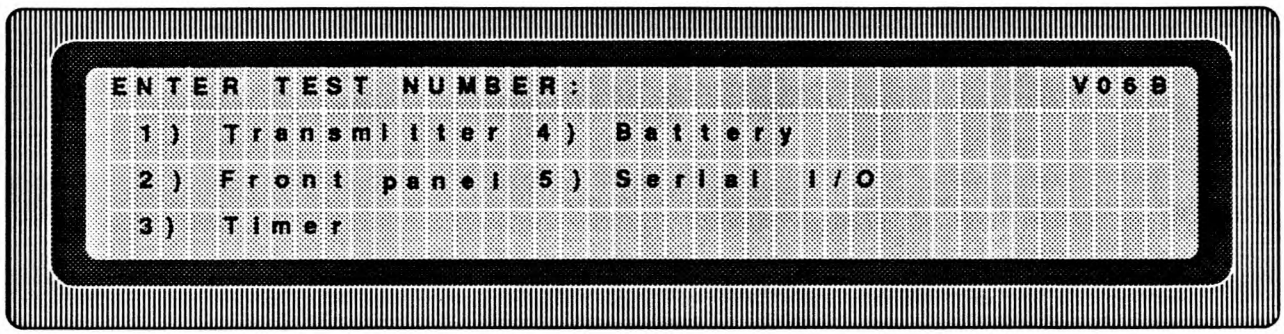


Figure 5-1. Test Menu

5-5.3 TRANSMITTER TEST. Pressing '1' on the SELF TEST menu begins the transmitter test. This consists of CW Calibration, Preselector and Postselector tests, Sideband test, and Full Power test. Figure 5-2 is the Transmitter Test menu. Key '6' to exit back to the main self test menu.

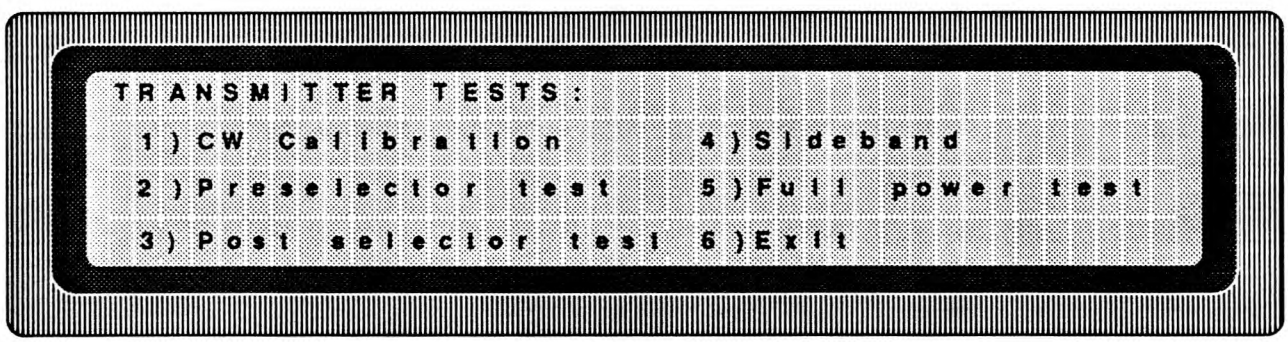


Figure 5-2. Transmitter Test Menu

a. CW Calibration. The CW Calibration test allows the TCS-5 transmitter to be brought up on any frequency and transmit a CW carrier at 10 or 100 watts. This is useful for testing the TCS-5 and equipment external to the TCS-5. The green Transmit Light will illuminate on first keying and will remain on until the CW mode is exited.

CAUTION

When using the CW test with the internal power amplifier, power will be present on the antenna terminal and thus, an antenna or dummy load must be used to prevent damage.

The Synth Alarm may occur while in CW Calibration. This indicates that the internal circuitry of the TCS-5 has detected a problem with the frequency synthesizer process or an RF overload. To reset the test, exit by pressing NEXT, and then return to the menu. The alarm can also be cleared by changing to any other frequency. However, if the same problem occurs, the Synth Alarm prompt will appear again. Refer to paragraph 5-5.3c for further information.

b. Preselector and Postselector Tests. These tests exercise and measure all of the filters in each filter subassembly. The 16 preselector or eight postselector filter numbers are displayed with a P or F below them. If the "Synth out of Lock" or "RF Modulator Failure" indications appear, the tests may fail. These indications reflect trouble in the synthesizer or other signal processing circuits of the downconverter/audio modulator assembly. The preselector test may fail if an external cable is connected to the transmitter exciter output, J3 on the rear panel. If the external connection provides an unusual load to the circuit, test measurements may be beyond normal tolerance.

c. Synth Alarm. If the Synth Alarm has occurred while in RUN, USB, LSB modes, or during the CW Calibration self test, the preselector or postselector test can be used to determine the cause. If "Synthesizer Out-of-Lock" is displayed, the synthesizer (A6) is the cause of the Synth Alarm. If "RF Modulator Failure" appears, the cause may be in the downconverter/audio modulator (A7) assembly.

CAUTION

Disconnect any audio source from rear panel audio line-in before performing the sideband or full power tests. Also do not key microphone as the TCS-5 may be damaged.

d. Sideband Test. The sideband test operates the transmitter into the internal dummy load in the comm mode. A built-in audio test oscillator is used to generate a simulated single sideband communications modulation. At the end of the test the display shows passed or failed. Refer to Table 5-3.

e. Full Power Test. The full power test operates the transmitter at full power (150 watts) into the internal dummy load and checks for proper output power. Refer to Table 5-3.

Table 5-3. Sideband and Full Power Test

Sideband Test	Nominal Power	Power Pass Rang	ALC Pass Range
SP On	15W	11-25W	25-120
SP Off	15W	11-20W	25-120
Tone Off	0W	0-5W	151-250
Full Power Test			
@ 2 MHz	150W	110-170W	51-160
@ 12 MHz	150W	110-170W	51-160
@ 29 MHz	150W	110-170W	51-160

f. The Sideband Test and Full Power Test show power and ALC values. The ALC values will be useful in analyzing tests that fail. Note: front panel backlight must be off while performing Sideband tests to obtain correct values. An ALC value higher than normal indicates a loss of gain somewhere in the signal train.

5-5.4 FRONT PANEL TEST. Selecting the front panel test will show the display shown in Figure 5-3. The display indicates any key or switch activation. The title of the activated key/switch is indicated in the first or second row after the colon. The status of the TX KEY and the rear panel INT/EXT switch are continuously shown on the upper right.

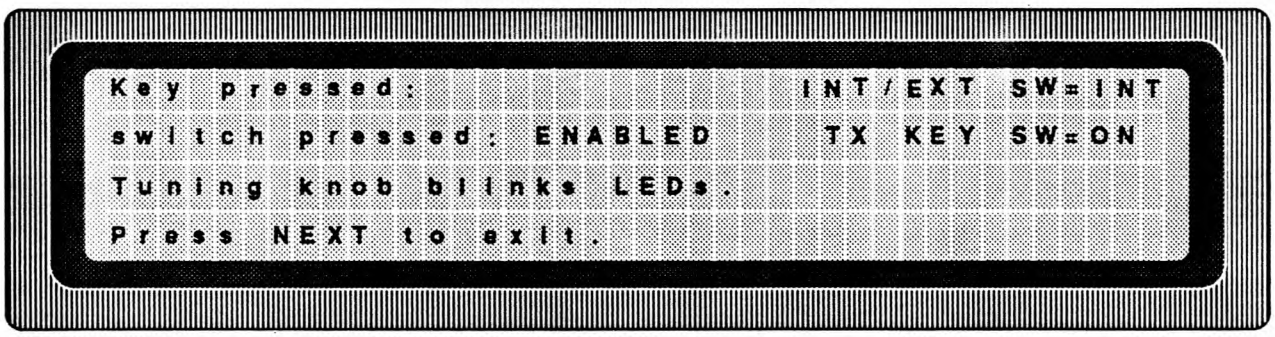


Figure 5-3. Front Panel Tests

5-5.5 TIMER. Selecting this function causes the clock/timer microprocessor to be tested. A 'P' or 'F' will show to the left of 3), as shown in Figure 5-1, indicating either a pass or fail condition.

5-5.6 BATTERY TEST. Both the battery charger and the batteries are tested. The charger test results are displayed as either GOOD or BAD (see Figure 5-4). The battery condition test measures the battery terminal voltage under load to determine battery charge. The results of the battery condition test are displayed as GOOD, FAIR, POOR, or BAD. After 48 hours of charging, the batteries should read GOOD. Note that a totally discharged battery which will test POOR or BAD, may also cause the charger test to show BAD.

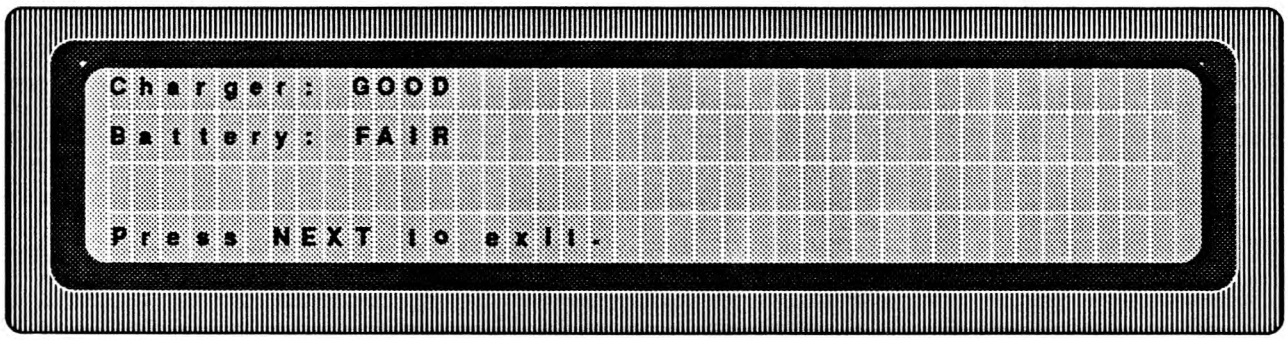


Figure 5-4. Battery Test

5-5.7 SERIAL I/O PORT TEST. The I/O port test menu is shown in Figure 5-5. If 1, 2, 3, or 4 is pressed, a display will show the proper rear panel jumpers that must be installed to loop-back test the selected I/O port. The selected I/O port will transmit a "Quick Brown Fox...." message; the display will show what is received by the port. The message will repeat continuously until NEXT is pressed. Local as well as remote loop back tests are supported. This allows testing of long haul communications channels end-to-end.

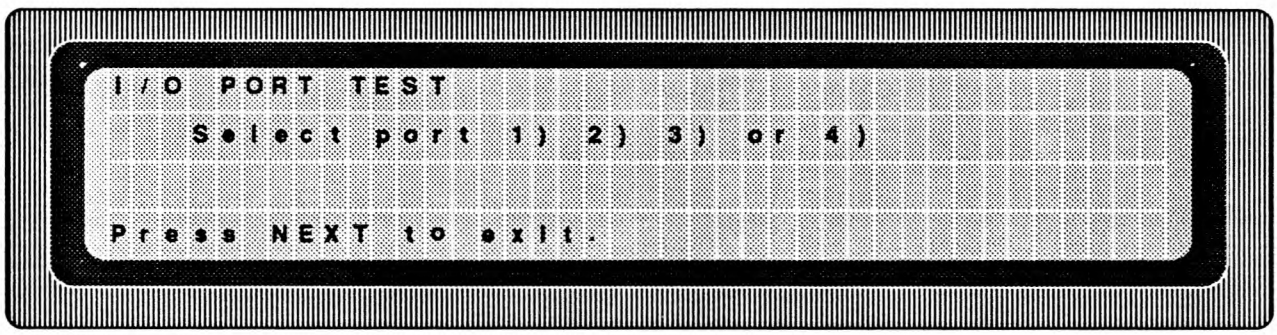


Figure 5-5. I/O Port Test

5-6 ADJUSTMENT PROCEDURES

5-6.1 GENERAL. All initial adjustments to the transmitter are made at the factory before shipment. These procedures are provided for use following repair or as required during the performance verification test. Figure 5-8 is a location drawing of the TCS-5 showing the location of major modules and assemblies.

WARNING

Use extreme care when making internal adjustments with power on. Dangerous voltages are present in the transmitter.

5-6.2 SYNTHESIZER ADJUSTMENTS. The VCO control range can be adjusted on the synthesizer (2840-2006) by following steps a through d. Residue Nulling can be adjusted by following steps 5-6.2e through 5-6.2h.

a. VCO Control Voltage Range Adjustment. This adjustment requires setting the synthesizer VCO tuning coil L3 such that the VCO control voltage remains between -5 Vdc and +8 Vdc for any programmed frequency. At low frequencies (transmitter set to 2 MHz) the control voltage will be between +5 and +8 volts, while at higher frequencies (29 MHz) the control voltage is typically between -1 and -5 volts. Perform the following procedures when the synthesizer is operating at normal room temperature.

b. Set the transmitter for LSB COMM mode at 10 MHz, and key ON the transmitter at LOW power. Measure the VCO control voltage with a DC coupled oscilloscope or DVM at TP2 on the synthesizer board (A6TP2). The voltage at TP2 should be between -1 and +6 Vdc when the transmitter RF output is 10 MHz (synthesizer VCO is at 50.25 MHz).

c. Alternate the transmitter operating frequency (and rekey the transmitter) between 2.0 MHz and 29.9 MHz and measure the VCO control voltage. The control voltage at TP2 must fall within the range of:

Transmitter Output	VCO Control Voltage		
Frequency	Acceptable	Better	Ideal
2.0 MHz	+4 to +8.5 V	+5 to +8V	+7V
29.9 MHz	0 to -5V	-1 to -4V	-2V

Also make sure that no low frequency (a few kHz) modulation is present on the VCO control voltage. This undesired modulation can occur if the control voltage goes beyond the limits listed above, i.e. above +8.5 volts at 2 MHz or below -5 volts at 29.9 MHz.

d. If the control voltage at TP2 is out of range, adjust the synthesizer variable inductor L3 until the VCO control voltage stays within the ranges specified in paragraph (c) above. Note that the adjusting slug of L3 is accessible through a hole in the VCO cover on the synthesizer board. To adjust, first set the transmitter to 29.9 MHz and initially adjust L3 for- 2 volts at TP2. Then change the frequency to 2 MHz and check the control voltage again. Try to set L3 so that the voltage stays within the "better" range, and preferably as close to the "ideal" settings as possible. Do not be concerned if you cannot obtain the "ideal" range; there can be significant deviation from the "ideal" settings depending on VCO component tolerances.

e. Residue Nulling. Connect a spectrum analyzer to the 40-70 MHz output (J7) of the synthesizer.

f. Set the transmitter operating frequency to 10.751 MHz. The synthesizer output frequency on J7 should be 51.001 MHz.

g. Adjust the spectrum analyzer to show the 1 kHz and 10 kHz sidebands on the output frequency.

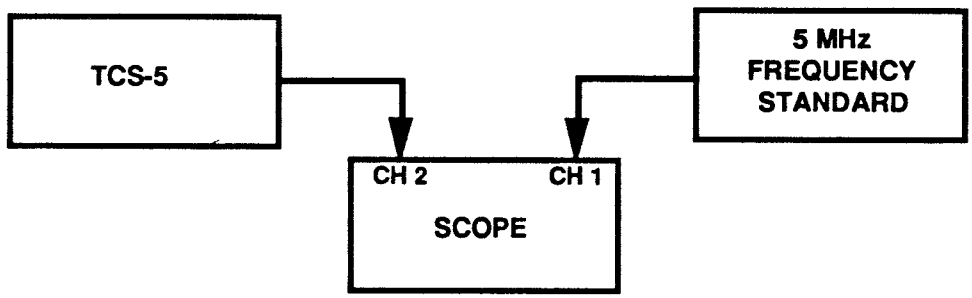
h. Adjust A6 R56 to minimize the 1 kHz sidebands and A6 R54 to minimize the 10 kHz sideband. Both should be at least 50 dB below the fundamental output.

5-6.3 FREQUENCY STANDARD ADJUSTMENT.

a. After the TCS-5 has been operating continuously for at least 24 hours, calibrate the internal 5 MHz standard, comparing it with a frequency standard with accuracy better than 1 part in 10^{10} in the following manner.

b. Set up the test equipment per Figure 5-6.

c. Observe the oscilloscope for 40 seconds. The 5 MHz signal on channel 2 may drift slowly left or right relative to the stationary signal on channel 1. The relative drift on the two sine wave traces should not exceed one complete cycle per 40 seconds.



MODE: CHOP
TRIGGER: CH1 ONLY
TIME BASE: 0.1 uS/DIV.
CH2: 10 mV/DIV.
CH1: AS REQUIRED

Figure 5-6. Frequency Standard Adjustment Set-up

d. If the TCS-5 drift is excessive, correct by adjusting the rear panel STD ADJ potentiometer (R1).

e. If adjustments are made, repeat the above 40 seconds observation two more times separated by at least 30 minutes until the draft rate is less than 1 cycle per 40 seconds.

5-6.4 RF POWER CALIBRATION.

a. Connect rear panel "Tx Out", J9, to wattmeter and 50 ohm termination.

b. Place mode switch to TEST. Press "1" for Transmitter test. Press "1" for CW Calibration.

c. Press keys for 12.345 MHz. Note that display accepts the frequency.

d. Press COMM POWER to LOW. Low power LED should light.

e. Turn XMIT key switch to ON (if it was on, cycle it off and back on). Transmitter should key on and the wattmeter should show about 10 watts.

f. Remove cover to downconverter module, 1220-2005, A7A3. Adjust R57 for 10 ±0.5 watts as indicated on wattmeter. Place the oscilloscope probe on E19 of the 1220-2005 board and read the ALC voltage. It should be -1.5 to -2.5 volts.

g. 100 Watt Test. With set up as in steps a through c, press the COMM PWR switch to high power and repeat step e. The wattmeter should read 100 ±5 watts. The ALC voltage should change to -1.0 to 0 volts. Un-key the transmitter.

h. Set rear panel S5 to EXT power amplifier. Connect cable from J3 (EXCIT OUT) to spectrum analyzer through an ACCURATE 20 dB pad. Set COMM PWR to low. Key the transmitter ON. Set the spectrum analyzer to display the 12.345 MHz signal. Use 2 dB LOG range. Adjust R56 on the 1220-2005, A7A3 board so the RF signal from the TCS-5 exciter output is exactly +10 dBm at J3 or -10 dBm at output of 20 dB pad into spectrum analyzer. Observe the ALC voltage on E19. It should be -1.5 to -2.5 volts.

i. With setup as in step h above, change power to HIGH. Exciter output should now read +20 dBm ±0.5 dB (0 dBm ±0.5 dB at spectrum analyzer input).

j. With setup as in i above, place the mode switch to SET COMM and turn audio test tone ON. (Use keypad key 3 to toggle AUDIO TEST TONE on or off when in SET COMM mode.) Place mode switch to USB. Key in 12.345 MHz. Set spectrum analyzer for 500 Hz/div., 10 dB log. Key transmitter to HIGH power and tune spectrum analyzer center frequency to 12.345 MHz. Refer to Figure 5-7.

k. SSB Generator Alignment. Adjust the Spectrum Analyzer attenuators until the 12.346 MHz (MAIN) signal is at 0 dBr (Ref. Level).

1. Alternately adjust R103 and R156 for maximum carrier rejection. It should be at least 50 dB (-50 dBr).
2. Turn the MODE switch to LSB, re-key transmitter ON. The carrier rejection should be somewhat worse. Adjust R156 for some improvement until the carrier rejection is the same whether the system is in LSB or USB mode.
3. Note the carrier rejection in USB and then note the carrier rejection in LSB. The results should be within 3 dB of each other, and each reading should be greater than 40 dB.

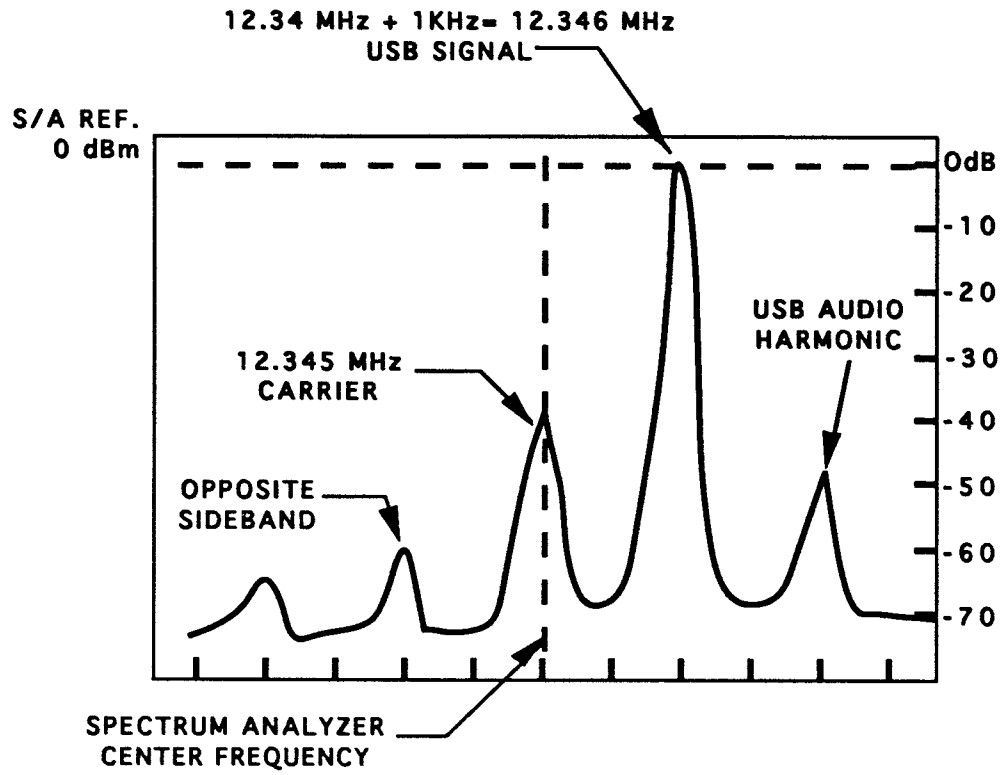


Figure 5-7. RF Power Calibration Spectrum Trace

5-6.5 FRONT PANEL RF POWER INDICATOR CALIBRATION.

a. Connect rear panel "Tx Out", J9 to calibrated 100 Watt, 30 dB attenuator in series with 20 dB fixed attenuator. Connect the output of the fixed attenuator to the input of the spectrum analyzer.

b. Follow the procedure described in paragraph 5-6.4, steps b through e.

c. The spectrum analyzer should read -10 dBm (10 Watts = +40 dBm; +40 dBm- 30 dB -20 dB = -10 dBm). If analyzer does not read -10 dBm ±0.25 dBm, readjust downconverter as described in paragraph 5-6.4f.

d. Observe the front panel LCD FWD PWR reading. Use digital voltmeter to observe A/D converter reference, TP25 on the CPU board, 1220-2001, A4.

e. Adjust A4R64 until the front panel FWD PWR reads 10 Watts. Adjust R64 over a range that causes the reading to go from 8 Watts to 12 Watts while noting the TP25 reading. Adjust R64 so the front panel reads 10 Watts and the voltmeter reads a voltage centered between the two measurements above. The final TP25 reading should be between 4.90V and 5.10V.

f. Press the COMM PWR switch to high power. Observe that the spectrum analyzer reads 0 dBm ±0.25 dBm. The front panel FWD PWR should now read 100 Watts.

5-7 PERFORMANCE TEST PROCEDURES

5-7.1 GENERAL. The following performance tests are designed to provide the most expedient method of checking overall TCS-5 operation within the limits of field maintenance. The order of performing the tests will depend entirely on the condition of the equipment. If the equipment is suspected of being below specifications, then the complete test in the order presented should be performed.

5-7.2 DC POWER SUPPLY TESTS. The following tests are divided into checks of the individual units comprising the TCS-5. All voltages are labeled adjacent to the terminal strip. No adjustment is provided. If an out-of-spec voltage is found, the unit is probably defective and should be returned to the depot for evaluation and repair.

a. Turn on the front panel breaker. The green power LED above the breaker should light and both of the fans must run. Use a DVM to measure DC voltage at the power supply (A13). Use caution as +54 and +310 volts are exposed on the terminal strip. Measure the following:

+310	(±40 volts)
+54	(±6 volts)
+28	(±3 volts)
+12.3	(±1 volts)
+6	(±0.3 volts)
+5.2	(±0.2 volts)
-12.3	(±0.6 volts)

b. All outputs of the power supply (A13) have foldback current limiting. If any output is shorted by other circuitry in the TCS-5, an output may read near zero volts even though the power supply is working normally. To verify if a low output voltage is the fault of the supply or load, disconnect the load from the supply and check if the supply output voltage returns to normal. Most failures of the power supply, including output overvoltage, will cause the front panel circuit breaker to trip.

CAUTION

If the breaker trips, do not reset for 60 seconds. Under no circumstances should be the breaker be toggled on and off rapidly.

c. Turn the rear panel battery switch off. Measure the voltages generated on the programmer board, 1220-2002, A5. Raise the left side (synthesizer) shelf for access to A5 on the underside of the synthesizer. Readings should be as follows:

Standby	+5B	TP3	+5 volts ±0.3V
Standby	+12B	(+ End of C34)	Approximately 0.6 volts below the +12.3 volts supply. (i.e. approx. 11.7V)
	+30	TP6	+30 volts ±5 volts

d. Measure output voltages on power conditioner board, 1220-2006 with the DVM. The +5A volts must be 5.1 ±0.3 volts. The +12A must be 11.5 to 12.0 volts. Measure +5A on E7 and +12A on E16.

5-7.3 BATTERY TEST. Turn the rear panel battery switch on. Verify that the front panel green battery LED is on. Turn the battery switch off. The battery LED must go off. Turn on the battery switch and watch the charger voltage on A5TP2. If the batteries are fully charged and the charger is operating in the float charge mode, the voltage at TP2 should be approximately 14.4 Vdc. If the batteries are discharged and the high current charger is on, the voltage at TP2 can be from 12.1, for completely discharged batteries, to 15.3 volts for almost completely recharged batteries. When the batteries reach full charge, the charger will automatically switch over to the 14.4 Vdc float level.

5-8 DISASSEMBLY/REASSEMBLY INSTRUCTIONS

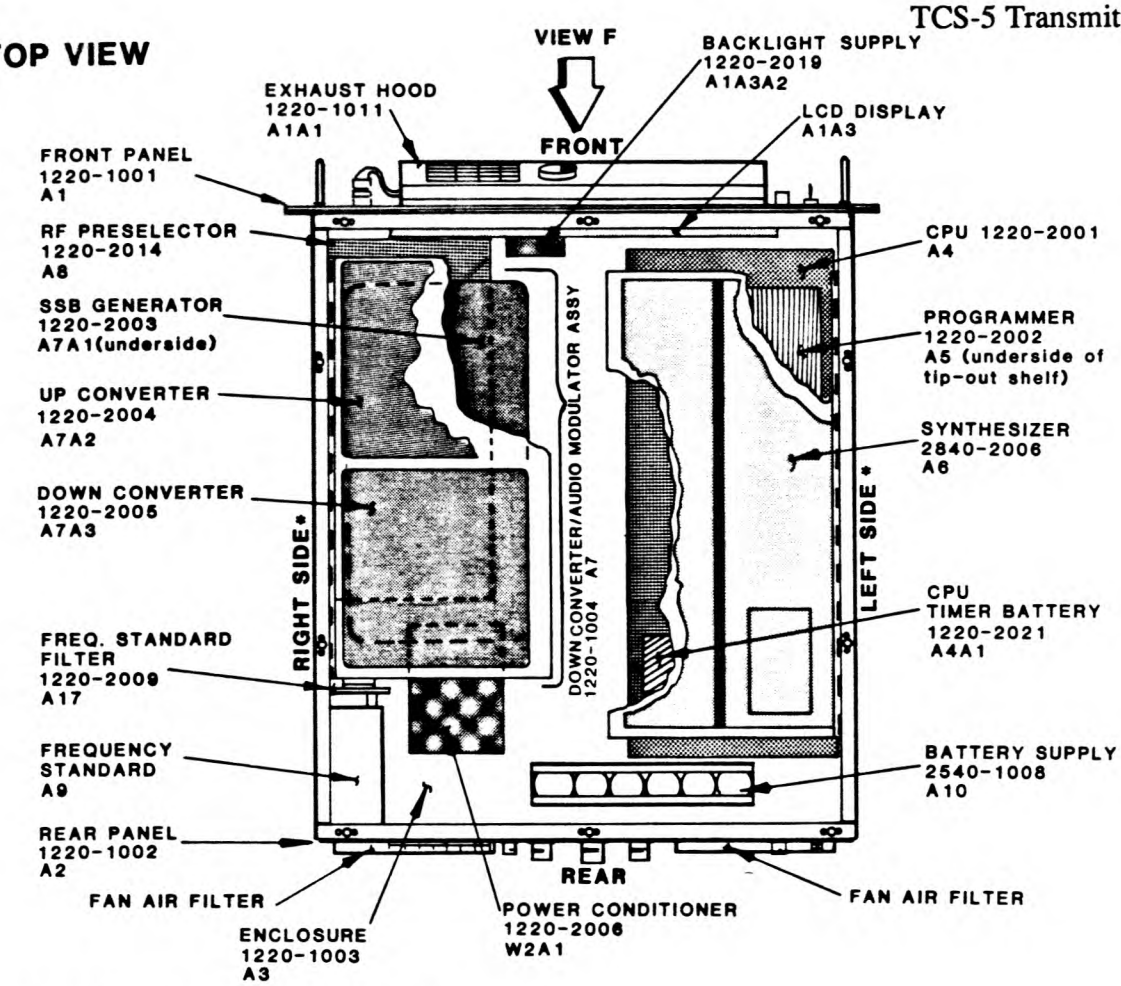
5-8.1 PREPARATION. The major components of the TCS-5 can be disassembled and reassembled using the following instructions. The method of repair is by replacement of assemblies with known good assemblies. These instructions describe how to remove the major modules for replacement. Refer to Figure 5-8 for location of major modules. Make sure that the TCS-5 is removed from any power source before any disassembly or reassembly. Left and right side references used in these instructions assume a front view of the unit.

5-8.2 COMPARTMENTS. The TCS-5 is housed in a metal chassis that is essentially divided into upper and lower compartments.

a. The upper compartment contains the digital section, including the CPU (A4), programmer (A5), synthesizer (A6), downconverter/audio modulator assembly (A7), preselector (A8), frequency standard (A9), and battery supply (A10). The LCD display (A1A3) is also accessible through the enclosure. To gain access to this compartment, place the unit in an upright position and remove the top cover. Tip-up shelves house three assemblies so that little disassembly is necessary to get to the other modules.

b. The lower compartment contains the RF amplifier section, including the postselector (A11), RF power amplifier (A12), power supply (A13), T/R switch (A14), and controller/driver (A15). The Postselector, RF power amplifier, and power supply are attached to the central chassis plate and the screws holding them must first be removed while the unit is in the upright position. Detailed procedures on the removal of these assemblies can be found later in these instructions. The bottom cover can be removed for access to the units of the amplifier section.

TCS-5 TOP VIEW



* As seen from front top view(VIEW F)

TCS-5 BOTTOM VIEW

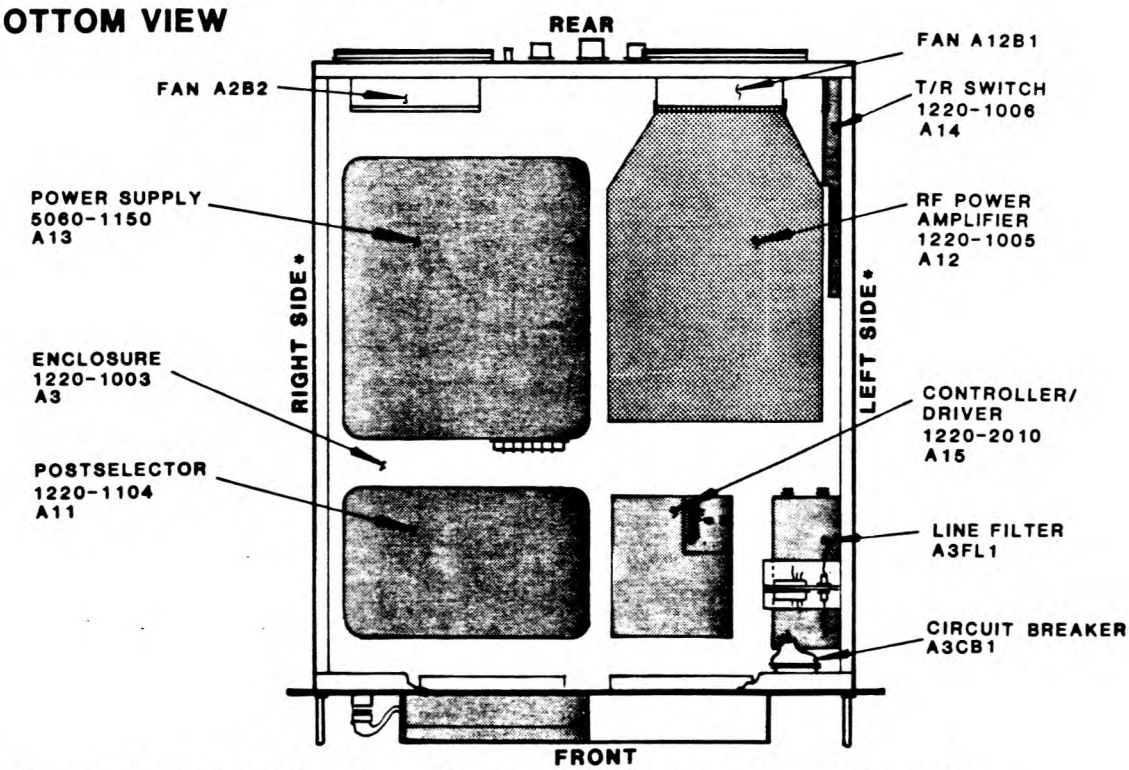


Figure 5-8. TCS-5 Transmitter: Location of Major Modules and Assemblies

c. The exhaust hood assembly (A1A1) is located on the front panel and can be removed to give access to the keypad (A1A1A1) and LED display (A1A1A2).

5-8.3 CPU (A4). The CPU is located on the top of plate, left side, dividing the two compartments. To gain access to the CPU, follow these steps.

a. Unlock the two tip-up shelves by sliding the locking fastener away from metal posts located in the center. Open up the two tip-up shelves so they are out of the way. The CPU board is located on the top left side of the center chassis plate and is clearly marked.

b. To remove the board, loosen the 12 captive screws holding the board to the plate.

c. Unplug all connections (J1 through J9) located on the periphery of the board.

d. Lift the board up out of the unit, making sure not to bump or slide against any part of the enclosure.

e. To reassemble, place the card in its proper location on the plate, align the screw holes, make the necessary connections, and secure with the captive screws. Tighten to finger tight, then tighten one half turn with a screwdriver.

5-8.4 PROGRAMMER (A5). The programmer circuit card is located on the underside of the left hand tip-up shelf.

a. Unlock the left tip-up shelf by sliding the retainer fasteners open. Tip the shelf up to expose the programmer card.

b. Unplug connections J1 through J7 on the card.

c. Remove the card from the shelf by lifting up on the card guide locks on either side and slide the card out of the card guides.

d. Reassemble by placing the card into the slot, locking the card guides, making the connections to J1 through J7.

5-8.5 SYNTHESIZER (A6). The synthesizer card is located on the topside of the left hand tip-up shelf.

a. Unlock the left hand tip-up shelf by loosening the fasteners. This allows flexibility while working with the circuit card.

b. Unplug the connectors to J1, J4, J5, and J7 on the board.

c. Remove the card from the slot by lifting up on the card guide locks on either side and slide the card out of the card guides.

d. Reassemble by placing the card into the slot, locking the card guides, and making the connections to J1, J4, J5, and J7.

5-8.6 DOWNCONVERTER/AUDIO MODULATOR ASSEMBLY (A7). The downconverter/ audio modulator assembly is located on the right hand tip-up shelf of the unit. The topside of the shelf contains the upconverter (A7A2) and the downconverter (A7A3). The SSB generator (A7A1) is located on the underside. These are all contained in shielded metal enclosures. Access to the circuit cards requires careful removal of all shielded cover screws for that subassembly. The circuit cards are mounted to the tip-up shelf and do not come free when the covers are removed. Note, however, that wiring through cover connectors and feed throughs prevent total removal of the covers and care must be used when opening these assemblies not to damage or stress wiring. Individual removal of these cards from the A7 assembly is not recommended at this level of maintenance. The entire assembly is removed for replacement in the following manner.

a. Unlock the center fasteners of the right side tip-up shelf. Tip the shelf up.

b. Unplug connectors to J1 through J7 and J12 of the assembly. Some cables are attached to the module with cable fasteners that may have to be removed.

c. Remove the six screws holding the assembly to the shelf hinge making sure that the assembly does not fall when the last screw is removed.

d. To reassemble, attach the module to the hinge with the six screws and make the cable connections.

5-8.7 RF PRESELECTOR (A8). The RF preselector is located on the top right hand side of the center chassis plate.

a. Unlock the fasteners on the right tip-up shelf and move out of the way.

b. Unplug connectors to J1, J2, and P1 of the board.

c. Loosen the 11 captive screws holding the board to the plate.

d. Lift the card out of the unit making sure not to bump or slide it against any part of the enclosure.

e. To reassemble, place the card in its proper location on the right side of the plate, align the screw holes, make the cable connections, and then use the captive screws to lock the board in place. Tighten finger tight, then tighten one half turn with a screwdriver.

5-8.8 FREQUENCY STANDARD (A9). The frequency standard is a small, enclosed metal box located in the right rear corner of the compartment.

a. Unlock the right tip-up shelf and move it out of the way.

b. Unplug connectors to J1 and J3 of the frequency standard.

c. Remove the four screws on the outside of the chassis holding the frequency standard and spacer plate to the right side panel.

d. Remove the unit.

e. To reassemble, place the frequency standard in the proper location, aligning the screw holes of the standard and spacer plate with the holes in the side panel.

f. Fasten the screws and then make the necessary cable connections.

5-8.9 BATTERY SUPPLY (A10). The battery supply consists of six lead-acid rechargeable batteries housed in a metal case. It is located at the center rear of the upper compartment.

a. Unlock both tip-up shelves and move them out of the way.

b. Unplug connector A10J1.

c. Remove the three nuts holding the battery supply to the center chassis plate.

d. Lift slowly, making sure that the battery supply does not snag on any cables located along the inside of the rear panel.

5-8.10 LCD DISPLAY (A1A3). The LCD is located on the inside of the front panel.

a. Unlock both tip-up shelves and move them out of the way.

b. Remove the front panel assembly following instructions in paragraph 5-8.17.

c. Unplug connector A1P49. Note that connector A1W10P21 must also be unplugged as wire A1W10 is not spared with the LCD, but as part of the front panel.

d. Remove the two nuts securing the backlight supply (A1A3A2) and brace bar from the LCD (A1A3A1). Remove the two spacers located at each top corner of the LCD. Remove the two screws at each bottom corner of the LCD.

e. Remove the unit.

5-8.11 POSTSELECTOR (A11). The postselector is located in the bottom compartment and is bolted to the metal chassis plate dividing the compartments. It is housed in a metal enclosure and the circuit cards within the unit are not available for maintenance at this level.

a. Remove the RF preselector (described in paragraph 5-8.7). Close the tip-up shelves and secure in the locking position.

b. Turn the TCS-5 so that it rests on its right side. Remove the bottom cover of the unit. Unlock and open the A7 tip-up shelf, making sure that it does not fall.

c. Remove the safety cover above the postselector and unplug all cable connections to the postselector.

d. The screws holding the postselector to the center chassis plate are accessible from the upper compartment. Hold the postselector in one hand and remove the four screws holding the postselector to the center chassis plate with the other hand.

e. To reassemble, make sure that the RF preselector is removed. Stand the unit on its right side and align the screw holes to the metal plate. Place the screws into the holes and tighten. Reconnect the cables to the postselector and replace the preselector.

5-8.12 RF POWER AMPLIFIER (A12). The RFPA is located in a large metal box located in the rear of the lower compartment. It is attached to the center chassis plate with screws that must be removed from the top compartment.

a. Remove the CPU assembly; see paragraph 5-8.3. Secure the tip-up shelves in the closed locking position.

b. Turn the TCS-5 on its left side. Unlock the left tip-up shelf (synthesizer) and carefully move it out of the way.

c. Disconnect only the RF cable connectors to the amplifier.

d. Hold the amplifier with one hand and remove the ten screws holding the RFPA assembly to the plate with the other hand. These screws are located in the upper compartment. Carefully move the amplifier off the chassis plate approximately 5 inches.

e. Unplug connectors to J1 and P50 of the amplifier. Carefully move the amplifier away from the chassis.

f. To reassemble, place the TCS-5 on its left side with bottom and top covers off.

g. Make sure that the CPU is removed.

h. Carefully move the amplifier to a position approximately 5 inches off its proper location on the chassis plate. Install connectors to J1 and P50.

i. Place the amplifier into its proper location in the lower compartment. Align it with the screw holes.

j. Secure the amplifier with the screws to the center chassis plate. Make the necessary RF cable connections. Install the CPU assembly.

5-8.13 POWER SUPPLY (A13). The power supply is located in a large metal box located in the lower compartment. It is attached to the center chassis plate with four long hex spacers that screw into studs attached to the center chassis.

a. Turn the unit upside down, making sure that the top tip-out shelves are secured.

b. Remove the 2 plates holding the power supply in place at either end. Each plate is held in place by two 5/16" screws.

c. Using a socket driver, remove the four hex spacers (one in each corner) that mount the power supply assembly to the studs attached to the center chassis plate.

d. Disconnect cable 8120-1025 from J3 on the power amplifier. Move this cable away from the power supply.

e. Carefully lift the power supply box out of the chassis. Care must be taken to not stress the connecting cables and other wiring in the vicinity of the unit. Rest the power supply on the chassis frame without stressing connecting cables.

f. Remove the connectors from the terminal boards on either end of the unit. the power supply can now be lifted out of the unit.

g. To reassemble, place the TCS-5 upside down. Place the power supply on the frame and reconnect the cables to the terminal boards. Carefully place the unit back down into the chassis. Reconnect J3 to the power amplifier. Replace the hex spacers and then replace the two plates at either end.

5-8.14 T/R SWITCH ASSEMBLY (A14). Access to the T/R switch is through a cut-out on the left rear side.

a. Turn the TCS-5 over and remove the bottom cover.

b. Unplug the two connectors, one BNC (P1) and one 15 pin D-submin (J1), connecting the assembly to the chassis. The plugs are located in front of the power amplifier. The two cables are approximately 9 inches long and dressed between the power amplifier and the left side panel.

c. Remove the plate holding the assembly to the rear panel. The plate fits over rear panel connectors J9 and J10. It is held in place by two panhead screws (#6-32 x 1/2).

d. Remove the two screws (counter sunk, cross-recessed) holding the assembly to the side panel. The assembly should release out slightly.

e. Tilt the assembly out, taking care not to stress the connecting wires. Place a finger inside chassis and gently push outward to loosen it enough to ease the cables out.

f. The cables can be pulled out gently through a semi-circular hole in the side cut-out. When the assembly is replaced, make sure that the connecting wires fit first through the small semi-circular hole within the side cut-out.

5-8.15 CONTROLLER/DRIVER (A15). The controller/driver is located in the lower compartment, and is protected by a green plastic cover.

a. Turn the TCS-5 on its left side with the bottom cover removed.

b. Unplug connectors to J1 and J2 of the controller/driver.

c. Remove the screws and stand-offs holding the safety cover and assembly.

d. Carefully remove the assembly.

5-8.16 EXHAUST HOOD ASSEMBLY (A1A1). The exhaust hood assembly can be removed from the front panel to gain access to the keypad and LED display.

a. Unplug the connector to J2 on the front panel.

b. Remove the 8 small black screws holding the hood front section to the front panel. Pull the hood front section away from the front panel.

c. Remove the keypad and LED display from the inside of the hood assembly for replacement. Removal of the 6 large black screws allows access to these assemblies.

d. To reassemble, make sure that the LED and keypad are attached to the hood assembly. Reattach it to the front panel with the 8 screws that were removed earlier.

5-8.17 FRONT PANEL ASSEMBLY (A1).

a. Place the TCS-5 on either side and remove the top and bottom covers.

b. Unplug A1P19 (at A4J1), A1P53 (at A4J2), A1W10P21 (at A4J6), and A1P20 in the upper section, and A1P30 in the lower section.

c. Remove the circuit breaker (A3CB1) from the front panel by removing the two mounting screws and hex nut.

d. Remove the four screws from each side panel immediately behind the front panel.

e. Carefully pull the front panel away from the chassis.

f. To reassemble, carefully place the front panel against the front of the chassis. Be careful not to pinch any wires coming through the notch in the center chassis plate, just below the MODE switch.

g. Replace the four mounting screws attaching the front panel to each side panel.

h. Replace the circuit breaker on the front panel.

i. Replace all connectors removed in step b.

j. Replace the top and bottom covers.

5-8.18 REAR PANEL ASSEMBLY (A2).

a. Remove the top and bottom covers.

b. Remove the 17 screws that secure the rear panel to the chassis (13 around the periphery, 4 just above the air filters).

c. The rear panel assembly can now be moved away from the chassis approximately 2 inches.

d. If it is necessary to move it farther, remove the following items:
1. J1-J8, S1-S5, and R1. All of these items can be removed from the backside of the rear panel without disconnecting any wiring.
2. Items J1, J2, J7, J8 and S2 require removal of their respective mounting screws.
3. Items J3-J6, S1, S3-S5, and R1 require removal of their respective outside mounting nuts.

c. During reassembly, care should be exercised to assure that no wires are pinched during replacement of the rear panel plate to the chassis.

5-9 FRONT PANEL/REAR PANEL WIRE TRACING

5-9.1 Tables 5-4 and 5-5 provide a guide in signal/wire tracing to items attached to the front and rear panels respectively. Although items are installed on the panels, they may be wired as part of another assembly. The table indicates the reference designator and title as they appear on the panel or item label, along with the complete unit reference designator, and the applicable wire list. A title in parenthesis means that the title is not indicated on the panel. The Wiring Diagram, FO-32, serves as a reference for determining interconnections within the unit.

Table 5-4. Wire Tracing Cross Reference Table (Front Panel)

Front Panel Ref Des-Title	Unit Ref Des	Wire List
J1 - Handset	A1J1	WL 1220-1001
J2	A1J2	WL 1220-1001
P1	A1A1P1	WL 1220-1011
P19	A1P19	WL 1220-1001
P20	A1P20	WL 1220-1001
P21	A1W10P21	WL 1220-1500
P22	A1W10P22	WL 1220-1500
P49	A1P49	WL 1220-1001
P53	A1P53	WL 1220-1001
P54	A1A1P54	WL 1220-1011
S1 - XMIT Key	A1S1	WL 1220-1001
S2 - Backlight	A1S2	WL 1220-1001
S3 - (Enable)	A1A1S3	WL 1220-1011
S4 - Mode	A1S4	WL 1220-1001
S5 - Comm Pwr	A1S5	WL 1220-1001
R1 - Mic Gain	A1R1	WL 1220-1001
R2 - View Angle	A1R2	WL 1220-1001
E8 - (Ground Terminal)	A1E8	WL 1220-1001
E9 - (Ground Terminal)	A1A1E9	WL 1220-1011
E12 - (Ground Terminal)	A1E12	WL 1220-1001
CB1 - Power (Circuit Breaker)	A3CB1	WL 1220-1003
DS1 - Power (Light)	A1DS1	WL 1220-1001
E1 - Tune	A1A1DE1	WL 1220-1011

Table 5-5. Wire Tracing Cross Reference Table (Rear Panel)

Rear Panel Ref Des-Title	Unit Ref Des	Wire List
J1 - AC Power Input	A3J1	WL 1220-1003
J2 - Battery Input (External)	W2J2	WL 1220-1009
J3 - Ext Out	W4J3	WL 1220-1500
J4 - Rcvr Audio In	W2J4	WL 1220-1009
J5 - 5 MHz In	W16J5	WL 1220-1500
J6 - 5 MHz Out	W15J6	WL 1220-1500
J7 - Remote I/O	A2J7	WL 1220-1002
J8 - Antenna Control Output	A2J8	WL 1220-1002
J9 - TX Out to Ant	A14J9	WL 1220-1006
J10 - To Rcvr	A14J10	WL 1220-1006
S1 - Reset	A2S1	WL 1220-1002
S2 - Voltage Selector	A3S2	WL 1220-1003
S3 - Audio Line - In Level	W2S3	WL 1220-1009
S4 - Btry On	W2S4	WL 1220-1009
S5 - Power Amp Int/Ext	A2S5	WL 1220-1002
R1 - Std Adjust	W2R1	WL 1220-1009
TB1 - Audio Line In	A2TB1	WL 1220-1002
TB4 - (Fan Control)	A2TB4	WL 1220-1002
E1 - Ground	A2E1	
E4 - (Ground Terminal)	A3E4	WL 1220-1003
E6 - (Ground Terminal)	A2E6	WL 1220-1002
E7 - (Ground Terminal)	A2E7	WL 1220-1002
E11 - (Ground Terminal)	A3E11	WL 1220-1003
B1 - (Fan)	A12B1	WL 1220-1005
B2 - (Fan)	A2B2	WL 1220-1002

Table 5-6. Preventive Maintenance Schedule

	Procedure	Schedule
1.	Make visual inspection of inter-connecting cables at rear of unit. Ensure that plugs are fully inserted and that no undue strain is being placed on the cables:	Monthly.
2.	Make visual inspection of the interior of the transmitter. Ensure that all modules are properly seated and that no loose wires or signs of overheating exist. Refer to Figure 5-8 for diagram of transmitter:	Quarterly.
3.	Check efficiency of cooling fans on the transmitter. Air intake is through two rear panel filters and exhausts out the front panel hood. Make sure that rear panel is located at least 4" away from blocking walls, etc. Ensure that front panel exhaust hood is not blocked (approximately 2.5 inches clearance). Clean filters periodically with low pressure compressed air, or water:	Monthly (Weekly if in a dusty area).
4.	Perform Self-Tests described in paragraph 5-5.	Upon receipt of unit and after long storage periods; monthly while in use.
5.	Check battery supply by performing the self test described in paragraph 5-5.6:	Monthly, or after long storage periods.

Table 5-7. Troubleshooting Guide

Indication	Cause/Solution
1. POWER light is OFF and both LOW and HIGH RF POWER lights are off (and cannot be turned ON in COMM mode by COMM Power switch). Circuit Breaker is on.	a. Possible loss of AC power: check that AC power cord is properly attached. b. AC voltage below minimum: check AC voltage.
2. LCD Display Garbled:	Temporary CPU malfunction. Press RESET button (S1) located on the rear panel. This will reset the CPU.
3. No characters, including "Rub Out" characters, on display. POWER light on.	a. Loose cable connection between CPU (A4) and LCD module (A1A3A1). Check that cable (A1W10) is properly seated at A4 and A1A3A1. b. Defective LCD module (A1A3A1). Replace LCD module. c. See Indication No. 7.
4. Display blank or garbled. Controls and instrument appear to be functioning correctly or functioning slowly.	Defective display (A1A3) or disconnected cable. a. Check cable to A4J8. b. Replace A1A3
5. Power goes off but circuit breaker does not trip.	See Indication No. 1.
6. Circuit breaker trips.	a. Possible overvoltage condition: check line voltage. Check that voltage selector switch (S2 on rear panel) is in correct position. b. Possible overtemp condition of power supply (A13). Ensure operation of fans, exhaust hood opening not blocked and fan filters not blocked or clogged. c. Defective power supply (A13). Replace A13.

NOTE:
Wait one minute after trip, before attempting to reset circuit breaker.

NOTE:
Over temperature of power supply (A13) is not indicated by OVTEMP alarm. Alarm only indicates RFPA (A12) over temperature condition.

Table 5-7. Troubleshooting Guide (Continued)

	Indication	Cause/Solution
7.	Display data does not change with Mode switch; clock not updating; display blank after pressing Reset.	Defective CPU (A4). Replace A4.
8.	Clock not updating. Display data changes with Mode switch. Response to front panel controls very slow. Sweeps not starting. Display is correct.	Perform timer test. If test fails: a. Check for loss of 12 Vdc or 300 Vdc supply line. b. Defective circuit in CPU (A4). Replace A4. c. Loss of 5 MHz. Check cable to CPU (A4J8) for proper connection. Replace frequency standard filter (A17). Replace frequency standard (A9).
9.	No forward and reflected power during Chirp Sweep, and in Comm Mode with XMIT key cycled on with audio input (voice, or Tone	a. Disconnected or defective cable to down-converter/audio modulator (A7), preselector (A8), RFPA (A12), postselector (A11), or T/R switch (A14). See Indications 13 and 17. b. Defective A7, A8, A11, A12, A13, A14 or A15 assemblies. See Indications 13 thru 19.
10.	No response to most front panel controls, but LCD data appears correct and clock updating.	Disconnected cable from front panel to CPU (A4J1). Ensure cable connection.
11.	No response to controls/indicators on exhaust hood (A1A1).	a. Disconnected cable to front panel J2. Ensure cable connection. b. Defective control/indicator on exhaust hood. Replace A1A1.
12.	No response to keypad inputs, but other front panel controls and indicators appear normal.	a. Disconnected or loose cable to CPU (A4J2) or keypad (A1A1A1J1). Ensure cable connection. b. Defective keypad. Replace exhaust hood assembly (A1A1).

Table 5-7. Troubleshooting Guide (Continued)

Indication	Cause/Solution
13. In Preselector Self Test all 16 filters fail.	a. Disconnected or defective RF connector or cable to downconverter/audio modulator (A7) or preselector (A8). Check RF connectors and cable to A7 and A8. Replace each cable to A7 and A8, one at a time. Repeat test after each one replaced. b. Disconnected cable at preselector (A8P1). Check connection. c. Disconnected or defective RF cable between A8 and RFPA (A12). Replace each cable and repeat test. d. Defective RFPA (A12). Replace A12 and repeat test.
14. In Preselector Self Test, all fail; "RF Modulator Failure" appears on display.	a. RF Interlock (connection from Pin 1 to 5 of J8 on rear panel) may be open. Check connection Pin 1 to 5 on external plug to J8. b. Defective synthesizer (A6) or downconverter/audio modulator (A7). Replace A6, then A7, one at a time. Repeat tests after each replacement.
15. In Preselector Self Test, some but not all fail.	Defective preselector (A8). Replace A8. Repeat test.
16. In Postselector Self Test, some fail; in Preselector Self Test, all pass.	Defective postselector (A11), controller/driver (A15), or RFPA (A12). Replace, in order: A11, A15, A12 one at a time. Repeat test after each replacement.
17. In Postselector Self Test, all fail; In Preselector Self Test, all pass.	a. Disconnected or defective RF connector or cable to A14 or postselector A11. Check RF connectors and cables. b. Defective RFPA (A12), T/R switch (A14), controller/driver (A15), or power supply (A13). Replace in order: A12, A14, A15 and A13. Repeat test after each replacement.
18. Sideband Self Test failed (see Table 5-3 for pass ranges of power and ALC).	Defective downconverter/audio modulator (A7) or RFPA (A12). Replace, in order: A7, A12, one at a time. Repeat test after each replacement.

Table 5-7. Troubleshooting Guide (Continued)

Indication	Cause/Solution
19. Full Power Test failed. One or two values outside pass ranges (see Table 5-3).	Defective RFPA (A12) or postselector (A11). Replace, in order: A12, A11, one at a time. Repeat test after each replacement.
20. Full Power Test failed. All three values outside pass range (see Table 5-3).	Defective RFPA (A12), downconverter/audio modulator (A7), or power supply (A13). Replace, in order: A12, A7, A13, one at a time. Repeat test after each replacement.
21. Timer Self Test failed.	Defective timer circuit in CPU (A4). Replace A4.
22. In Battery Self Test, POOR or BAD battery condition indicated. Charger condition GOOD.	Repeat test after 24 hours continuous operation with battery switch on. If POOR/BAD battery condition still indicated, replace battery supply (A10).
23. In Battery Self Test, BAD Charger indication with rear panel battery switch (S4) on, but GOOD Charger indication with S4 off.	Discharged or defective batteries. Repeat test after 24 hours of continuous operation with S4 on. If BAD Charger still indicated, replace battery supply (A10) or programmer (A5).
24. In Battery Self Test, bad charger condition indicated with rear panel battery switch (S4) off.	Defective battery charger circuit on programmer (A5). Replace A5. Repeat test.
25. In Serial I/O Self Test 1, 2, 3 or 4, no received message.	a. Loop back jumper not correctly installed. Check jumpers per display instructions. b. Defective I/O port circuit in CPU assembly (A4). Replace A4. Repeat test.
26. In Remote mode, unit does not function. Unit functions properly in local control	a. Baud rate of unit and remote control device not the same. Verify unit baud rate (Test Mode, Test No. 6) matches b. Defective I/O port circuit in CPU assembly (A4). Replace A4, repeat test.

Table 5-7. Troubleshooting Guide (Continued)

Indication	Cause/Solution
27. No RF output at J9 on rear panel. Transmitter Self Tests 2-5 pass. Power Amp Int/Ext switch (S5 on rear panel) in Int position.	Defective T/R switch A14. Replace A14.
28. No receive RF to receiver (J10 on rear panel).	Defective T/R switch (A14). Replace A14. Check that receive RF is present on plug connected to rear panel connector J9.
29. RF OVLD lights intermittently.	a. No load or mismatched load connected at J9 of rear panel. Verify proper load (50 ohm). (OVLD light may not light when operating at low power, but will light at high power into same mismatched load.) b. Excessive external RF power induced into antenna from nearby HF transmitters. Verify by connecting J9 to external dummy load. Repeat operation into dummy load. If no overload condition indicated, problem is external to unit. c. Defective postselector (A11), RFPA (A12), or T/R switch (A14). Replace, in order: A11, A12 and A14, one at a time. Repeat operation to verify correction.
30. OVTEMP alarm light on.	a. RFPA fan (A12B1) not operative. Air filter blocked or clogged. Exhaust hood blocked. Check proper air flow to and from RFPA. b. Ambient temperature too high (above +55°C). Reduce ambient temperature to allow unit to cool.
31. AUDIO OVLD alarm on.	Audio input level too high. If using handset, turn Mic Gain control on front panel counter clockwise. If external audio signal is applied to TB1 on rear panel, move Audio Line-In Level switch (S3 on rear panel) to middle or upper position.

SECTION VI
OPTIONS, VERSIONS, AND PRODUCT IMPROVEMENTS

6-1 INTRODUCTION

6-1.1 The TCS-5 Transmitter is available with different hardware options, hardware configurations, and firmware (software) versions. These options and versions are encoded in the BR part number (on rear panel) as explained below. This section describes the options and versions applicable to the unit bearing the appropriate part number. Product improvement information related to the application of these options and/or versions is also provided in this section.

6-2 HARDWARE OPTIONS AND CONFIGURATIONS

6-2.1 HARDWARE IDENTIFICATION. Different hardware configurations are identified by the seventh and eighth digit of the BR part number. Two common options are listed below; other applicable options are listed on the following pages.

Option	BR P/N
TCS-5 Transmitter (Standard Configuration)	1220-1500-XX
with environmental case	1220-1501-XX
with rack slides	1220-1502-XX

6-3 FIRMWARE

6-3.1 FIRMWARE IDENTIFICATION. The TCS-5 Transmitter is produced in several firmware (software) versions. Different versions provide for special operating functions or optional features to fit the needs of different applications of the transmitter. Firmware (software) versions are indicated by the last two digits of the 10 digit BR part number. Different firmware is installed in the transmitter by changing plug-in Programmable Read Only Memories (PROMS) in various assemblies (typically digital logic or CPU boards). Changing the PROMs to create various versions of the TCS-5 results in instrument and assembly part numbers with version suffixes (i.e. the ninth and tenth digit). Note that two assemblies (e.g. CPU) with the same name and the same first 8 digits of the part number but with different two-digit version suffixes are not interchangeable. Thus, when ordering spare parts or exchanging assemblies for maintenance purposes it is important to properly match version numbers. Version suffix numbers are located on labels attached to each assembly marked "VER XX", where XX is the version suffix of that assembly. Different assemblies within an instrument may have different versions. Assemblies without version labels are VER 01. The overall version of the instrument is identified on the rear panel ID tag.

6-3.2 FIRMWARE VERSIONS. There have been six firmware versions of the TCS-5, of which the first five have been superseded by Version -06. This section describes firmware versions -06 of the TCS-5, including:

Version	Brief Description
-06	ASCII Coded Remote Control Interface with 7057 Antenna Coupler Menu

6-3.3 FIRMWARE CONTROL DRAWING. The firmware control drawing (FCD) shown in Table 6-1 lists all assemblies produced in different versions used in this instrument, and all components in these assemblies that are changed to produce this version. Note that the part numbers of the PROMs listed on the FCD are not listed in the Parts List of the Illustrated Parts Breakdown. Thus, replacement PROMs must be ordered by part numbers listed on the FCD. The last column ("Additional Instructions") of the FCD lists minor hardware changes such as internal switch settings, jumpers on boards, special factory select component values etc., that are used to implement a particular version.

a. Column 1 (ITEM). Sequentially numbered list of all assemblies produced in multiple versions in this unit.

b. Column 2 (ASSEMBLY). The 10-digit BR part number of the versioned PC board or assembly.

c. Column 3 (DESIG). This column gives the reference designator of the particular part (IC, PROM etc.) affected by this version. This designation is printed on the PC board next to the socket used for the part (typically a PROM with a "U" designation).

d. Column 4 (BR PART No.). This is the part number of the programmed PROM (i.e. the part number of the IC with the versioned software code burned-in.) The user must order replacement PROMs using this number and the revision letter which is labelled on the PROM itself. Do not use the revision letter on the Firmware Control Drawing when referring to firmware revisions.

e. Column 5. This column is for BR internal use only.

f. Column 6 (PROGRAM NAME & No.). The name of the program that is contained in the PROM is found here.

g. Column 7 (ADDITIONAL INSTRUCTIONS). This column provides additional information, where required, such as jumpers or minor hardware changes that affect the assembly.

6-4 VERSIONS -01 THROUGH -05

6-4.1 Versions -01 through -05 have been superseded by Version -06 for almost all uses of the TCS-5. Users with versions -01 through -05 firmware should be aware that the TCS-5 will operate differently (including displays) from that described in manuals dated later than 1989 because of significant changes in the TCS-5 operating system. Information about earlier versions may be obtained by contacting BR Communications.

6-5 VERSION -06

6.5.1 Version -06 is the current standard version of the TCS-5 firmware. It incorporates all features that were available with version -03, and enables the TCS-5 to control the 7057 Antenna Coupler (Version -02) from the TCS-5. A wideband blanker function is provided with Version -06. An antenna crossover menu has been added that allows the TCS-5 to set any frequency between 2-30 MHz to control selection of a different antenna with an external antenna relay driven from the TCS-5. This version is compatible with FMT-5A versions -03, -04, -05. The TCS-5 Operating and Service manual dated later than March, 1989 should be used with this version.

6-5.2 The remote control interface for the TCS-5, version -06, permits external control of all sounder function and read-out of sounder parameters, using ASCII command and data codes. BR Communications Interface Control Document K11078, provided with this manual as Appendix A, describes remote control operation.

Table 6-1. TCS-5 Firmware Control Drawing (Version -06)

FIRMWARE CONTROL DRAWING 1220-FW06 **REV** B

ITEM	ASSEMBLY	PROGRAMMED DEVICE		MADE FROM ITEM No	PROGRAM NAME & No	ADDITIONAL INSTRUCTIONS HARDWARE CHANGES ETC.
		DESIG	BR PART No			
01	(1220-2001-06)	U10	1220-E106-1	101	IC TCS-5 W/CPLR MENU OPER	P-1220-E106 JUMPERS FOR BALANCED POLAR INPUT E4 TO E5 E6 TO E7 E10 TO E11 E12 TO E13
		U25	2540-E501-1	102	IC TIMER	P-2540-E501

BR Communications

FIRMWARE CONTROL DRAWING

FCD,TCS-5 W/ANT COUPLER MENU

33783 1220-FW06 Rev B

BR FORM 129A SHEET 1 OF 1

6-6 (RESRVED)

6-7 (RESERVED)

6-8 REVISIONS

6-8.1 BR Communications maintains an on-going product improvement program. Hardware and firmware (software) are reviewed by the factory for performance, reliability and maintainability.

6-8.2 When improvements or modifications to the equipment are made, the equipment and supporting documentation are updated to the next revision level if the existing assembly is compatible with older equipment. Higher (more recent) revision assemblies are compatible and interchangeable in form, fit, and function with lower (older) revision levels. Revisions are controlled and documented by a revision (REV) letter. There are separate revisions for hardware and firmware. Hardware revisions letters are stamped on all assemblies. Firmware (software) revisions may be viewed on the various Test Displays of the unit, as illustrated in Section V. The firmware revision letter is also labelled on the component (PROM) itself. The I.D. plate on the instrument rear panel shows the revision letter for the hardware. Assemblies which have been changed such that they are not compatible or interchangeable with older equipment are identified by changing the configuration or version number. The ID plate format is shown in Figure 6-1.

6-8.3 When contacting the factory about any maintenance questions or when ordering spare parts, it is best to supply the complete BR part number, version number, revision letters and unit serial number from the ID plate, Test displays, and PROM with your inquiry or order.

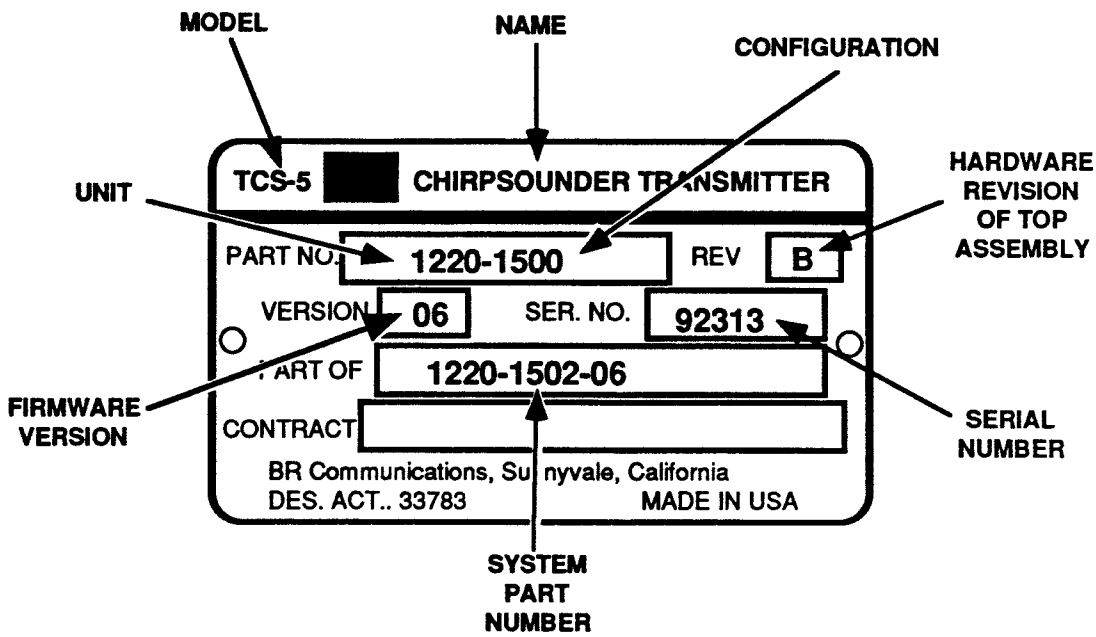


Figure 6-1. Identification Plate Format

REVISIONS			
LTR	DESCRIPTION	DATE	BY/APPD
B	CORRECTED TABLE 1 PER ECO # 6561	5/8/90	TSH/
C	ADDED DESCRIPTION OF TEST FUNCTION	12/13/90	S:/
D	changes PER ECO# 7011	2/25/91	SS/
D	CLARIFY GREETING COMMANDS	6/5/91	/
E	DOC UPDATE ECO # 7224	7/31/91	/
F	CHANGES IN ASCII REM OF RSS-5, ECO 7478	4/10/92	SS/

TCS-5
Interface Control Document
BR Communications
Drawing Number K11078

DR R. Schmidt	10-26-89	APPD	10-26-89
CHK	10-26-89	APPD	

BR COMMUNICATIONS

TCS-5
Interface Control Document

USED ON	NEXT ASSY
APPLICATION	

SIZE	CODE IDENT NO		REV
A	33783	K11078	F

SHEET 1 OF 29

BR FORM 013A

TCS-5

Interface Control Document
BR Communications
Drawing Number K11078

10 April 1992

1 SCOPE

The purpose of this Interface Control Document is to specify the electrical, physical, and operational aspects for remote control of a BR Communications TCS-5 Chirpsounder Transmitter. A TCS-5 operating and service manual and this interface document provide a systems integrator with all information needed to remotely control TCS-5 operation.

2 OVERVIEW

Remote control of the TCS-5 Chirpsounder Transmitter requires a full-duplex serial data link with the remote user. The TCS-5 front panel mode switch must be placed in the REMOTE position to enable remote control.

The TCS-5 is capable of remote control for all sounder functions with remote readout of sounder sweep parameters. This includes setting the TCS-5 real-time clock, sweep start offset, and Chirpcomm message composition and transmission. Refer to BR drawing K11103 for additional instructions regarding Chirpcomm.

3 INTERFACE SPECIFICATIONS

3.1 Electrical/Physical

Communications with the TCS-5 Chirpsounder Transmitter requires a full duplex serial link, operating at 75, 300, 1200, or 9600 baud. The baud rate is selected via the TCS-5 front panel keypad in the Baud Rates submenu, while in the Test mode. The serial signals from the TCS-5 are unbalanced low polar levels in accordance with MIL-STD-188-114 or EIA RS-423 standards. The TCS-5 accepts balanced or unbalanced signals (RS-422/RS-423). The following table describes interface signal descriptions.

Serial Signal Levels and Data Polarity

Standard configuration: differential low polar data input to TCS-5 per EIA RS-422/RS-423. Requires CPU assembly 1220-2001 terminals E6 jumpered to E7. Note: TCS-5 only provides unbalanced RS-423 output signals.

	If source is:	Unbalanced	Balanced (IN only)
Low True Data:	signal line:	MARK = -5V	MARK = -3V
		SPACE = +5V	SPACE = +3V
	reference line:	MARK = 0V	MARK = +3V
		SPACE = 0V	SPACE = -3V

Optional configuration: unbalanced (reference ground provided by TCS-5) low polar data input configuration. Requires CPU assembly 1220-2001 terminals E7 jumpered to E8.

Low True Data:	signal line (IN1/OUT1 signal)	MARK = -5V
		SPACE = +5V
	reference line (IN1/OUT1 REF)	MARK = 0V (gnd)
	internally grounded	SPACE = 0V (gnd)

All characters sent between the controlling unit and the TCS-5 are 10 bits: 1 start, 8 data (least significant bit first), and 1 stop bit. All commands and qualifying data are ASCII codes. ASCII data characters used in TCS-5 communications should have the parity bit (most significant bit) set to zero.

3.2 I/O Port Configuration

The TCS-5 has three bidirectional serial ports available at rear panel connector J7, with port 1 used for remote control. The following describes connector J7 pinout, with IN1 Signal and REF as serial remote control inputs to the TCS-5 and OUT1 Signal and REF as serial remote control outputs.

TCS-5 Rear Panel Connector J7 (Remote I/O) Pin Out

Pin		Function	Pin	Function
1	*	IN1 Signal	14	+5 Vdc
2		+12 Vdc	15	OUT2 REF
3	*	IN1 REF	16	+5 Vdc
4		+12 Vdc	17	IN3 Signal
5	*	OUT1 Signal	18	IN3 REF
6		Circuit Gnd	19	OUT3 Signal
7	*	OUT1 REF	20	OUT3 REF
8		Circuit Gnd	21	Not connected
9		IN2 Signal	22	Spare out
10		-12 Vdc	23	Spare in
11		IN2 REF	26	TX key status
12		-12 Vdc	27	Start of Sweep
13		OUT2 Signal	37	Chassis Gnd

* denotes used for remote control interface

3.3 Operational

The TCS-5 responds to remote commands when its MODE SWITCH is in the REMOTE position. All commands are initiated from the remote control unit. To find out if the TCS-5 is connected, a 4 or 6 character greeting command string is issued to the TCS-5. The TCS-5 responds with its identification code (ID CODE) and two status bytes containing status information on transmitter keying, sweep in progress, remote or local mode, blanking, standby, and interlock conditions. The TCS-5 responds to the greeting whether in remote or local mode, but will respond to commands only in remote mode. A greeting must be received by the TCS-5 before it will respond to commands. If the TCS-5 does not recognize a command from the controller, then it will send the controlling unit a "Not Acknowledge" or NACK code. Once the TCS-5 has accepted a greeting command, other commands may be sent using the following procedure.

There are three possible greeting commands accepted by the TCS-5. The "Greeting" and "Autogreet" commands must contain the proper ID code before the intended TCS-5 will respond. Other TCS-5's with a different ID code will not respond to the Greeting or Autogreet that contains a mismatched ID.

The "Allgreet" command does not require the controller to know the specific TCS-5 ID code in order to communicate with it. The TCS-5 always responds to Allgreet independent of ID code. Use of Allgreet is recommended for control of a single TCS-5 connected on a data link. The Allgreet command should not be used to communicate with multiple TCS-5's on a single data link. All TCS-5's connected would attempt to reply at the same time.

The remote control protocol uses the following rules. An example is listed for setting the path sweep start offset.

- The remote controller sends a single byte command to the TCS-5 (except for greeting). Example; send "F".

- The TCS-5 echoes the command if recognized as a valid command. Example; TCS-5 sends "F" back.

- If TCS-5 receives a command that it does not recognize, then it sends a not-acknowledge code (NACK) to the remote controller.

- The remote controller sends qualifying data and checksum (if required) to TCS-5. The controller does not have to wait for the command echo to send qualifying data, i.e, command, data, and checksum can be sent as a continuous string. Example; send offset data (OFDATA), and checksum (CKSUM).

- TCS-5 sends a command completed (COMP) reply when qualifying data and checksum is accepted, and command is executed. Example; TCS-5 sends "/" back.

- The TCS-5 then sends required data and checksum if needed. The command echo and command completed (COMP) characters are not included in the checksum calculation.

- The TCS-5 sends a checksum error (NOCHECK) reply when the received checksum character does not agree with the calculated checksum. The TCS-5 ignores the command in this case.

- The TCS-5 sends a command not completed (NOCOMP) when the data received is not a permitted value.

- The controller can abort a command set-up or a data transfer in progress with the RESTART command. The GOODBYE command is used to terminate remote communications with the TCS-5.

3.3.1 TCS-5 Command Summary and Protocol

Remote control commands are listed in table 1 in summary format to indicate commands and data exchanged between the TCS-5 and a remote controller. The commands are grouped by function and are listed numerically. The number preceeding a command in table 1 may be used to locate a detailed description of the command and accompanying data located in table 2.

Several terms and abbreviations used in the interface description require definition for clarity. All remote control commands and data are standard printable ASCII characters. Printable ASCII characters are listed within quotes (i.e. "A"). ASCII decimal numeric values ("0" to "9") are referred to as ASCII digits. ASCII codes are also used to express Hex values A through F. The lower 4 bits of the ASCII character (bits 0-3) are actually in Hex format, and appear as follows:

ASCII Char	Represents Hex Value
"0"	0
"1"	1
"2"	2
"3"	3
"4"	4
"5"	5
"6"	6
"7"	7
"8"	8
"9"	9
":"	A
";"	B
"<"	C
"="	D
">"	E
"?"	F

Special control functions such as greetings, goodbye and restart commands use non-printable ASCII control codes. ASCII control codes are listed using standard ASCII nomenclature. Control codes may be generated on ANSI compatable CRT terminals by pressing the CTRL key in conjunction with another key. Control codes used by the TCS-5 are:

Name	ASCII function	Hex	CRT terminal entry
ENQ	Enquiry	05H	control E
ACK	Acknowledge	06H	control F
BEL	Bell or alarm	07H	control G
BS	Backspace	08H	control H
HT	Horizontal tab	09H	control I
LF	Line feed	0AH	control J
VT	Vertical tab	0BH	control K
FF	Form Feed	0CH	control L
CR	Carriage return	0DH	control M

The remote control command summary, table 1, lists ASCII command codes and defines qualifying data by name and indicates the number of bytes of data in parenthesis. If the qualifying data is a single byte, no parenthetic value is included. For example, PDATA(2) is two bytes and INTERVAL is a single byte value.

A checksum value is sent with multi-character command strings to verify that the received data is error-free. The checksum value is calculated as an 8-bit binary sum of all transmitted data characters excluding the command and command completed (COMP) characters. Each received character is added to the previous sum. The resulting binary sum may produce a value larger than eight bits. That is, a ninth binary bit, or carry may occur from the addition of two eight bit values. Carrys generated out of the most significant bit during the addition are discarded, and are not added back in to subsequent sums. While data is being received, a running sum is calculated. The received checksum character is compared to the calculated checksum value.

The 8 bit binary checksum value may range from 0 to FF (expressed in Hexidecimal). As data transmitted over the serial link must be in ASCII, the two most significant bits are masked out of the checksum value. Six significant bits are used to detect transfer errors. The checksum value is sent with bit 7 set to 0 and bit 6 set to 1, resulting in ASCII character "@" (40H) to DEL (delete control character = 7FH). Bits 0 to 5 contain the binary checksum value. This guarantees that the checksum value is not a reserved ASCII control character.

A special ASCII control character may be sent in place of the checksum value to force the TCS-5 to accept the command data regardless of the calculated checksum. This special character (FF or form feed) permits remote control without having to calculate a checksum. The TCS-5 will send out a calculated checksum value accompanying requested data, regardless of the type of checksum sent with the command.

All remote control ASCII data sent out by the TCS5 is checked to be valid printable ASCII characters (except for greeting response). In the event that data is corrupted in the TCS5 such that the data about to be transmitted is outside the printable ASCII character set (20 Hex to 7F Hex), a tilde ("~") character is substituted for the erroneous character.

Refer to BR drawing K11103 for special instructions covering remote programming of the receiver ID and remote readout of Chirpcomm messages.

TABLE 1 - REMOTE CONTROL COMMAND SUMMARY

FUNCTION	TO TCS-5 --------->	FROM TCS-5 <---------
GREETINGS AND STATUS		
1. GREETING	ENQ + BEL + ACK + BEL + ID(2)	BEL + ID(2) + STATUS(2)
2. ALL_GREET	ENQ + BEL + ACK + BS	BS + ID(2) + STATUS(2)
3. AUTO_GREET	ENQ + BEL + ACK + HT + ID(2)	HT + ID(2) + STATUS(2)
4. AUTO_STATUS		CR + BEL + LF + ID(2) + STATUS
5. GOODBYE	ENQ + BS + ACK + ID(2)	ENQ + BS + ACK + ID(2)
RUN MODE		
6. RUN MODE	"A"	"A" + COMP
7. READ SWEEP FREQUENCY	"B"	"B" + COMP + FREQ(4) + CKSUM
PATH PROGRAMMER		
8. READ PATH PROGRAMMER	"C"	"C" + COMP + PDATA(24) + CKSUM
9. SET PATH PROGRAMMER	"D" + INTERVAL + PDATA(2) + CKSUM	"D" + COMP
SET PATH		
10. READ PATH OFFSET	"E"	"E" + COMP + OFDATA(8) + CKSUM
11. SET PATH OFFSET	"F" + OFDATA(8) + CKSUM	"F" + COMP

FREQUENCY BLANKING

12. READ NARROW "G" BLANKER LIST		"G" + COMP + LIST(128) + CKSUM
13. WRITE NARROW "H" + LIST(128) + CKSUM BLANKER LIST		"H" + COMP
14. ADD NARROW "I" + FREQ(4) + CKSUM BLANKER FREQ		"I" + COMP
15. DELETE NARROW "J" + FREQ(4) + CKSUM BLANKER FREQ		"J" + COMP
16. READ WIDE "K" + BAND + CKSUM BAND BLANKER		"K" + COMP + BAND + START_STOP_FREQ(6) + CKSUM
17. WRITE WIDE "L" + BAND + START_STOP_FREQ(6) BAND BLANKER + CKSUM		"L" + COMP
18. BLANKER ON "M"		"M" + COMP
19. BLANKER OFF "N"		"N" + COMP
20. STANDBY ON "O"		"O" + COMP
21. STANDBY OFF "P"		"P" + COMP

SET CLOCK

22. READ CLOCK "Q"		"Q" + COMP + TIME(6) + CKSUM
23. SET CLOCK	"R" + TIME(6) + CKSUM	"R" + COMP
24. ADVANCE CLOCK	"S" + A/R TIME(2) + CKSUM	"S" + COMP
25. RETARD CLOCK	"T" + A/R TIME(2) + CKSUM	"T" + COMP

CHIRPCOMM MESSAGE

26.	READ CCOM MESSAGE	"U" + TYPE + CKSUM	"U" + COMP + TYPE + MSG(40) + CKSUM
27.	NEW MESSAGE	"V" + QUAL + MSG(38) + CKSUM	"V" + COMP
28.	NEW ID & MESSAGE	"W" + QUAL + MSG(40) + CKSUM	"W" + COMP
29.	SEND STORED MESSAGE	"X" + QUAL + CKSUM	"X" + COMP
30.	CLEAR MESSAGE	"Y"	"Y" + COMP
31.	ABORT CHIRPCOM	"Z"	"Z" + COMP

COMM MODE

32.	COMM MODE	"[" + MODE + CKSUM	"[" + COMP
33.	READ COMM MODE	"\"	"\" + COMP + MODE + POWER + FREQ(7) + CKSUM
34.	READ COMM ANTENNA	"]"	"]" + COMP + ANTENNA
35.	SET [illegible] ANTENNA	"^" + ANTENNA + CKSUM	"^" + COMP
36.	SPEECH COMP. ON	"_" (underscore)	"_"
37.	SPEECH COMP. OFF	"`"	"`"
38.	COMM MODE POWER	"a" + POWER + CKSUM	"a" + COMP
39.	TUNE COMM FREQUENCY	"b" + FREQ(7) + CKSUM	"b" + COMP
40.	TUNE COMM CHANNEL	"c" + CHNL(2) + CKSUM	"c" + COMP
41.	READ COMM CHNL FREQ	"d" + CHNL(2) + CKSUM	"d" + COMP + CHNL(2) + FREQ(6) + CKSUM

42. READ COMM FREQ LIST	"e"	"e" + COMP + LISTID(5) + DATA(1600) + CKSUM
43. READ LIST ID	"f"	"f" + COMP + LISTID(5) + CKSUM
44. WRITE COMM FREQ LIST	"g" + LISTID(5) + DATA(1600) + CKSUM	"g" + COMP + CKSUM
45. INCREMENT FREQ	"h"	"h" + COMP
46. DECREMENT FREQ	"i"	"i" + COMP
47. XMITTER ON	"j"	"j" + COMP
48. XMITTER OFF	"k"	"k" + COMP
49. ENABLE TCS LOCAL KEYING	"l"	"l" + COMP
50. DISABLE TCS LOCAL KEYING	"m"	"m" + COMP

ANTENNA COUPLER

51. READ COUPLER SETTINGS	"o"	"o" + COMP + ON/OFF + SETTING + CKSUM
52. WRITE COUPLER SETTINGS	"r" + SETTING + CKSUM	"r" + COMP
53. ENABLE COUPLER	"s" + ON/OFF + CKSUM	"s" + COMP

MISCELLANEOUS COMMANDS

54. TEST MODE	"t"	"t" + COMP + RESULTS + CKSUM
55. READ FWD/ RFL POWER	"u"	"u" + COMP + FWDPWR(3) + RFLTPWR(3) + CKSUM

56.	NACK		"n"
57.	COMP		"/"
58.	NOCHECK		"q"
59.	NOCOMP		"p"
60.	RESTART	VT + VT	VT
61.	READ 1PPS	"v"	"v"
62.	ECHO	"w"	"w"
63.	READ CROSSOVER FREQUENCY	"x"	"x" + COMP + CROSS-FREQ(3) + CKSUM
64.	NEW CROSSOVER FREQUENCY	"y" + CROSS-FREQ(3) + CKSUM	"y" + COMP
65.	READ VERSION	"?"	"?" + VERSION(4) + COMP
66.	READ EXTENDED BLANKER LIST	">"	">" + COMP + LIST(384) + CKSUM
67.	WRITE EXTENDED BLANKER LIST	"=" + LIST(384) + CKSUM	"=" + COMP

TABLE 2 - REMOTE CONTROL COMMAND DETAILS

GREETINGS AND STATUS

GENERAL:

One or more instruments can share the same data link to a remote controller. Only one of these instruments can be controlled at one time, however. The TCS-5 continually monitors the receive serial port for a greeting command preceeded by an "attention-getter" string (ENQ BEL ACK). The TCS-5 is put "on-line" and accepts commands from the remote contrroller only following a valid geeting sequence with the front panel mode switch in the REMOTE position. It will not respond to commands until placed in the "on-line" state. If the TCS-5 receives a "goodbye" string (ENQ BS ACK) or a greeting with a different ID (placing it "off-line"), the unit will not respond to further commands detected on the link until it receives another "attention-getter" and a valid greeting. Note that if no ID was previously programmed into the TCS-5 (e.g. at first-time turn on), the TCS-5 will accept either an ALLGREET or a regular GREETING with a default ID consisting of two ASCII colons ("::"). The ASCII colon is interpreted as a wildcard character for ID only. Similarly, the TCS-5 will return two colons for its default ID if no other ID was previously programmed.

1. GREETING:

   The greeting contains an ID code which identifies the TCS-5 that the remote controller wishes to communicate with. When a TCS-5 receives its own ID code in a greeting, it will respond to all further commands until it receives a greeting with an ID code not its own. It will not respond to further commands until it receives a new greeting with its own ID code again. The TCS-5 will not respond to a greeting with the wrong ID. The TCS-5 will respond to greetings in local or remote mode, but will only execute remote commands when the front panel mode switch is set to REMOTE.

   ID 2 bytes

   The Chirpcomm transmit ID code which identifies this TCS-5 transmitter. The ID is locally programmed with the front panel controls in the CHIRPCOMM mode, or remotely as described in item 28. (See also K11103)

STATUS 2 bytes
Byte 1, ASCII character from "0" to "?" depending on bits set.

7	6	5	4	3	2	1	0

Bit
0: 0 = local mode, 1 = remote mode
1: 0 = no sweep, 1 = sweep in progress
2: 0 = sweep enabled, 1 = sweep disabled (comm or test mode).
3: 0 = Blanking off, 1 = blanking on
4: 1
5: 1
6: 0
7: 0

Byte 2, ASCII character from "0" to "?" depending on bits set.

7	6	5	4	3	2	1	0

Bit
0: 0 = tx not keyed, 1 = tx keyed
1: 0 = run, 1 = standby
2: 0 = TX enabled, 1 = tx disabled (interlock open).
3: 0 Not used
4: 1
5: 1
6: 0
7: 0

2. ALL_GREET:
A greeting without an ID code which will cause the TCS-5 to respond to commands without verifying an ID code. The TCS-5 will return its ID code. (See also K11103)

STATUS See 1

3. AUTO_GREET:
This greeting is sent to the TCS-5 when it is desired that the TCS-5 automatically send status to the controller whenever any status item (for example, run/standby) changes states. The TCS-5 will continue to send status updates to the controller until it receives a GREETING, ALL_GREET or GOODBYE command. Cold start power-up (batteries off) of the TCS-5 terminates AUTO_GREET mode.

STATUS See 1

4. AUTO_STATUS:
Whenever the TCS-5 has been sent an AUTO_GREET command, the TCS-5 will automatically send status to the controller whenever any status item (for example, run/standby) changes states. The TCS-5 will continue to send status updates to the controller until it receives a GREETING or ALL_GREET command. AUTO_STATUS will be sent in local and remote mode.

ID 2 bytes

The chirpcomm transmit ID code which identifies this TCS-5 transmitter.

STATUS See 1

5. GOODBYE:
This command terminates communications with the TCS-5 specified in the ID code. A greeting is required to resume communications.

ID 2 bytes

The chirpcomm transmit ID code which identifies this TCS-5 transmitter. The TCS-5 will accept either the regular ID or a default ID consisting of two ASCII colons ("::"). The ASCII colon is interpreted as a wildcard character for the ID only.

6. RUN MODE:
Enables sweeps to start. Used to exit comm mode.

7. READ SWEEP FREQUENCY:

FREQ 4 bytes

Sweep frequency MSD is sent first specifying the 10's MHz digit, followed by the 1's MHz digit, 100's kHz digit, and the 10's kHz digit.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

8. READ PATH PROGRAMMER:

PDATA 24 bytes

Bytes 1-12:
Twelve bytes of path programmer data correspond to the twelve 5 min. sweep intervals in an hour. The first 5 minute interval data is sent first. PDATA ASCII digits are as follows:

Mode definition:
"0" = No sweep
"1" = 2-16 MHz, 1/10 power
"2" = 2-30 MHz, 1/10 power
"3" = 2-16 MHz, full power
"4" = 2-30 MHz, full power

Bytes 13-24:
Twelve bytes of path programmer antenna selection correspond to the twelve 5 min. sweep intervals in an hour. The first 5 minute interval data is sent first. ASCII digits are as follows:

Antenna selection:
"1" = Antenna 1
"2" = Antenna 2
"3" = Antenna 3

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

SET PATH PROGRAMMER:

INTERVAL 1 byte
ASCII character corresponds to the 5-minute interval of the hour. Character = "1" specifies the first 5-minute interval, while character = "9" specifies the ninth interval. Other intervals are specified as follows:

Char = ":" specifies interval 10
Char = ";" specifies interval 11
Char = "<" specifies interval 12

PDATA 2 bytes
Byte 1: ASCII digit selects mode for specified interval.

Mode definition:
"0" = No sweep
"1" = 2-16 MHz, 1/10 power
"2" = 2-30 MHz, 1/10 power
"3" = 2-16 MHz, full power
"4" = 2-30 MHz, full power

Byte 2: ASCII digit select antenna for specified interval.

Antenna selection: "1" = Antenna 1
"2" = Antenna 2
"3" = Antenna 3

10,11. READ / SET PATH START TIME OFFSET:

OFDATA 8 bytes
Offset data consists of sign character (always "+") followed by path offset minutes, seconds, and fractional seconds. Offsets can range from 0 seconds to 4 Minutes 58.9995. Half millisecond resolution in the offset may be specified. Negative offsets may not be set. Negative offsets are possible only in the RCS-5A/B.

byte 1 = offset sign, ASCII "+"
byte 2 = offset minutes, ASCII "0" to "4"
byte 3 = offset 10's of seconds, ASCII "0" to "5"
byte 4 = offset 1's of seconds, ASCII "0" to "9"
byte 5 = offset 100's of milliseconds, ASCII "0" to "9"
byte 6 = offset 10's of milliseconds, ASCII "0" to "9"
byte 7 = offset 1's of milliseconds, ASCII "0" to "9"
byte 8 = offset .5's of milliseconds, ASCII "0" or "5"

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

12,13. READ / WRITE NARROW BAND BLANKER FREQUENCY LIST:

Commands 66 and 67 should be used for units with firmware versions V06J and higher. They allow reading and writing of all 96 blanker channels. Use of write command 13 clears channels 33 through 96.

LIST 128 bytes
32 four digit ASCII frequencies specifying blanker channels 1 through 32 (also see commands 66 and 67).

Each frequency consists of 4 ASCII digits. The blanker frequency MSD is sent first specifying the 10's MHz digit, followed by the 1's MHz digit, 100's kHz digit, and the 10's kHz digit. Unused frequencies have all digits = "F".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

14,15. ADD / DELETE NARROW BAND BLANKER FREQUENCY:

BLFREQ 4 bytes
Each frequency consists of 4 ASCII digits. The blanker frequency MSD is sent first specifying the 10's MHz digit, followed by the 1's MHz digit, 100's kHz digit, and the 10's kHz digit. Unused frequencies have all digits = "0".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

16,17. READ / WRITE WIDE BAND BLANKER:
The wide band blanker command permits transmit blanking (no RF) over two programmed frequency bands during sweeps.

BAND 1 byte
ASCII "1" or "2" specifies band number to revise.

START_STOP_FREQ 6 bytes
First 3 ASCII digits determine the start frequency of the blanked band to 100 kHz resolution. Second 3 digits determine the stop frequency. The start frequency must be less than the stop frequency, and both must be within 2-30 MHz. To clear a band, start and stop frequencies should both be set to 0.

byte 1 = start freq 10's MHz, ASCII "0" to "2".
byte 2 = start freq 1's MHz, ASCII "0" to "9".
byte 3 = start freq 100's kHz, ASCII "0" to "9".
byte 4 = stop freq 10's MHz, ASCII "0" to "3".
byte 5 = stop freq 1's MHz, ASCII "0" to "9".
byte 6 = stop freq 100's kHz, ASCII "0" to "9".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

18. BLANKER ON:
Enable TCS-5 to blank frequencies in its narrow band blanker list, or within the range of the wide blanker bands. RF transmission is gated off during blanking.

19. BLANKER OFF:
Disable the TCS-5 from blanking frequencies in its blanker list, or within the range of the wide blanker bands. RF transmission is gated on during the entire sweep.

20. STANDBY ON:
Disable RF transmission during sweeps. Sweeps are generated when in standby but no RF output is available. Standby may be turned on or off at anytime, including during sweep.

21. STANDBY OFF:
Enable RF transmission during sweeps. This is the "normal" operating mode.

22,23. READ / SET CLOCK:

TIME 6 bytes
Real time clock set to time specified by ASCII digits. Time value ranges from 00:00:00 to 23:59:59. Hours MSD sent first.

byte 1 = time 10's hours, ASCII "0" to "2"
byte 2 = time 1's hours, ASCII "0" to "9"
byte 3 = time 10's minutes, ASCII "0" to "5"
byte 4 = time 1's minutes, ASCII "0" to "9"
byte 5 = time 10's seconds, ASCII "0" to "5"
byte 6 = time 1's seconds, ASCII "0" to "9"

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

24,25. ADVANCE / RETARD CLOCK:

A/R TIME 2 bytes
The first byte sent specifies whether 100's, 10's or 1's of milliseconds decades are to be slipped by the amount specified in the second byte. The first byte can be an ASCII "H" (100's), "T" (10's) or "O" (1's). The second byte is an ASCII digit ranging from "0" to "9".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

26. READ CHIRPCOMM MESSAGE:

TYPE 1 byte
ASCII character specifies which message is to be read.
"C" = currently sending message
"W" = waiting to send message
"S" = stored message

MSG 40 bytes
ASCII chirpcomm characters consisting of two ID characters followed by 38 message characters. See K11103 for allowed Chirpcomm character set and other special instructions.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

27. NEW CHIRPCOMM MESSAGE:

QUAL 1 byte
ASCII character specifies what to do with the message that follows. (w-t-s = waiting to send)
"S" = store msg.
"O" = send msg once (put in w-t-s buffer).
"C" = send msg continuously (put in w-t-s buffer).
"N" = send msg now (put in current buffer).
"T" = send msg twice (put in w-t-s buffer).

MSG
38 bytes of ASCII chirpcomm characters with first character of message sent first. See K11103 for allowed Chirpcomm character set and other special instructions.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

28. NEW CHIRPCOMM ID & MESSAGE:

QUAL 1 byte
ASCII character specifies what to do with the message that follows. (w-t-s = waiting to send)
"S" = store msg.
"O" = send msg once (put in w-t-s buffer).
"C" = send msg continuously (put in w-t-s buffer).
"N" = send msg now (put in current buffer).
"T" = send msg twice (put in w-t-s buffer).

MSG
40 bytes of ASCII Chirpcomm characters consisting of two ID characters followed by 38 message characters. See K11103 for allowed Chirpcomm character set and other special instructions.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

29. SEND STORED MESSAGE:

QUAL 1 byte
ASCII character specifies what to do with the stored message. (w-t-s = waiting to send)
"O" = send msg once (put in w-t-s buffer).
"C" = send msg continuously (put in w-t-s buffer).
"N" = send msg now (put in current buffer).
"T" = send msg twice (put in w-t-s buffer).

30. CLEAR MESSAGE:
Clear the waiting-to-send chirpcomm message to rubouts so there is no message waiting. The ID is retained.

31. ABORT MESSAGE:
The TCS-5 will immediately rubout the current message and transmit only the ID.

32. COMM MODE:

MODE 1 byte
ASCII character selects the comm mode.
This command will abort a sweep in progress.
"U" = USB.
"L" = LSB

33. READ COMM MODE:

MODE 1 byte
ASCII character defines the comm mode.
This command will abort a sweep in progress.
"U" = USB.
"L" = LSB

POWER 1 byte
ASCII character defines comm mode power level.
"L" = low power
"H" = high power

FREQ 7 bytes
Monitor mode tuned frequency, ranging from 1.6 MHz to 29.99999 MHz, with 10 Hz resolution. ASCII digits sent most significant digit first (10's MHz), with last character specifying 10 Hz digit. Decimal point not sent.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

34,35. COMM ANTENNA:

ANTENNA 1 byte
ASCII digit selects comm mode antenna.

Antenna selection:
"1" = Antenna 1
"2" = Antenna 2
"3" = Antenna 3

36. SPEECH COMPRESSION ON:
Enhance the comm mode audio signal for voice transmission.

37. SPEECH COMPRESSION OFF:
Normal comm mode audio for data modem transmission.

38. COMM MODE POWER:

POWER 1 byte
ASCII character selects comm mode power level.
"L" = low power
"H" = high power

39. TUNE TO COMM FREQUENCY:

FREQ 7 bytes
Monitor mode tuned frequency, ranging from 1.6 MHz to 29.99999 MHz, with 10 Hz resolution. ASCII digits sent most significant digit first (10's MHz), with last character specifying 10 Hz digit. Decimal point not sent.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

40. TUNE TO COMM CHANNEL:

CHNL 2 bytes
ASCII digits, sent MSD first, specify channel number to use. Frequency list channel numbers range from 00 to 99.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

41. READ COMM CHNL FREQUENCY:

CHNL 2 bytes
ASCII digits, sent MSD first, specifies channel number. Frequency list channel numbers range from 00 to 99.

FREQ 6 bytes
Monitor mode tuned frequency, ranging from 1.6 MHz to 29.9999 MHz, with 100 Hz resolution. ASCII digits sent most significant digit first (10's MHz), with last character specifying 100 Hz digit. Decimal point not sent.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

42. READ COMM FREQ LIST:

LISTID 5 bytes
ASCII list ID number consists of 4 digits and a letter (A to F), and can range from "0001A" to "9999F". MSD sent first. A list ID of "00000" indicates a cleared list.

DATA 1600 bytes
100 channels of 16 bytes each. Transmission order is channel 0 first through 99 last. Channel number assumed based on position in list. Each channel will have 6 ASCII digits specifying frequency 020000 - 299999 MHz (100 Hz resolution) with the MSD sent first. If the channel is not used, 6 ASCII "F"'s are sent as frequency. Each channel also has a 10 byte ASCII comment field.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

43. READ LIST ID:

LISTID 5 bytes
ASCII list ID number consists of 4 digits and a letter (A to F), and can range from "0001A" to "9999F". MSD sent first. A list ID of "00000" indicates a cleared list.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

44. WRITE COMM FREQ LIST:

LISTID 5 bytes
ASCII list ID number consists of 4 digits and a letter (A to F), and can range from "0001A" to "9999F". MSD sent first. A list ID of "00000" indicates a cleared list.

DATA 1600 bytes
100 channels of 16 bytes each. Transmission order is channel 0 first through 99 last. Channel number assumed based on position in list. Each channel will have 6 ASCII digits specifying frequency 020000 - 299999 MHz (100 Hz resolution) with the MSD sent first. If the channel is not used, 6 ASCII "F"'s are sent as frequency. Each channel also has a 10 byte ASCII comment field.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

45. INCREMENT COMM FREQUENCY:
Increment the comm frequency by 10Hz.

46. DECREMENT COMM FREQUENCY:
Decrement the comm frequency by 10Hz.

47. TRANSMITTER ON:
Key on the transmitter (RF gated on). This command must be sent at least once every 10 sec in the COMM MODE when transmitting or the TCS-5 will turn off its power amplifier.

48. TRANSMITTER OFF:
Key off the transmitter (RF gated off) while the transmitter is in COMM MODE.

49. ENABLE TCS-5 LOCAL KEYING:
This command enables an operator at the TCS-5 to manually key the transmitter using the hardware keying switches or rear panel key input. This command only affects keying operation while the TCS-5 is under remote comm mode control.

50. DISABLE TCS-5 LOCAL KEYING:
This command disables the TCS-5 from responding to any local hardware transmitter keying input. This command only affects keying operation while the TCS-5 is under remote comm mode control. Only the controller can key the transmitter after the command is received by the TCS-5. Transmitter is keyed off as a result of this command.

51. READ ANTENNA COUPLER SETTINGS:
The ON/OFF command indicates if the TCS-5 is enabled for antenna coupler operation. If enabled, the mode of coupler operation is indicated by SETTING.

ON/OFF 1 byte
"1" = Coupler operation enabled.
"0" = Coupler operation disabled.

SETTING 1 byte
ASCII character depending on bits set. Valid characters include "Q","R","U","V","X","a","b","e","f","h".

7	6	5	4	3	2	1	0

Bit
0: = Tx Auto Tune = 1
1: = Tx Memory Tune = 1
2: = Tx Learn new antenna = 1
3: = Tx Bypass = 1
4: = Rx Bypass = 1
5: = Rx Memory Tune = 1
6: 1
7: 0

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

52. WRITE ANTENNA COUPLER SETTINGS:
Operation of the antenna coupler with the TCS-5 is enabled with the ON/OFF command. If enabled, the mode of coupler operation is specified by SETTING. SETTING command code must have a Receive (Rx) and transmit (Tx) state selected to be valid. If "Learn New Antenna" state is selected, either "Tx Auto Tune" or "Tx Memory Tune" must also be selected.

SETTING 1 byte
ASCII character depending on bits set. Valid characters include "Q","R","U","V","X","a","b","e","f","h".

7	6	5	4	3	2	1	0

Bit
0: = Tx Auto Tune = 1
1: = Tx Memory Tune = 1
2: = Tx Learn New Antenna = 1
3: = Tx Bypass = 1
4: = Rx Bypass = 1
5: = Rx Memory Tune = 1
6: 1
7: 0

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

53. ENABLE ANTENNA COUPLER OPERATION:
Operation of the antenna coupler with the TCS-5 is enabled with the ON/OFF command. If enabled, the mode of coupler operation is specified by SETTING (See previous command).

ON/OFF 1 byte
"1" = Coupler operation enabled.
"0" = Coupler operation disabled.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

54. TEST:
This command will terminate any sweeps in progress and will take approximately 45 seconds to perform and send RESULTS. No sweeps will be allowed to start until RESULTS is sent.

RESULTS 1 byte
ASCII character from "0" to "?" depending on bits set.

7	6	5	4	3	2	1	0

Bit
0: = Memory test passes = 0, fails = 1
1: = battery test passes = 0, fails = 1
2: = timer test passes = 0, fails = 1
3: = transmit test passes = 0, fails = 1
4: 1
5: 1
6: 0
7: 0

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

55. READ FORWARD/REFLECTED POWER:

FWDPWR 3 bytes
ASCII digits represents antenna forward power.
Range: "000" to "180" WATTS.

RFLTPWR 3 bytes
ASCII digits represents antenna reflected power.
Range: "000" to "180" WATTS.

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

56. NACK:
Not acknowledge command. If the TCS-5 does not acknowledge a command sent to it, then the TCS-5 sends a NACK. This results from the command being garbled such that it is not a valid command code.

57. COMP:
Command completed. The checksum received from the remote controller matches the calculated checksum. The command has been completed, and the requested data, if any, follows.

58. NOCHECK:
Checksum error detected. The checksum character received from the remote controller does not match with the calculated checksum. The command has not been completed.

59. NOCOMP:
Command not completed. The data was received correctly but was not a value permitted for this command, and the command was not completed. For example, a frequency of 40 MHz was specified in a comm frequency command.

60. RESTART:
The TCS-5 will stop its present data transfer and prepare to receive a new command. Restart causes current command processing to abort.

61. READ 1PPS:
When the TCS-5 receives the read 1PPS command, the TCS-5 will respond with an ASCII "v" that is output on the next 1PPS tick of the TCS-5 real time clock. This can be used to check the accuracy of the TCS-5 real time clock. NOTE: the receipt of the ASCII "v" by the remote device will be delayed by the serial data interface UART (approx. 9 milliseconds at 1200 baud) and the remote data link delay. See #62 below. NOTE: COMP is not returned by the TCS-5 for this command.

62. ECHO:
When the TCS-5 receives the echo command, the TCS-5 will immediately respond with an ASCII "w". This allows the remote device to measure the remote data link delay to/from the TCS-5. See #61 above. NOTE: COMP is not returned by the TCS-5 for this command.

63. READ CROSSOVER FREQUENCY:
The antenna crossover function allows the TCS-5 to operate with two antennas with different frequency ranges. The crossover frequency determines which antenna is selected at a given transmit frequency. Refer to the operating and service manual for details.

CROSS-FREQ 3 bytes
Frequency consists of 3 ASCII digits. The crossover frequency MSD is sent first specifying the 10's MHz digit, followed by the 1's MHz digit, and the 100's kHz digit. When the crossover function is disabled, the crossover frequency digits all equal "0".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

64. NEW CROSSOVER FREQUENCY:
The antenna crossover function allows the TCS-5 to operate with two antennas with different frequency ranges. The crossover frequency determines which antenna is selected at a given transmit frequency. Refer to the operating and service manual for details.

CROSS-FREQ 3 bytes
Frequency consists of 3 ASCII digits. The crossover frequency MSD is sent first specifying the 10's MHz digit, followed by the 1's MHz digit, and the 100's kHz digit. To disable the crossover function, set all frequency digits equal to "0".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

65. READ VERSION:

VERSION 4 bytes
ASCII digits representing the firmware version of the unit. The version MSD will be either "X" (experimental version) or "V" (production version). Followed by two digits representing the version number. The revision letter is the LSD ranging from "A" to "Z".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

66,67. READ / WRITE EXTENDED NARROW BAND BLANKER FREQUENCY LIST:
The extended blanker function applies to units with firmware versions V06J and higher. The function checks that each frequency in the list is within the range 2.00 - 29.99 MHz. If any frequency is outside the range, the entire list will be rejected. The TCS-5 must receive the list without frequency duplicates.

LIST 384 bytes
64 four digit ASCII frequencies specifying blanker channels 1 through 96 (also see commands 12 and 13).

Each frequency consists of 4 ASCII digits. The blanker frequency MSD is sent first specifying the 10's MHz digit, followed by the 1's MHz digit, 100's kHz digit, and the 10's kHz digit. Unused frequencies have all digits = "F".

CKSUM 1 byte
ASCII character where bits 0-5 contain binary checksum value.

REVISIONS			
LTR	DESCRIPTION	DATE	BY/APPD
A	CHNG TO ASCII DATA READ FROM TCS-5 CC BUFFER. ECO 7193	7/25/91	SS/

SPECIAL INSTRUCTIONS FOR REMOTE CONTROL OF CHIRPCOMM MESSAGES

BR COMMUNICATIONS
Drawing Number K11103

Applies to TCS-5, RCS-5A/B, and 3085
with ASCII Remote Protocol

DR		QA	
CHK		ENG	

USED ON	NEXT ASSY
APPLICATION	

BR COMMUNICATIONS

REMOTE CHIRPCOMM INSTRUCTIONS

SIZE	CODE IDENT NO		REV
A	33783	K11103	A

SHEET 1 OF 10

BR FORM 013 B

1 Scope

These instructions supplement the Remote Protocol Documents for the BR Chirpsounder transmitters and receivers. Specifically, the additional information in this document covers special remote interface requirements for transmitting and receiving Chirpcomm messages. This document is applicable to the following equipment and corresponding Remote Protocols:

Unit		Remote Protocol Document
TCS-5	Chirpsounder Transmitter	K11078
RCS-5A	Chirpsounder Receiver	K11074
RCS-5B	Chirpsounder Receiver	K11074
3085	Propagation Analyzer	K11097

2 Overview

Forty-character ong Chirpcomm messages can be transmitted by BR TCS-5 Chirpsounder transmitters and received by RCS-5 series receivers. In addition, Chirpcomm messages can be transferred in and out of these instruments through the 3085 Propagation Analyzer. When remotely sending or receiving these messages, certain specific rules and restrictions apply regarding the control of the equipment for proper operation of the Chirpcomm circuitry within the TCS-5 and RCS-5.

The 40-character Chirpcomm message consists of a 2-character Transmit ID, followed by a 38-character message. The Transmit ID can be any 2-character alphanumeric code. The 38-character message can be composed from the Chirpcomm character set which consists of all 26 upper-case English letters, numbers (0-9), space, nine punctuation marks (! + / > . < ' ? -), and a special Alarm character (^).

When a Chirpcomm message is sent on a Chirp sweep, the Chirpsounder transmitter modulates the linear FMCW sweep with the data from the Chirpcomm message. Chirpcomm generates a modulation that is similar to a 250 Hz FSK modulation of the linear sweep at a 55 bit per second rate. This modulation produces sidebands on the transmitted Chirp sweep which may be seen on the Chirpsounder record received by the Chirpsounder receiver at the far end of the HF path. The modulation sidebands appear as weak "ghosts" or duplicate spurious images of the mode traces on the receiver CRT display. That is, Chirpcomm will produce a weak second copy of the Chirp trace in the upper half of the CRT display that is a copy (ghost) of the trace in the lower half of the display. The strength of the Chirpcomm induced ghost trace is a function of the message length; short messages produce very weak spurious ghosts, longer messages produce stronger ones.

If the main purpose of the Chirpsounder system is to send Chirpcomm messages, these ghost traces can be ignored. (There is no degradation of Chirpcomm performance due to these ghost images.) However, if the Chirpsounder transmitter is used primarily to transmit a Chirp sweep for frequency management purposes, the ghost Chirpcomm traces appearing on the Chirpsounder receiver may make it more difficult to interpret the Chirpsounder record for selection of optimum communications frequencies. In this case, Chirpcomm messages should be kept as short as possible. Ideally, only the Transmit ID should be sent repeatedly, sweep after sweep.

3 Message Format

The first 2 characters of the 40-character field are typically reserved for the Transmit ID. The next two characters (i.e. characters 3 and 4 of the 40-character field) can be used for a Receive ID if the selective calling Chirpcomm alarm feature is used. The Chirpcomm message alarm allows a Chirpcomm transmitter to alert the operator of a specific Chirpcomm receiver that a new message has been received. The alarm will activate on only those receivers whose Chirpcomm Receive ID matches that of the Receive ID contained in the message.

If the selective calling alarm is used, the message format is:

TTRR^xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

where:
TT is the transmit ID
RR is the receive ID
^ is the alarm character (must be in 5th position)
xxxxx is a 35-character message field.

If a general alarm is desired (to alert all Chirpcomm receivers which are synchronized to the transmitter, regardless of their receiver IDs), the message format is:

TT^xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

where:
TT is the transmit ID
^ is the alarm character
(must NOT be in 1st, 2nd or 5th position)
xxxxx is a 37-character message field.

If no alarm is required, the message format is simply the 2-character Transmit ID followed by a 38-character message field.

Note that the Chirpcomm system does not necessarily require the use of a Transmit ID. Instead, the entire 40-character field can be used for the message. However, using a Transmit ID is the recommended normal procedure so that the operator of a Chirpcomm receiver will have a positive identification of the sender of the message.

4 Chirpcomm Modulation of the Transmitted Chirp Sweep

Chirpcomm modulates the standard linear FMCW Chirp sweep by offsetting the transmit sweep by a negative 250 Hz when the Chirpcomm message bit is a logic 0, and by returning the sweep to it's regular frequency vs. time sweep position when the Chirpcomm bit is a logic 1. Thus, Chirpcomm modulation resembles a 250 Hz frequency shift modulation superimposed on the FMCW linear sweep of the Chirp signal. (The actual Chirpcomm modulation is not FSK, but for simplicity of discussion, it is often referred to as an FSK submodulation of the Chirp sweep.) The Chirpcomm character set is coded into 6-bit characters which are sent synchronously, using the Chirp sweep timing for synchronization; no start/stop bits are used. Thus, the 40-character Chirpcomm message is encoded into 240 bits (6 x 40) which modulate the FMCW Chirp sweep at 55 bits per second.

A Chirp sweep with no Chirpcomm modulation is exactly the same as a Chirpcomm sweep in which all bits of the Chirpcomm ID and message are logic 1.

When programming Chirpcomm for a new ID and message, the Chirpsounder transmitter initializes the message composition buffer by setting all 240 bits to logic 1, the same as for an unmodulated Chirp sweep. As ID and message characters are entered into the buffer, the Chirpsounder transmitter will automatically change the data in the buffer to the 6-bit codes corresponding to each allowed Chirpcomm character. If the Chirpsounder transmitter is programmed to send only the Chirpcomm Transmit ID, only the first two characters (first 12 bits) are modulated. The remaining 38 message characters (228 bits) are sent as a continuous string of logic 1 bits. In the Chirpcomm character set, the "all ones" (111111) code defines the "rubout" character. When only the Transmit ID is sent, the complete Chirpcomm message would contain the 2-character Transmit ID followed by 38 rubouts.

If more than a 2-character ID is entered into the composition buffer, the 38 characters of the message field are first automatically converted by the Chirp transmitter from rubouts to the Chirpcomm "space" or blank character. This occurs when a third character is entered into the composition buffer (i.e. the first character of the 38-character message). When the 38 rubouts are converted to spaces, the continuous string of 228 logic one bits in the message field are converted to a code of 111110 repeated 38 times. In the Chirpcomm character set, the 111110 code defines the space (blank) character.

Thus, the entry of just one message character beyond the 2-character Transmit ID results in continuous modulation of the Chirp sweep, even if the extra character is a space. This occurs because the Chirp transmitter will automatically convert the remaining characters in the message field to a string of space characters. A string of spaces will then produce a 250 Hz frequency shift every 6th bit. The logic 0 in the 6th bit shifts the sweep for approximately 18.2 milliseconds (1/55). The five consecutive logic 1 bits in the space character return the sweep to the standard sweep format for approximately 90.9 ms. This cycle repeats for every space character in the message. By comparison, if only a Transmit ID is sent, the sweep is modulated for 218 ms (12 bits) followed by approximately 4.15 seconds (228 bits) of unmodulated sweep (38 rubout characters).

Chirpcomm modulation of the standard FMCW linear sweep causes a slight degradation in the quality of the received Chirpsounder record. The extent of the degradation is determined by the amount of modulation, i.e. by the number of logic 0 bits versus the number of logic 1 bits in the 240 bit Chirpcomm message. On average, only 2.5% (6 out of 240) of the bits are logic 0 when only the Transmit ID is sent. In this case, the degradation of the Chirpsounder record is virtually undetectable. For a very short message of less than 10 alphanumeric characters (with the remaining characters all "space" or blank), the degradation is minor, producing some minor spurious responses in the upper half of the CRT graphic record due to modulation sidebands. In addition, the Chirpsounder receiver will show an approximate 3 dB reduction in apparent received signal to noise ratio of the Chirp signal. If all 40 characters are programmed with printed text characters, the degradation will be more noticeable with additional spurious responses in the Chirp graphic record and an approximate 6 dB reduction in apparent received signal to noise ratio.

In general, Chirpcomm messages should be kept as short as possible if the Chirpsounder receiver is also being used for frequency management purposes. If the receiver is not being used for frequency management, there is no need to limit the message length. If Chirpcomm is used only to identify the Chirpsounder transmitter, make certain that the Transmit ID is entered only in the first 2 characters of the 40-character field. Check also that only "rubouts" (no printable characters and no space/blank characters) are in the 38-character message field.

The ABORT MSG or CLEAR MSG function can be used to insure that all 38 characters of the message field are filled with rubouts. The ABORT MSG / CLEAR MSG function terminates the Chirpcomm modulation of the 38-character message field by replacing all 38 characters with rubout characters. The Transmit ID (if any) will continue sending for the remainder of a sweep in progress, and on successive sweeps if Chirpcomm was programmed for Continuous (SEND CONT. or SEND NOW) operation.

If no Chirpcomm modulation of any kind is wanted (i.e. the entire sweep is to be a pure FMCW Chirp sweep with no Chirpcomm modulation whatsoever), then all 40 Chirpcomm characters must be rubouts.

5 Remote Programming the TCS-5 to Send Chirpcomm Messages

The remote controller (computer) can read from or write to the "current," "waiting-to-send," or "store" Chirpcomm message buffers in the TCS-5 using the commands defined in the TCS-5 Interface Control Document (K11078). The following rules must be observed with regard to this interface:

a. The ASCII colon character (:) is substituted for the Chirpcomm "rubout" character in the remote interface.

b. If a Transmit ID has not been previously programmed (either locally or manually), the TCS-5 will default to an ID of "rubout rubout" which will be transferred to the remote computer as "::" (colon colon) if the READ CCOM MESSAGE command is used.

c. When remotely programming a NEW MESSAGE or a NEW ID & MESSAGE, all characters must be valid Chirpcomm characters listed in Table 1. Note that the TCS-5 will accept all printable ASCII characters via the remote interface. However, any ASCII character that is not a valid Chirpcomm character is automatically converted by the TCS-5 to a rubout character for Chirpcomm transmission. If the remote controller queries the TCS-5 using the READ CCOM MESSAGE command after programming a message containing invalid characters, the TCS-5 will respond with the ASCII characters as programmed. The TCS-5 stores the invalid characters as they are programmed by the remote controller, but substitutes rubouts during the Chirpcomm modulation.

d. ASCII data sent to the TCS-5 with HEX values less than 20H or greater than 7EH will cause the TCS-5 to return a NOCOMP.

e. ASCII data read from the TCS-5 Chirpcomm buffer memories with HEX values less than 20H or greater than 7EH will be returned to the remote controller as tilde (~).

f. To program a new Chirpcomm Transmit ID and a new message, use the NEW ID & MESSAGE command and transfer the 40-character MSG field as follows:

TTxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

where:
TT = transmit ID (must be alphanumeric characters)
xxxx = 38 valid Chirpcomm characters
(no colons or rubouts and unused characters must be filled with "space" characters)

g. To program a new Chirpcomm message only, (without changing the ID) use the NEW MESSAGE command and transfer the 38-character MSG field containing 38 valid Chirpcomm characters (no colons or rubouts). All unused characters must be filled with the "space" (blank) characters.

h. To program a new Chirpcomm Transmit ID only, use the NEW ID & MESSAGE command and transfer the 40-character MSG field as follows:

TT::::::::::::::::::::::::::::::::::::::

where:
TT = transmit ID (must be alphanumeric characters)
:::: = 38 ASCII colon characters

Another way to program the TCS-5 to send only a Chirpcomm Transmit ID is to load the TCS-5 with the desired ID followed by any 38-character message, followed immediately by the ABORT or CLEAR message command.

i. To program the TCS-5 to send a pure FMCW Chirp sweep with no Chirpcomm modulation whatsoever (i.e. to program all 40 characters to rubouts), use the NEW ID & MESSAGE command and program the 40-character MSG field with 40 ASCII colons.

j. The remote computer should not send the ASCII rubout character (7F Hex) to the TCS-5 for any Chirpcomm ID or message character.

k. Note that the Transmit ID stored in the non-volatile STORE MSG memory of the TCS-5 is always the most recent ID that was used to send a Chirpcomm message. Therefore, the stored Transmit ID is not necessarily the one that was originally programmed to the STORE MSG buffer. When a new ID is entered, (either locally or remotely) with the NEW ID & MSG command, the new ID automatically replaces the old ID stored in the STORE MSG buffer. Note that the automatic replacement of the Transmit ID affects the ID only, not the 38-character message stored in the STORE MSG buffer.

6 Remote Interface to RCS-5A/B Chirpsounder Receiver

The remote controller (computer) can read received Chirpcomm messages through I/O port 1 of the RCS-5A/B. In addition, the remote computer can program the RCS-5A/B Chirpcomm Receive ID, which identifies the receiver and allows Chirpcomm messages to initiate selective calling alarms. Use of this remote interface is defined in the RCS-5A/B Interace Control Document (K11074). The following rules must be observed with regard to this interface:

a. The ASCII colon character (:) is substituted for the Chirpcomm "rubout" character in the remote interface.

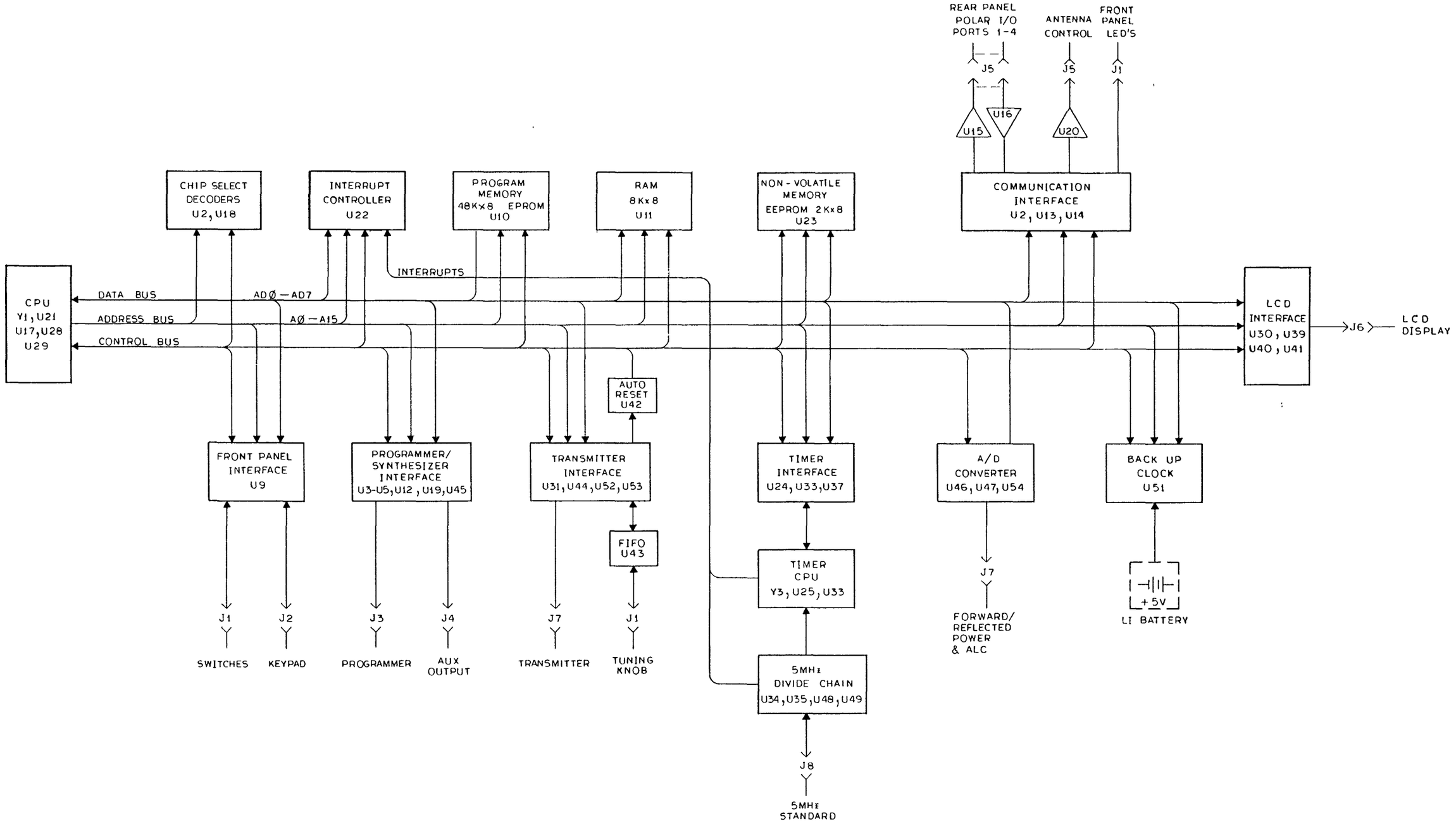
b. If a Receive ID has not been previously programmed (either locally or manually), the RCS-5A/B will default to an ID of "::" (colon colon).

c. If more than 7 rubout characters are detected by the RCS-5 in the Chirpcomm message (indicating an unmodulated sweep), the RCS-5 will output a lower case ASCII status message "no message" in the 38-character Chirpcomm message field.

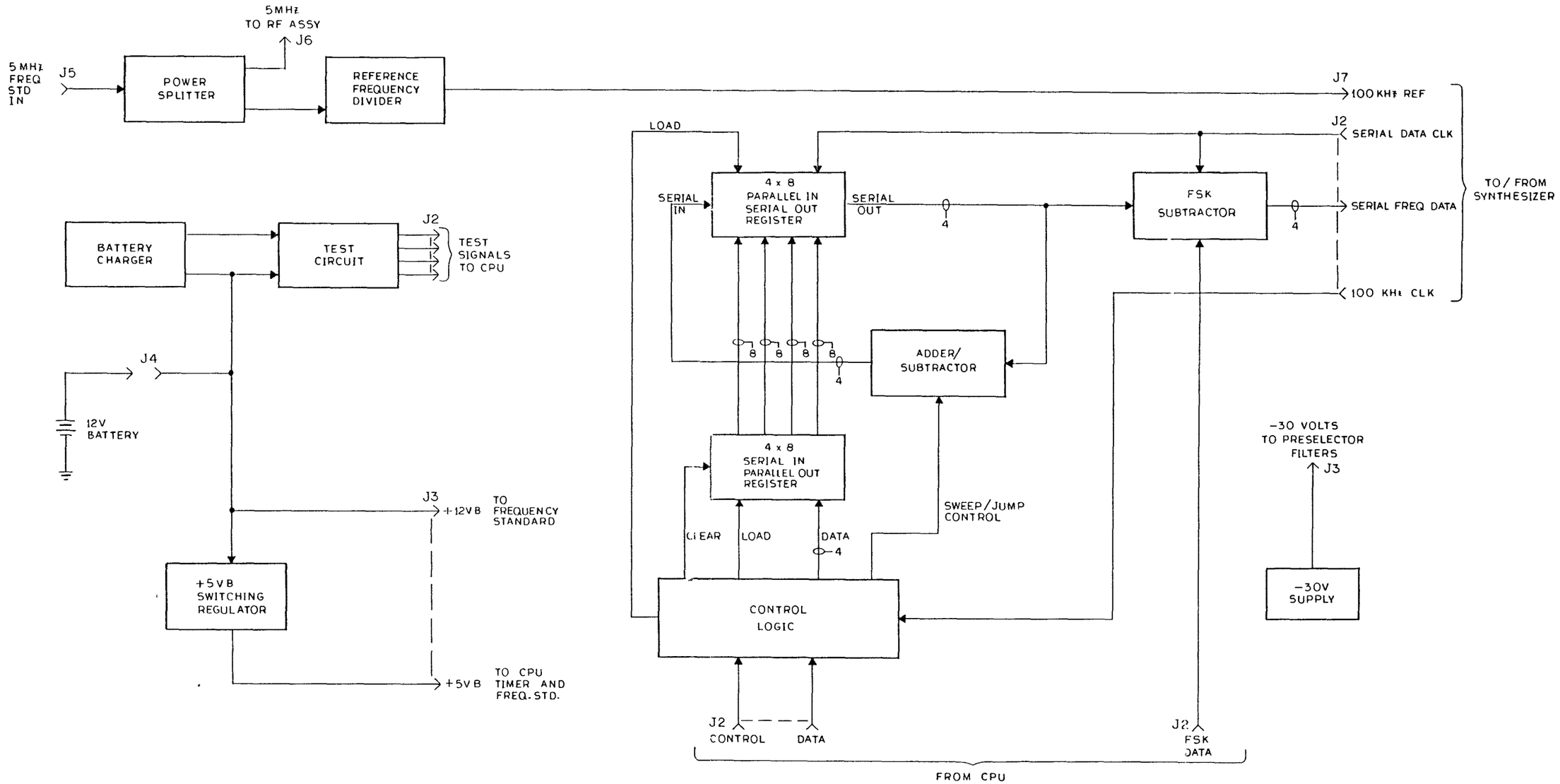
d. Received Chirpcomm data that is corrupted by noise or poor propagation and decoded by the RCS-5 into a non valid Chirpcomm character will be converted to the ASCII asterisk ("*") character or characters. If more than 3 non valid (asterisk) characters are detected by the RCS-5, the RCS-5 will output the "no message" status message.

TABLE 1
Chirpcomm Character Set

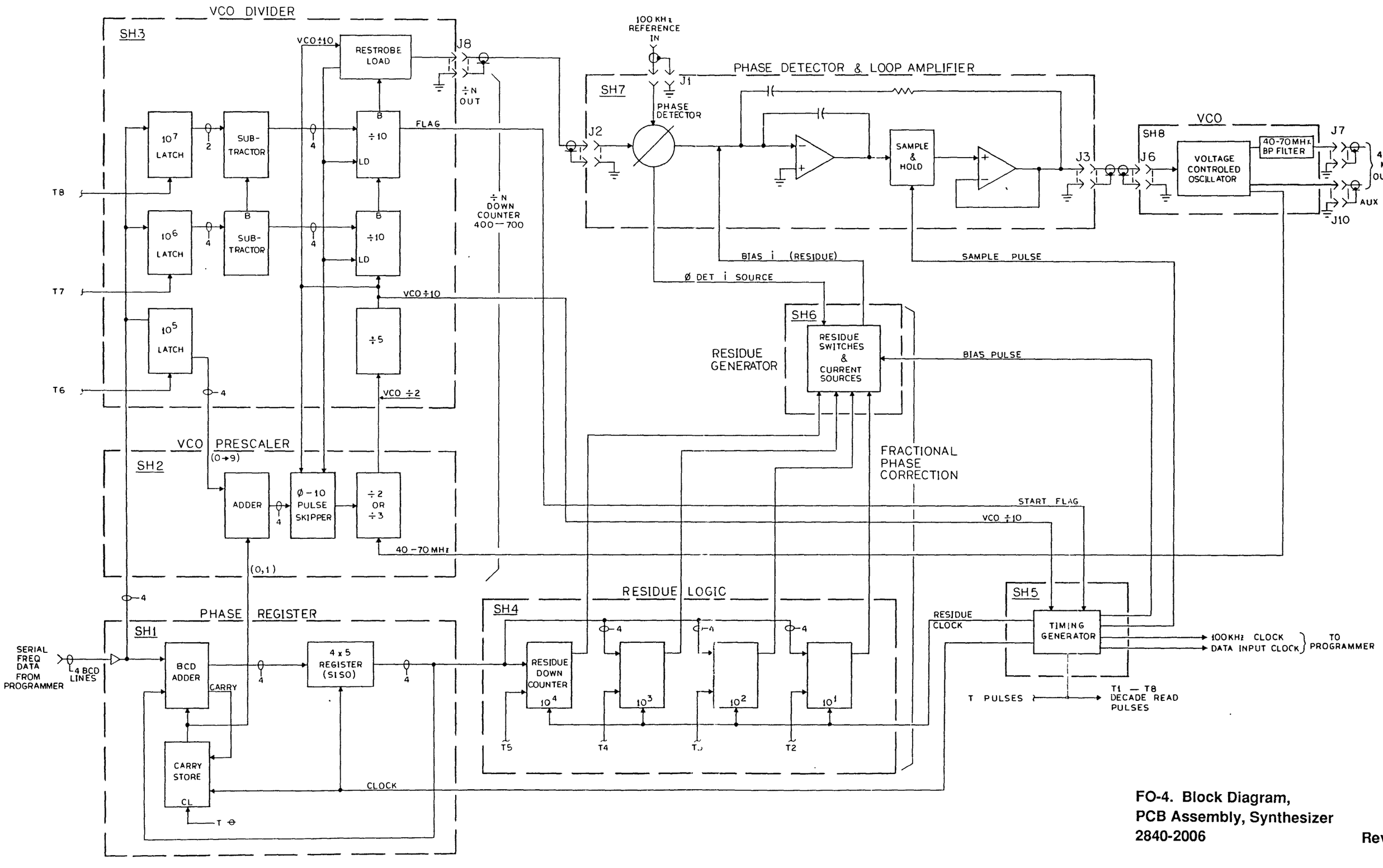
Chirpcomm Characters	ASCII (Hex code)
A	41
B	42
C	43
D	44
E	45
F	46
G	47
H	48
I	49
J	4A
K	4B
L	4C
M	4D
N	4E
O	4F
P	50
Q	51
R	52
S	53
T	54
U	55
V	56
W	57
X	58
Y	59
Z	5A
0	30
1	31
2	32
3	33
4	34
5	35
6	36
7	37
8	38
9	39
<	3C
>	3E
?	3F
space	20
!	21
'	27
+	2B
-	2D
.	2E
/	2F
^ (alarm)	5E
:	7F



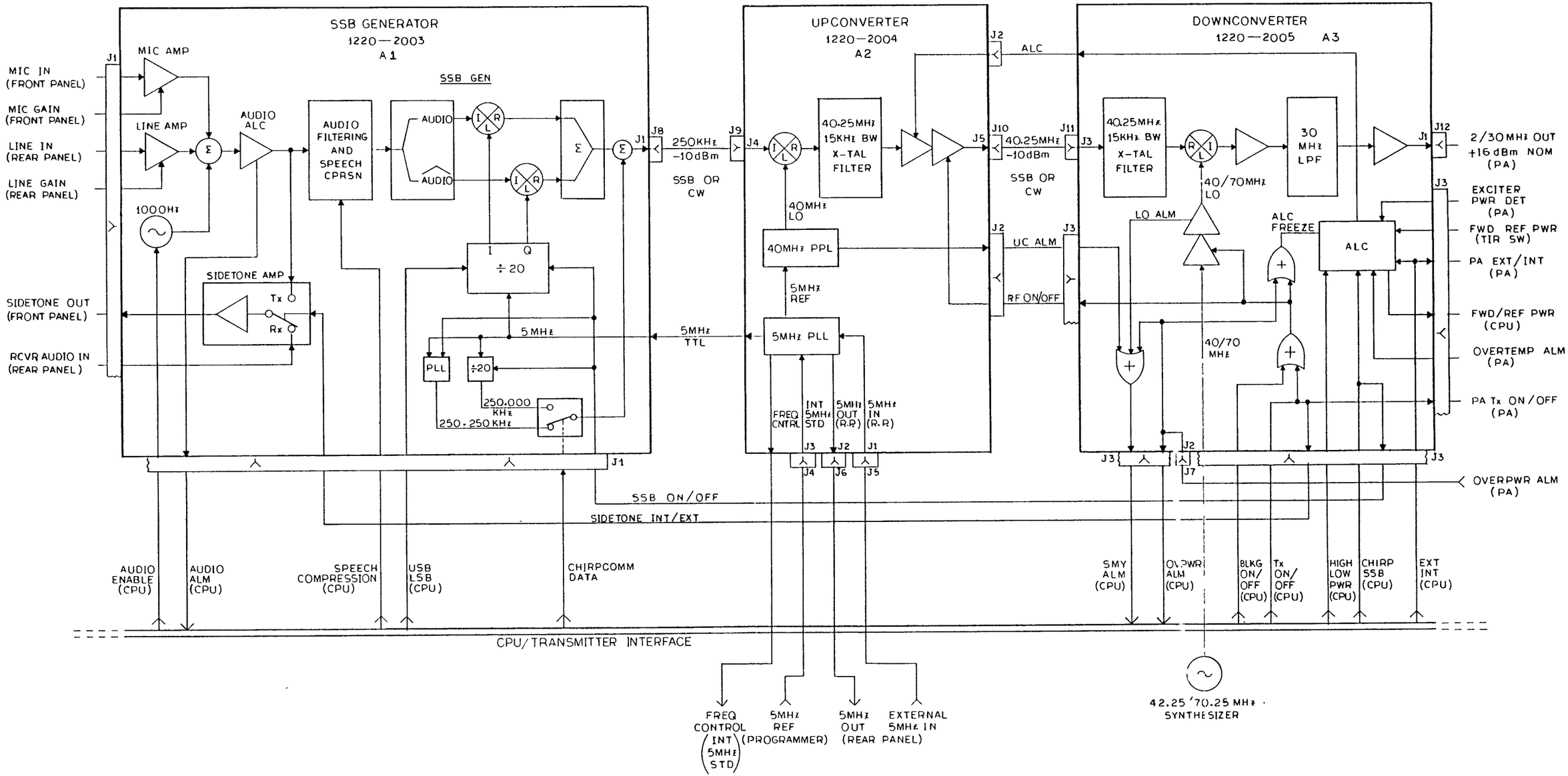
FO-2. Block Diagram, PCB Assembly, CPU 1220-2001 **Rev A**



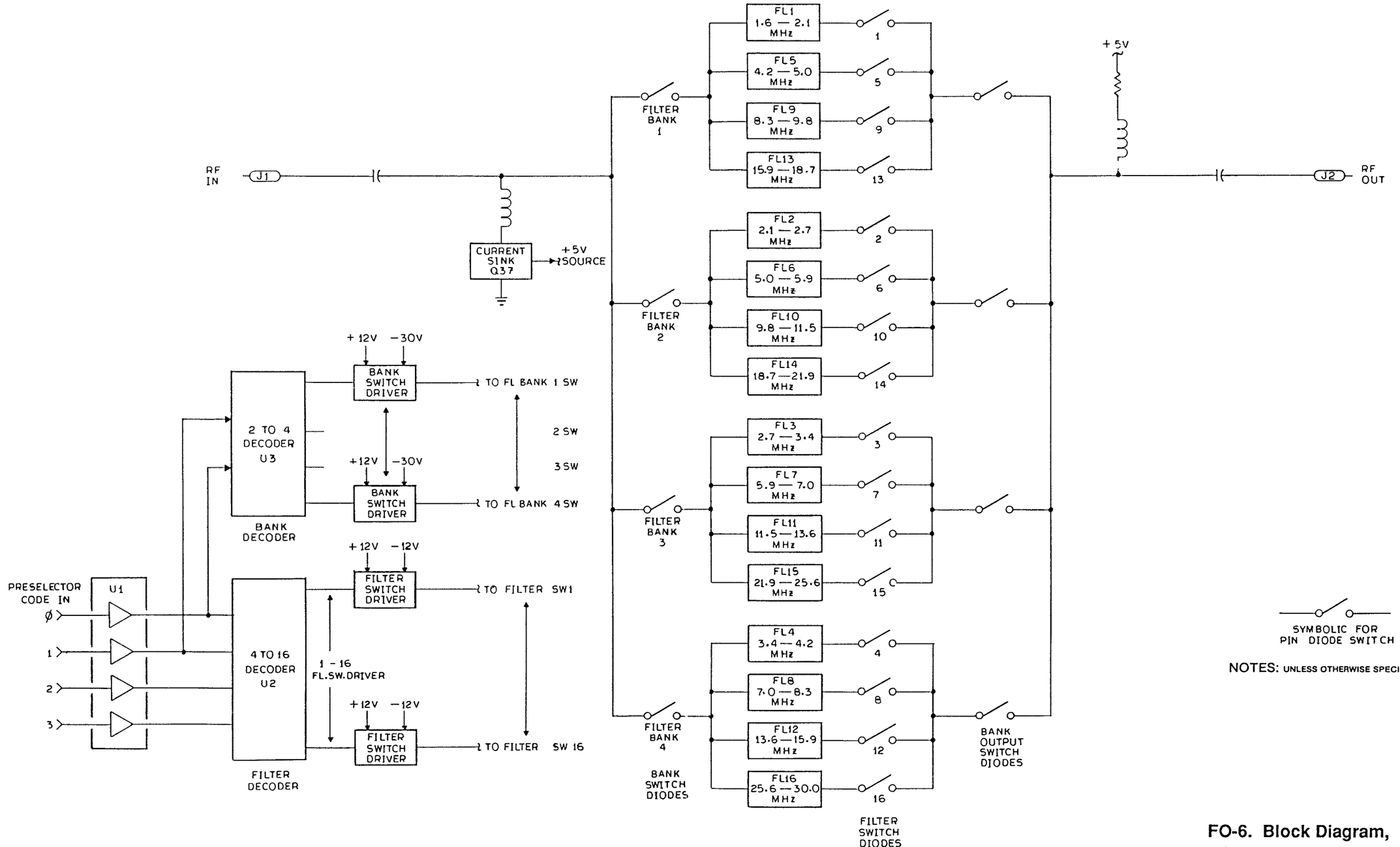
FO-3. Block Diagram,
PCB Assembly, Programmer
1220-2002 **Rev A**



FO-4. Block Diagram, PCB Assembly, Synthesizer 2840-2006 **Rev A**



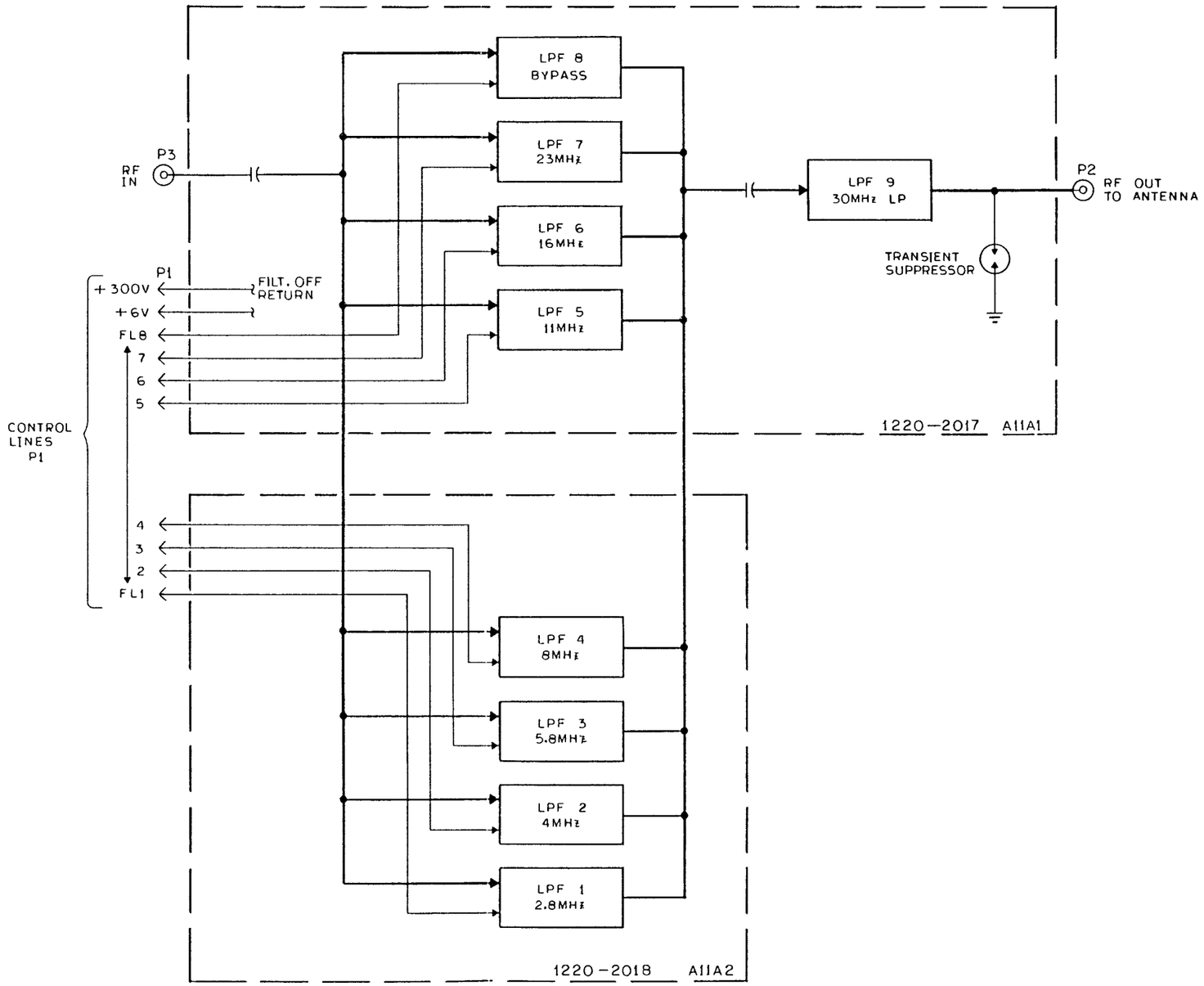
FO-5. Block Diagram, Downconverter/ Audio Modulator Assembly 1220-1004 **Rev B**



SYMBOLIC FOR PIN DIODE SWITCH

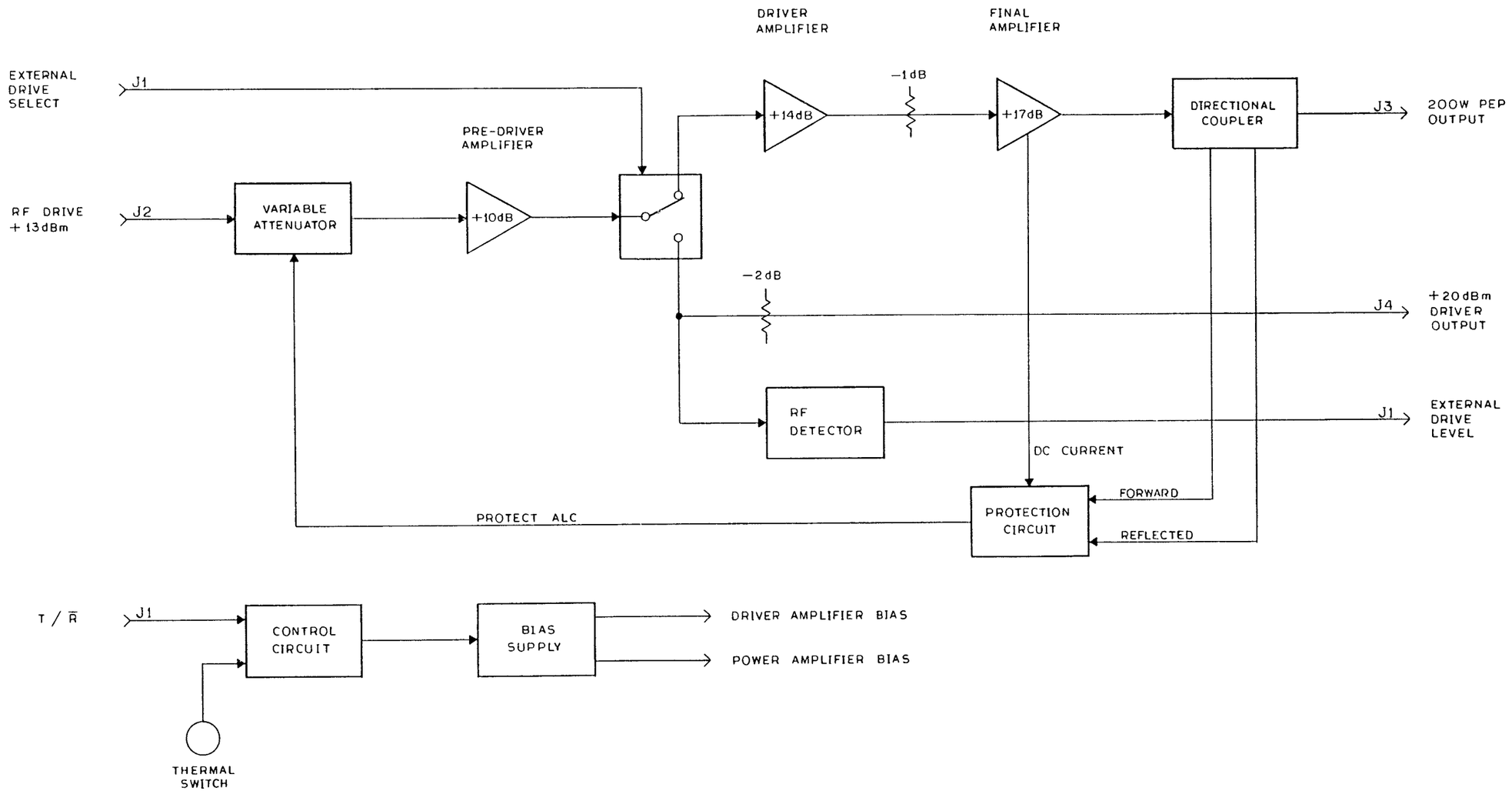
NOTES: UNLESS OTHERWISE SPECIFIED.

FO-6. Block Diagram, PCB Assembly, RF Preselector 1220-2014 Rev A

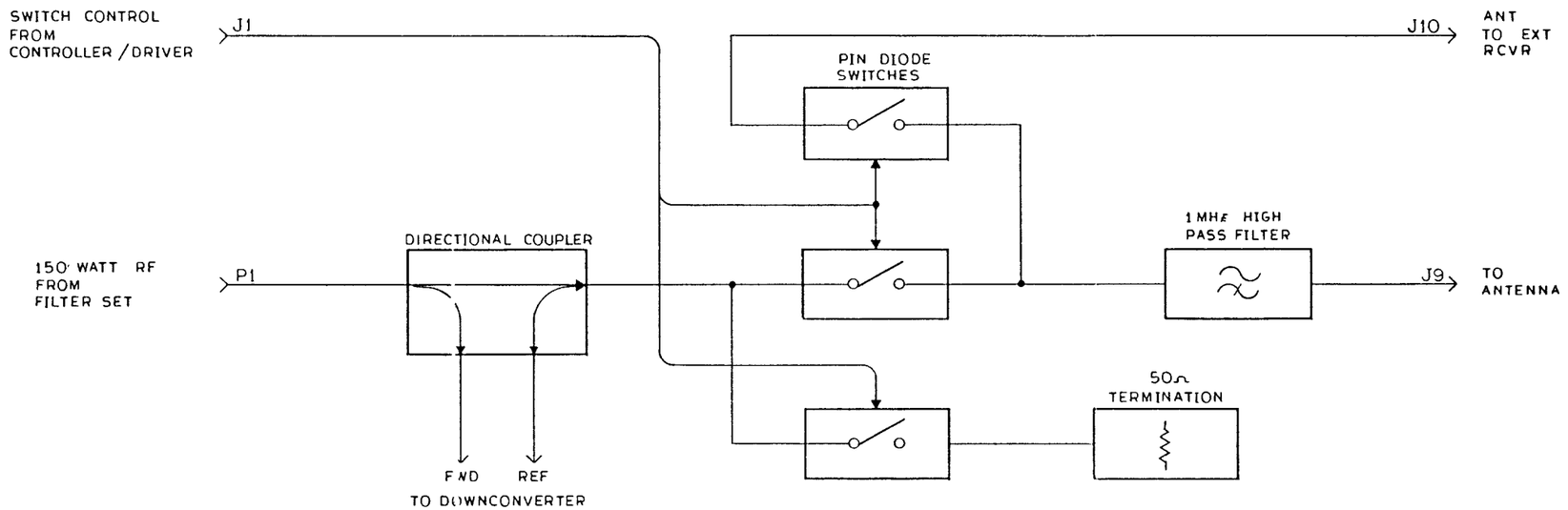


A11 POST SELECTOR ASSY

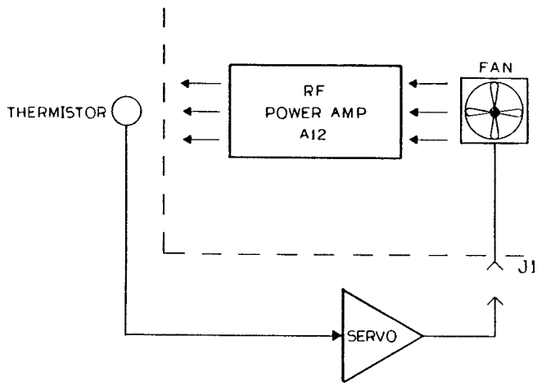
FO-7. Block Diagram, Postselector Assembly 1220-1104 **Rev A**



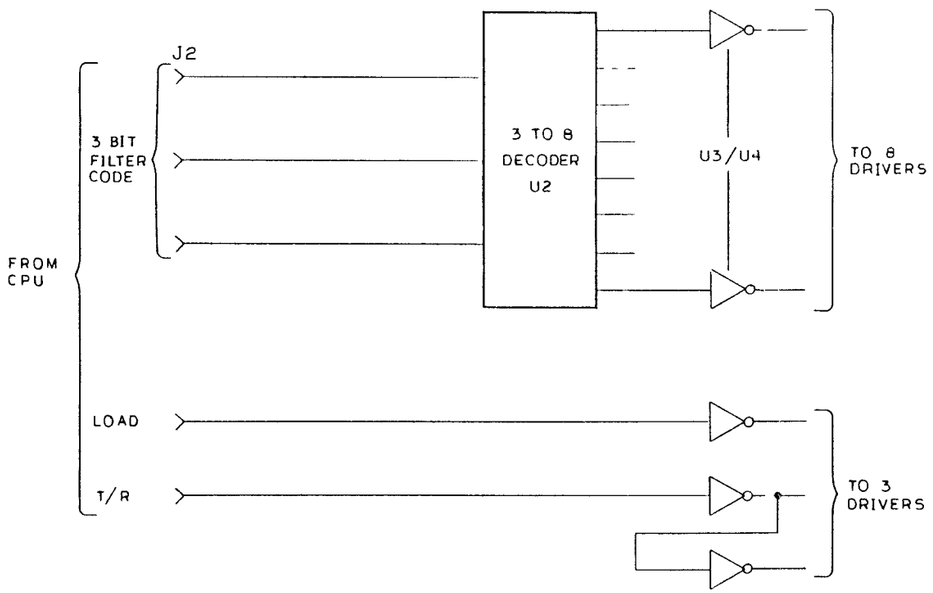
FO-8. Block Diagram,
RF Power Amplifier Assembly
1220-1105 **Rev A**

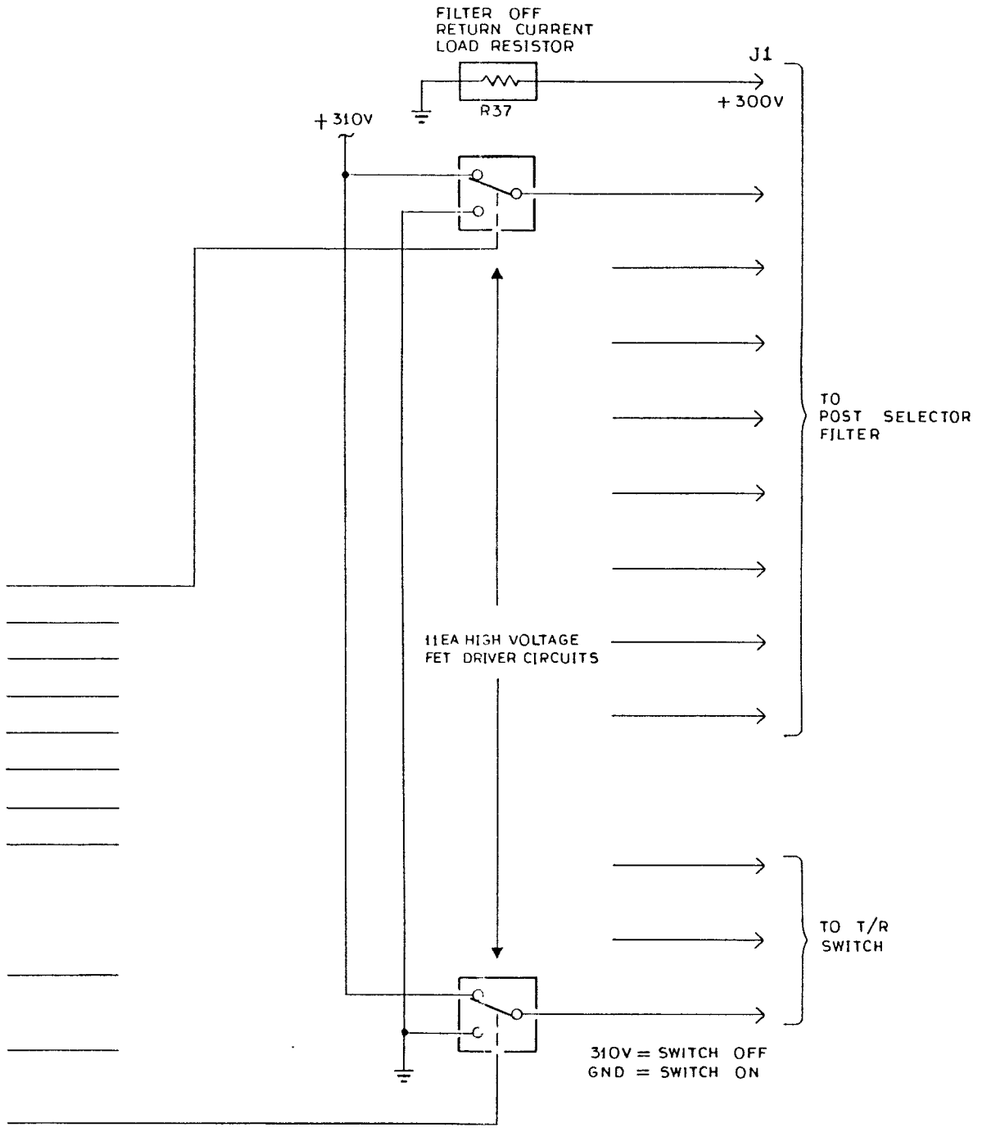


FO-9. Block Diagram,
T/R Switch Assembly
1220-1106 **Rev A**

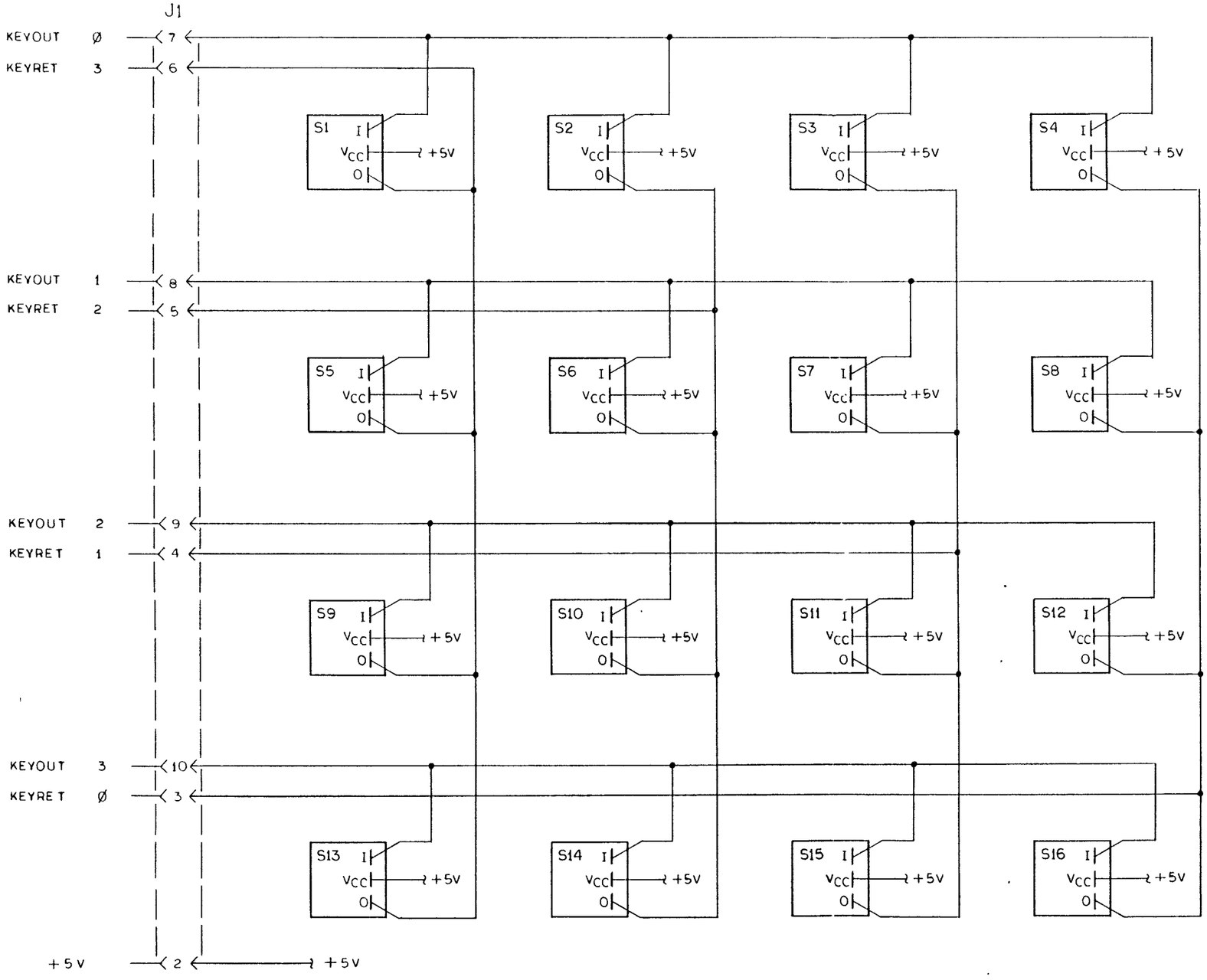


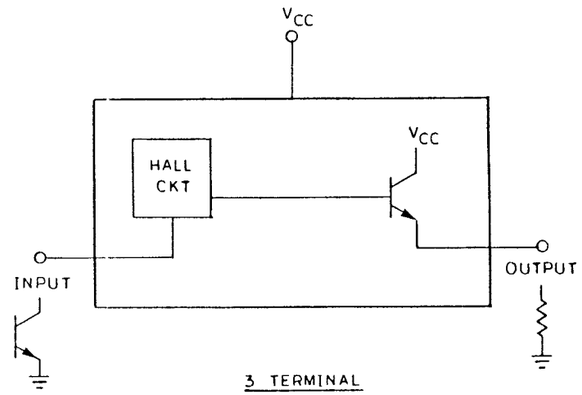
FAN CONTROLLER



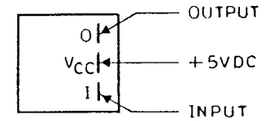


FO-10. Block Diagram,
PCB Assembly, Controller/Driver
1220-2010 **Rev A**





3 TERMINAL

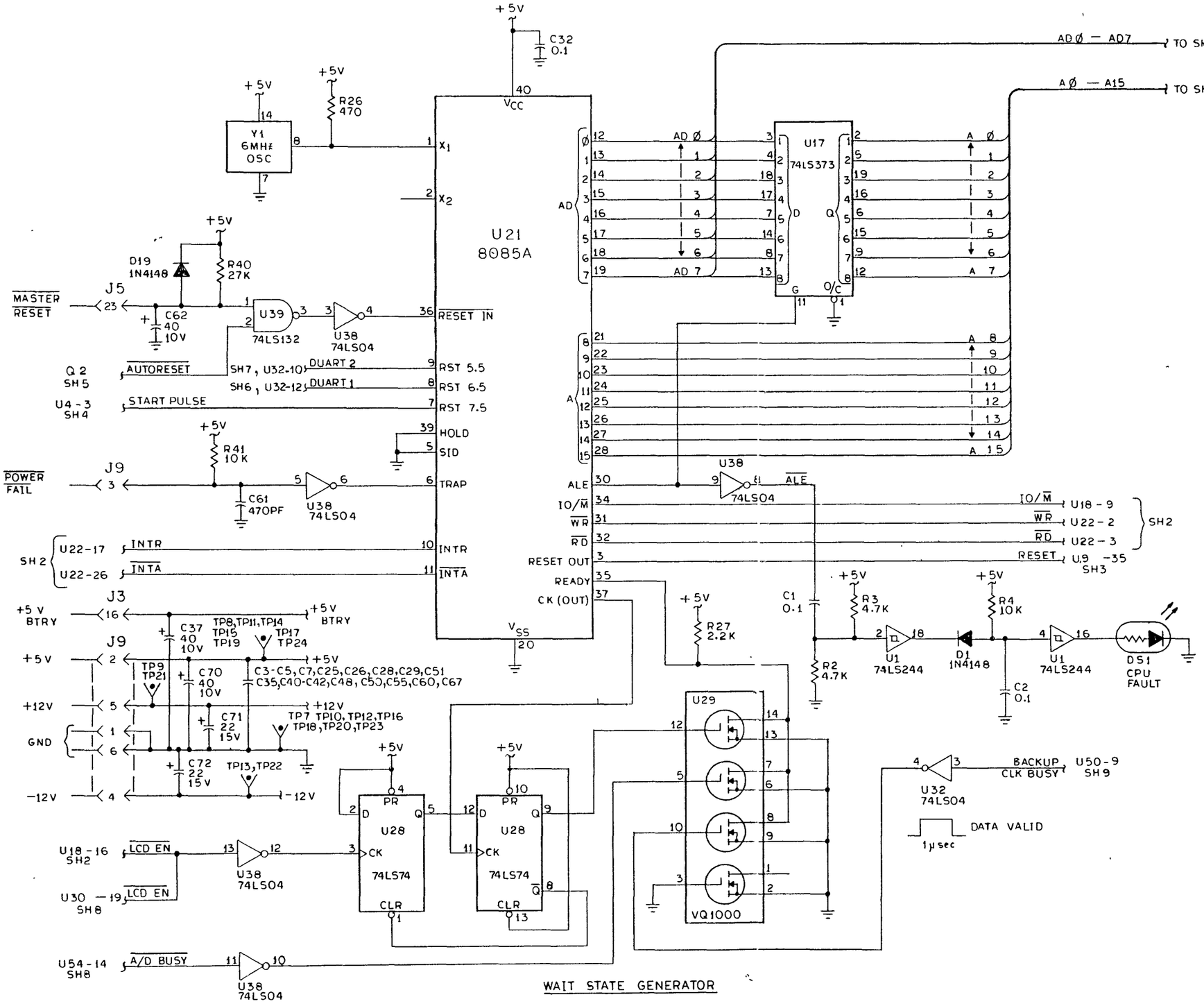


BOTTOM VIEW

KEYPAD
FRONT VIEW

7	8	9	NEXT
4	5	6	MHz HRS
1	2	3	MIN
0	•	CLR	SEC ENTER

FO-11. Schematic Diagram, Keypad Assembly 1220-1010 **Rev B**



POWER DISTRIBUTION.		
DEVICE	+5V	GND
74LS00	14	7
74LS02	14	7
74LS04	14	7
74LS74	14	7
74LS244	20	10
74LS245	20	10
74LS373	20	10
74LS390	16	8
96L02	16	8
CD4049	1	8
CD4050	1	8
CD4536	16	8
CD40109	1	8
74LS132	14	7

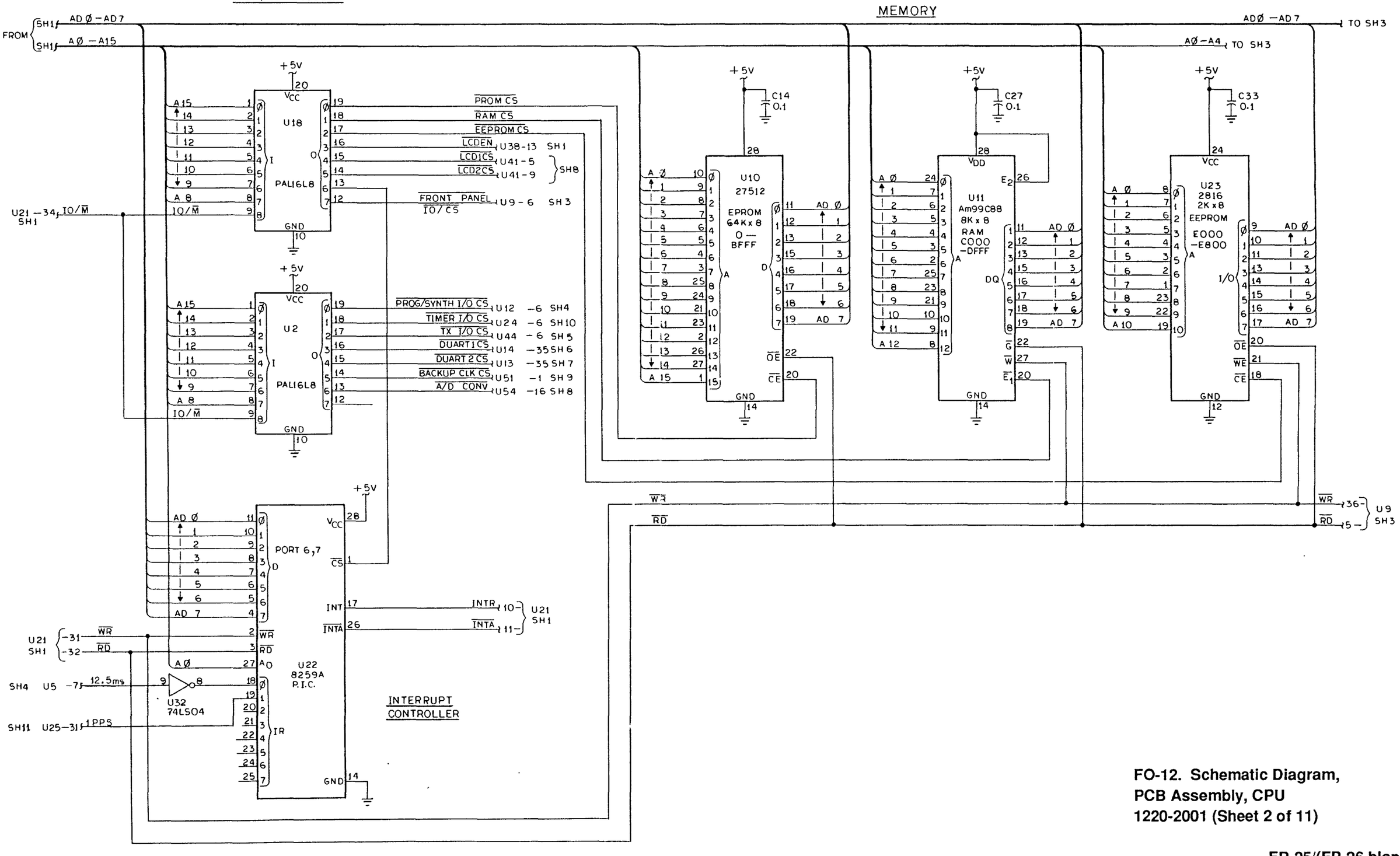
[4] RESISTOR, SIP 8 PIN (ALLEN BRADLEY) 1088103 10.0K 2, LOW PROFILE.

3. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

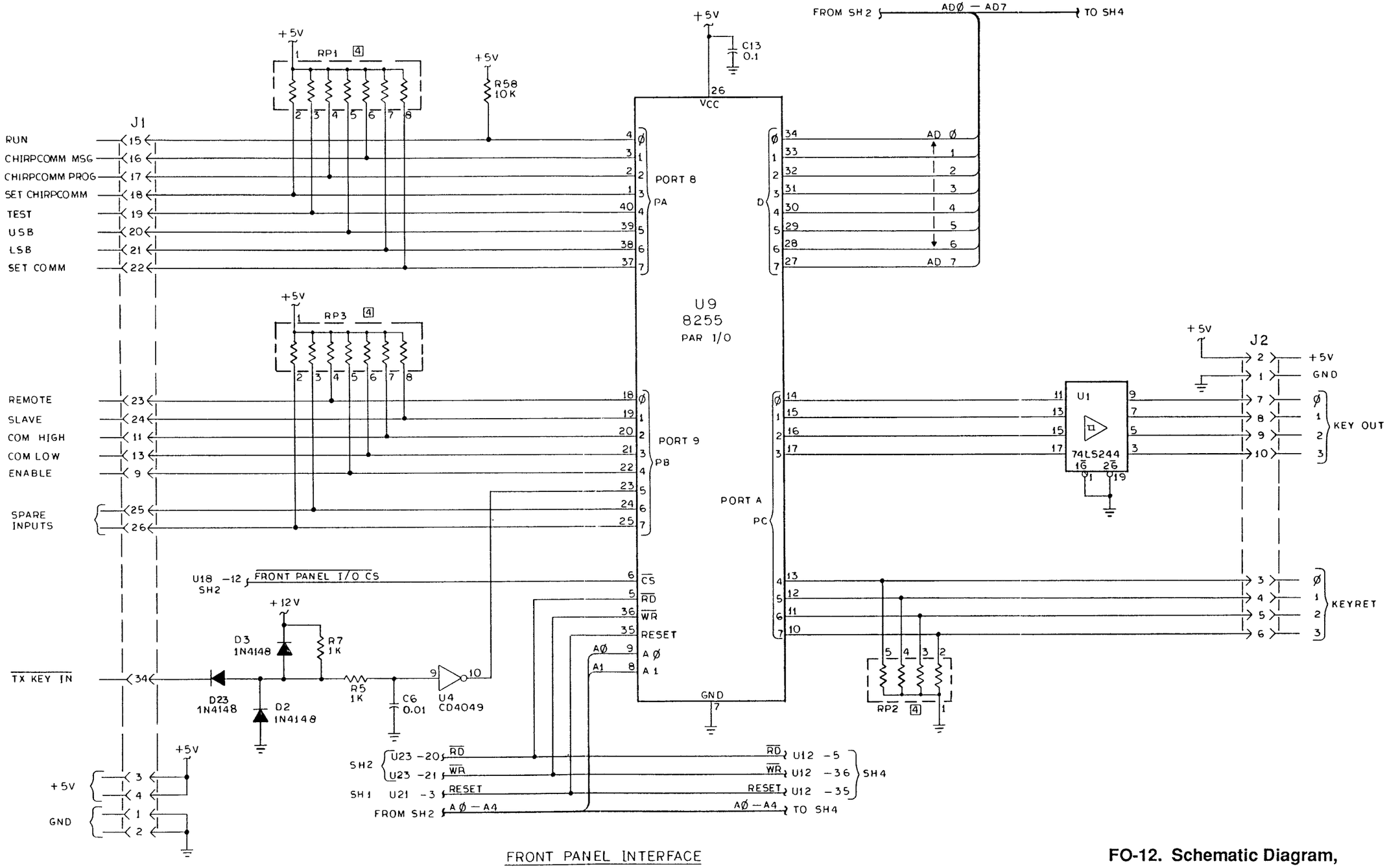
NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.												
BT1	C78	D24	DS1	E14	F1	J9	Q2	R68	TP25	U55	VR2	Y4
REF. DESIGNATION NOT USED.												
	C65	D20		E1,E2				R37 R45	TP5 TP6			

FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 1 of 11) Rev T

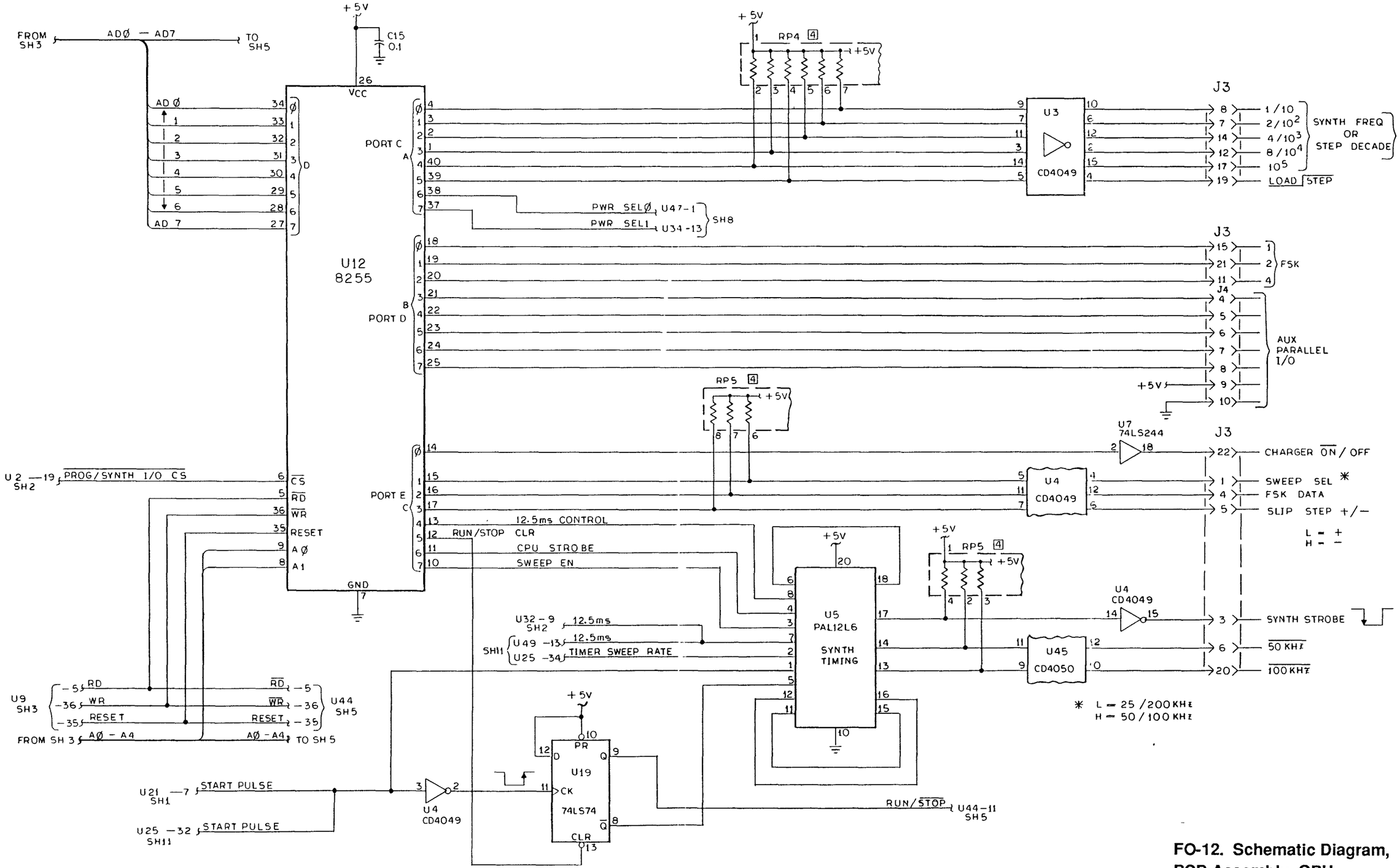


FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 2 of 11)



FRONT PANEL INTERFACE

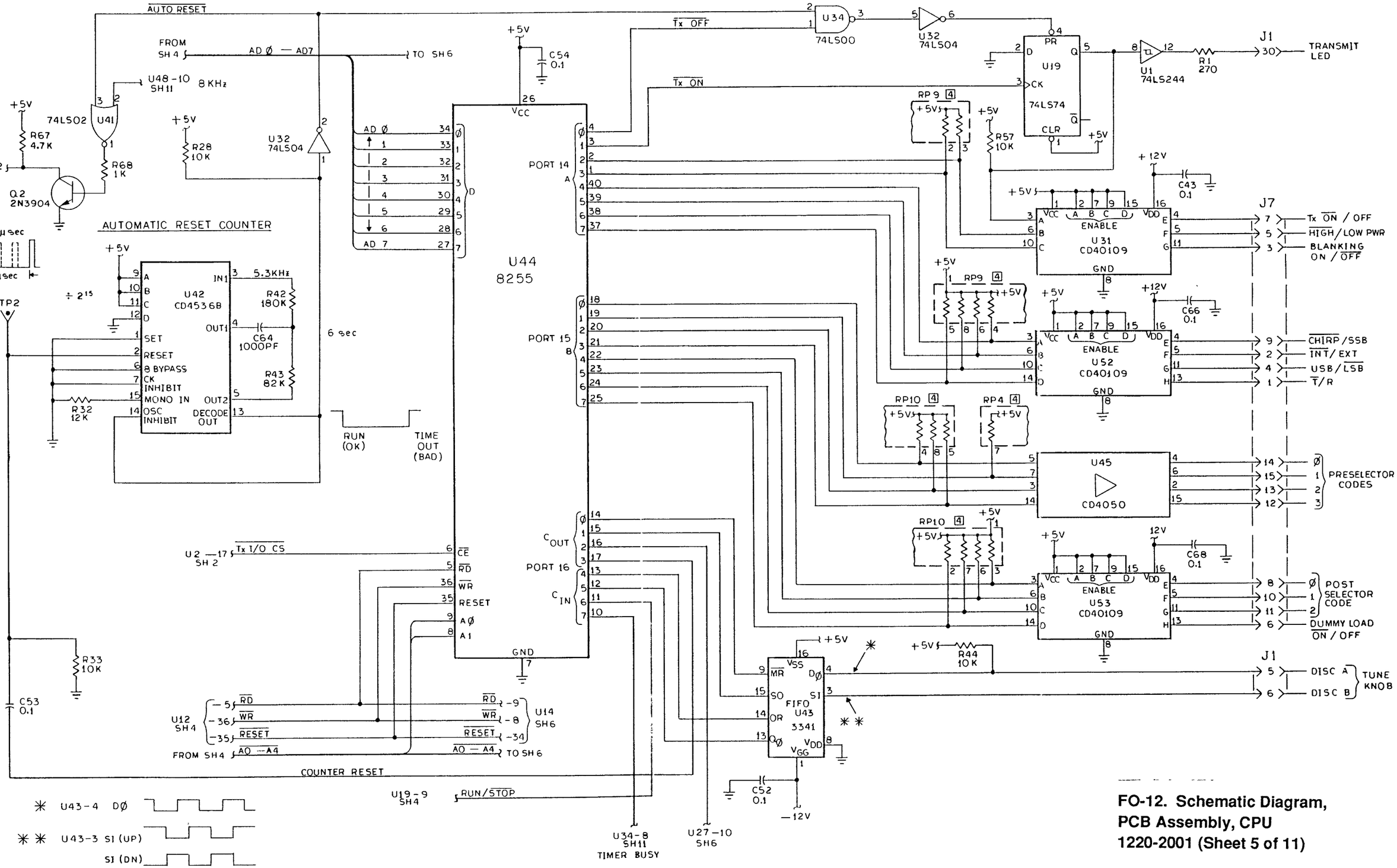
FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 3 of 11)



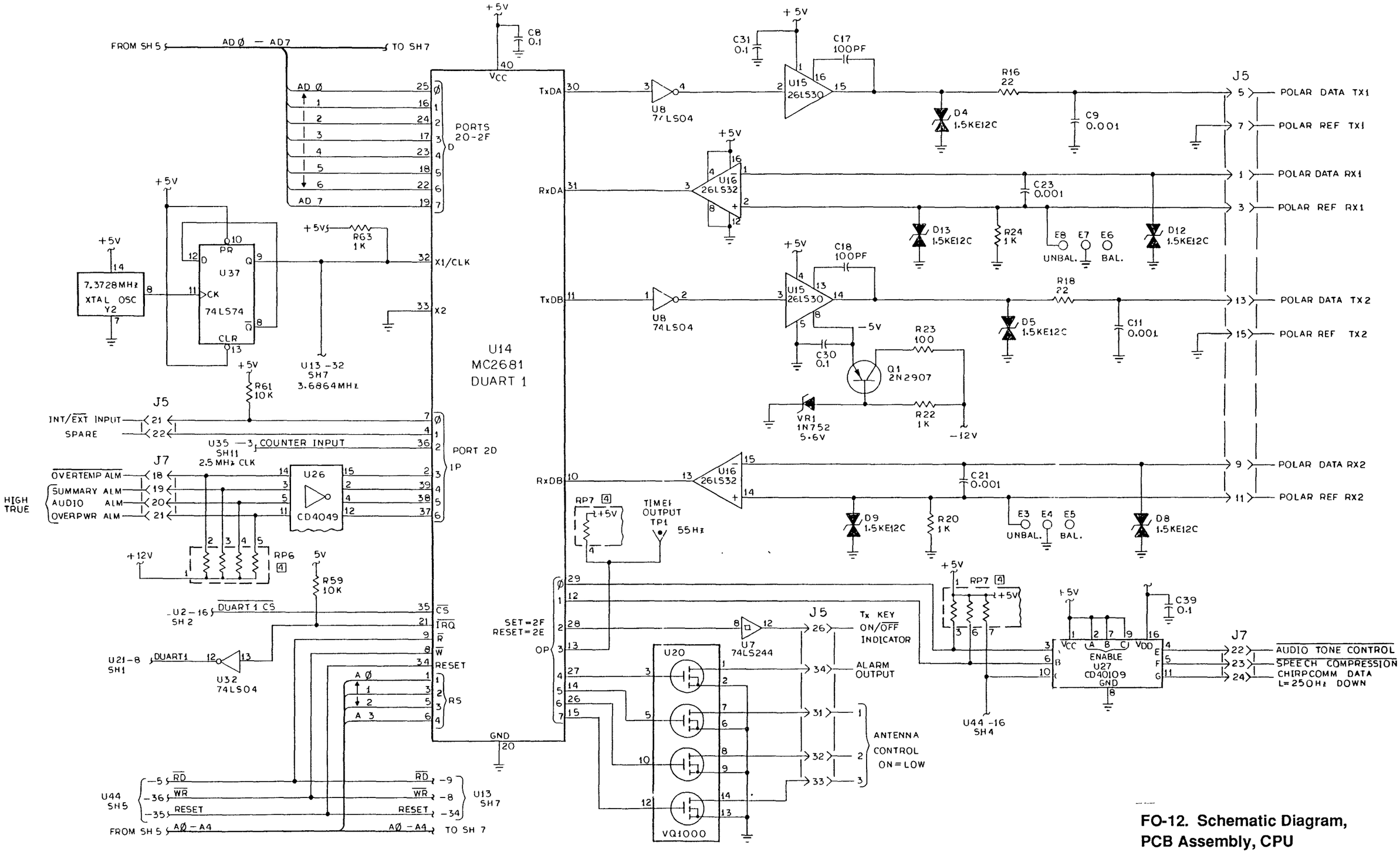
PROG/SYNTH I/O

FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 4 of 11)

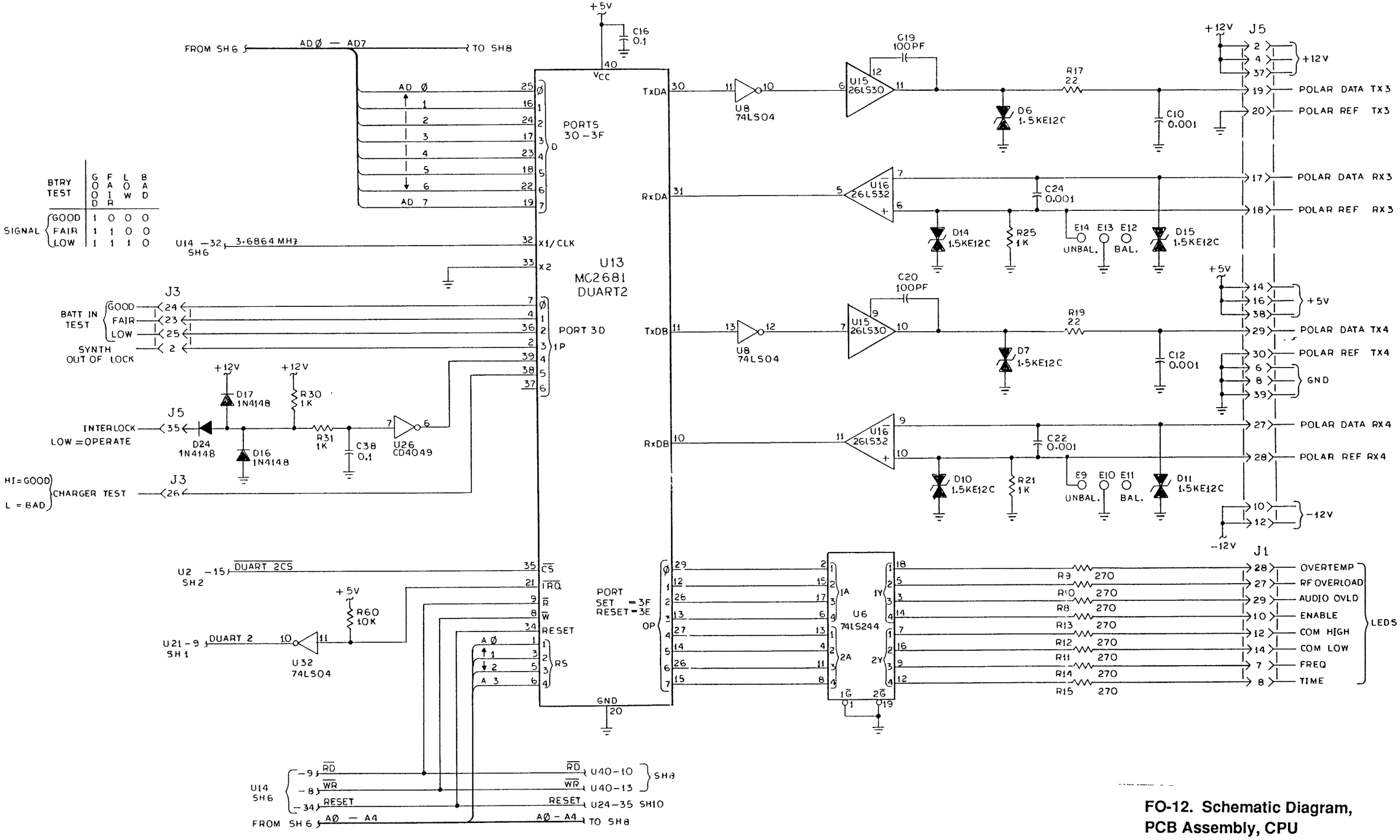
TRANSMIT I/O



FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 5 of 11)



FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 6 of 11)



FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 7 of 11)

NON INVERTING BUFFER

A/D CONVERTER

FROM SH 7 AD Ø — AD7

AD Ø — AD7 TO SH9

± 3V FORWARD PWR

± 3V REFLECTED PWR

± 5V ALC VOLTAGE

J7

R53 4640, 1%

R50 10K, 1%

R51 100K

R34 4640, 1%

R36 10K, 1%

R52 100K

U46 µA774

U12 SH4

PWR SEL Ø *

PWR SEL 1 *

U34 74LS00

R62 10K

C78 0.1

U47 DG201

+12V R49 47

C56 0.1

C58 470PF

C57 0.1

R35 47

−12V

U2 SH2 −13 A/D CONV CS

+12V R48 1.0K 1%

R64 2.0K CW

VR2 1N4582 6.4V

TP25 +5.00V

+5V R46 120K

C69 100PF

TP3

R47 10K

U54 AD7574

BOFS

AIN

AGND

PORT Ø

DR

CS

RD

BUSY

VREF

DGND

AD Ø

AD 7

A/D BUSY U38-11 SH1

−5V

R66 4.64K 1%

R65 4.64K 1%

U46 774

RD U51 −2 SH9

ANALOG SWITCH INPUT SELECTION TABLE

* PWR SEL SIGNALS		
Ø	1	CONDITION
Ø	Ø	FWD
Ø	1	FWD
1	Ø	ALC
1	1	RFLT

LCD BI-DIRECTIONAL DATA BUFFER

U30 74LS245

AD Ø

AD 7

G DIR

LCD EN

U38-13 SH1

U13 −9 RD SH7

LCD INTERFACE

PORTS 2-5

J6

LCD DATA

GND

R/W

LCD E1

LCD E2

RS

+5V

U40 74LS74 PR D CK Q CLR

150 n sec DELAY

U39 74LS132

R39 1K

C63 150PF

U38 74LS04

U41 74LS02

U13 −8 WR

WR U51 −3 SH9

U18 SH2 −15 LCD1 CS

−14 LCD2 CS

U1 74LS244

AØ

FROM SH7 AØ — A4

AØ — A4 TO SH9

J1

33

VIEWING ANGLE ADJUST

J6

4

+5V

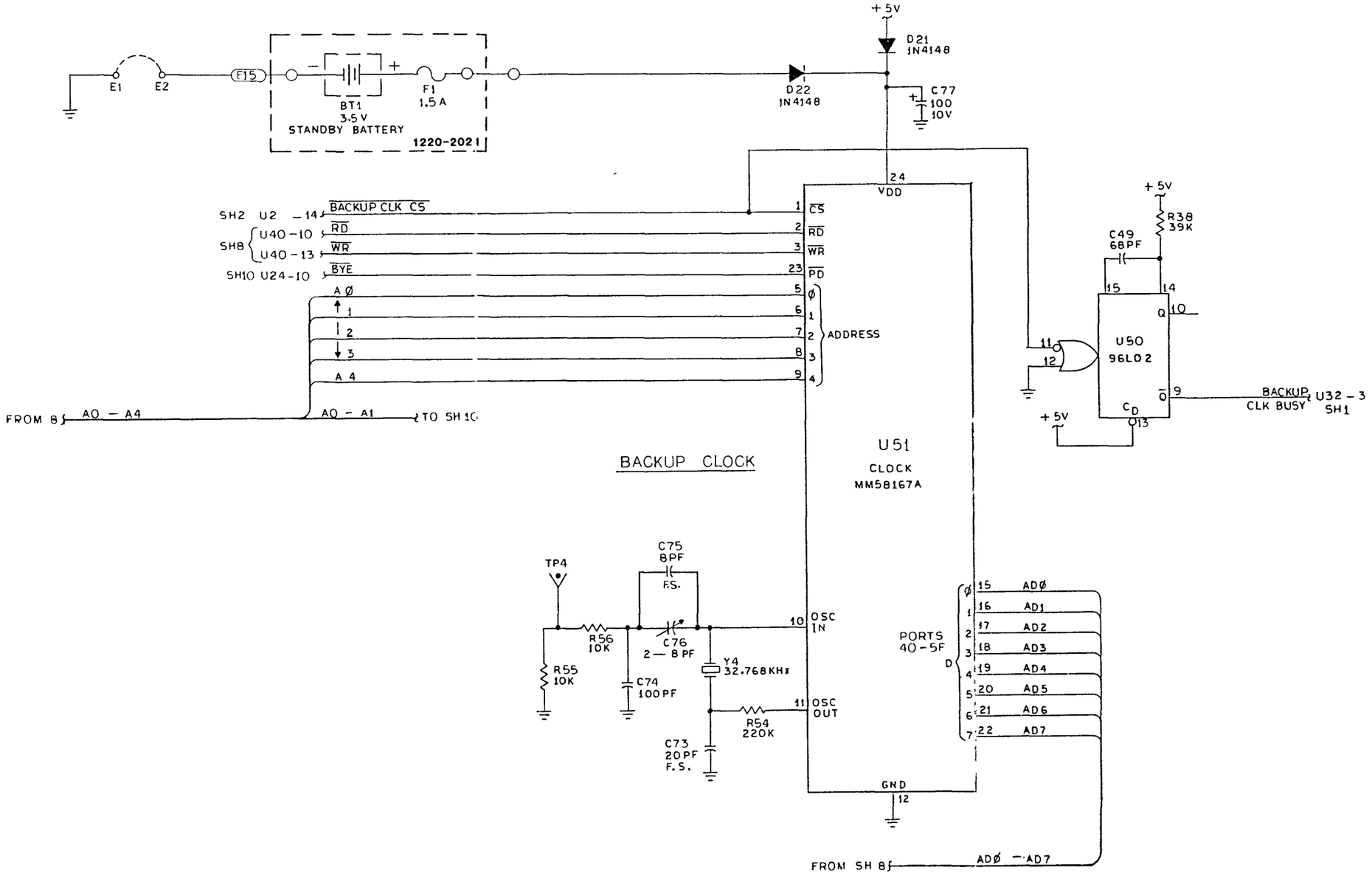
J6

22

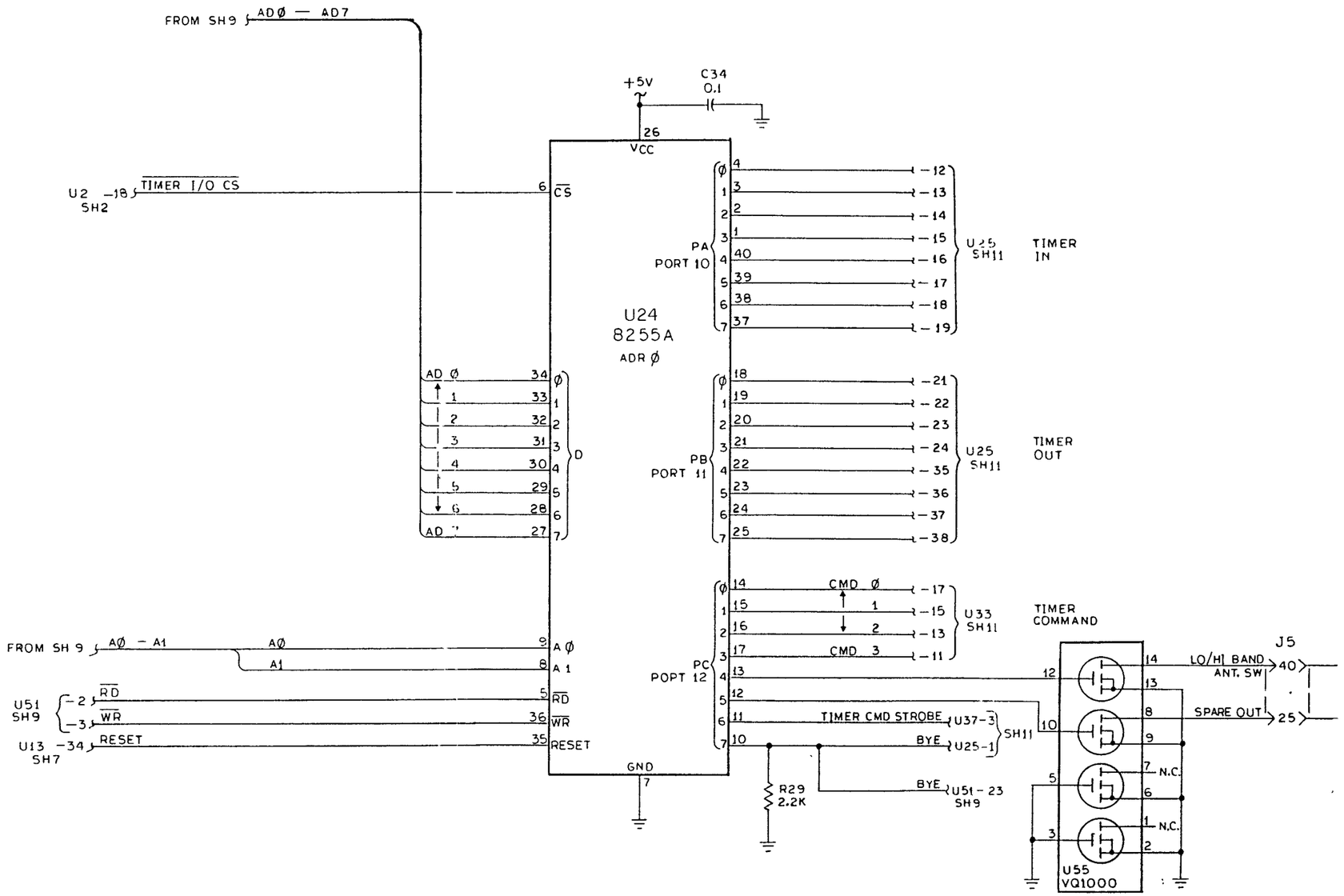
24

+5V

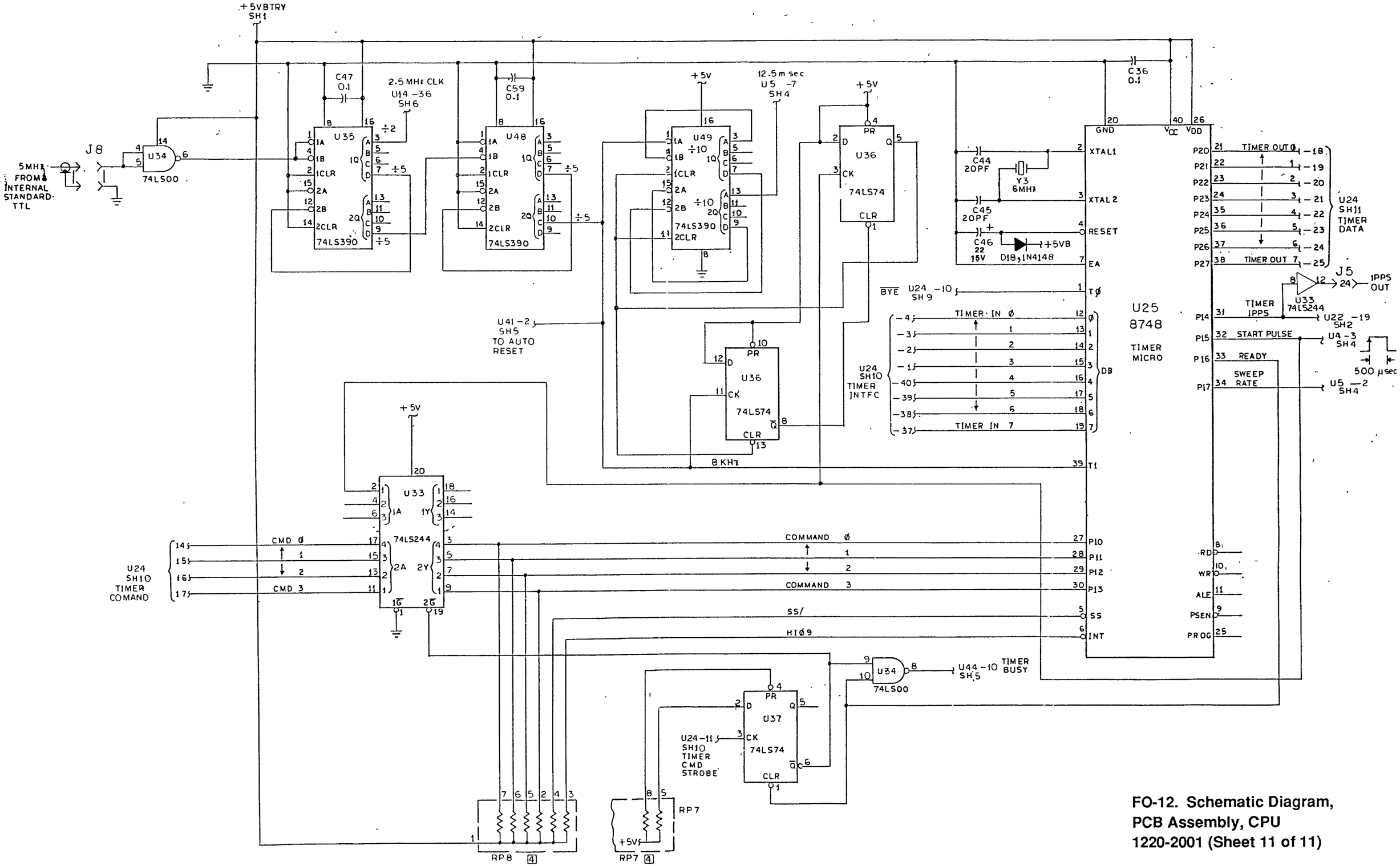
FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 8 of 11)



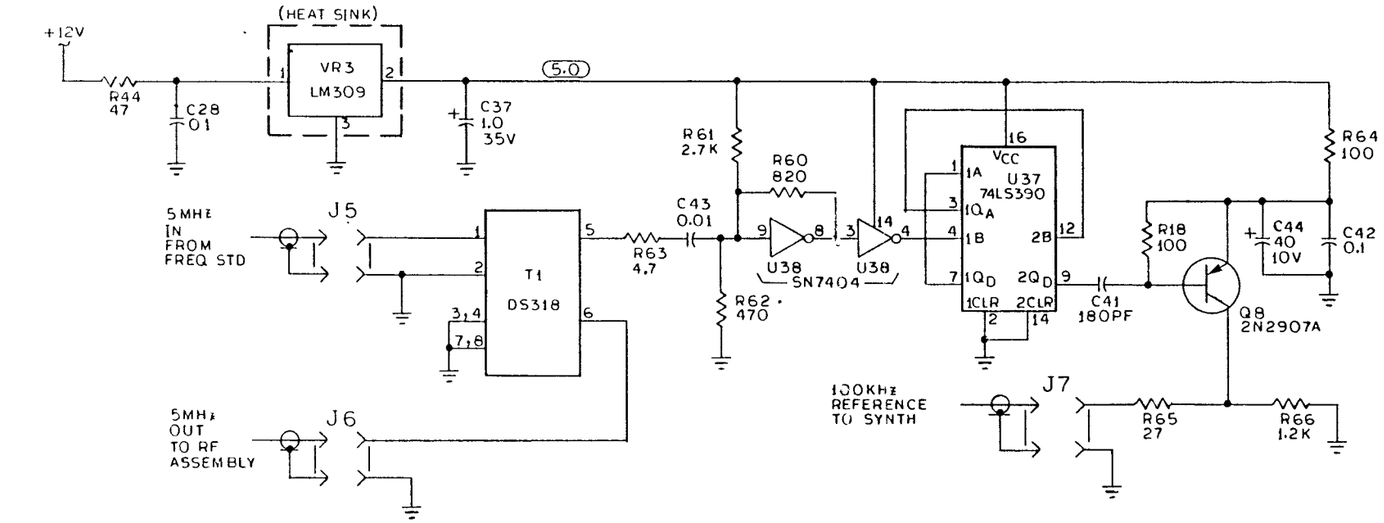
FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 9 of 11)

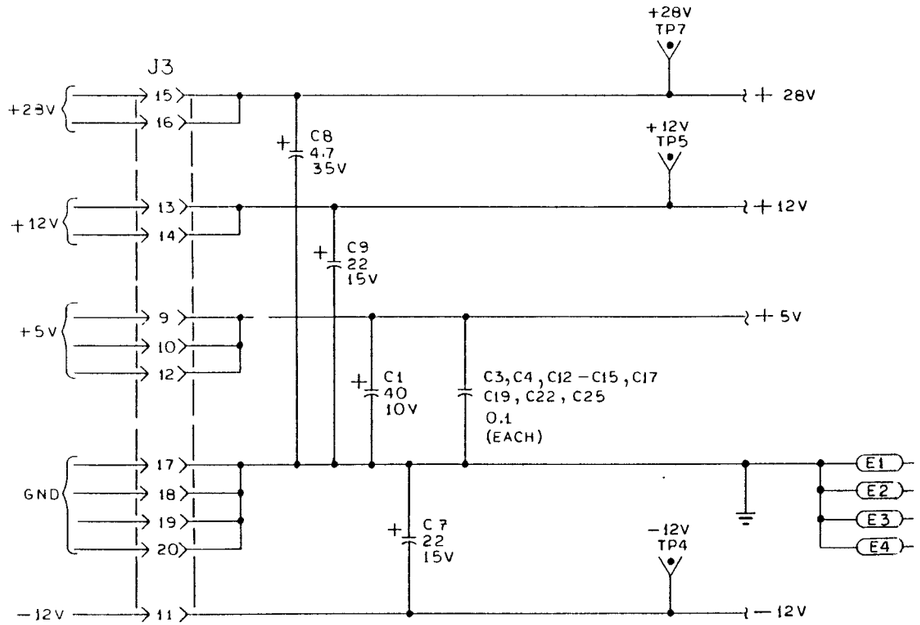


FO-12. Schematic Diagram,
PCB Assembly, CPU
1220-2001 (Sheet 10 of 11)



FO-12. Schematic Diagram, PCB Assembly, CPU 1220-2001 (Sheet 11 of 11)





POWER DISTRIBUTION		
DEVICE	+5V	GND
74LS03	14	7
74LS04	14	7
74LS74	14	7
74LS132	14	7
74LS164	14	7
74LS165	16	8
74LS175	16	8
74367	16	8
CD4049	1	8
CD4050	16	8
96L02	16	8

⑥ ⬭ D.C. VOLTAGE, ✳ INDICATES VOLTAGE READING TAKEN AT ROOM TEMP.

[5] RESISTOR, DIP 14PIN BECKMAN 899-1-R 4.7 K.

4 ALL INDUCTORS ARE IN MICROHENRYS

3 ALL CAPACITORS ARE IN MICROFARADS

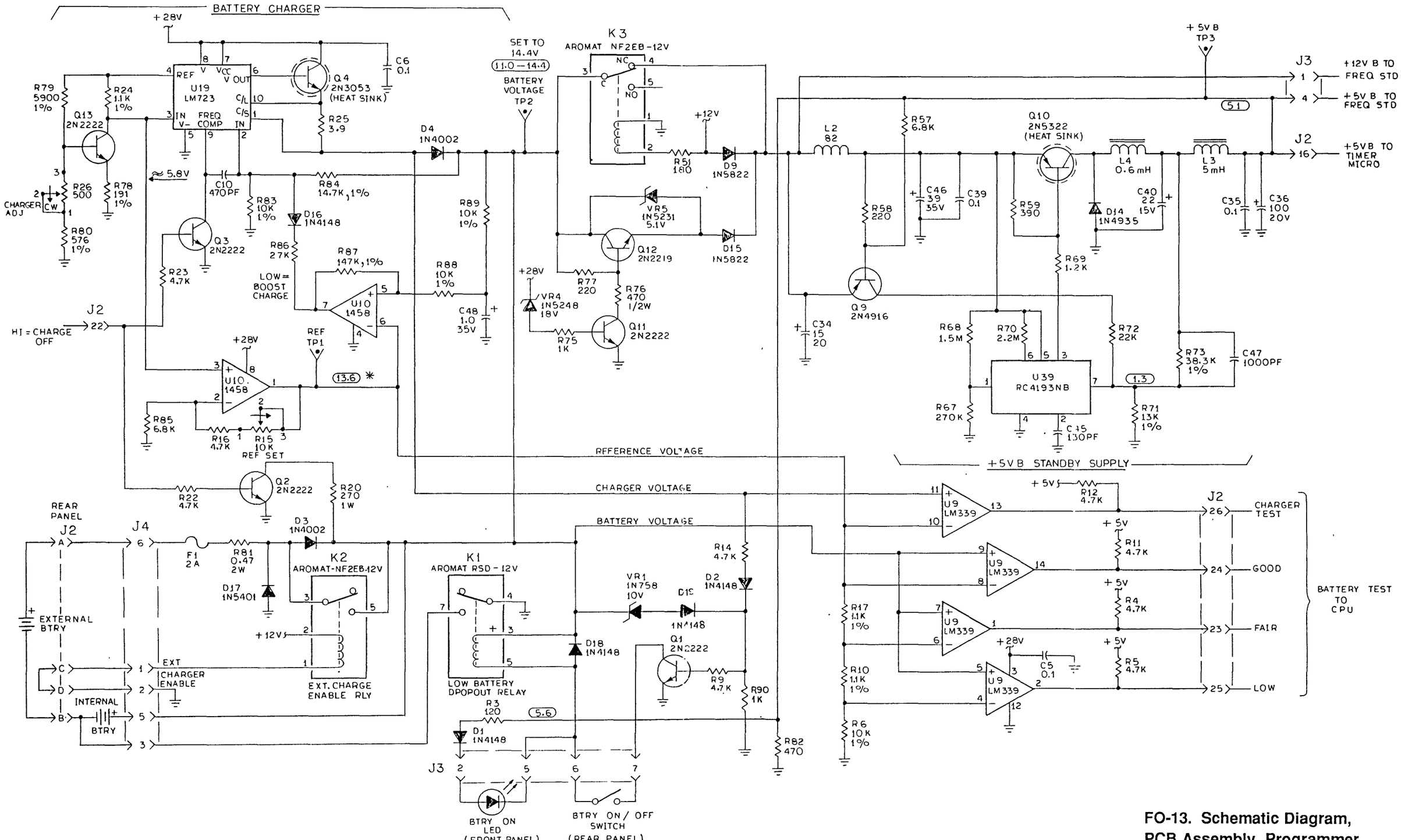
2 ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.

1 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

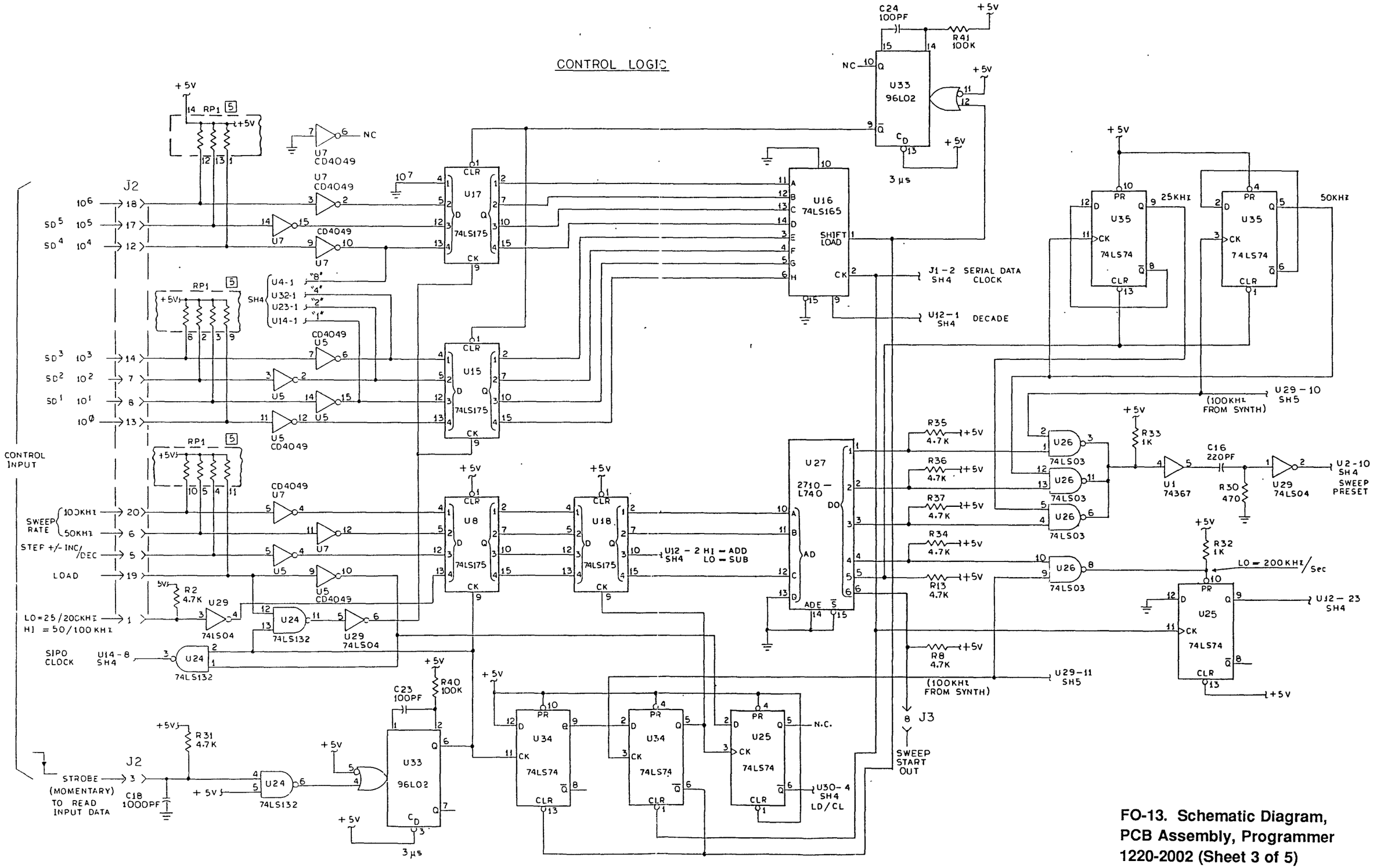
NOTES: UNLESS OTHERWISE SPECIFIED

HIGHEST REFERENCE DESIGNATION															
C48	D18	E4	C48	D18	F1	J7	K3	L4	Q13	R89	RP1	T1	TP7	U40	VR5
REF. DESIGNATION NOT USED															
	D5, D10 D11, D12 D13									R19 R21, R27-R29				U6	

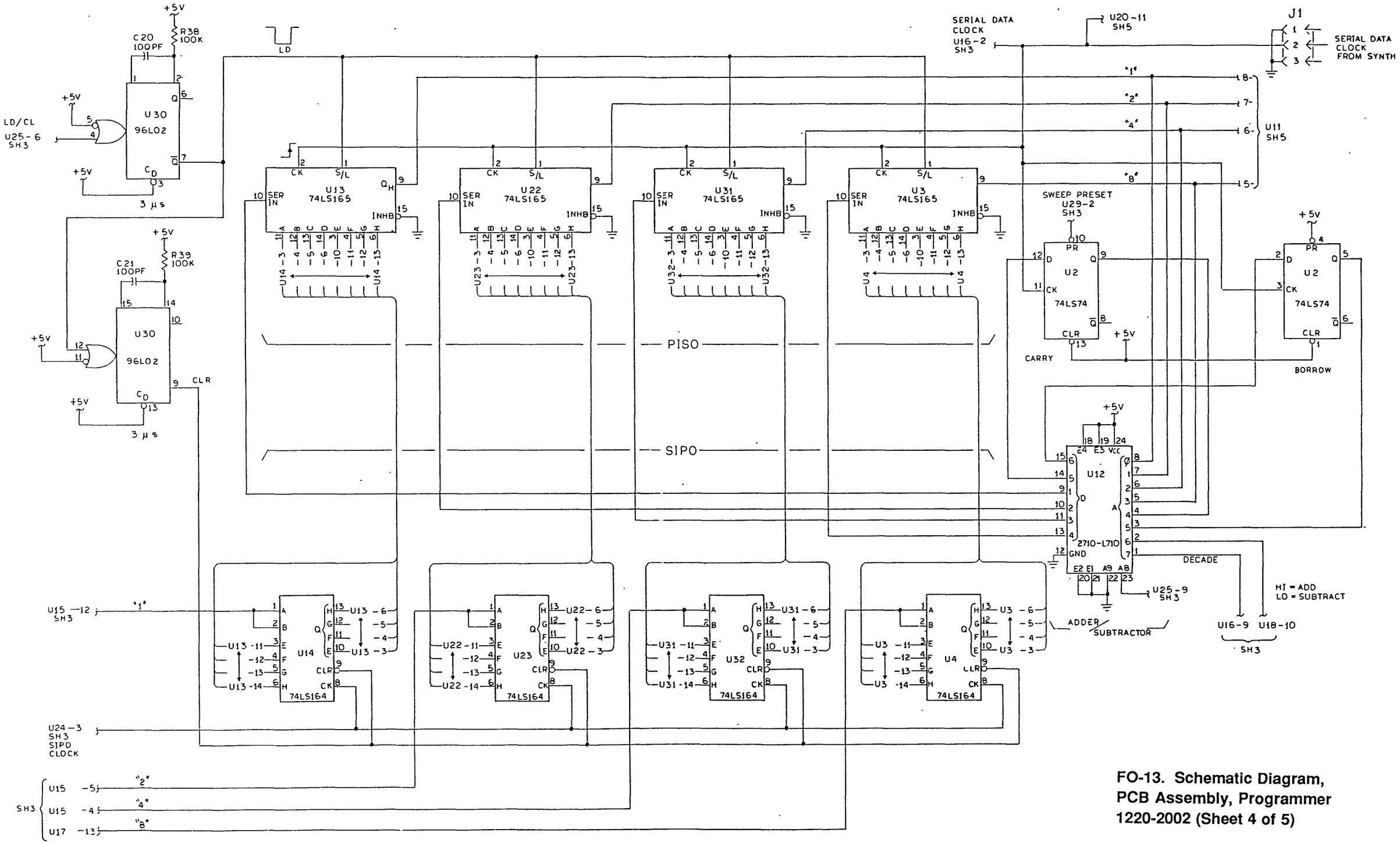
FO-13. Schematic Diagram, PCB Assembly, Programmer 1220-2002 (Sheet 1 of 5) Rev L



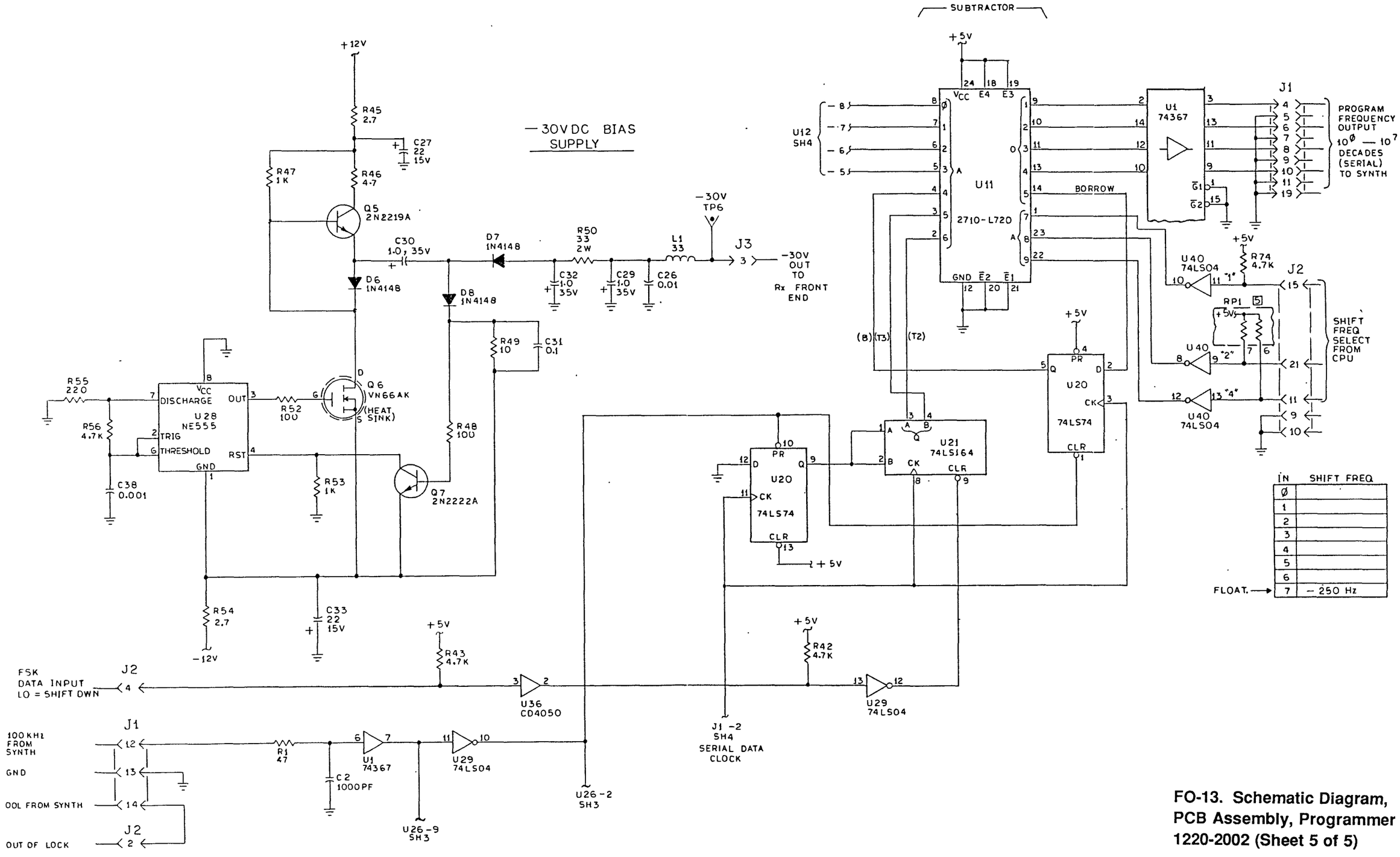
FO-13. Schematic Diagram, PCB Assembly, Programmer 1220-2002 (Sheet 2 of 5)



FO-13. Schematic Diagram, PCB Assembly, Programmer 1220-2002 (Sheet 3 of 5)



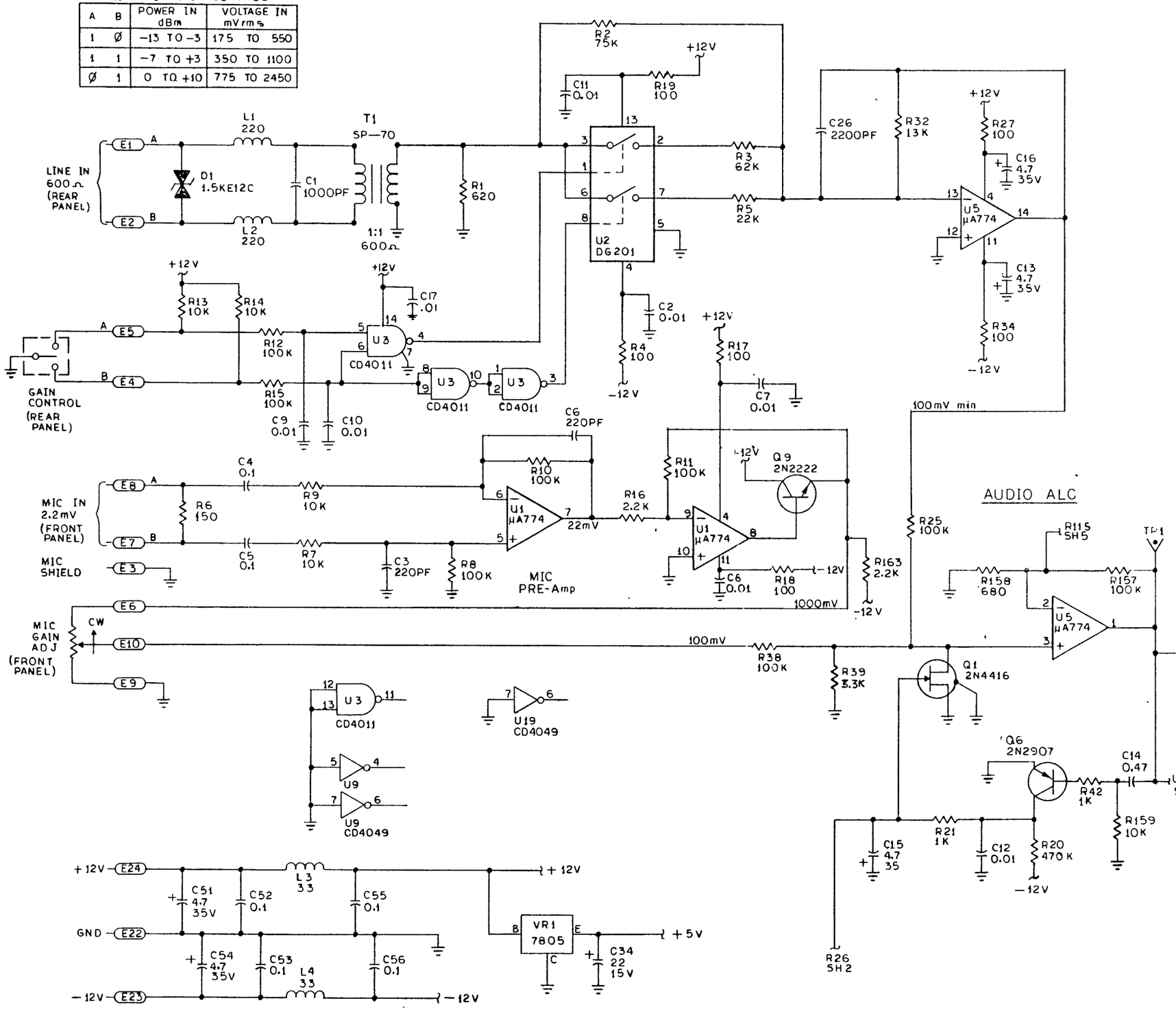
FO-13. Schematic Diagram, PCB Assembly, Programmer 1220-2002 (Sheet 4 of 5)



FO-13. Schematic Diagram, PCB Assembly, Programmer 1220-2002 (Sheet 5 of 5)

LINE — IN GAIN CONTROL

A	B	POWER IN dBm	VOLTAGE IN mVrms
1	Ø	−13 TO −3	175 TO 550
1	1	−7 TO +3	350 TO 1100
Ø	1	0 TO +10	775 TO 2450

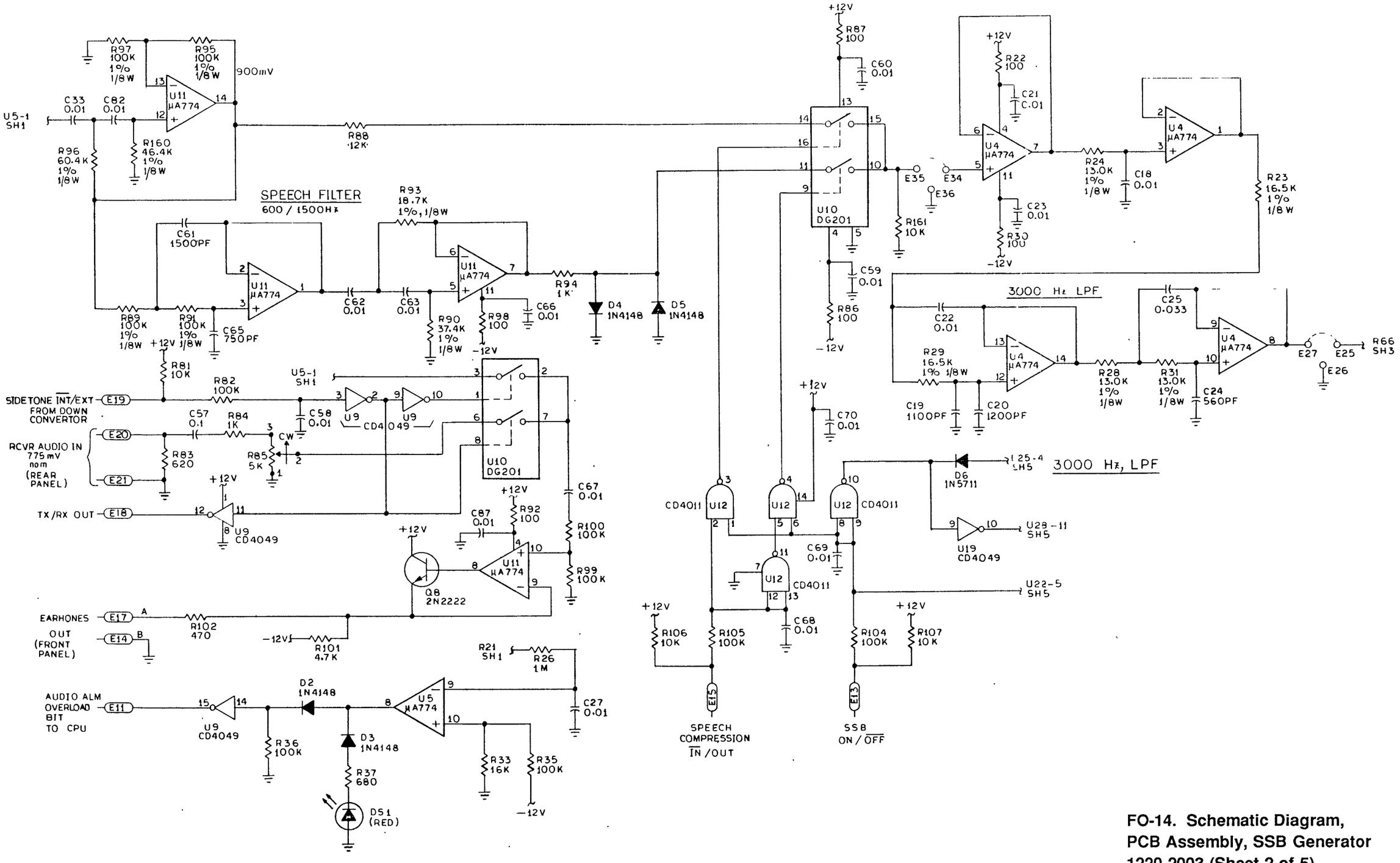


4. ALL INDUCTORS ARE IN MICROHENRYS
3. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

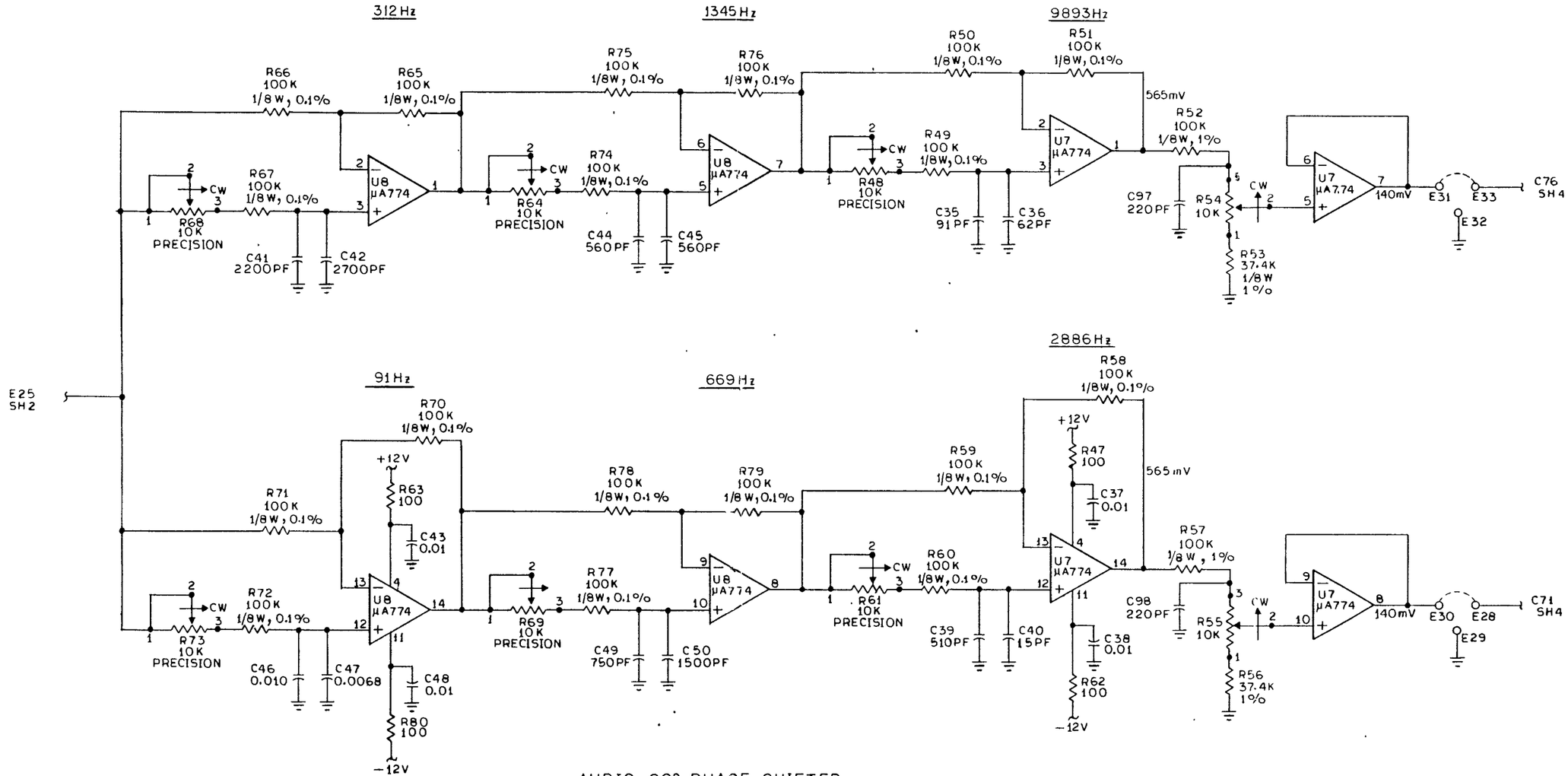
NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.										
C99	D6	E39	J1	L5	Q9	R189	T1	U31	VR2	
REF DESIGNATION NOT USED.										
					Q2			U27		

FO-14. Schematic Diagram, PCB Assembly, SSB Generator 1220-2003 (Sheet 1 of 5) Rev K

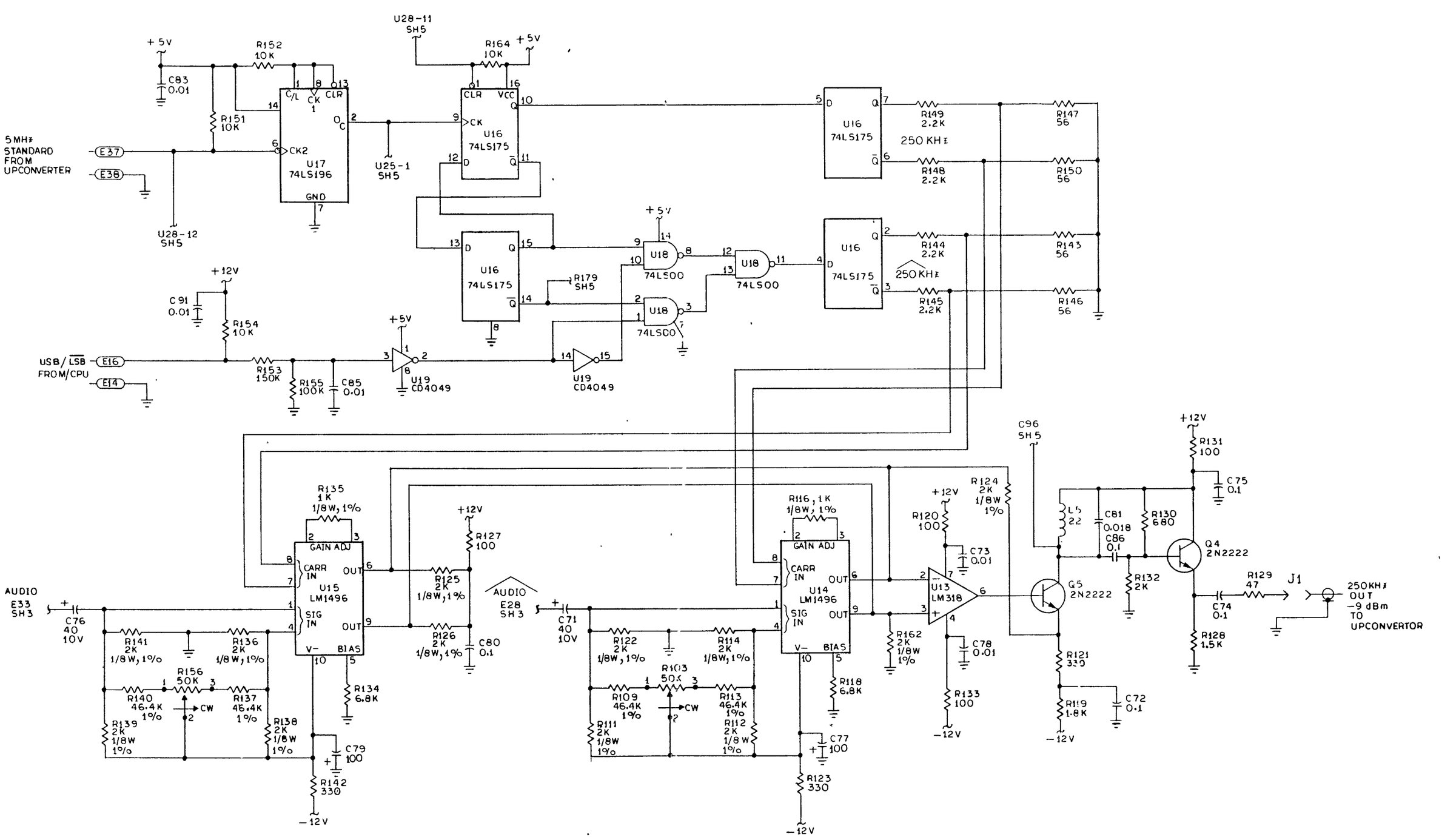


FO-14. Schematic Diagram, PCB Assembly, SSB Generator 1220-2003 (Sheet 2 of 5)

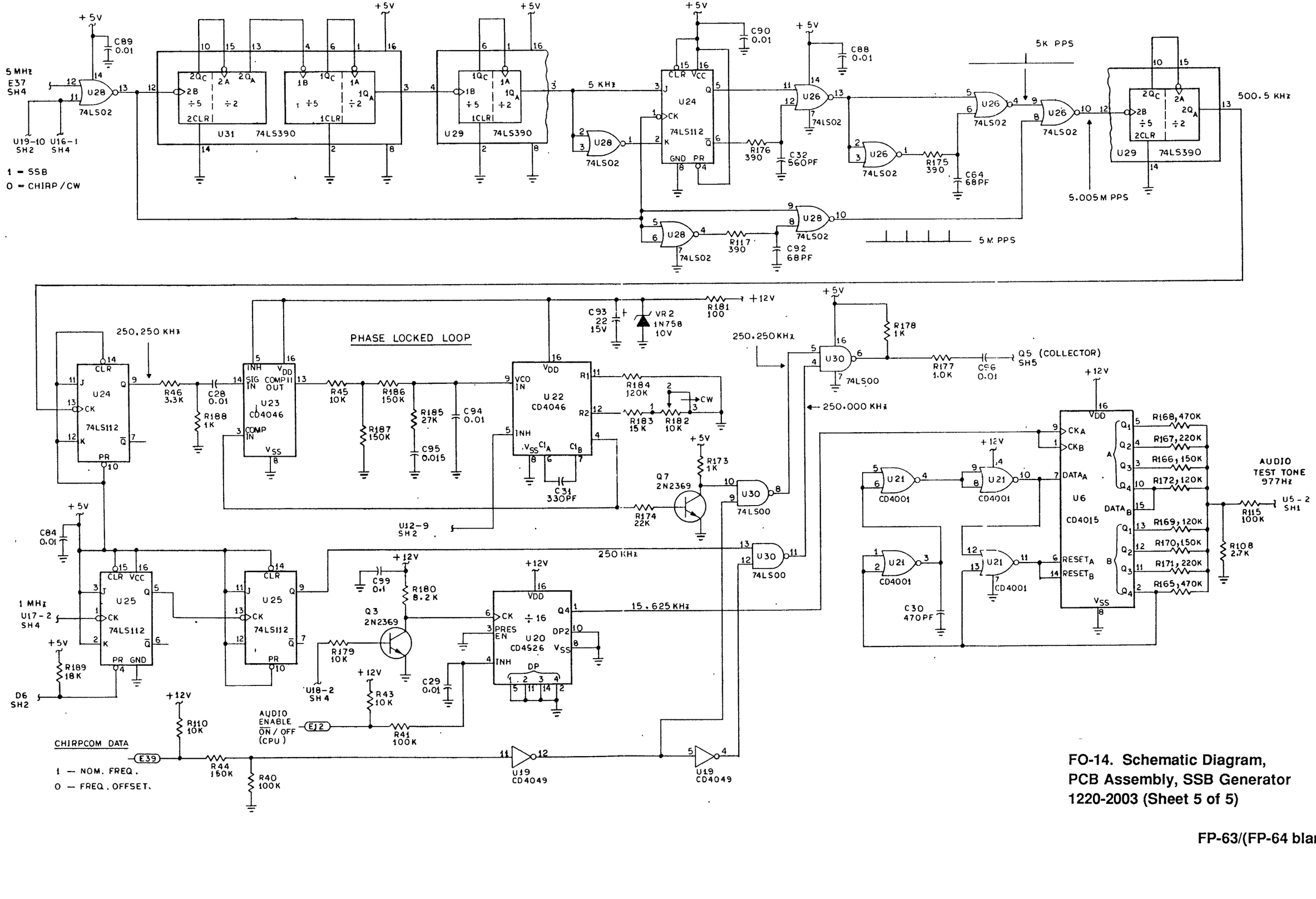


AUDIO 90° PHASE SHIFTER

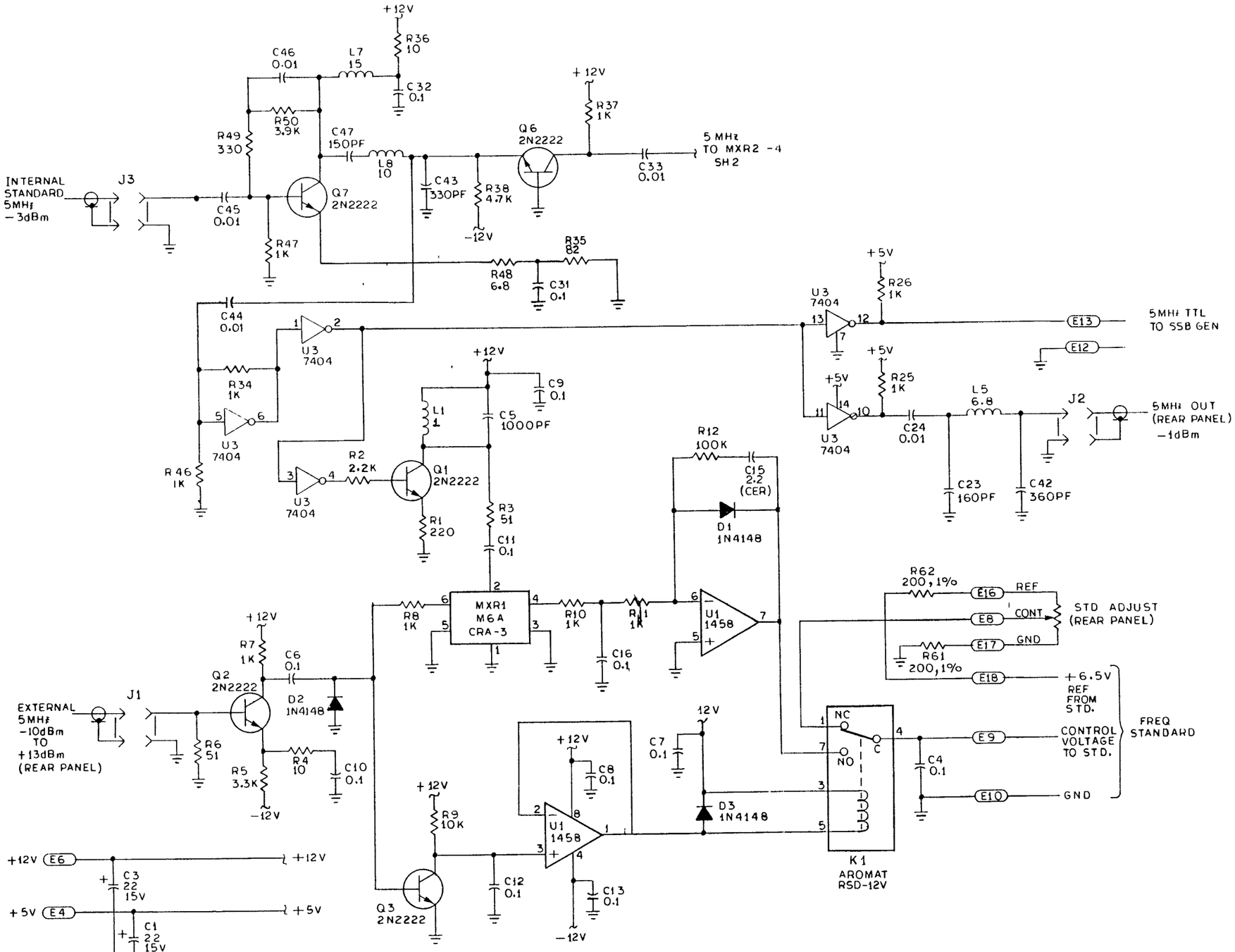
FO-14. Schematic Diagram, PCB Assembly, SSB Generator 1220-2003 (Sheet 3 of 5)



FO-14. Schematic Diagram, PCB Assembly, SSB Generator 1220-2003 (Sheet 4 of 5)



FO-14. Schematic Diagram, PCB Assembly, SSB Generator 1220-2003 (Sheet 5 of 5)



5 MHz PHASE-LOCKED LOOP

4 ALL INDUCTORS ARE IN MICROHENRYS

3 ALL CAPACITORS ARE IN MICROFARADS

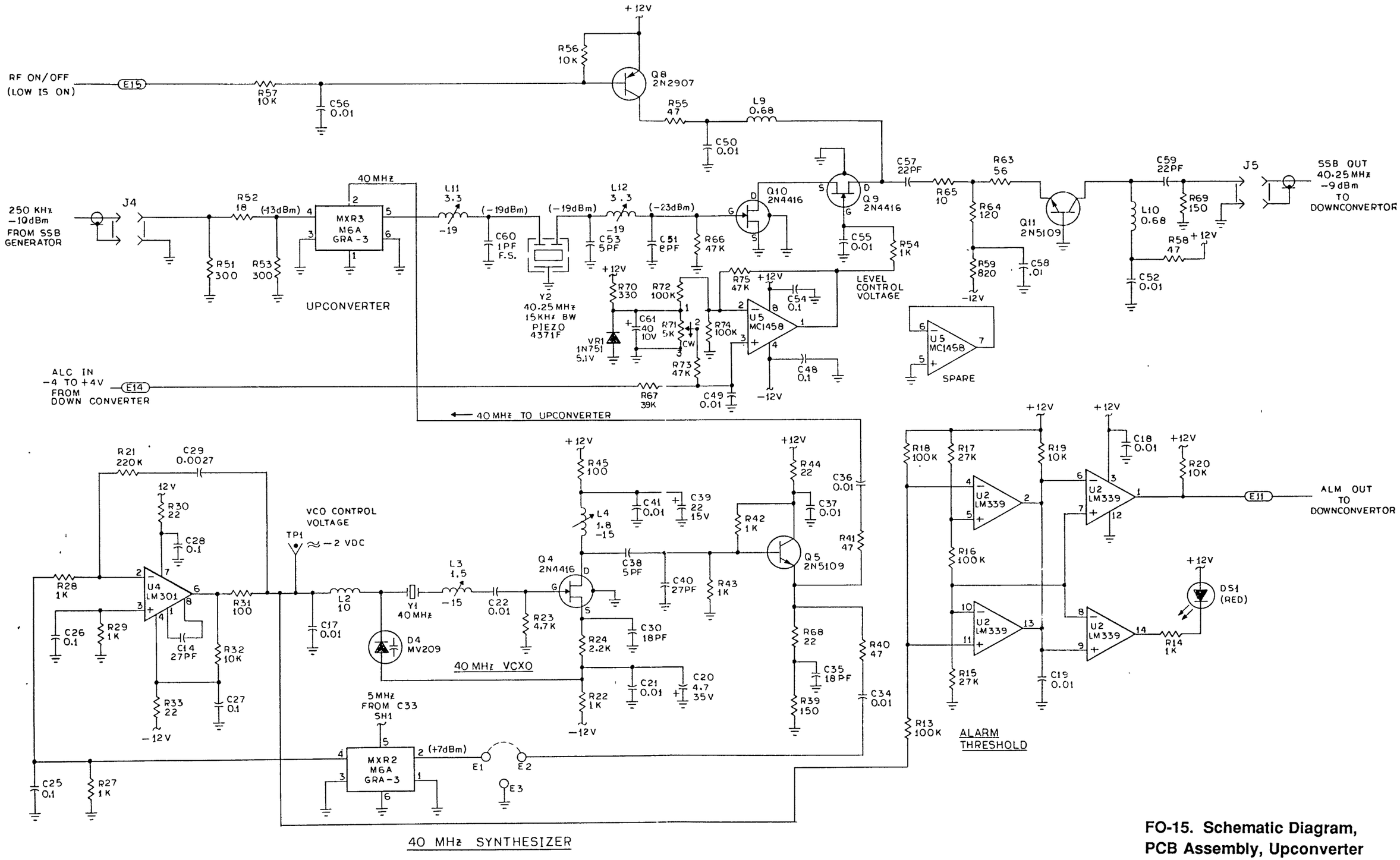
2 ALL RESISTORS ARE IN OHMS, 1/4W, ±5%

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION

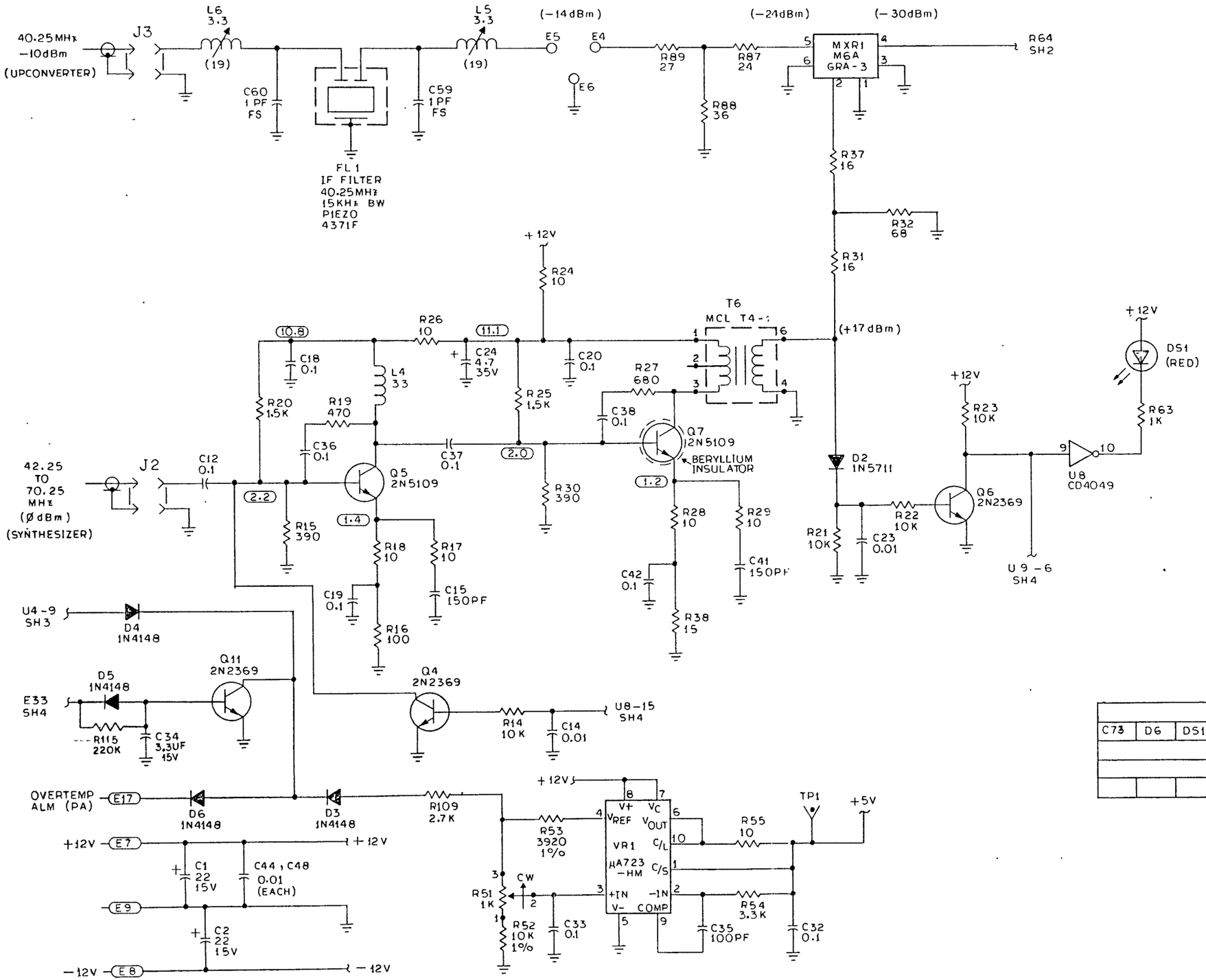
NOTES: UNLESS OTHERWISE SPECIFIED

HIGHEST REFERENCE DESIGNATION												
C61	D4	E18	J5	K1	L12	MXR3	Q10	R75	U5	VR1	Y2	
REF. DESIGNATION NOT USED.												
					L6							

FO-15. Schematic Diagram, PCB Assembly, Upconverter 1220-2004 (Sheet 1 of 2) Rev H



FO-15. Schematic Diagram, PCB Assembly, Upconverter 1220-2004 (Sheet 2 of 2)

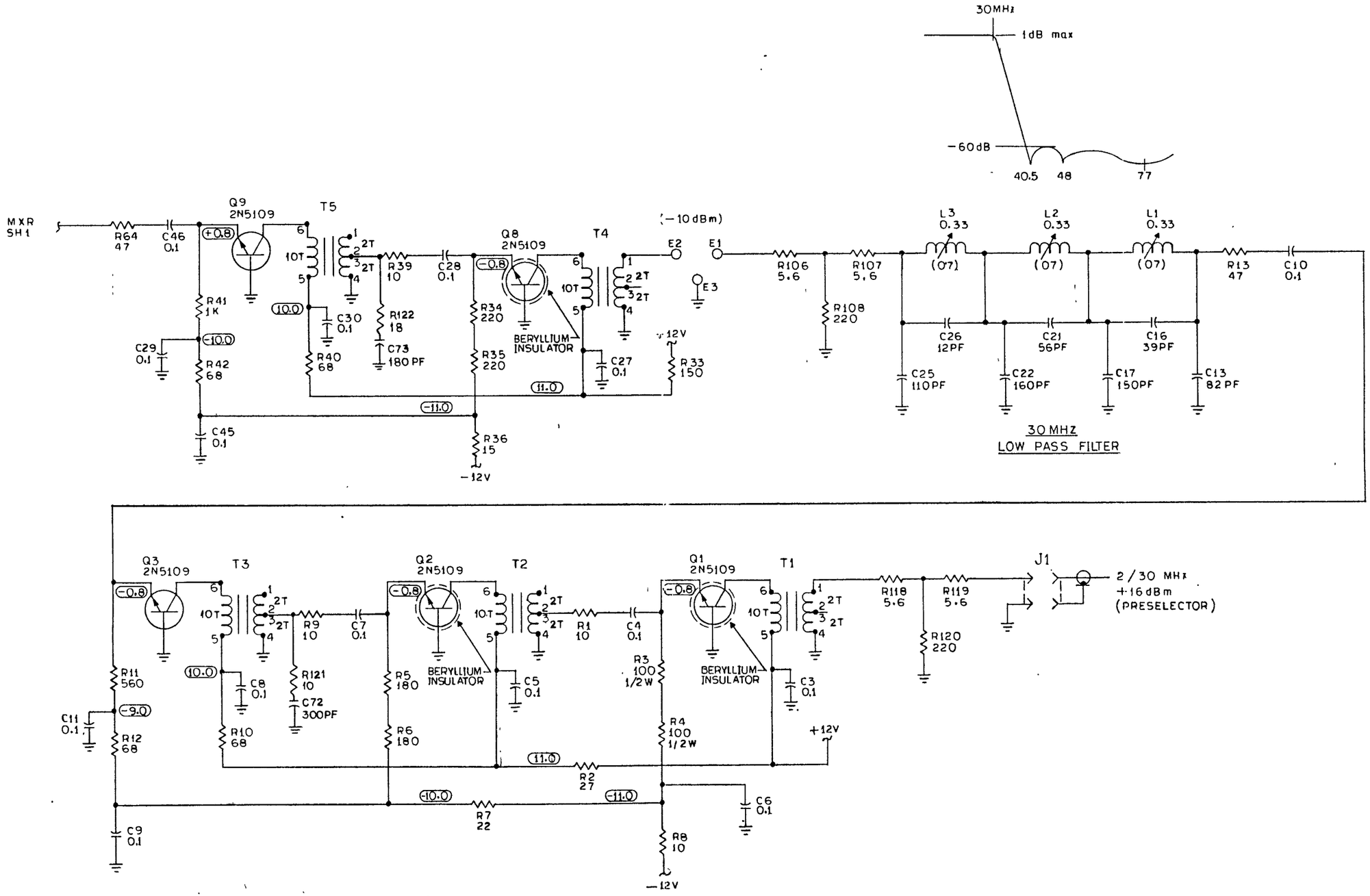


4. ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.													
C73	D6	DS1	E33	FL1	J3	L6	MXR1	Q11	R122	T6	TP3	U9	VR1
REF. DESIGNATION NOT USED.													

FO-16. Schematic Diagram, PCB Assembly, Downconverter 1220-2005 (Sheet 1 of 4) Rev K

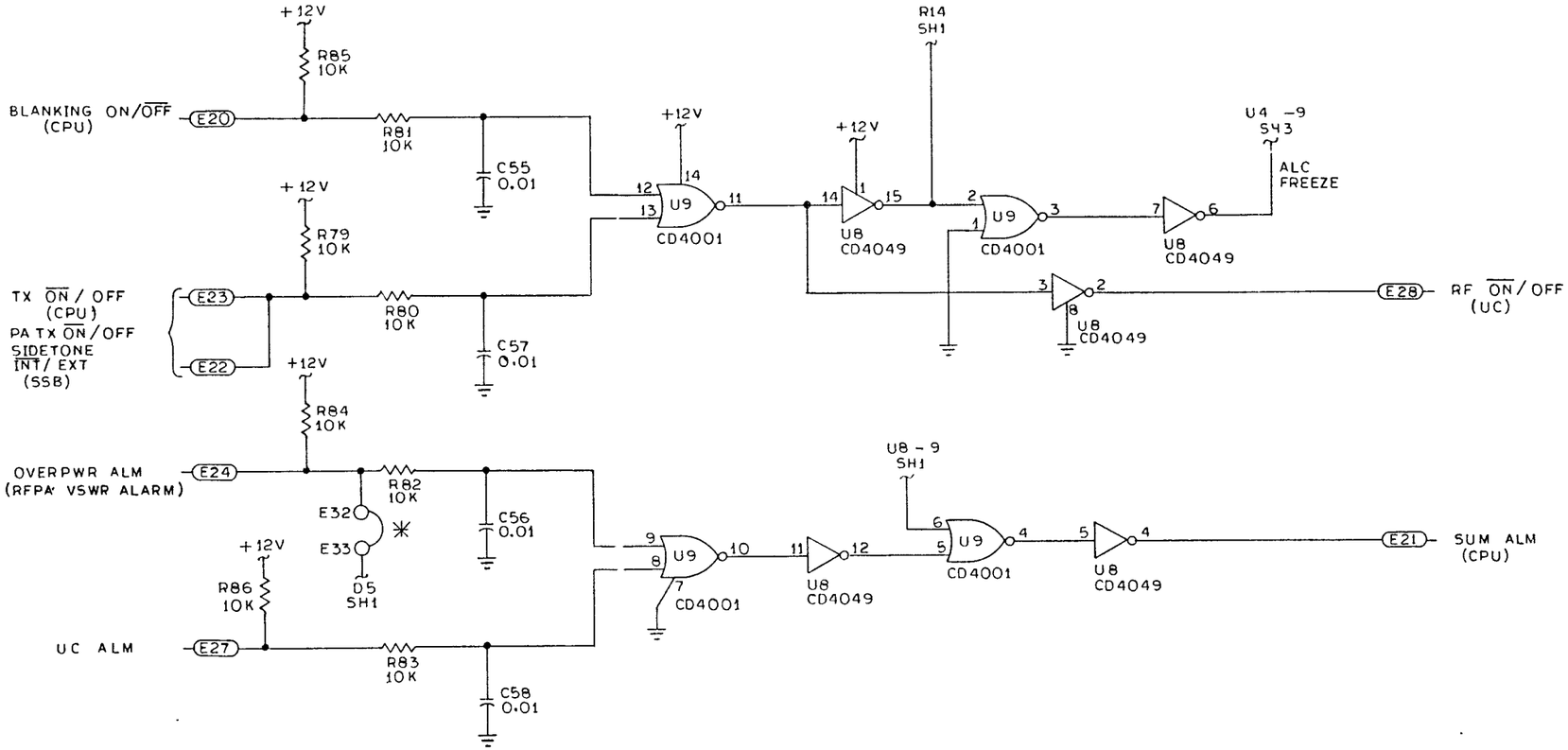


FO-16. Schematic Diagram, PCB Assembly, Downconverter 1220-2005 (Sheet 2 of 4)

ALC MODE SELECTION

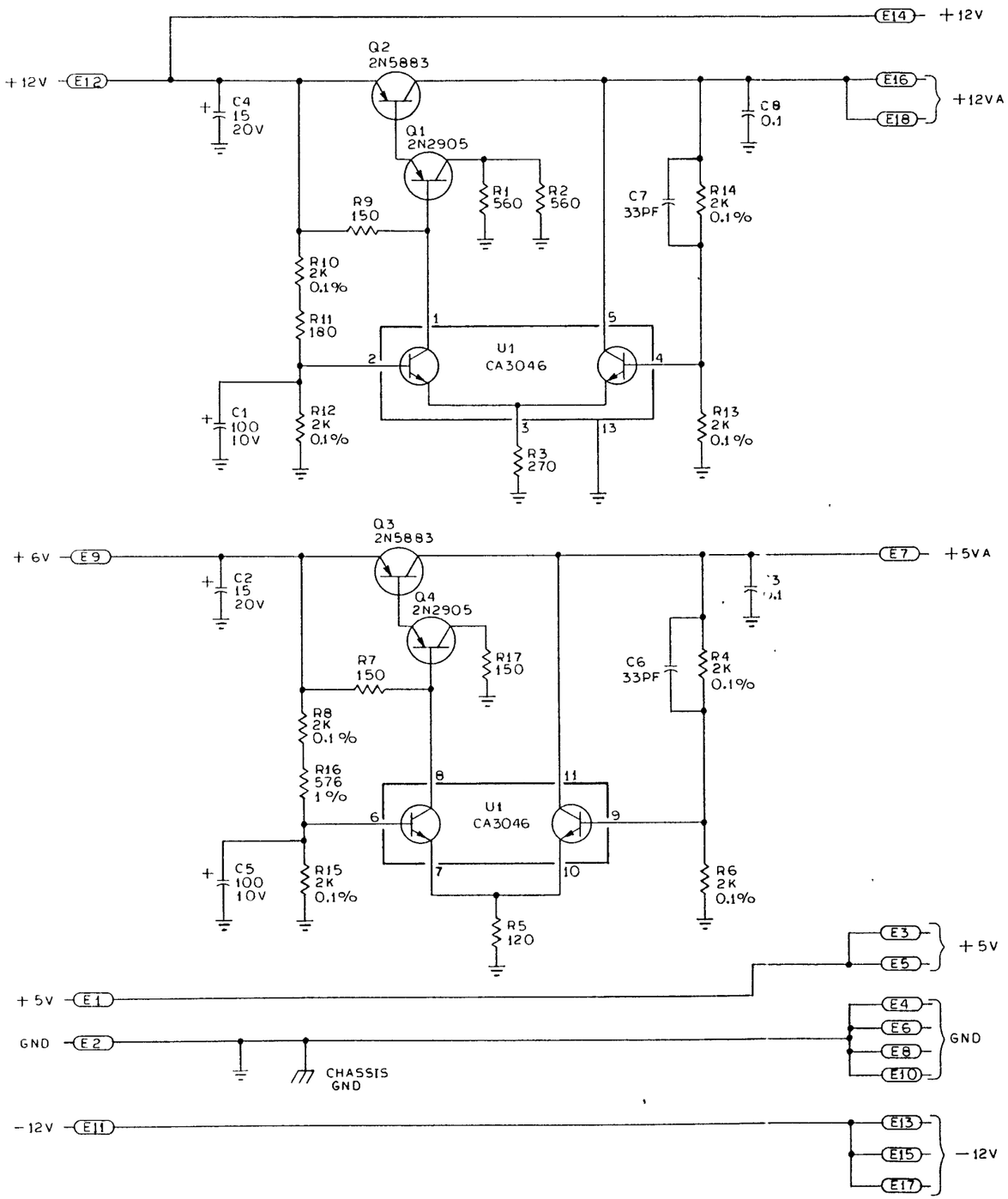
EXT/INT	HIGH/LOW PWR	CHIRP/SSB	PA MODE	PO
0	0	0	INT	100W
0	0	1	INT	150W
0	1	0	INT	10W
0	1	1	INT	15W
1	0	0	EXT	100 mW
1	0	1	EXT	100 mW
1	1	0	EXT	10 mW
1	1	1	EXT	10 mW

FO-16. Schematic Diagram, PCB Assembly, Downconverter 1220-2005 (Sheet 3 of 4)



✳ INSTALL JUMPER TO CAUSE ALC REDUCTION OF RF DRIVE WHEN OVERPWR ALM (RFPA VSWR ALARM) IS PRESENT.

FO-16. Schematic Diagram, PCB Assembly, Downconverter 1220-2005 (Sheet 4 of 4)



3 ALL CAPACITORS ARE IN MICROFARADS

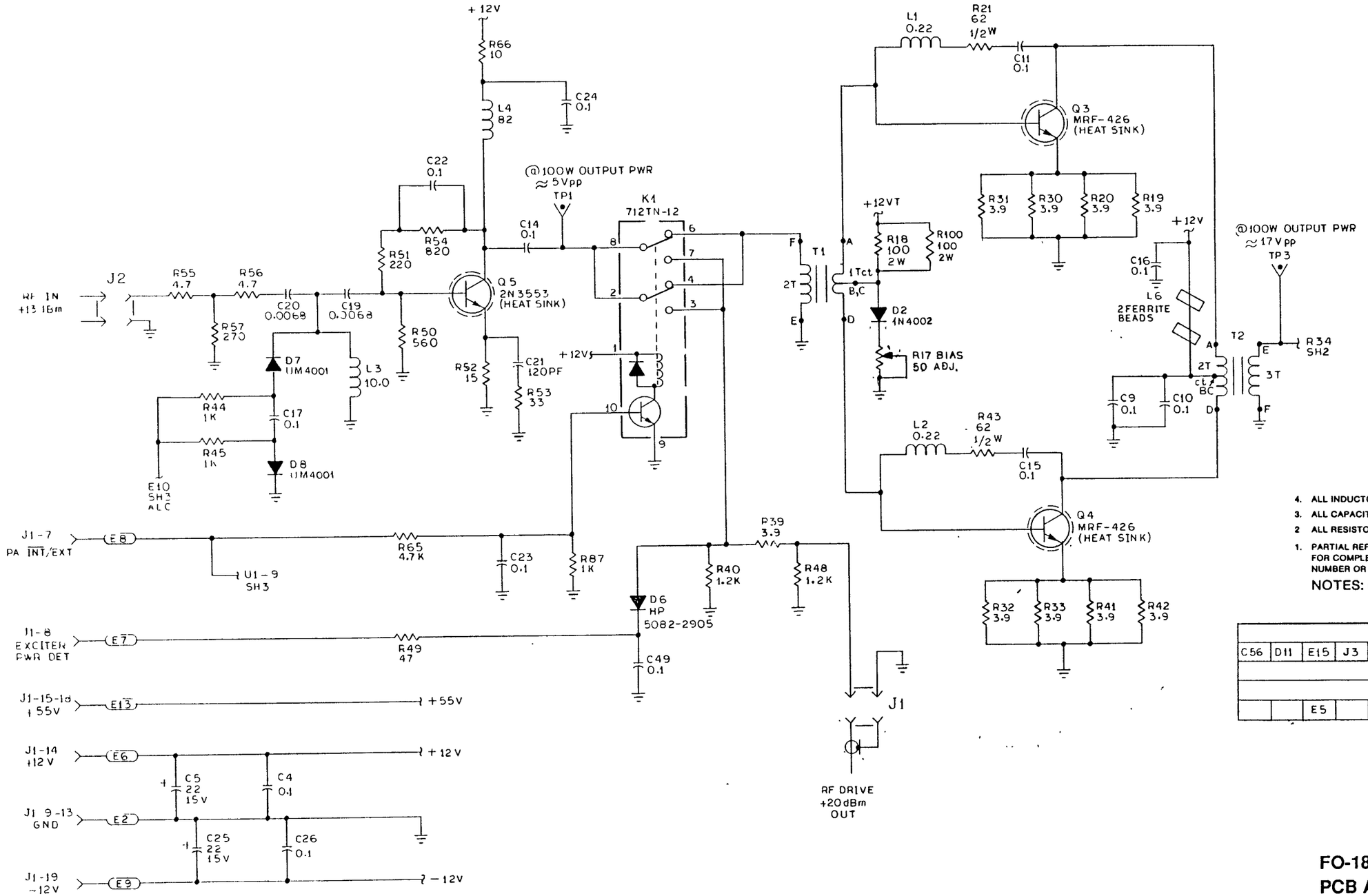
2 ALL RESISTORS ARE IN OHMS, 1/4W, ±5%

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION

NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION					
C8	R17	Q4	U1	E18	
REF. DESIGNATION NOT USED.					

FO-17. Schematic Diagram, PCB Assembly, Power Conditioner 1220-2006 Rev E



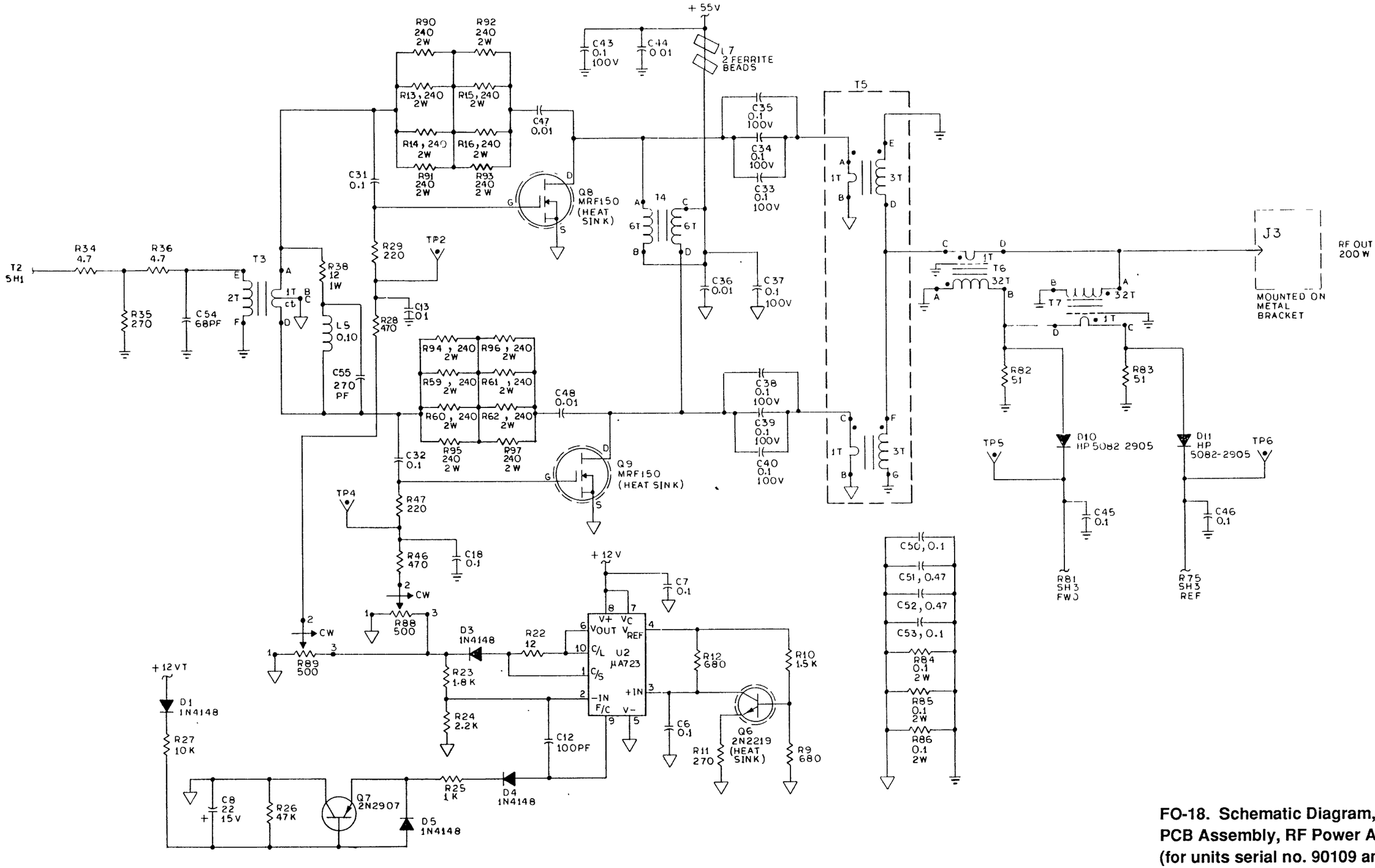
4. ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN MICROFARADS
2 ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED.

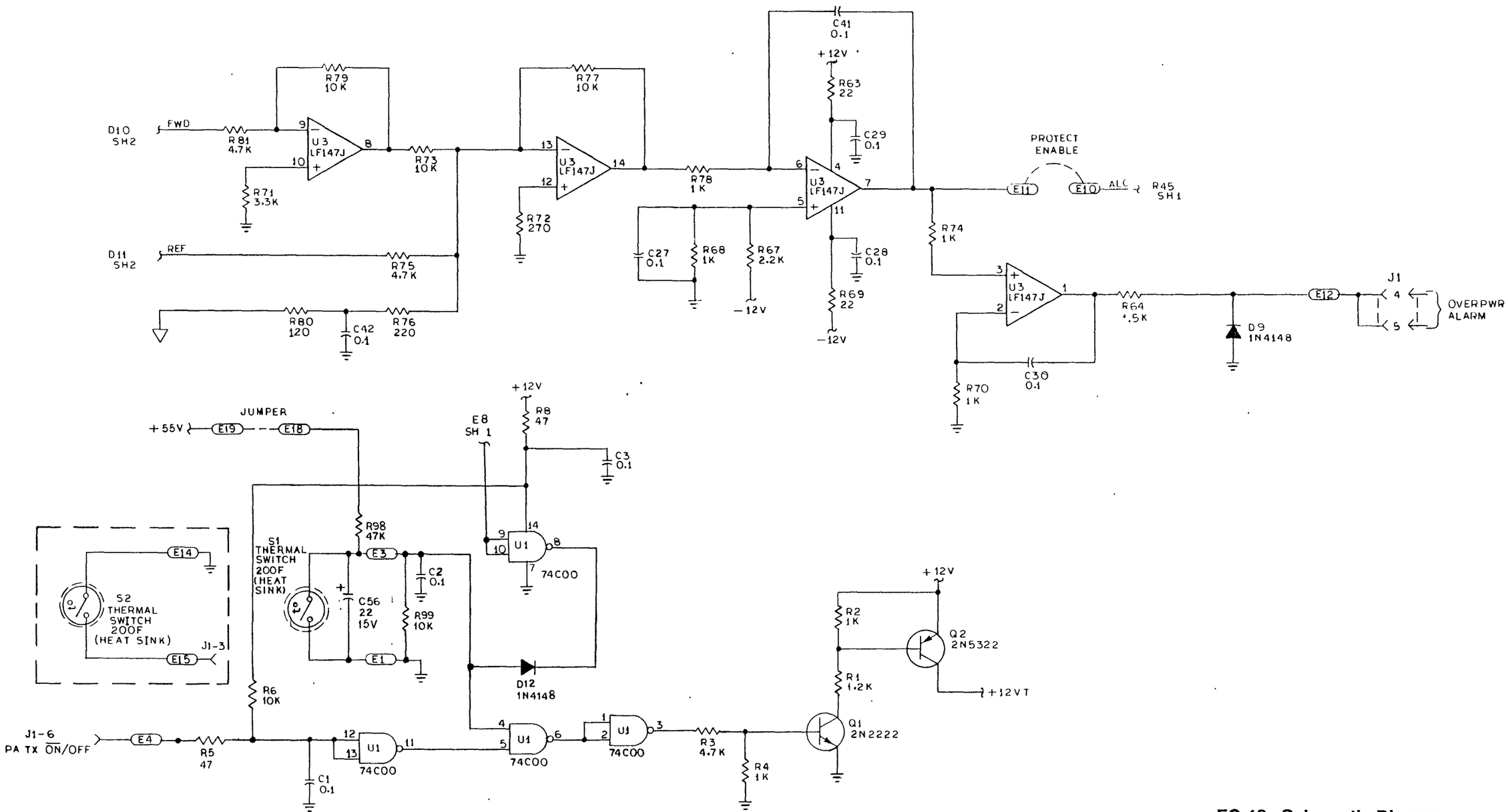
HIGHEST REFERENCE DESIGNATION											
C56	D11	E15	J3	K1	L9	Q9	R99	S2	T7	TP6	U3	

REF DESIGNATION NOT USED.											
		E5				R37 R58 R7					

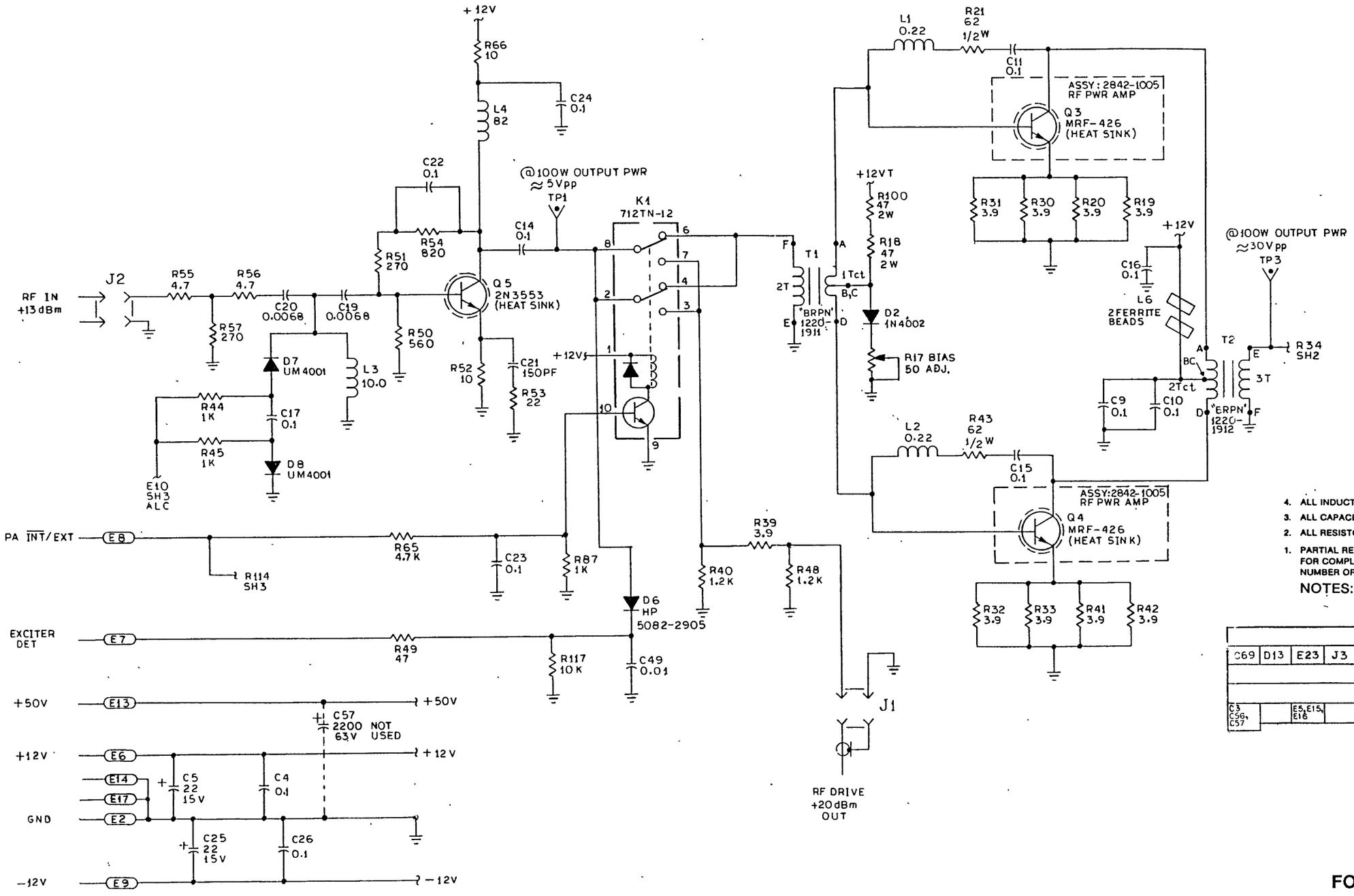
FO-18. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90109 and lower) 1220-2007 (Sheet 1 of 3) Rev N



FO-18. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90109 and lower) 1220-2007 (Sheet 2 of 3)



FO-18. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90109 and lower) 1220-2007 (Sheet 3 of 3)

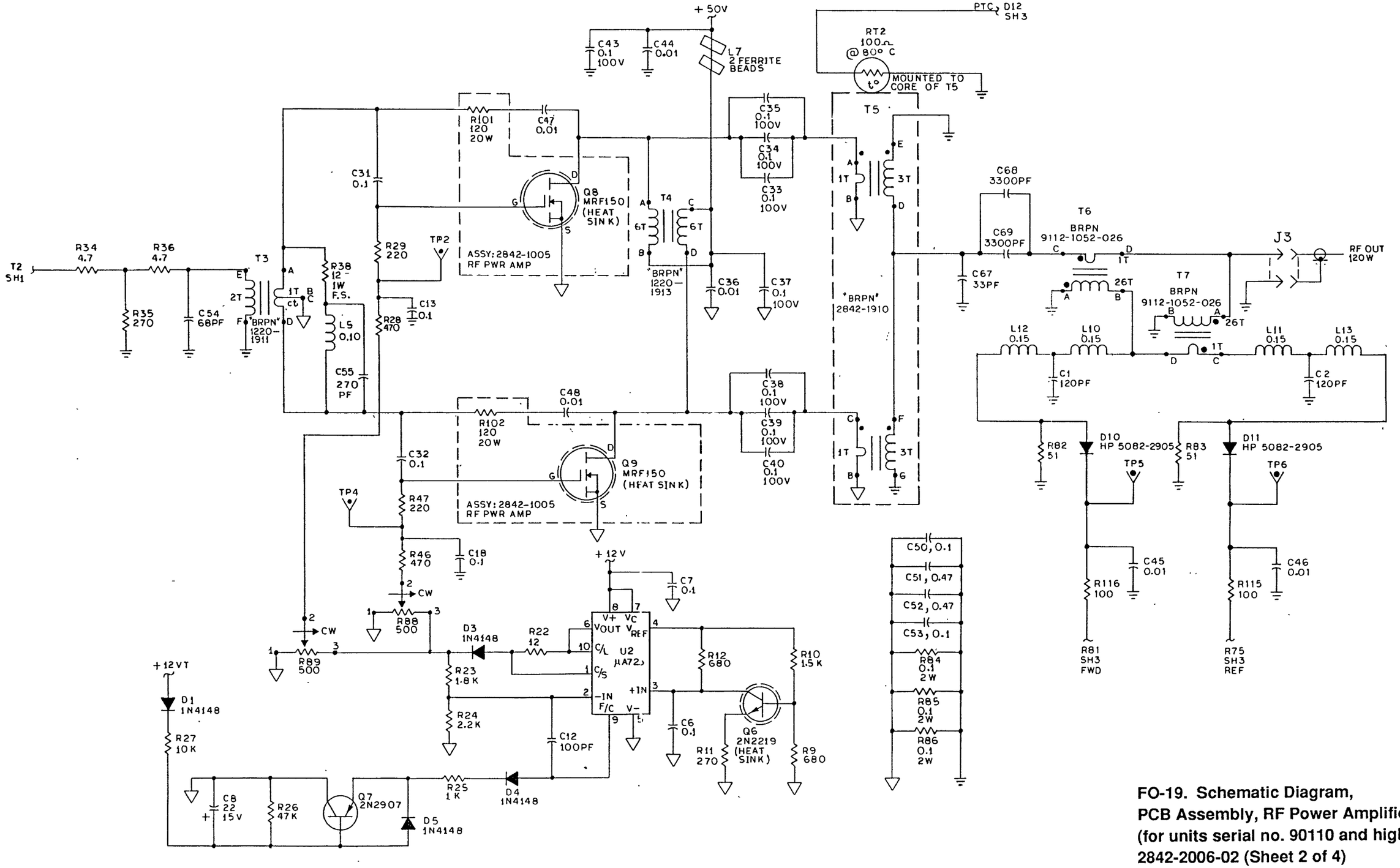


4. ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

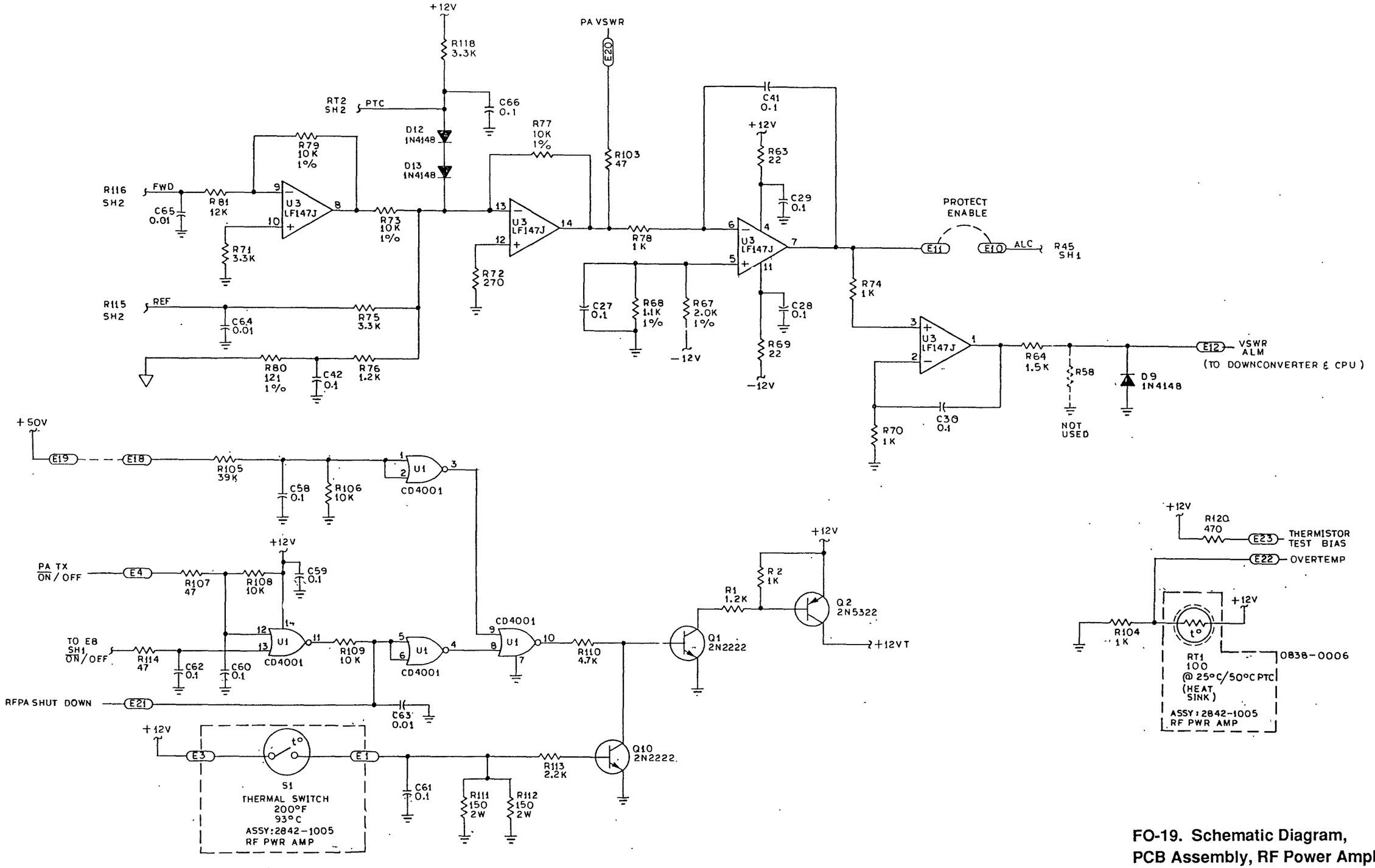
NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.												
C69	D13	E23	J3	K1	L13	Q10	R120	S1	T7	TP7	U3	RT2
REF. DESIGNATION NOT USED.												
C3, C56, C57		E5, E15, E16					R3-R8, R13-R16, R57, R58-R62, R90, R119, R101, R102					RT1

FO-19. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90110 and higher) 2842-2006-02 (Sheet 1 of 4) Rev B



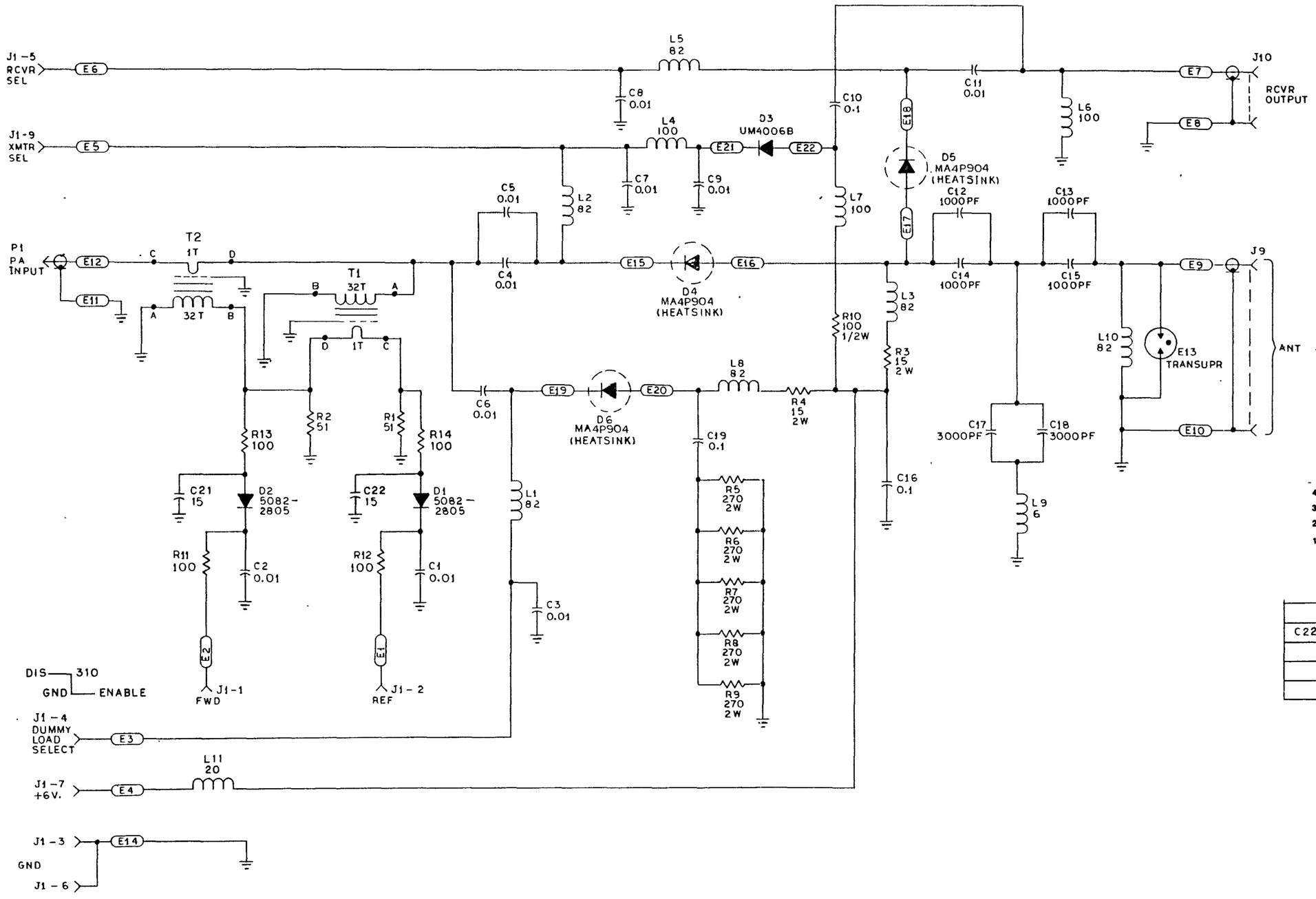
FO-19. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90110 and higher) 2842-2006-02 (Sheet 2 of 4)



FO-19. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90110 and higher) 2842-2006-02 (Sheet 3 of 4)

CONN	PIN	SIGNAL	LOCATION SHEET	LOCATION ZONE	COMMENTS
	E1	THERMAL SWITCH	3	A6	INTERNAL SIGNAL TO MODULE
	E2	GROUND	1	A8	
	E3	THERMAL SWICH	3	A7	INTERNAL SIGNAL TO MODULE
	E4	TX $\overline{ON}$/OFF	3	B7	TX CONTROL TO RFPA
	E5				
	E6	+12V	1	A8	
	E7	EXCITER DET	1	B8	TO TRANSMIT IF—FOR +20dBm LEVEL
	E8	PA $\overline{INT}$/EXT	1	B8	SELECTS INTERNAL OR EXTERNAL PA
	E9	--12V	1	A8	
	E10, E11	PROTECT ENABLE	3	C3	JUMPER
	E12	VSWR ALM	3	D5	TO CPU — VSWR PROTECT ACTIVE
	E13	+50V	1	A8	
	E14				
	E15				
	E16				
	E17				
	E18, E19	50V TO PROTECT	3	B8	
	E20	PA VSWR	3	D5	TO TRANSMIT IF SHOWS POWER DISSIPATION
	E21	RFPA SHUTDOWN	3	A7	OVER TEMP SHUTDOWN
	E22	THERMISTOR	3	B2	THERMISTOR TO FAN CONTROLLER
	23	THERMISTOR TEST BIAS	3	B2	
J1		SMB — RF DRIVE	1	A4	+20dBm OUT 2/30 MHz
J2		SMB — RF IN	1	C8	+13dBm IN 2/30 MHz
J3		BNC — RF OUT	2	C1	120W OUT 2/30 MHz

FO-19. Schematic Diagram, PCB Assembly, RF Power Amplifier (for units serial no. 90110 and higher) 2842-2006-02 (Sheet 4 of 4)

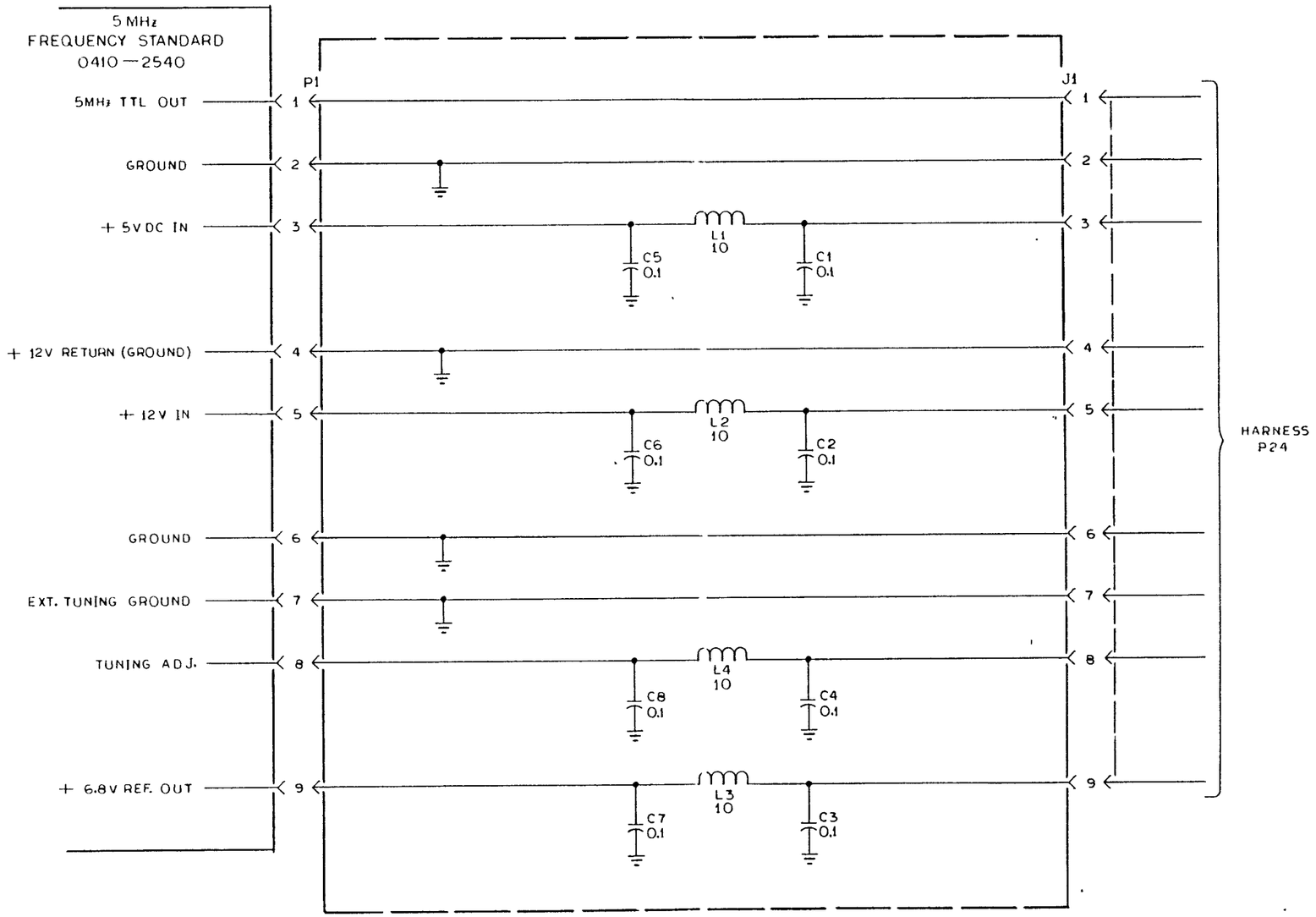


4. ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.					
C22	D6	E20	L11	R14	T2
REF. DESIGNATION NOT USED.					

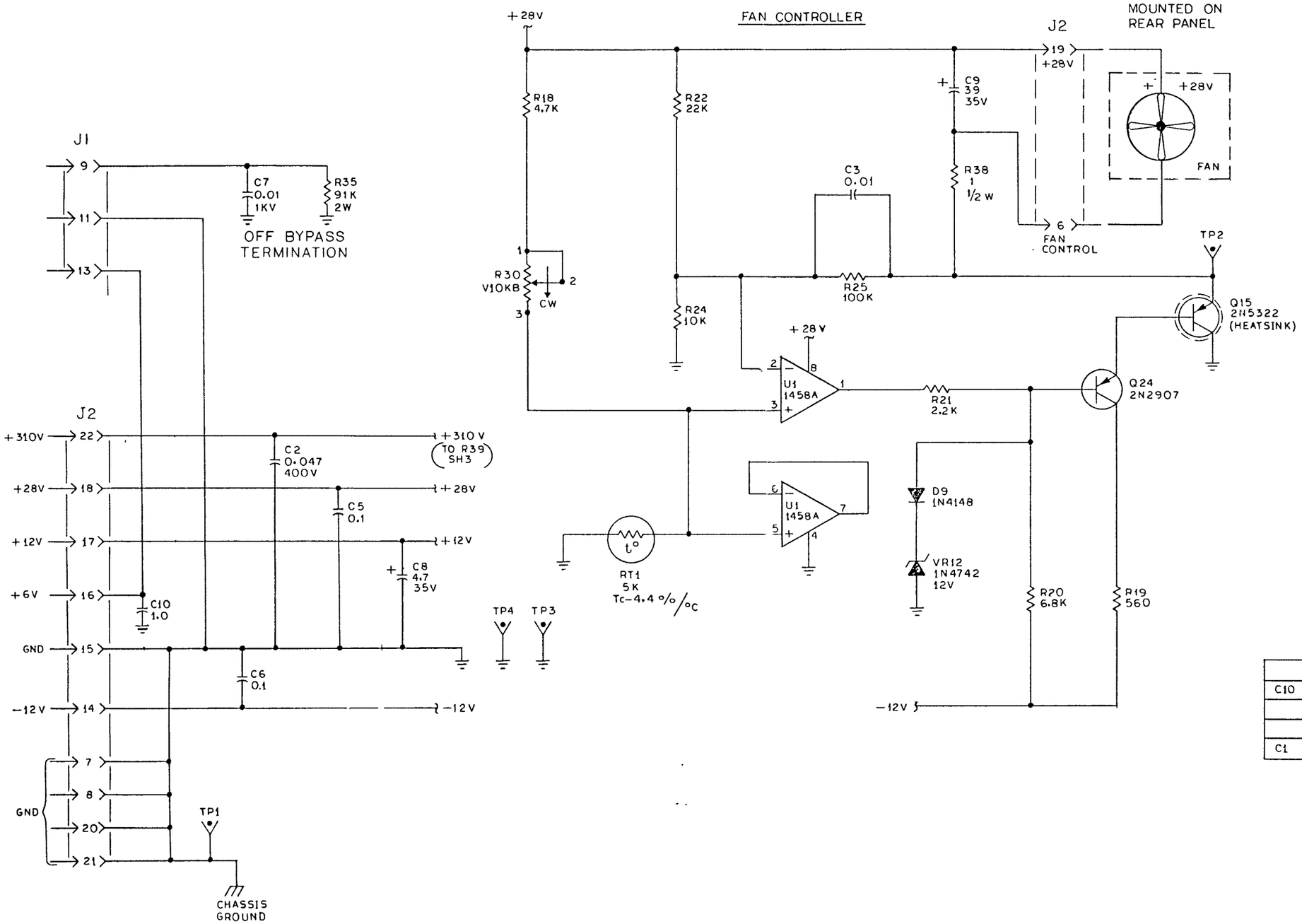
FO-20. Schematic Diagram, PCB Assembly, T/R Switch 1220-2008 **Rev S**



3. ALL INDUCTORS ARE IN MICROHENRYS.
2. ALL CAPACITORS ARE IN MICROFARADS
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED.

FO-21. Schematic Diagram,
PCB Assembly,
Frequency Standard Filter
1220-2009 **Rev D**

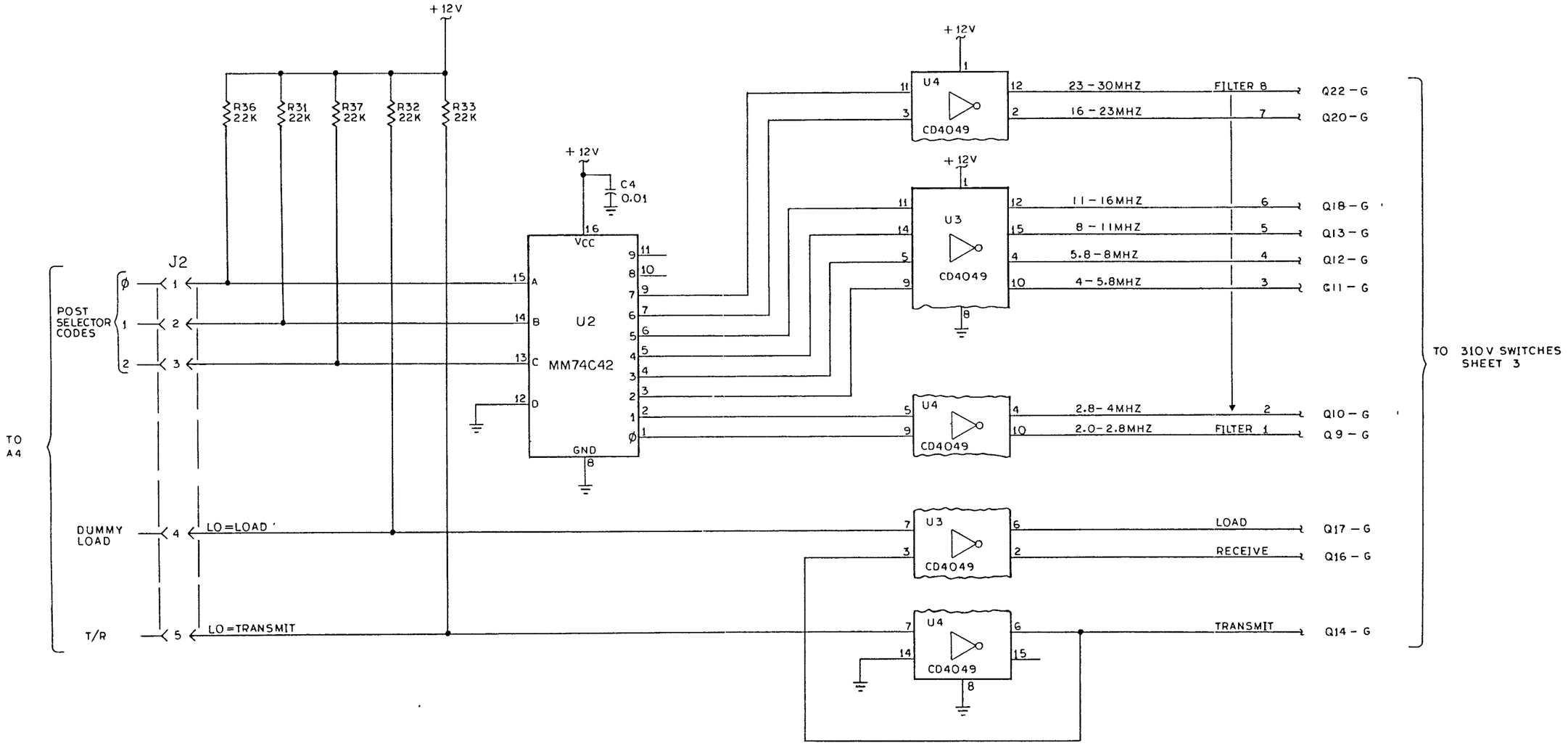


4. ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

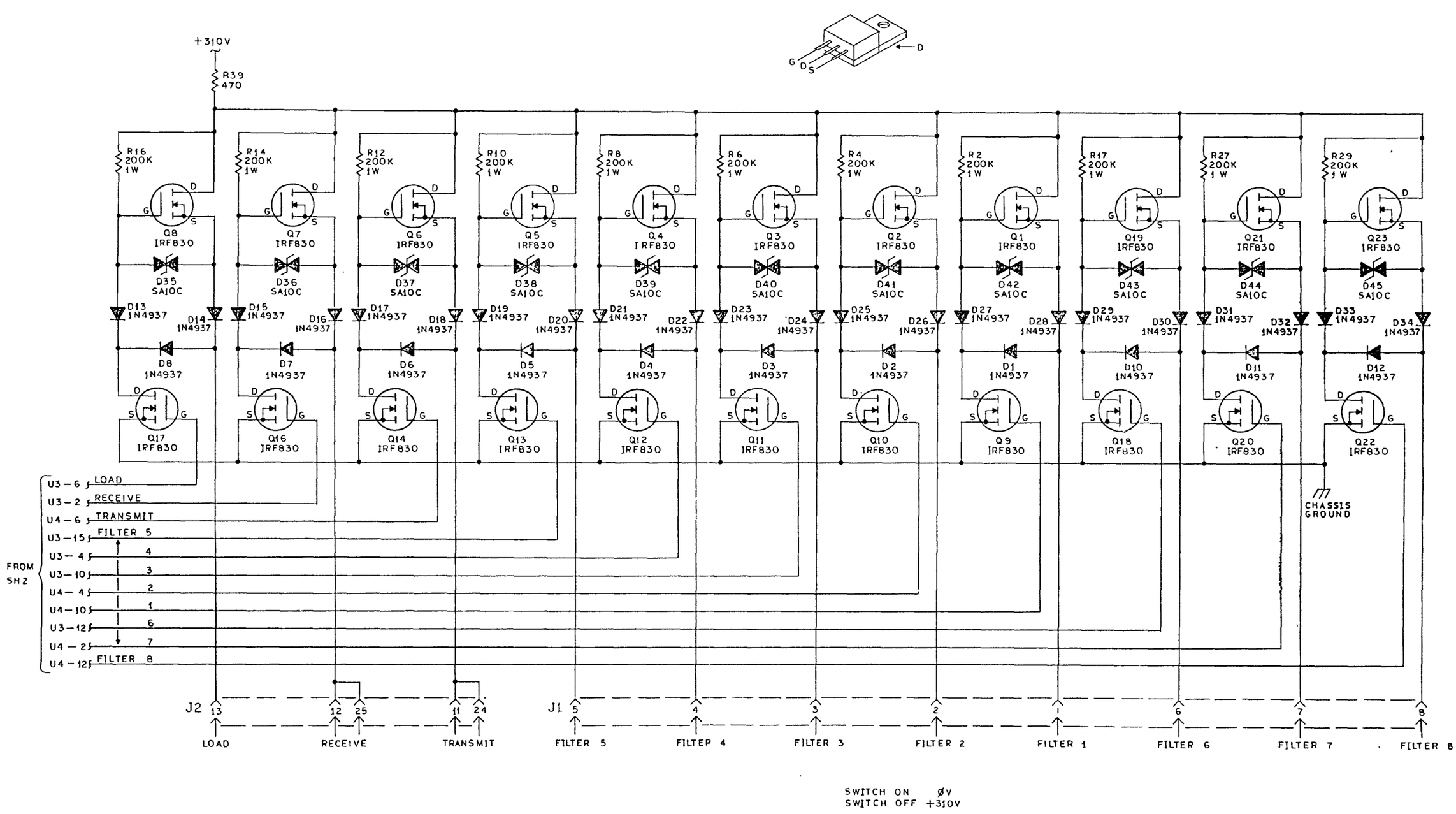
NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.									
C10	D12	J2	Q23	R38	RT1	TP4	U4	VR12	
REF. DESIGNATION NOT USED.									
C1				R26					

FO-22. Schematic Diagram, PCB Assembly, Controller/Driver 1220-2010 (Sheet 1 of 3) Rev H

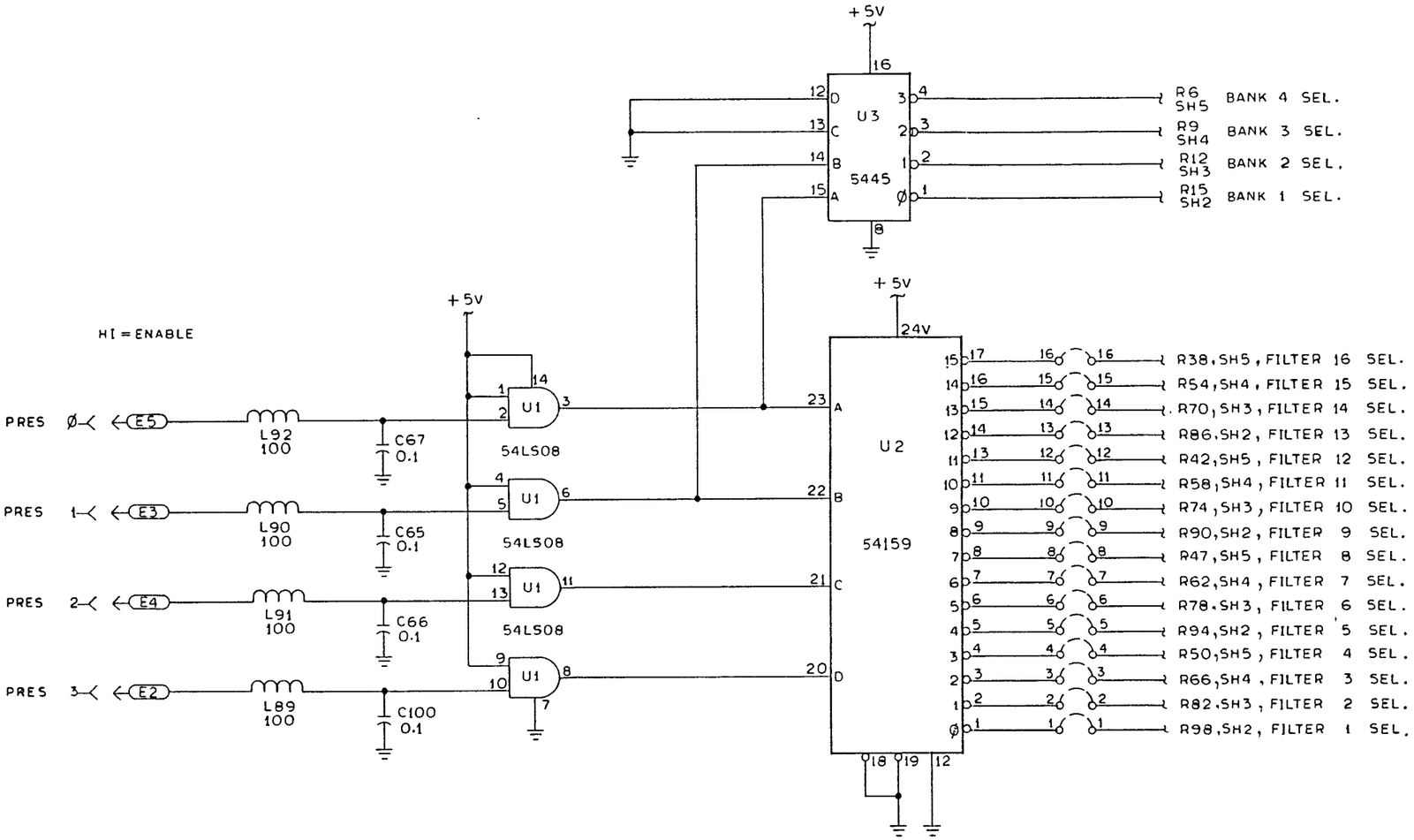


FO-22. Schematic Diagram, PCB Assembly, Controller/Driver 1220-2010 (Sheet 2 of 3)

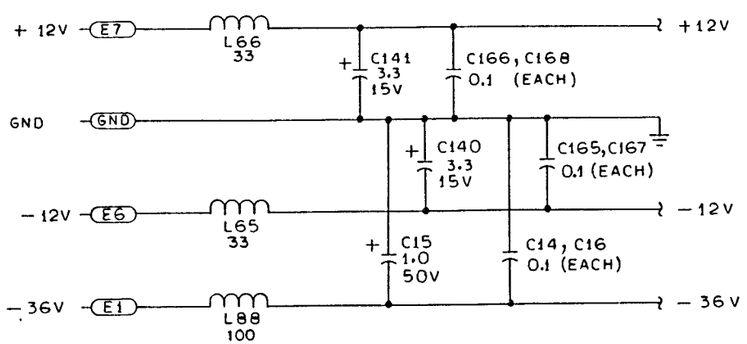


OUTPUT TO POST-SELECT FILTER SET

FO-22. Schematic Diagram, PCB Assembly, Controller/Driver 1220-2010 (Sheet 3 of 3)



FILTER SELECT DECODE LOGIC



FILTER SELECT CODE

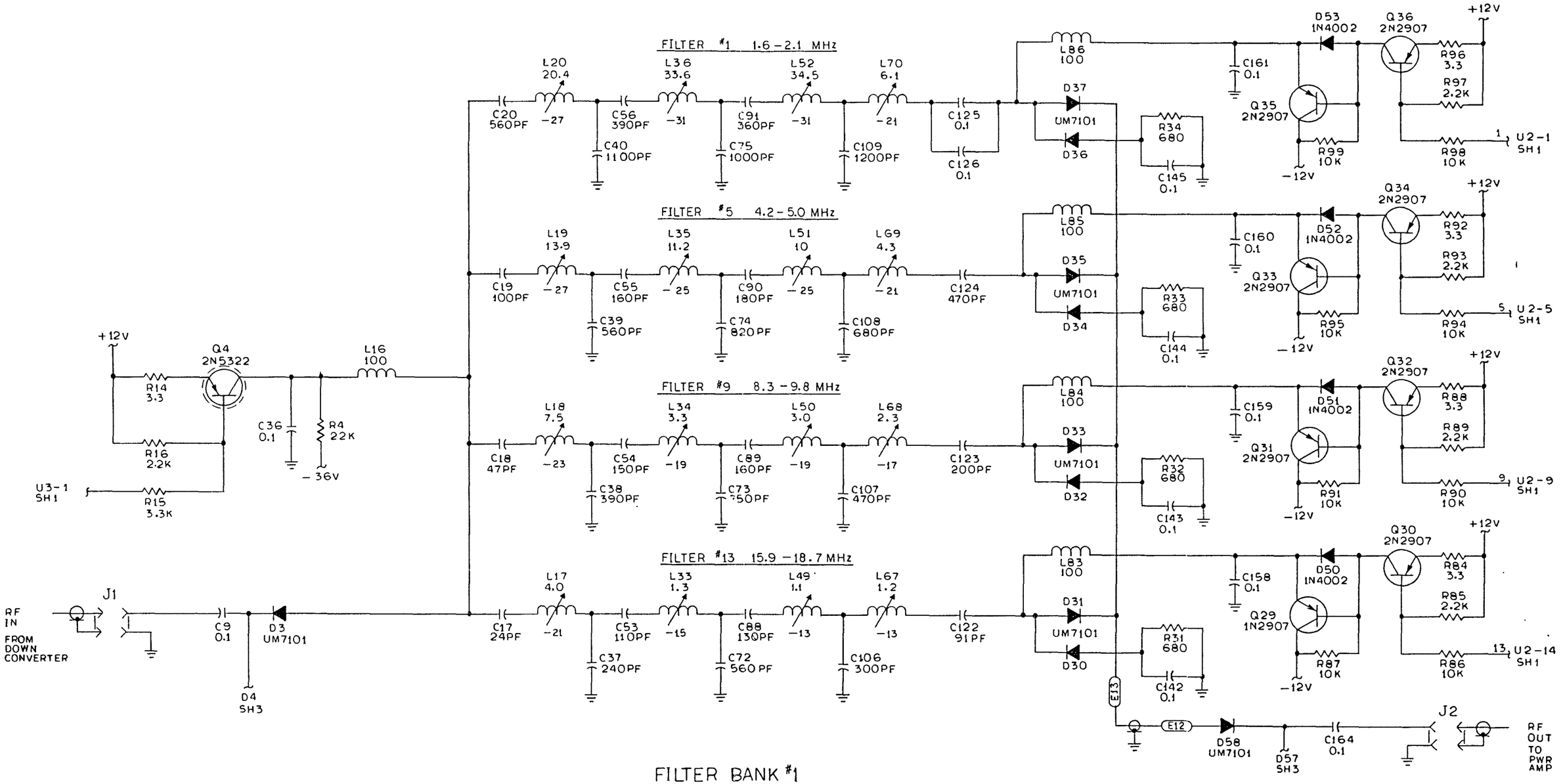
FILTER #	E5	E3	E4	E2
1	0	0	0	0
2	1	0	0	0
3	0	1	0	0
4	1	1	0	0
5	0	0	1	0
6	1	0	1	0
7	0	1	1	0
8	1	1	1	0
9	0	0	0	1
10	1	0	0	1
11	0	1	0	1
12	1	1	0	1
13	0	0	1	1
14	1	0	1	1
15	0	1	1	1
16	1	1	1	1

4 ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED

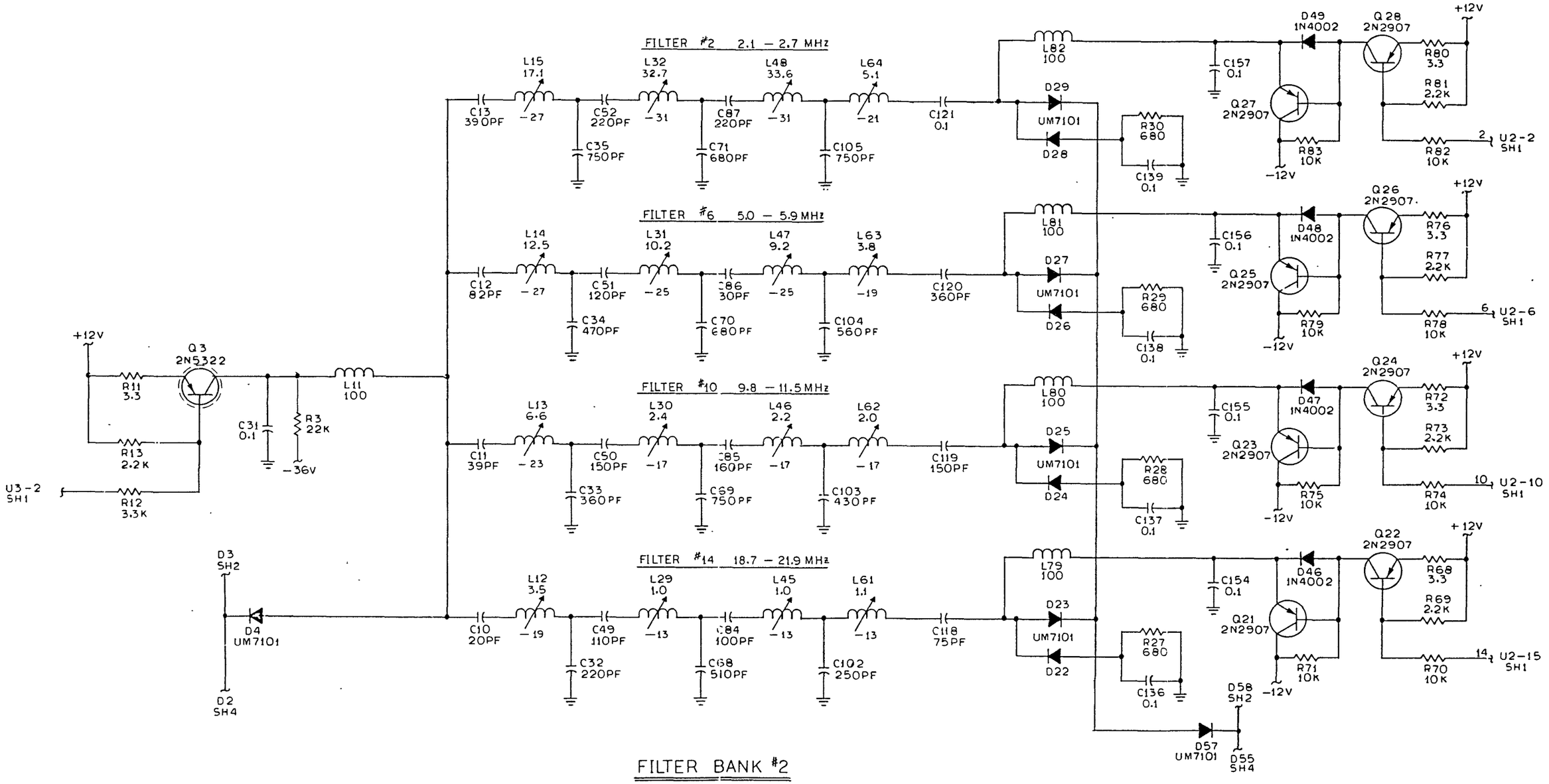
HIGHEST REFERENCE DESIGNATION									
C168	D58	E13	J2	L93	Q37	R101	U3		
REF. DESIGNATION NOT USED									
		E8,E9							

FO-23. Schematic Diagram, PCB Assembly, RF Preselector 1220-2014 (Sheet 1 of 5) Rev F



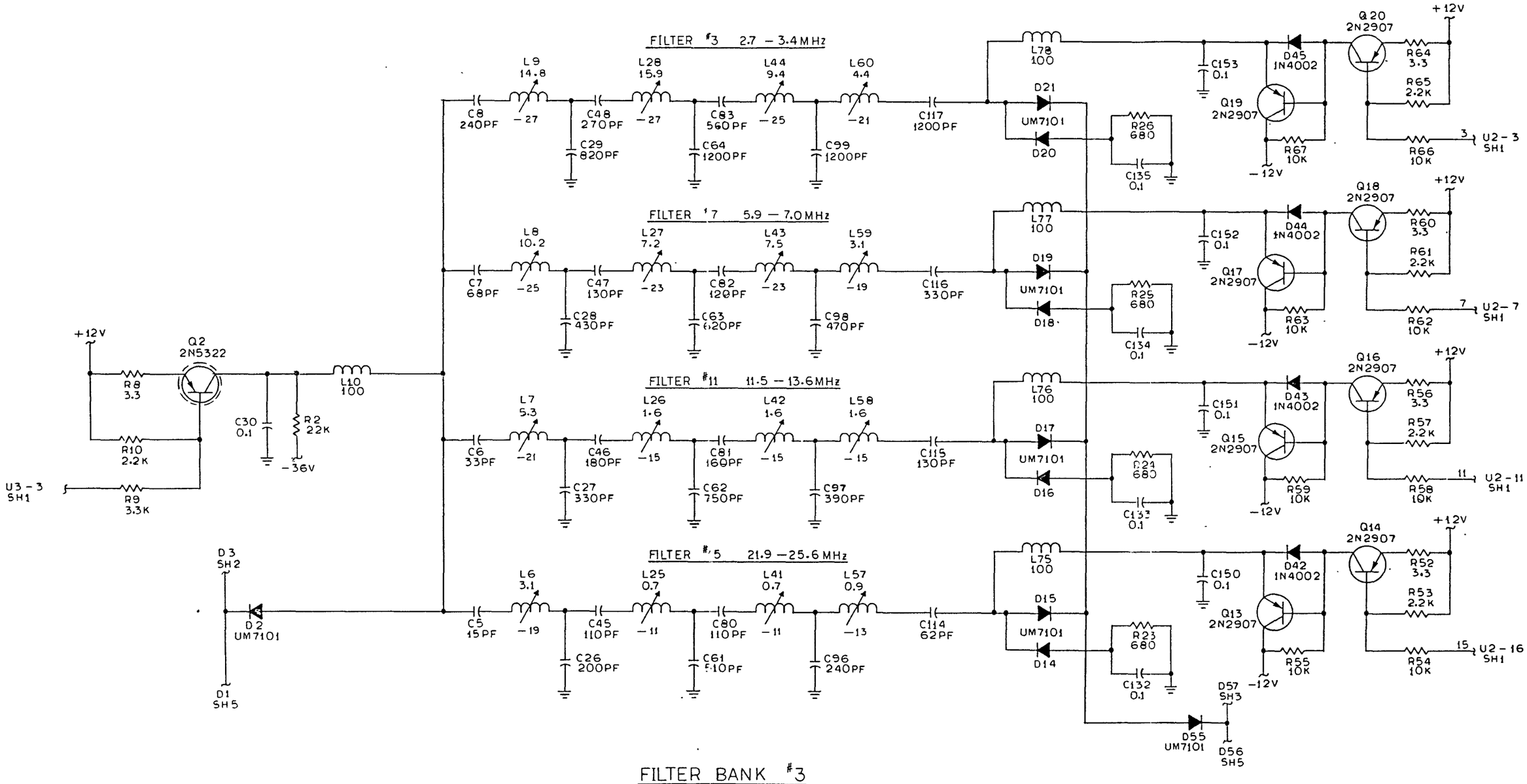
FILTER BANK #1

FO-23. Schematic Diagram, PCB Assembly, RF Preselector 1220-2014 (Sheet 2 of 5)



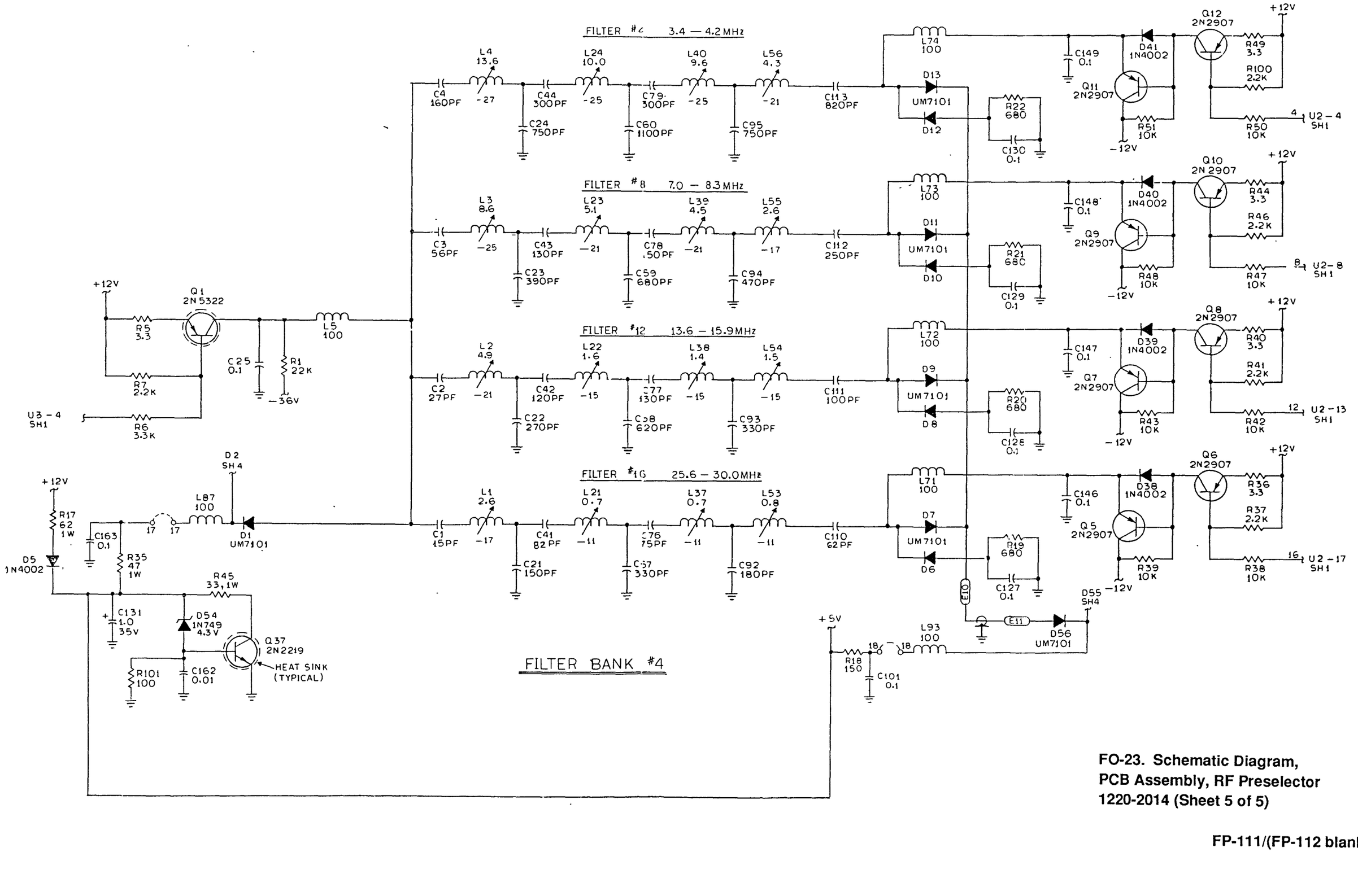
FILTER BANK #2

FO-23. Schematic Diagram, PCB Assembly, RF Preselector 1220-2014 (Sheet 3 of 5)

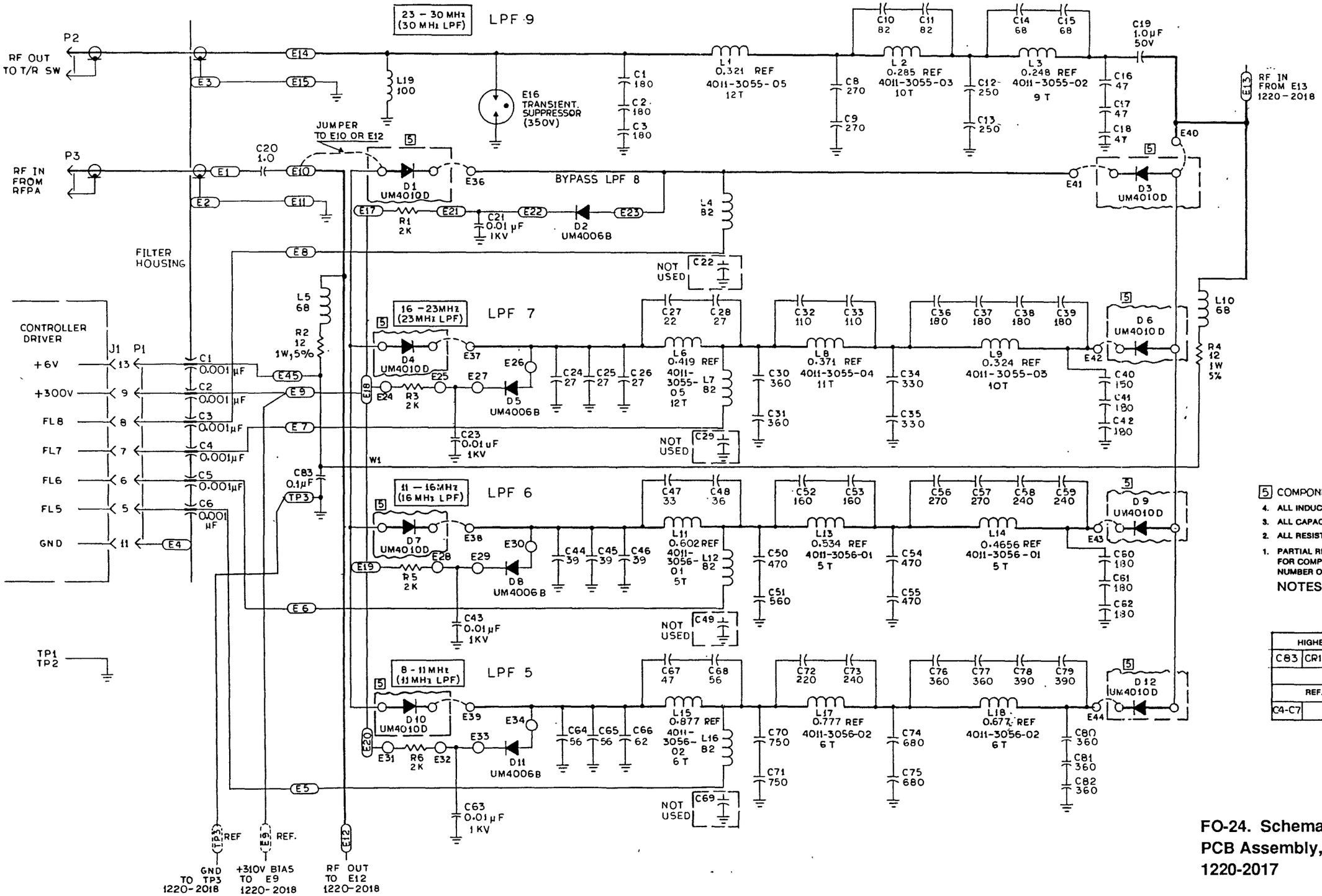


FILTER BANK #3

FO-23. Schematic Diagram, PCB Assembly, RF Preselector 1220-2014 (Sheet 4 of 5)



FO-23. Schematic Diagram, PCB Assembly, RF Preselector 1220-2014 (Sheet 5 of 5)



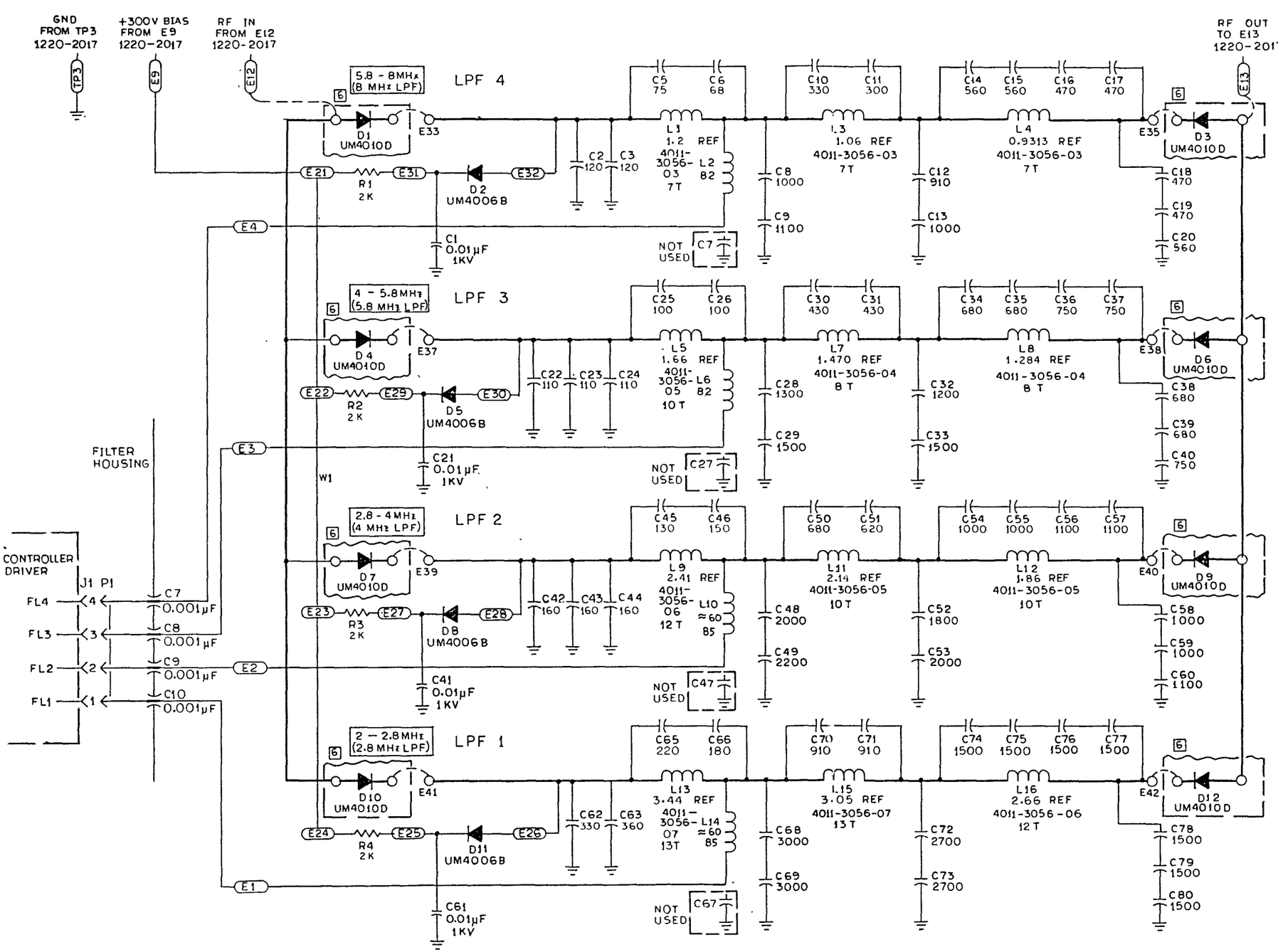
5 COMPONENTS ON NEXT ASSY 1220-1104

4. ALL INDUCTORS ARE IN MICROHENRYS.
3. ALL CAPACITORS ARE IN PICOFARADS
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION.						
C83	CR12	E45	J3	L19	R6	W1
REF. DESIGNATION NOT USED.						
C4-C7		E1-E4				

FO-24. Schematic Diagram, PCB Assembly, Filter 1220-2017 **Rev J**

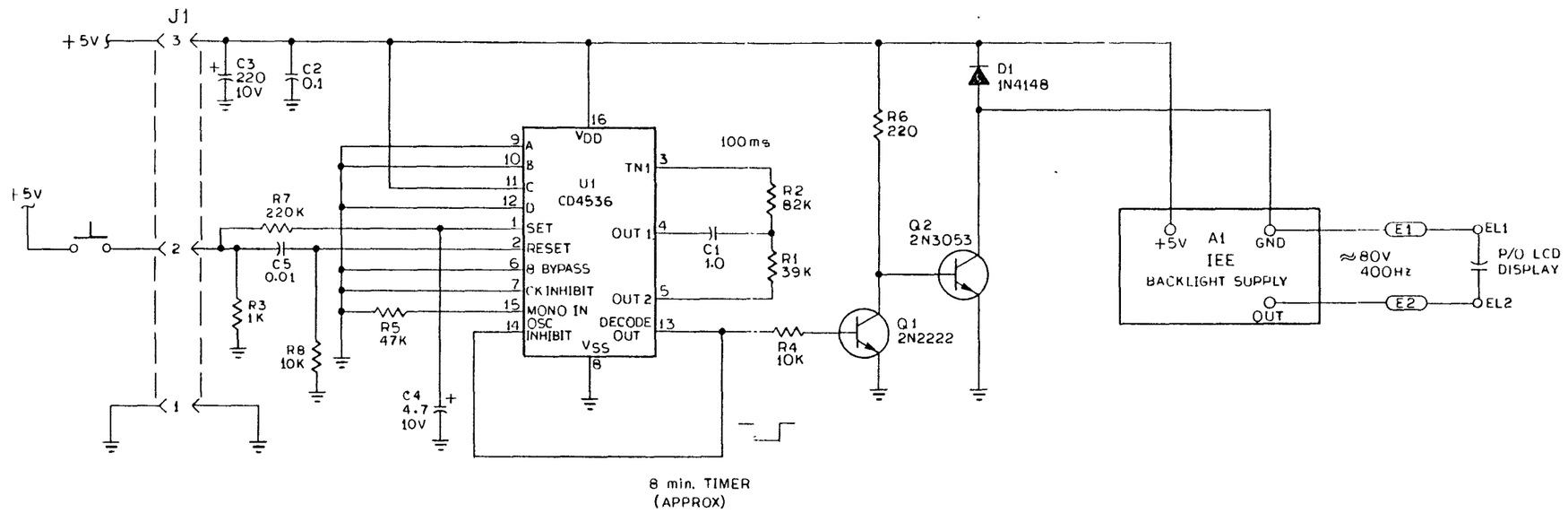


6. COMPONENTS ON NEXT ASSY 1220-1104
5. DIODES CR7, 8, 10, AND 12 ARE SELECTED FOR -60 dB OR BETTER HARMONIC RESPONSE AT 120 WATTS, BETWEEN 2 AND 4 MHz.
4. ALL INDUCTORS ARE IN MICROHENRYS..
3. ALL CAPACITORS ARE IN PICOFARADS.
2. ALL RESISTORS ARE IN OHMS 1/8W, ±1%.
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER OR SUBASSY DESIGNATION.

NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION						
C80	CR12	E32	J2	L16	R4	W1
REF DESIGNATIONS NOT USED						
C4, C64		E5-E8, E10 E11, E18-E20 E34, E36	J1			

FO-25. Schematic Diagram, PCB Assembly, Filter 1220-2018 **Rev F**



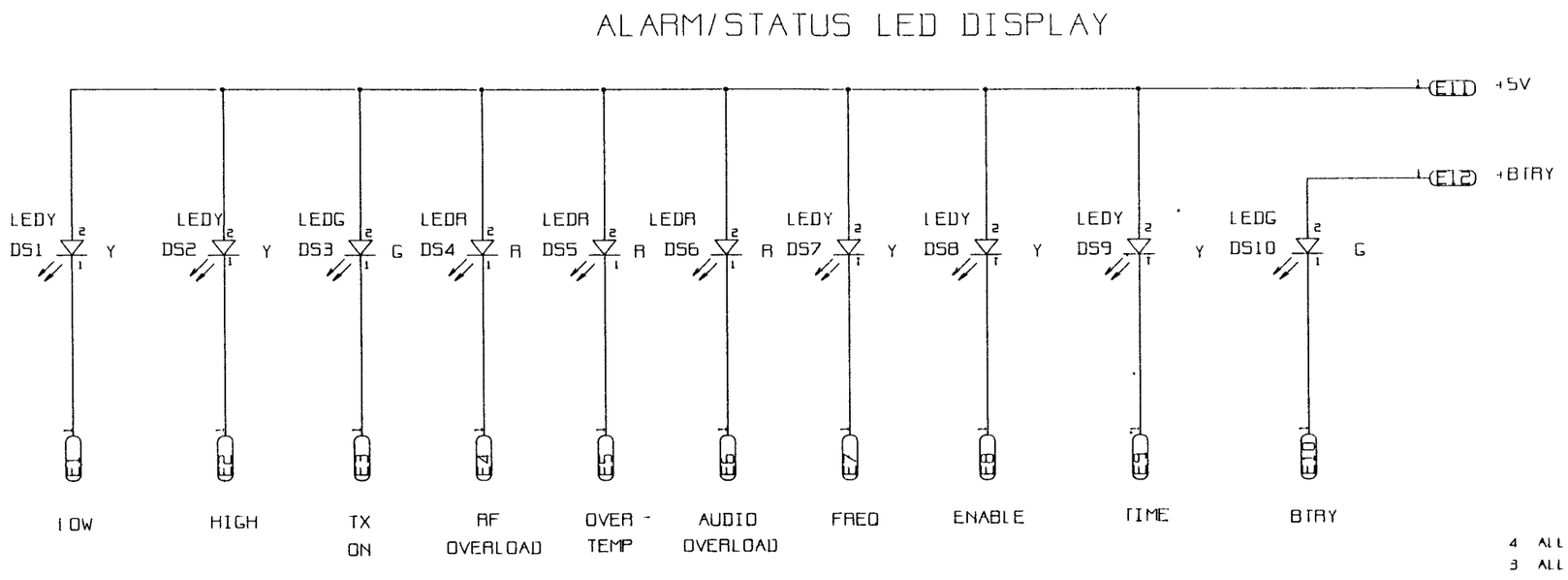
3 ALL CAPACITORS ARE IN MICROFARADS

2 ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION

NOTES: UNLESS OTHERWISE SPECIFIED.

FO-26. Schematic Diagram,
PCB Assembly,
Backlight Delay Timer
1220-2019 **Rev C**

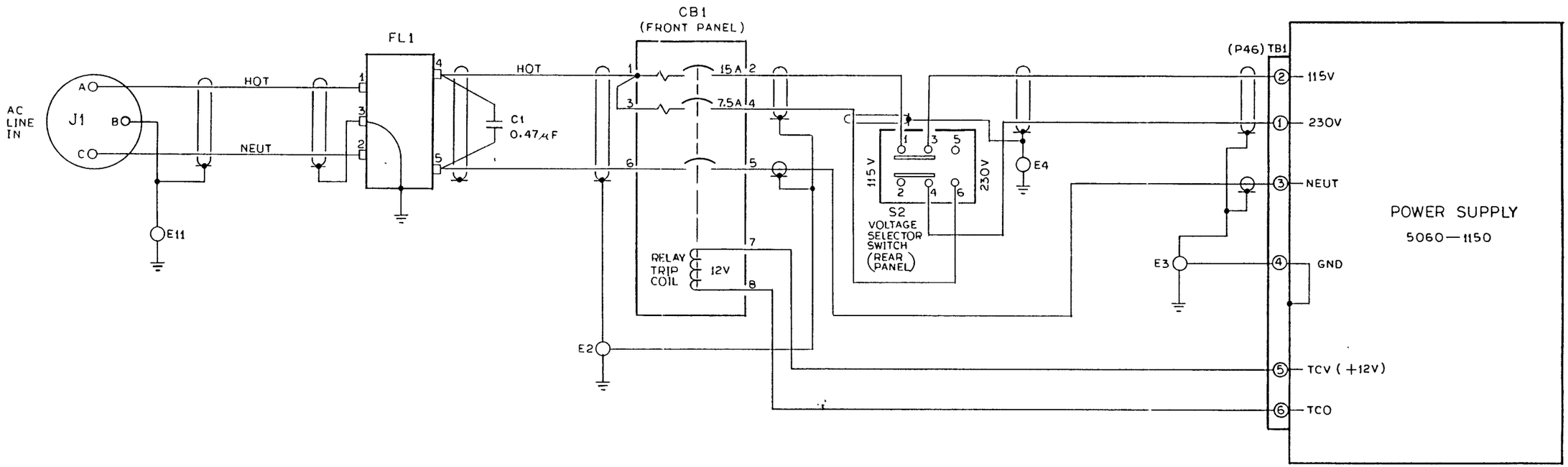


4 ALL INDUCTORS ARE IN MICROHENRYS
3 ALL CAPACITORS ARE IN MICROFARADS
2 ALL RESISTORS ARE IN OHMS 1/4W ±5%
1 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION.

NOTES- UNLESS OTHERWISE SPECIFIED

HIGHEST REFERENCE DESIGNATION											
REF DESIGNATION NOT USED											

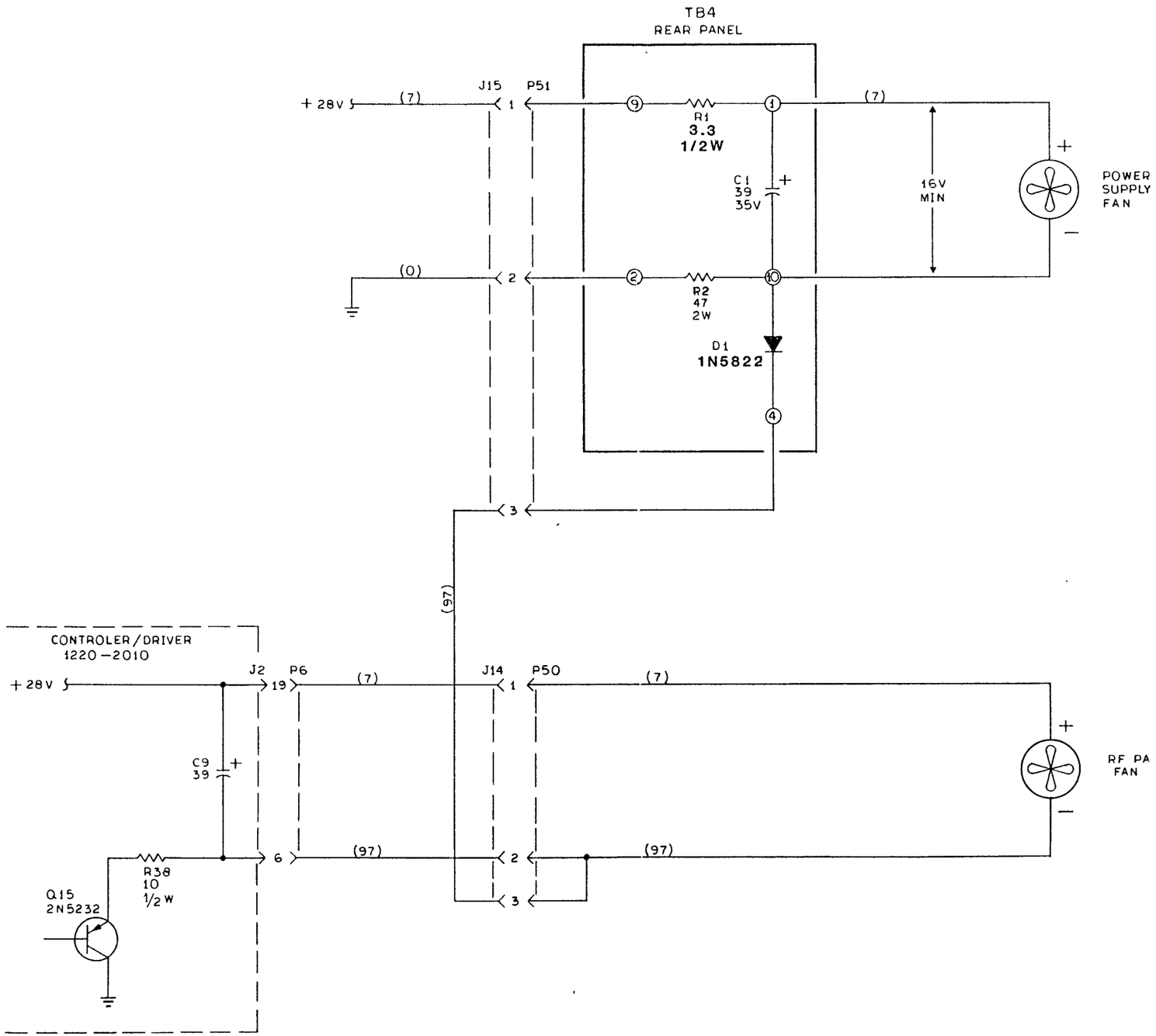
FO-27. Schematic Diagram, PCB Assembly, Alarm/Status LED Display 1220-2020 Rev B



1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION

NOTES: UNLESS OTHERWISE SPECIFIED.

FO-28. Schematic Diagram, Power Section, AC Power
BR Drawing No. 1220-5026 Rev C



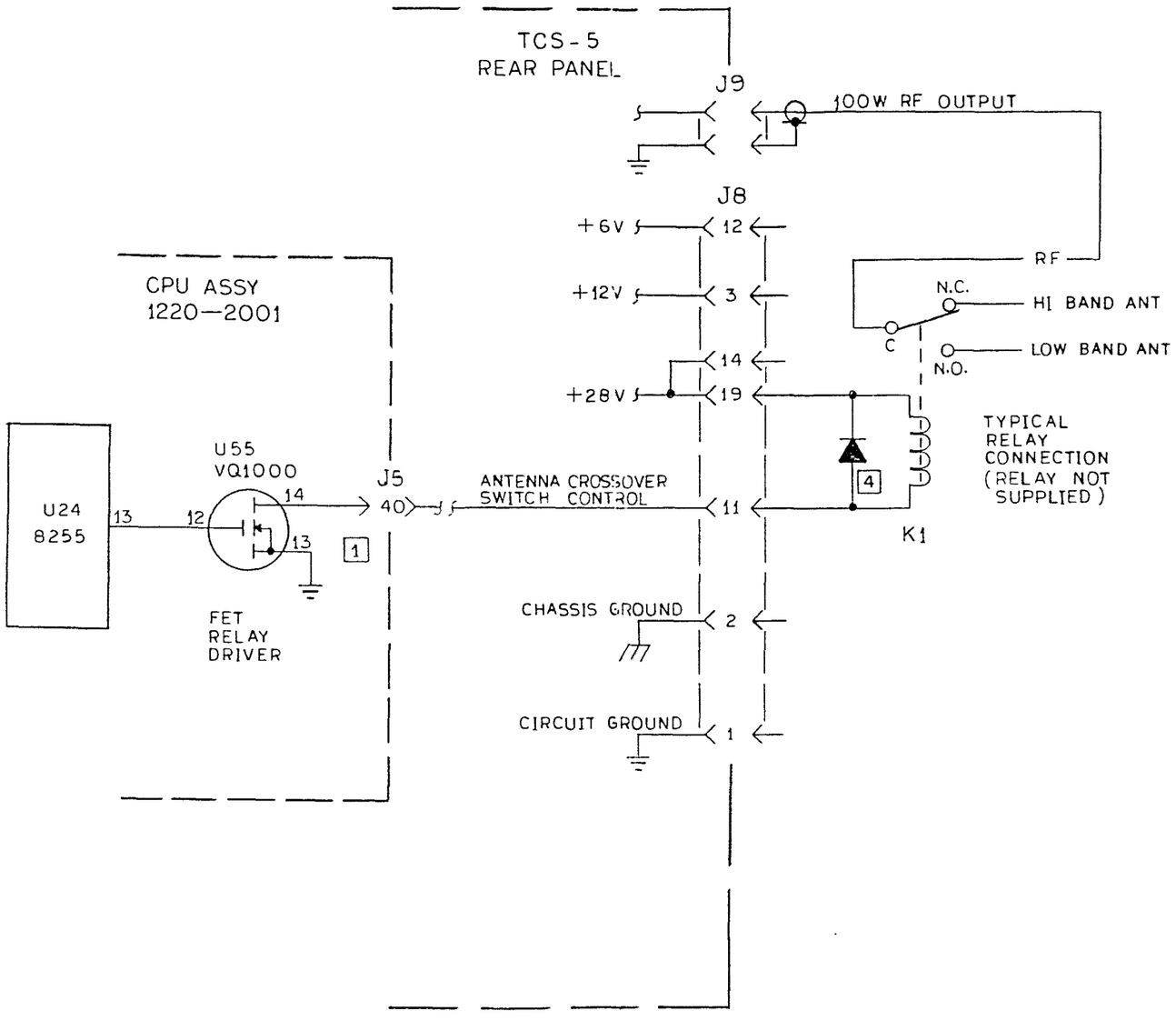
3 ALL CAPACITORS ARE IN MICROFARADS

2 ALL RESISTORS ARE IN OHMS, 1/4W, ±5%

1 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION, PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION

NOTES: UNLESS OTHERWISE SPECIFIED.

FO-29. Schematic Diagram, Power Section, Fan
BR Drawing No. 1220-5027 Rev D



NOTES: UNLESS OTHERWISE SPECIFIED;

[1] FOR TCS-5 VERSION 06 FIRMWARE, FET RELAY DRIVER CONNECTED TO TCS-5 REAR PANEL CONNECTOR J8 PIN 11 WILL DRIVE AN EXTERNAL RELAY (NOT PROVIDED) THAT WILL SWITCH WHEN TCS-5 RF OUTPUT CROSSES THE "CROSSOVER" FREQUENCY PROGRAMED ON TCS-5 "ANTENNA CROSSOVER" MENU. FET DRIVER WILL BE "ON" (CONDUCTING) FOR FREQUENCIES BELOW THE CROSSOVER FREQUENCY, AND "OFF" (OPEN CIRCUIT) FOR FREQUENCIES AT OR ABOVE THE CROSSOVER FREQUENCY.

2. MAX. CURRENT SINK ON J8 - 11 IS 200 MA.

3. MAX. ALLOWABLE VOLTAGE AT J8 - 11 IS + 40 VDC.

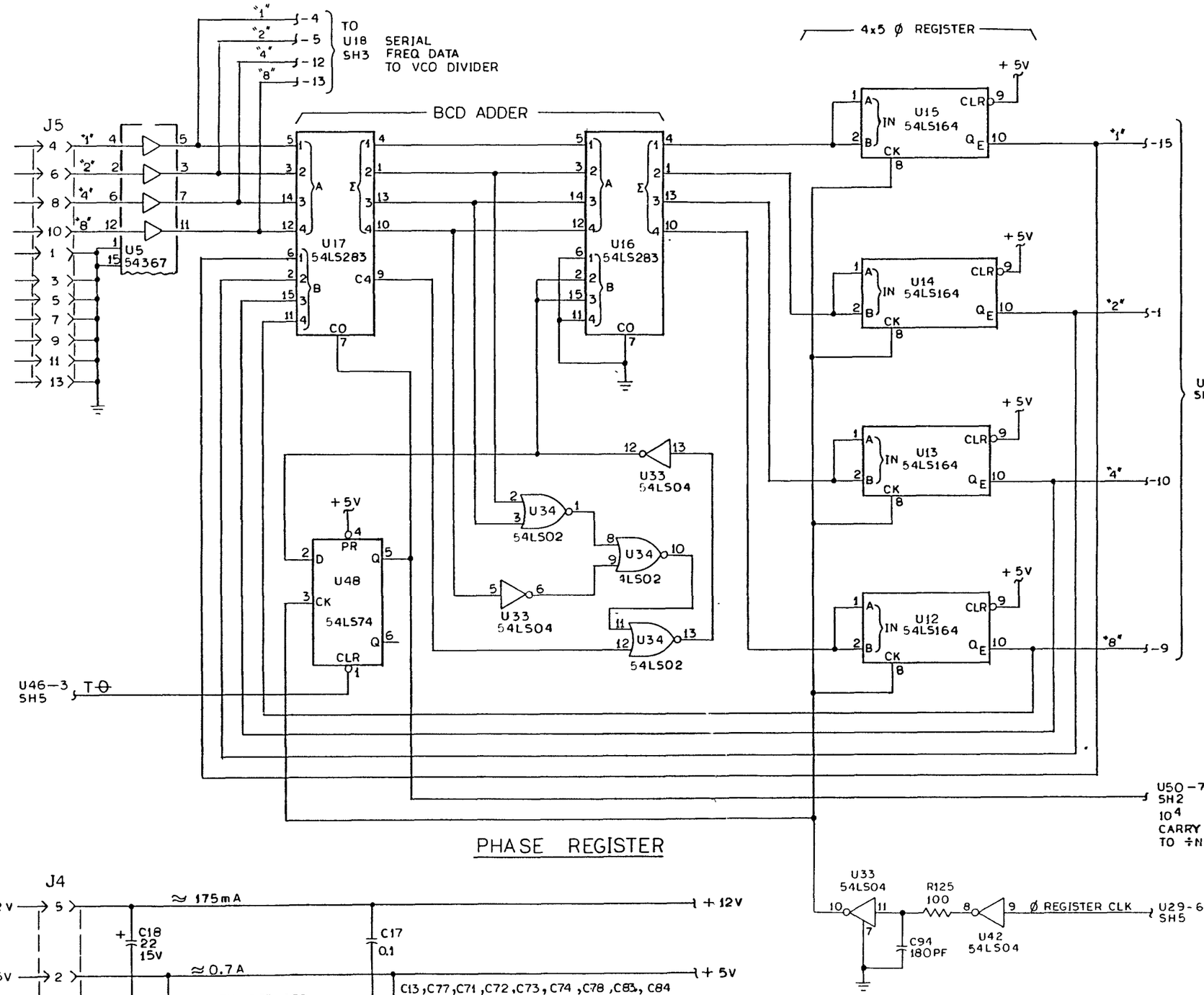
[4] A RELAY COIL TRANSIENT SUPPRESSOR DIODE (SUCH AS A 1N4002) MUST BE INSTALLED ACROSS THE RELAY COIL.

5. J5 CONNECTOR IS BR P/N 1253-0006 (MS-27508E12F35S).

6. J8 MATING CONNECTOR IS PROVIDED IN THE TCS-5 ACCESSORY KIT. THE UNASSEMBLED MATING CONNECTOR IS BR P/N 1253-0005 (MS-27473E12F35P), WITH CABLE CLAMP BR P/N 1253-0025 (MS-27506F12-2)

7. SUITABLE RELAY FOR K1 IS BRPN 0490-0016.

FO-30. Schematic Diagram, TCS-5 Antenna Crossover BR Drawing No. 1220-5029



POWER DISTRIBUTION.		
DEVICE	+5VD	GND
54(S)(LS)00	14	7
54LS02	14	7
54(S)(LS)04	14	7
54(S)(LS)74	14	7
54(S)(LS)112	16	8
54LS164	14	7
54LS175	16	8
54(S)(LS)192	16	8
54LS283	16	8
54367	16	8

[8] U19 AND U36 ARE 2840-L6ØØ BCD SUBTRACTOR PROMS.

[7] RESISTOR, DIP 14PIN BECKMAN 899-1-R4.7K.

6. (XXX) INDICATES D.C. VOLTAGE.

5. +5V IS +5VD.

4. ALL INDUCTORS ARE IN MICROHENRYS.

3. ALL CAPACITORS ARE IN MICROFARADS.

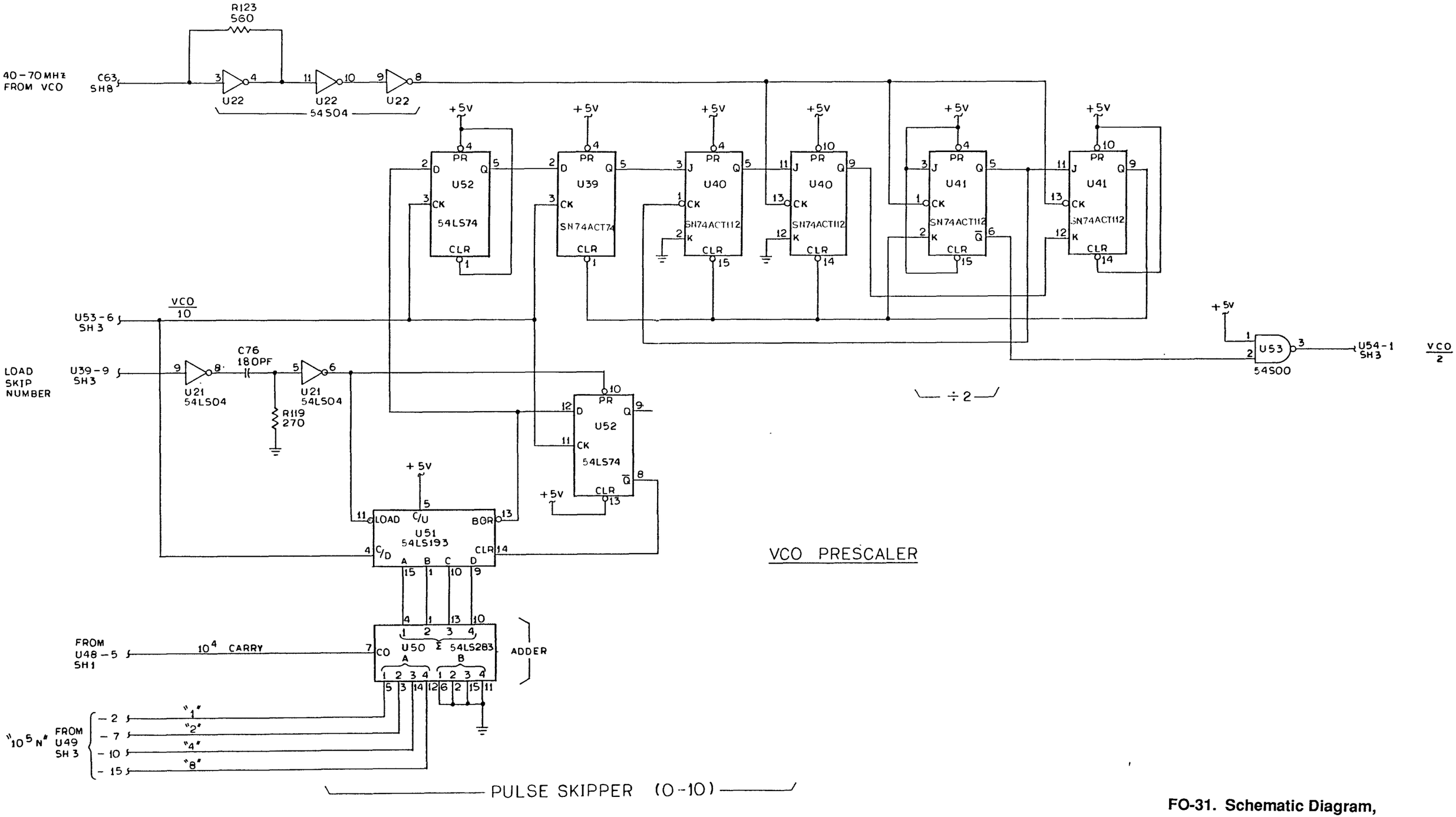
2. ALL RESISTORS ARE IN OHMS 1/4W, 5%.

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER OR SUBASSY DESIGNATION

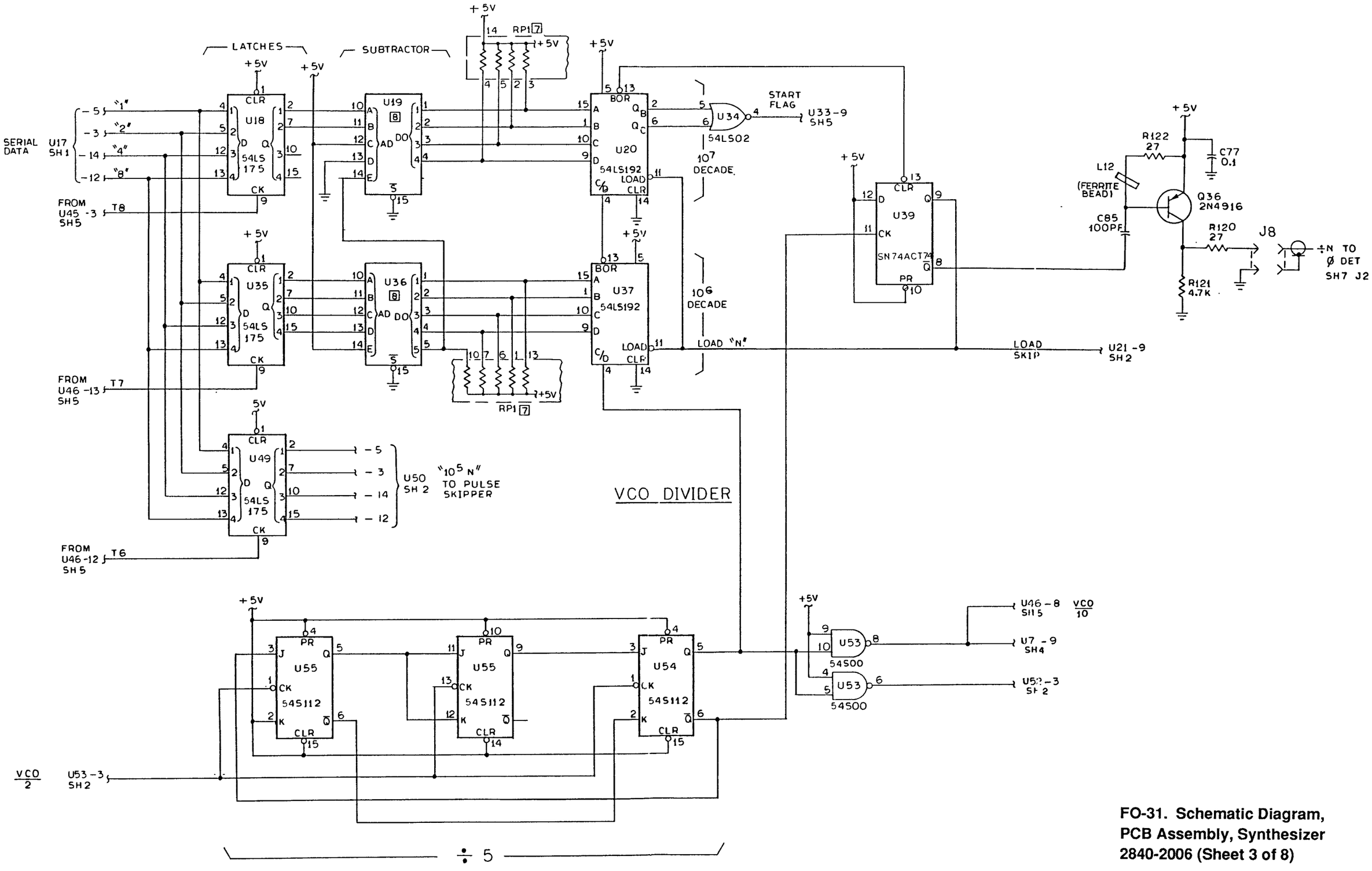
NOTES: UNLESS OTHERWISE SPECIFIED.

HIGHEST REFERENCE DESIGNATION										
C100	D21	DS1	J10	L12	Q38	R134	RP1	TP4	U55	VR5
REF DESIGNATIONS NOT USED										
		J9						U31 U38		

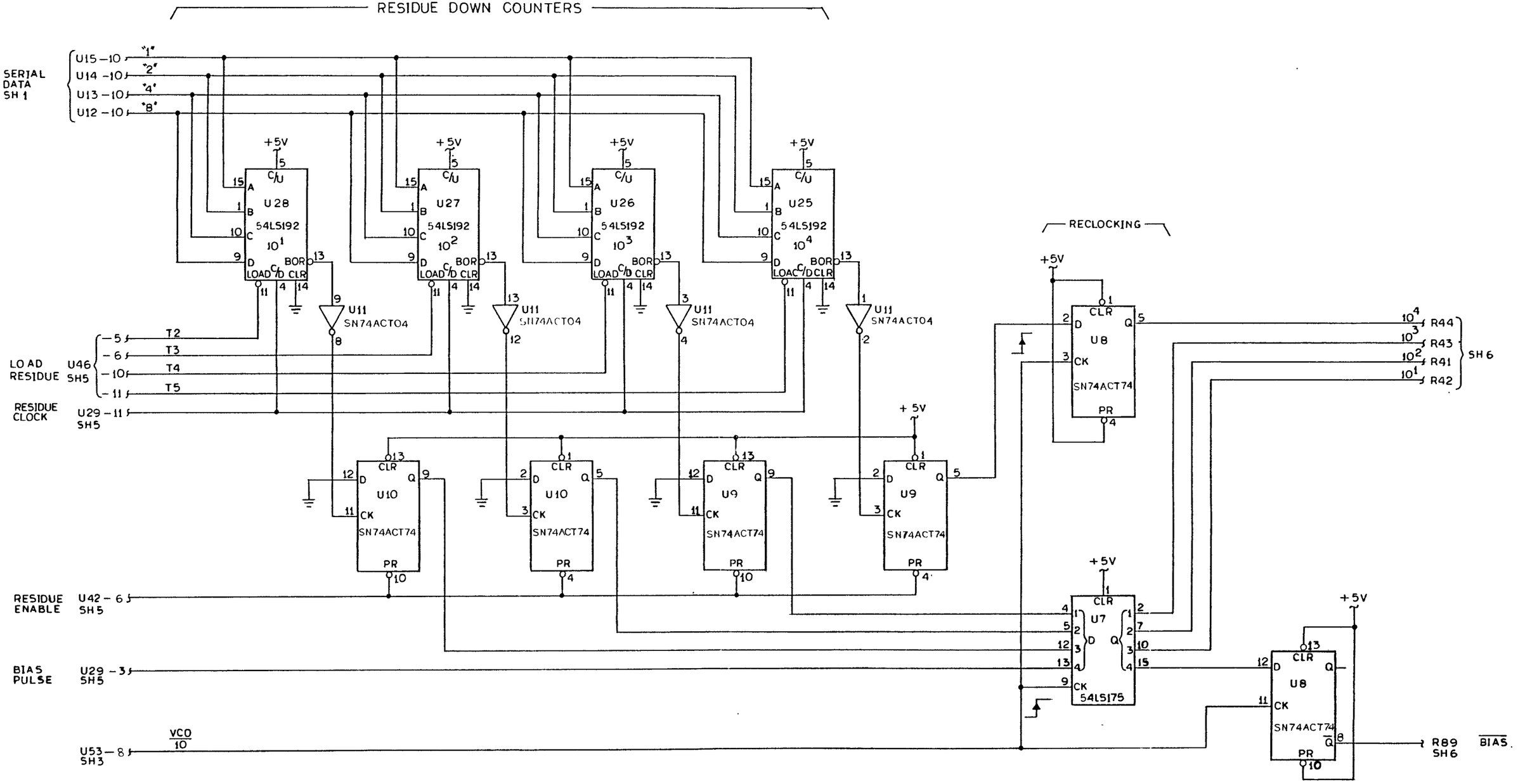
FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 1 of 8) Rev F



FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 2 of 8)

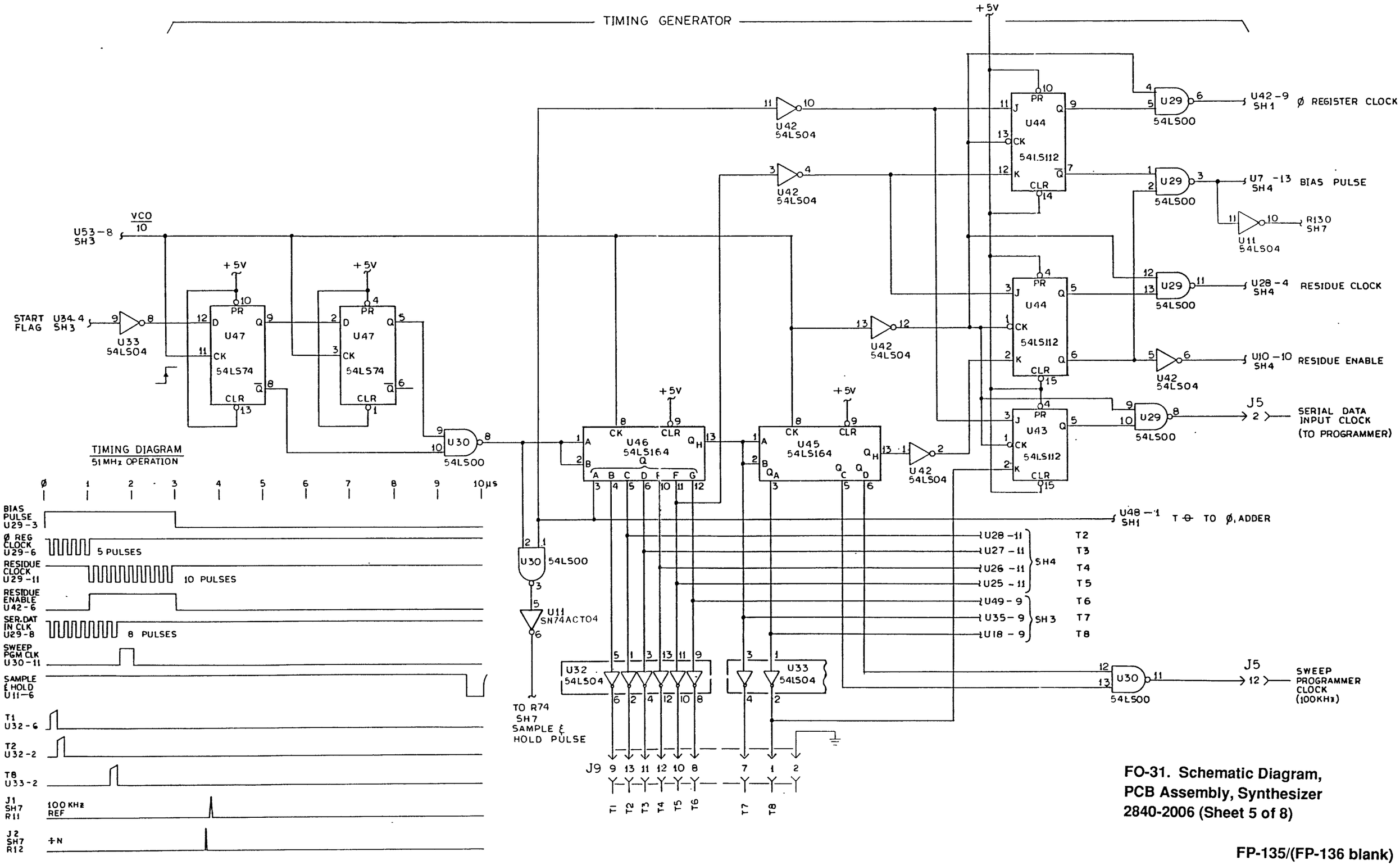


FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 3 of 8)

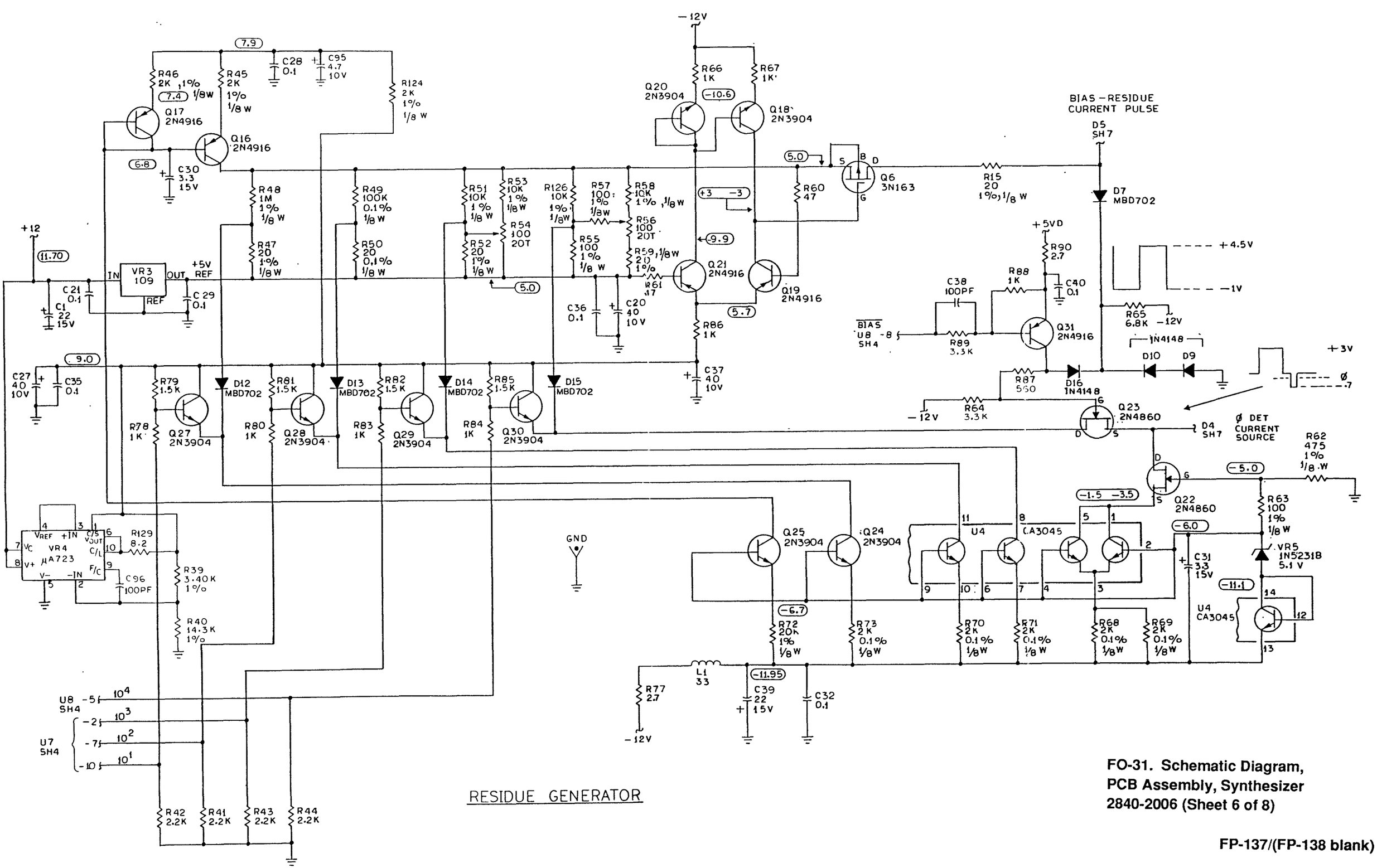


RESIDUE LOGIC

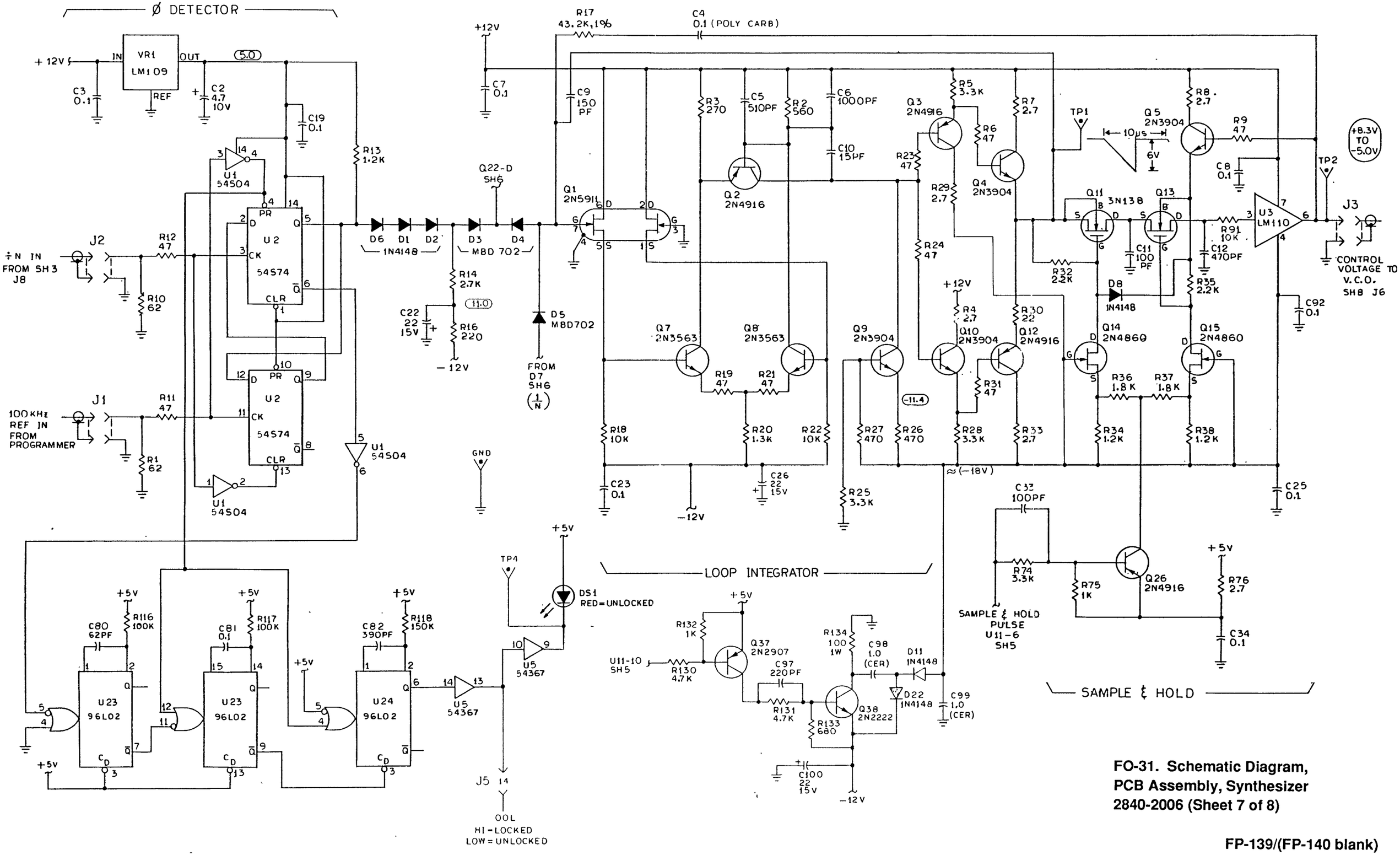
FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 4 of 8)



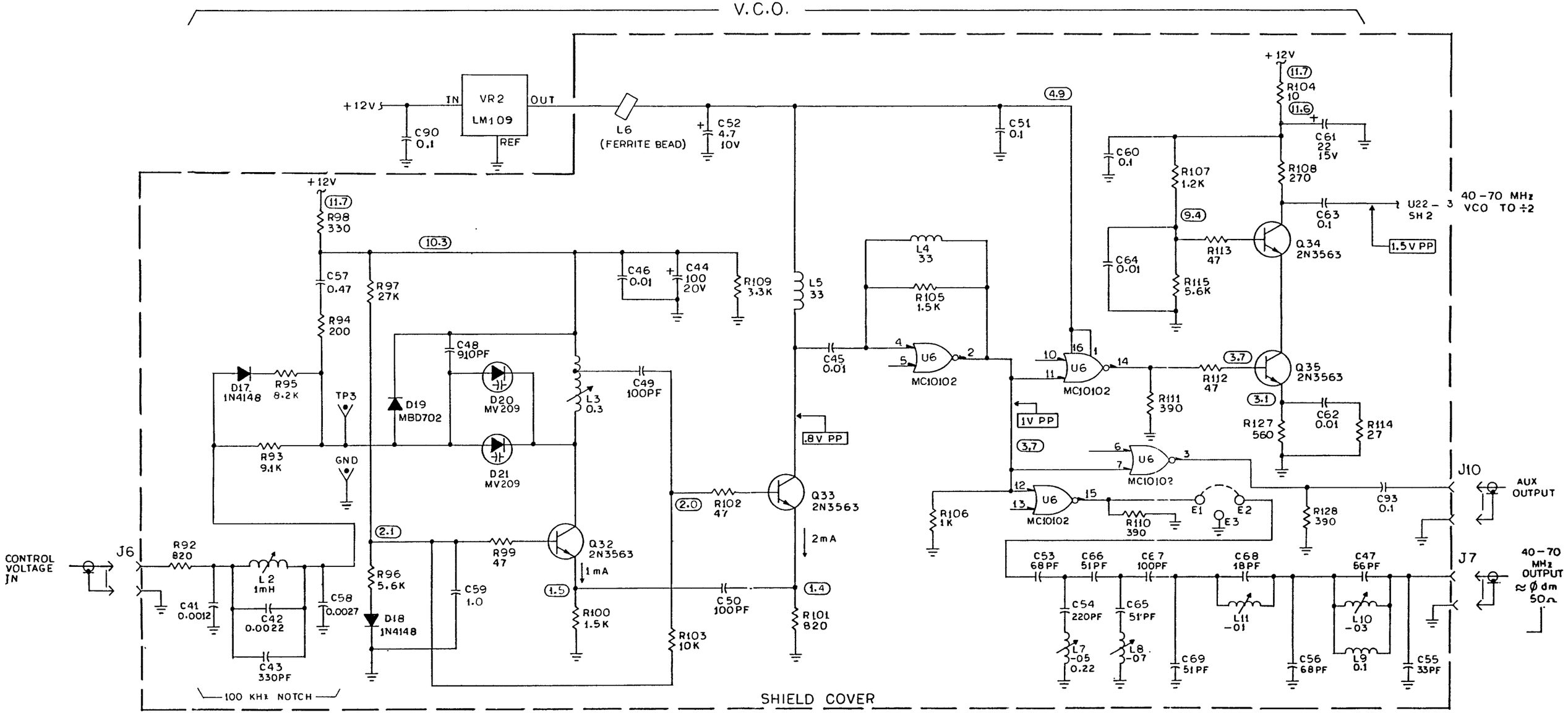
FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 5 of 8)

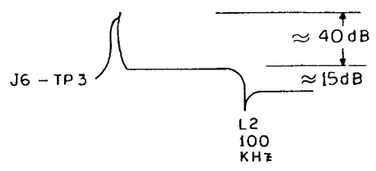


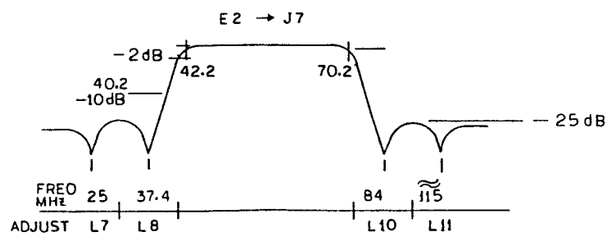
FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 6 of 8)



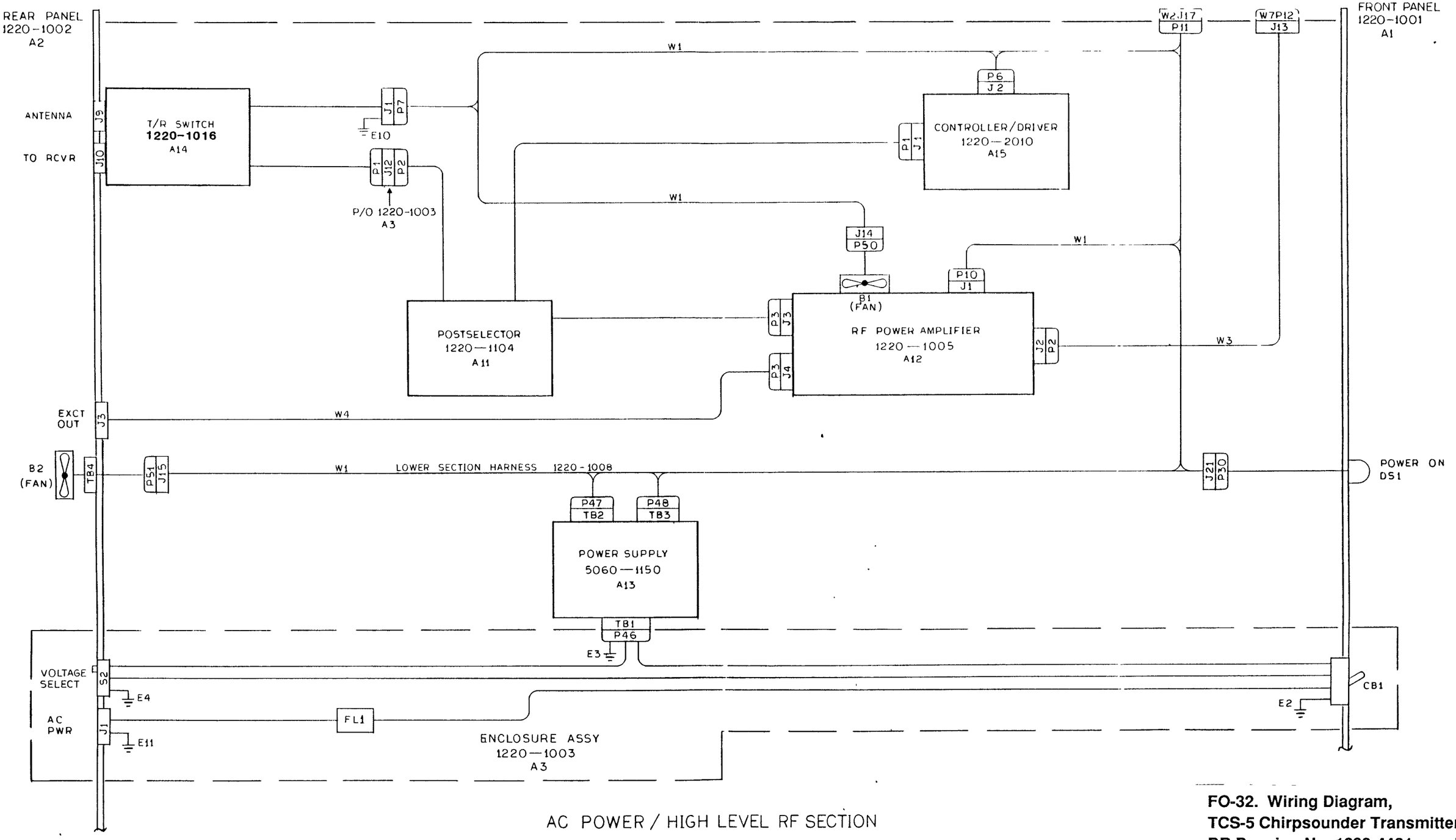
FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 7 of 8)







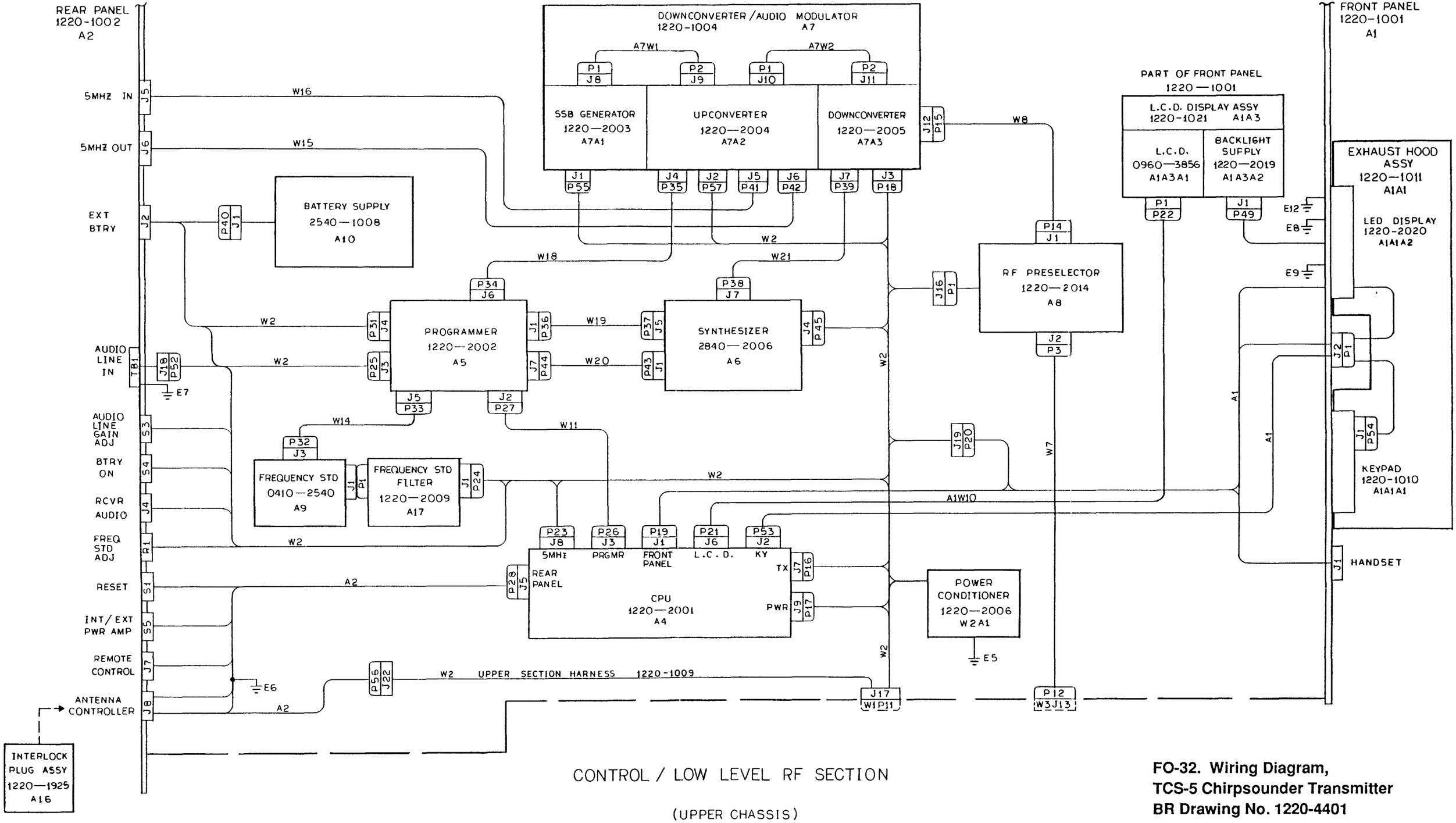
FO-31. Schematic Diagram, PCB Assembly, Synthesizer 2840-2006 (Sheet 8 of 8)



AC POWER / HIGH LEVEL RF SECTION

(LOWER CHASSIS)

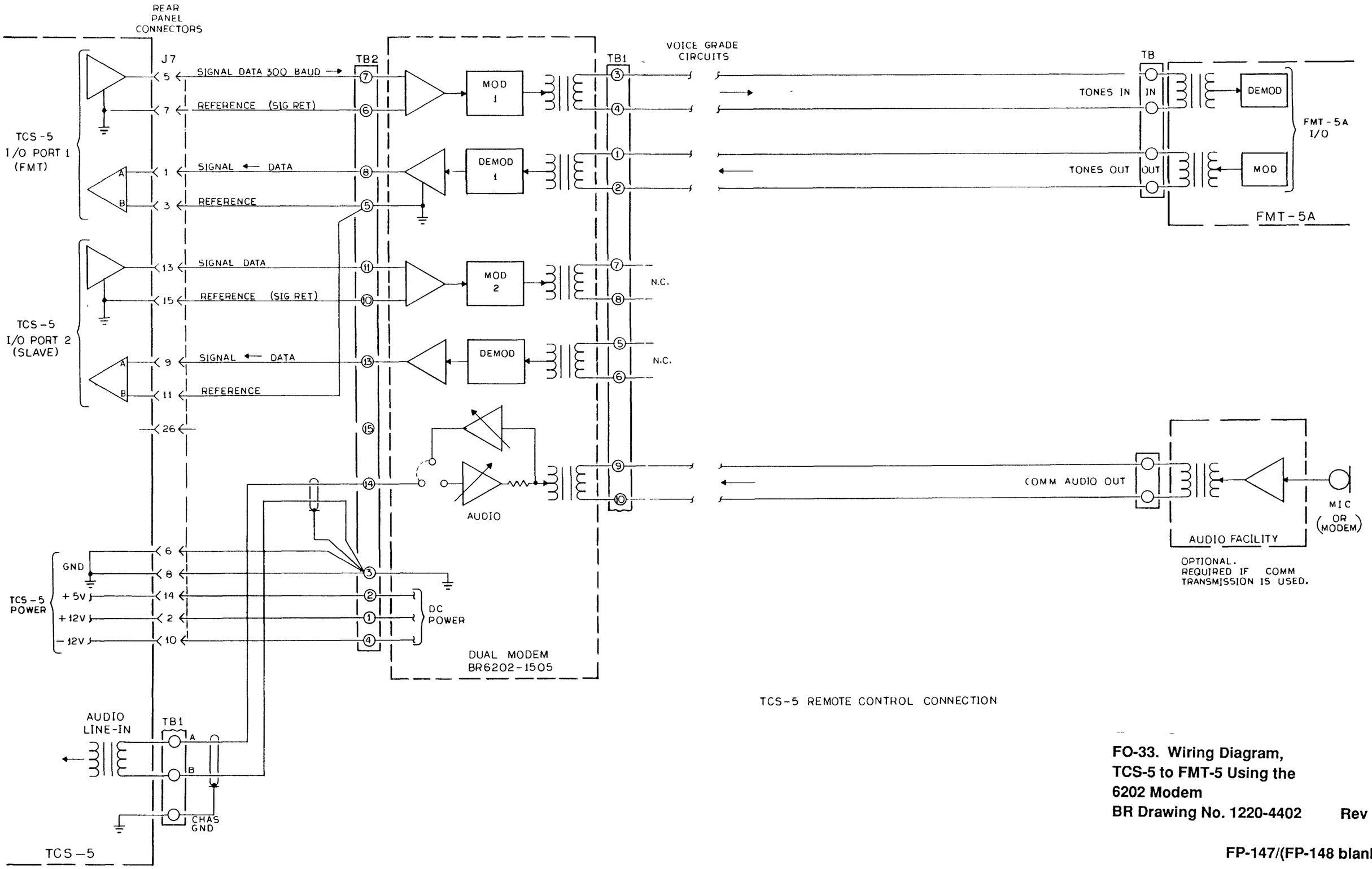
FO-32. Wiring Diagram,
TCS-5 Chirpsounder Transmitter
BR Drawing No. 1220-4401 Rev A
(Sheet 1 of 2)



CONTROL / LOW LEVEL RF SECTION

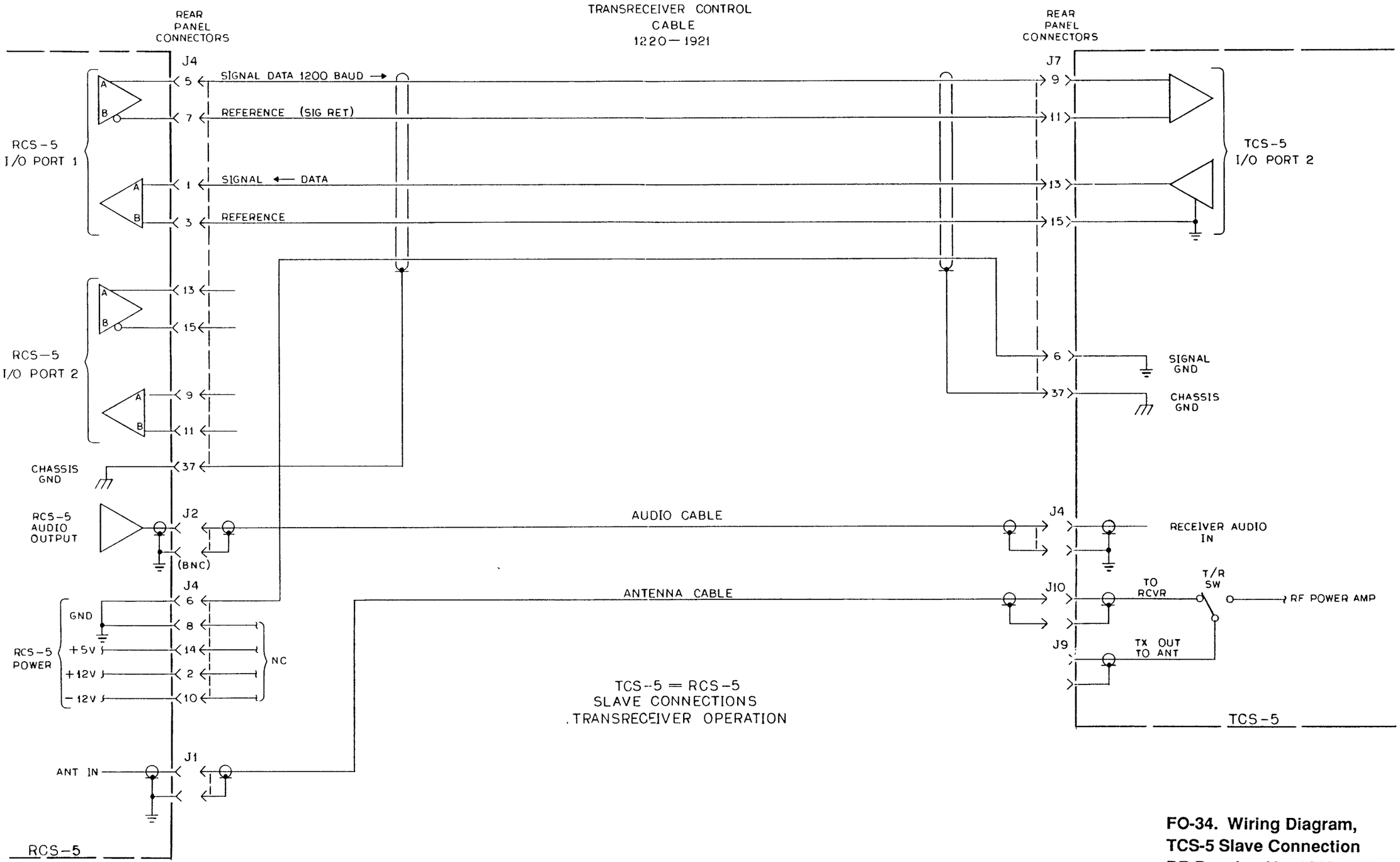
(UPPER CHASSIS)

FO-32. Wiring Diagram,
TCS-5 Chirpsounder Transmitter
BR Drawing No. 1220-4401
(Sheet 2 of 2)



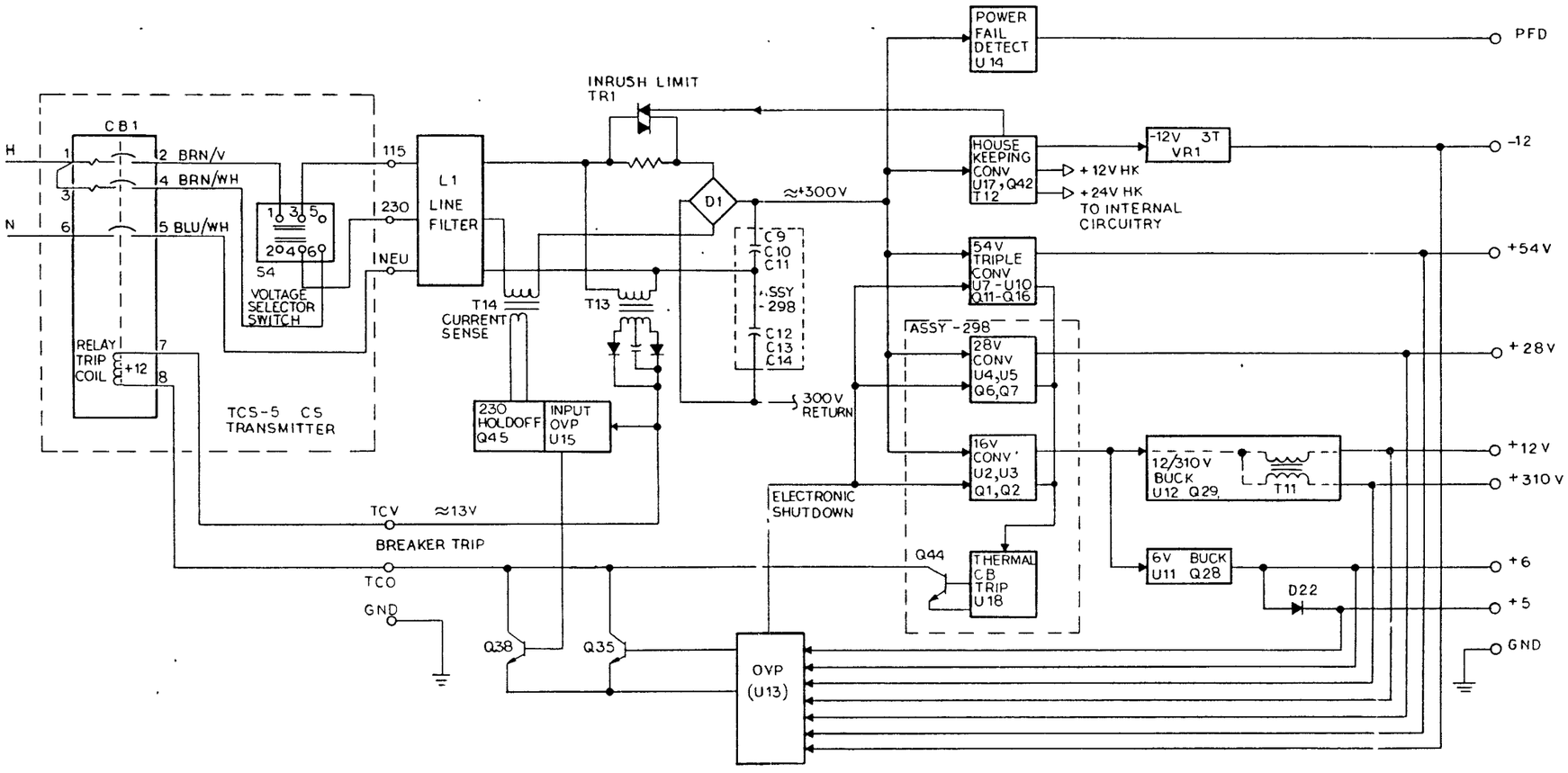
TCS-5 REMOTE CONTROL CONNECTION

FO-33. Wiring Diagram, TCS-5 to FMT-5 Using the 6202 Modem
BR Drawing No. 1220-4402 **Rev A**

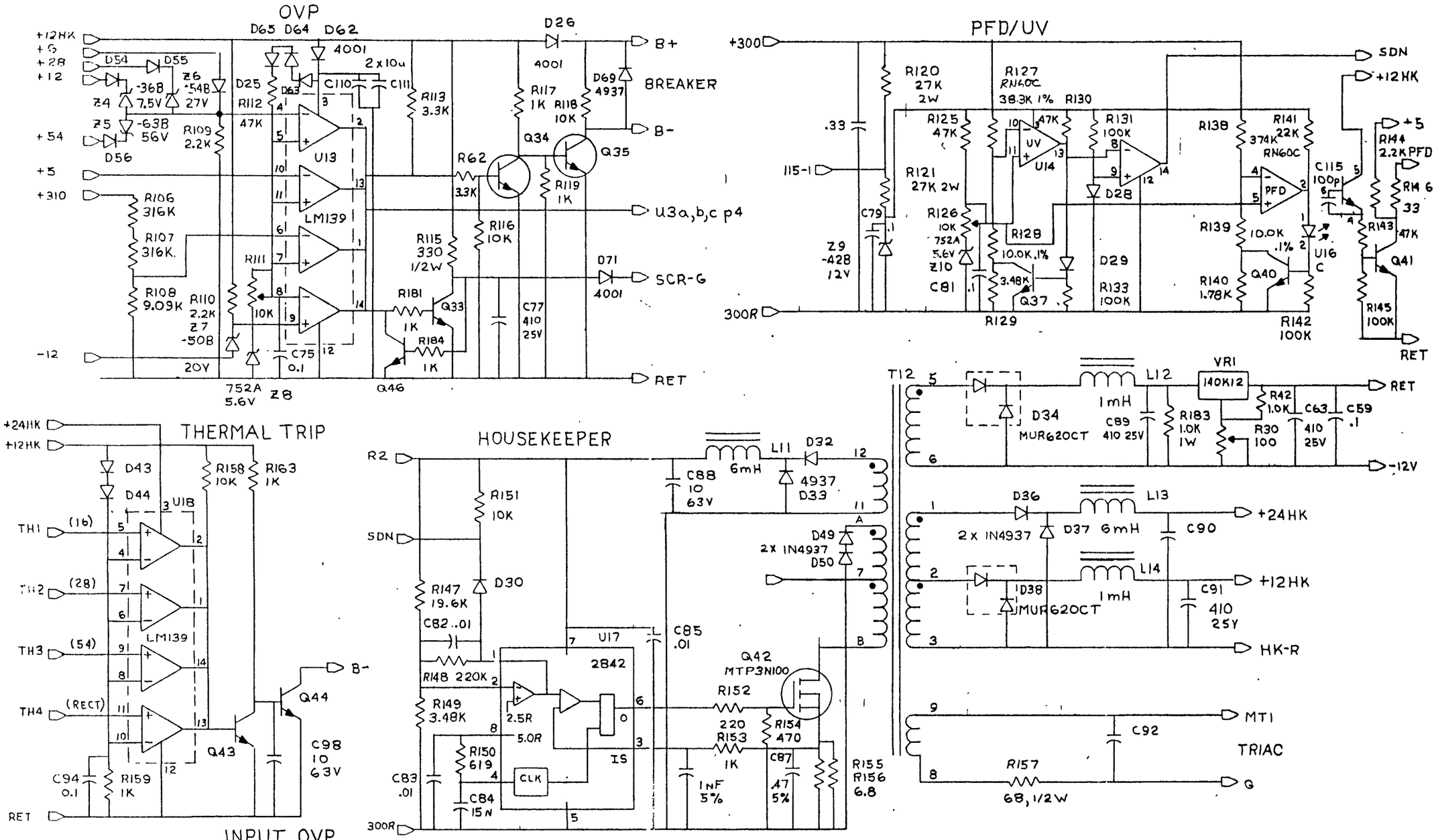


TCS-5 = RCS-5
SLAVE CONNECTIONS
TRANSRECEIVER OPERATION

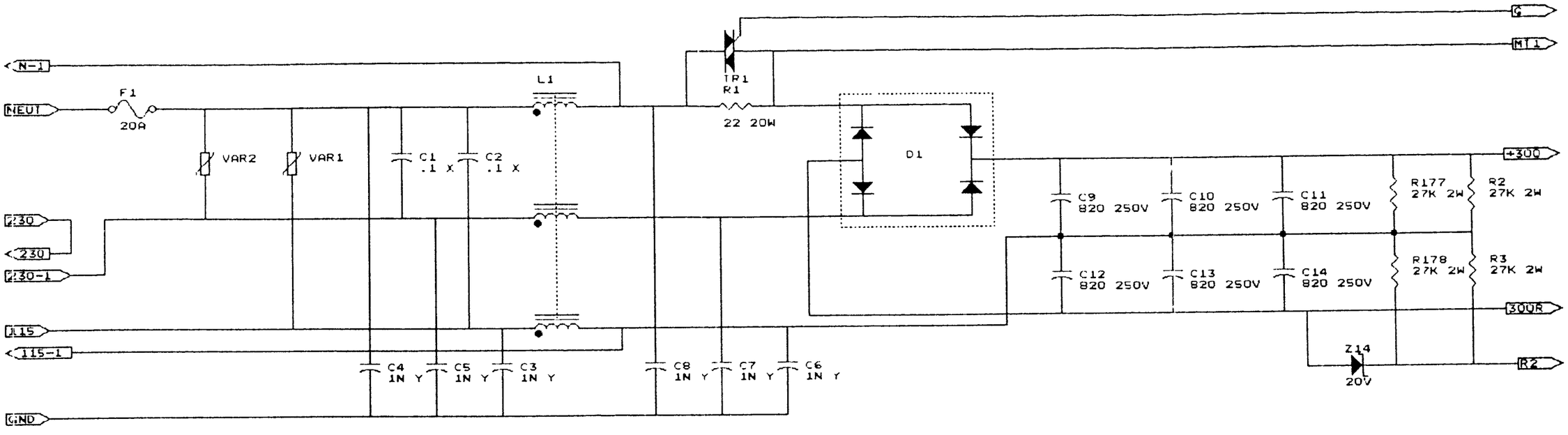
FO-34. Wiring Diagram, TCS-5 Slave Connection BR Drawing No. 1220-4403 Rev A



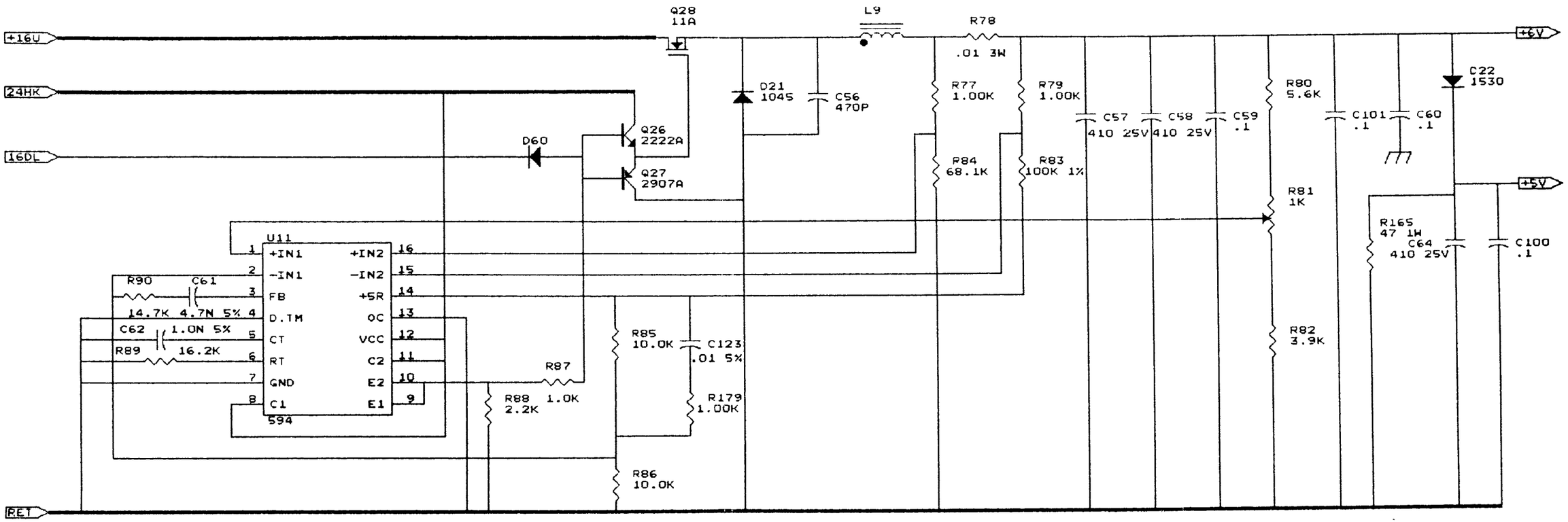
FO-35. Block Diagram, TCS-5 Power Supply 5060-1150



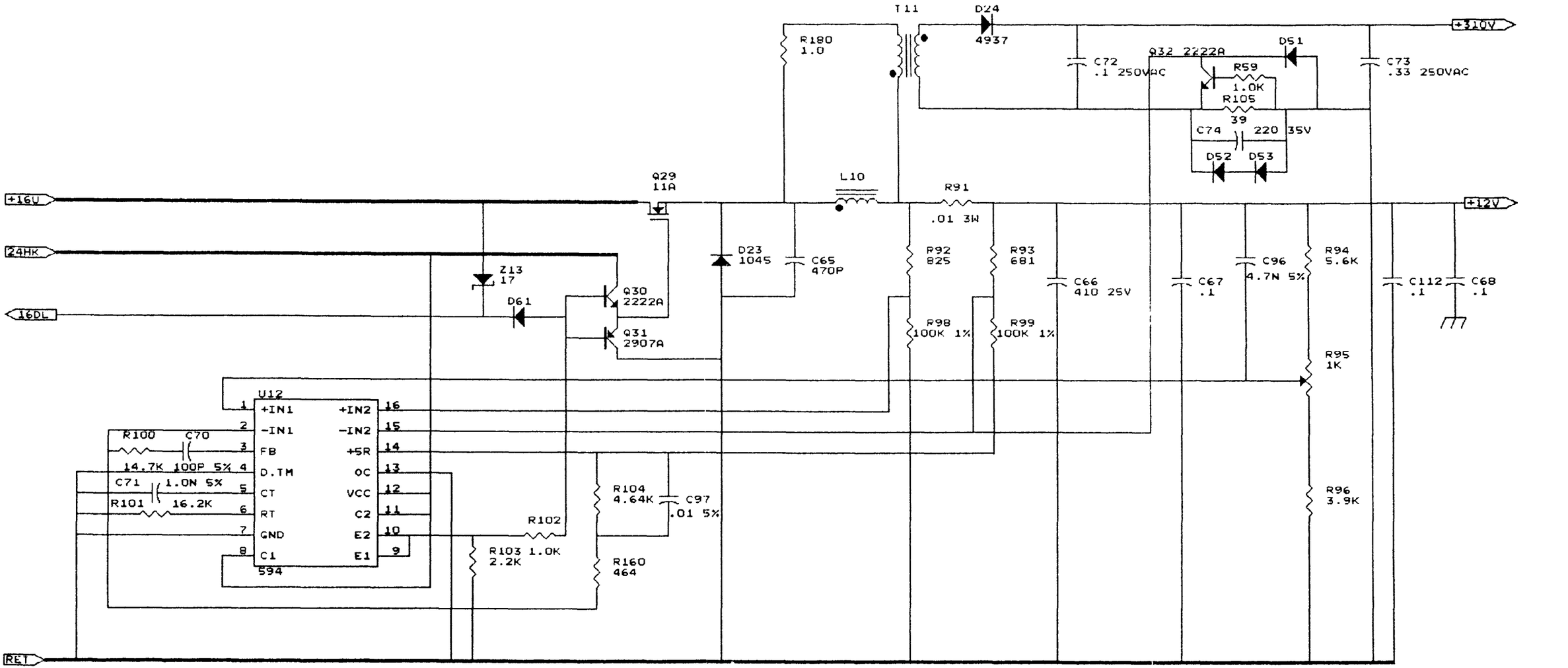
FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 1 of 9) **Rev D**



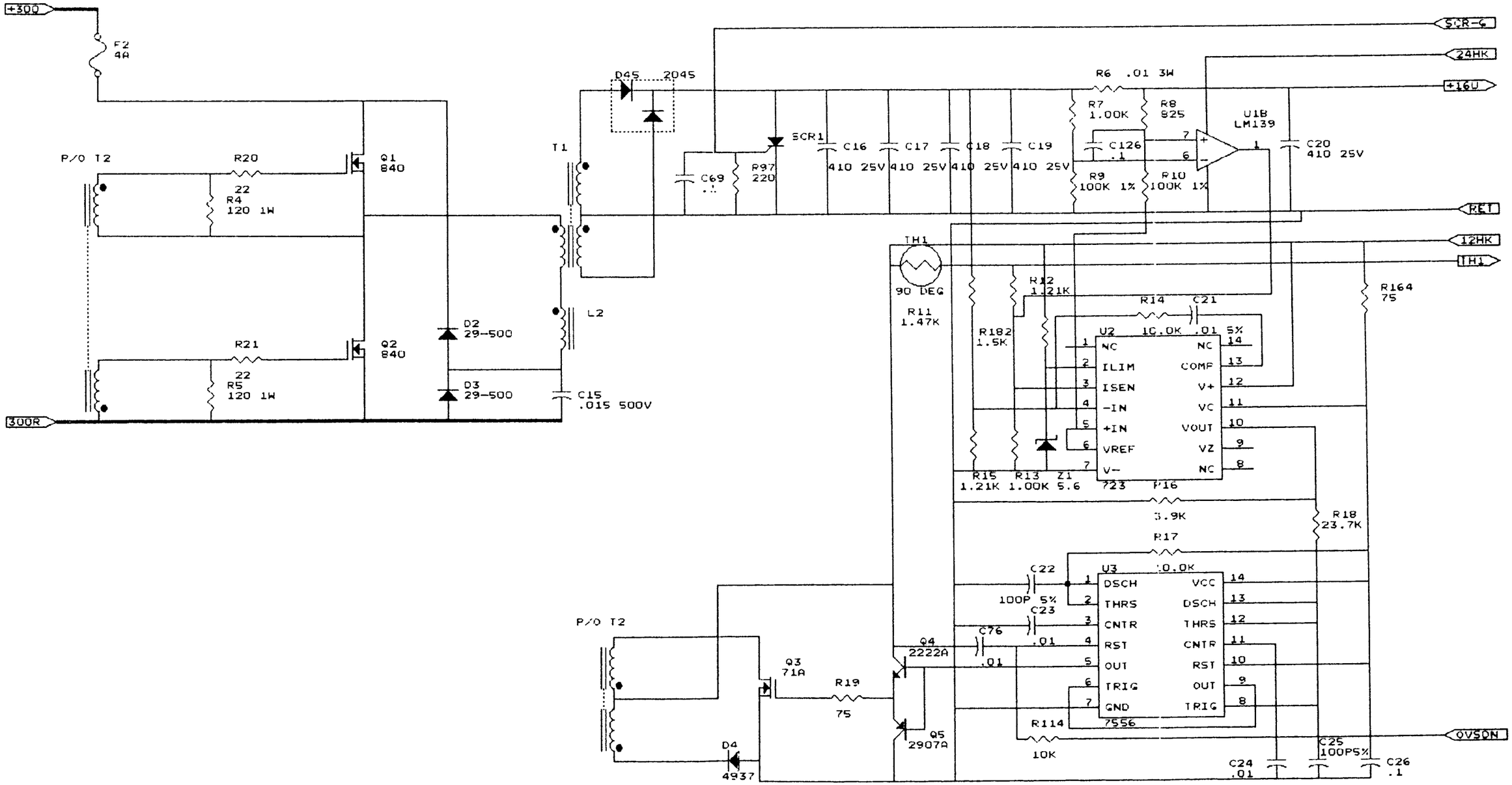
FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 2 of 9)



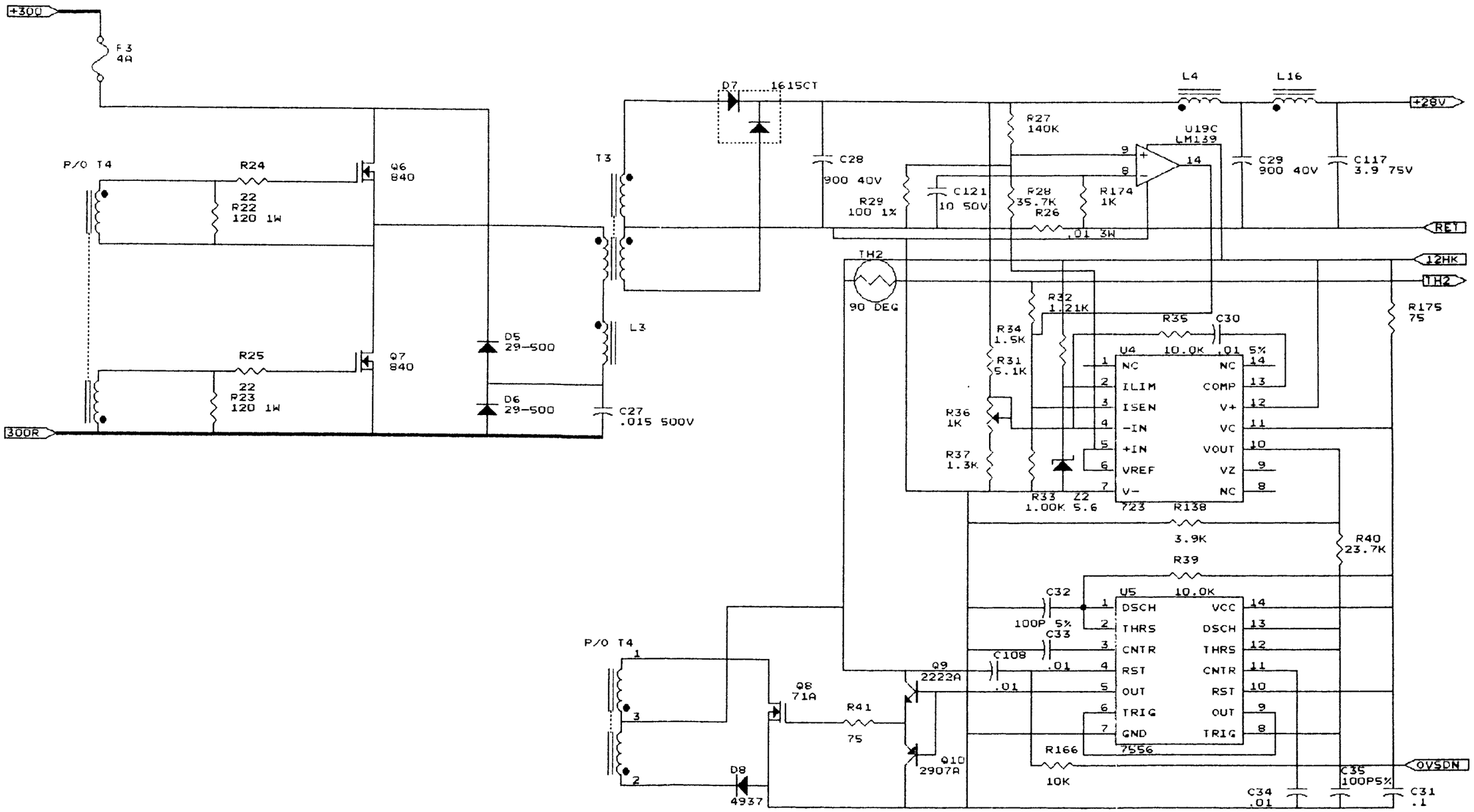
FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 3 of 9)



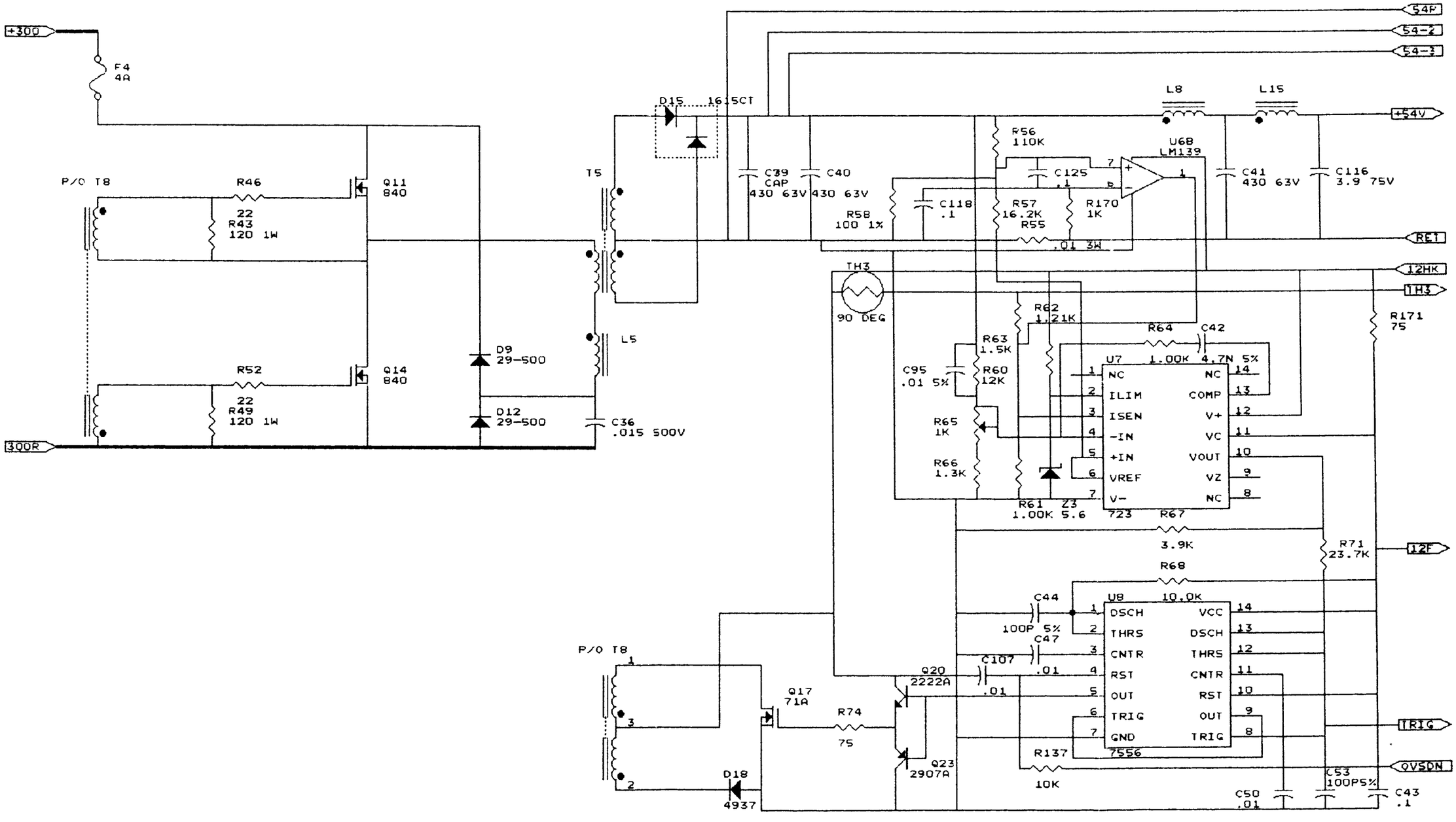
FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 4 of 9)



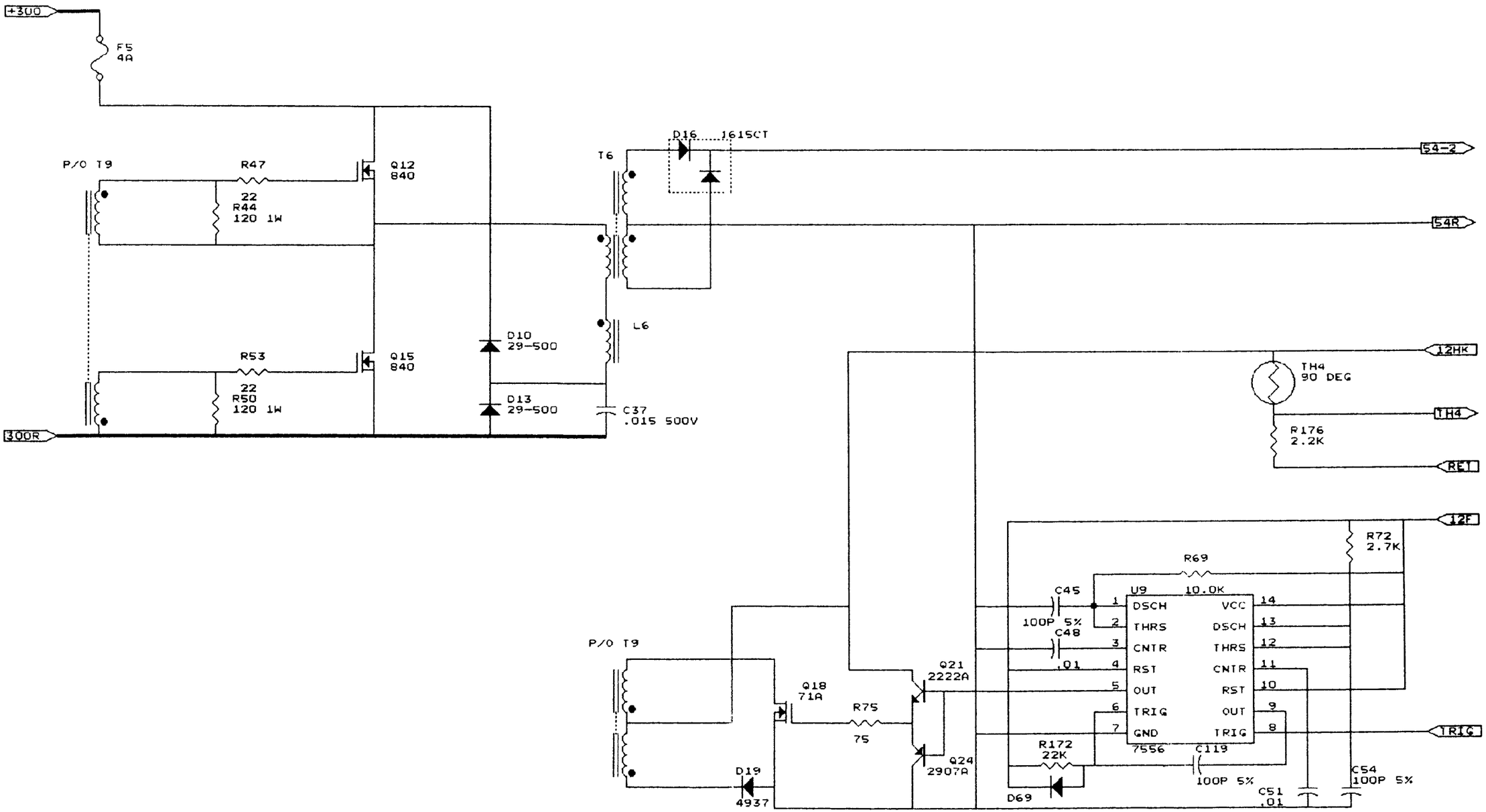
FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 5 of 9)



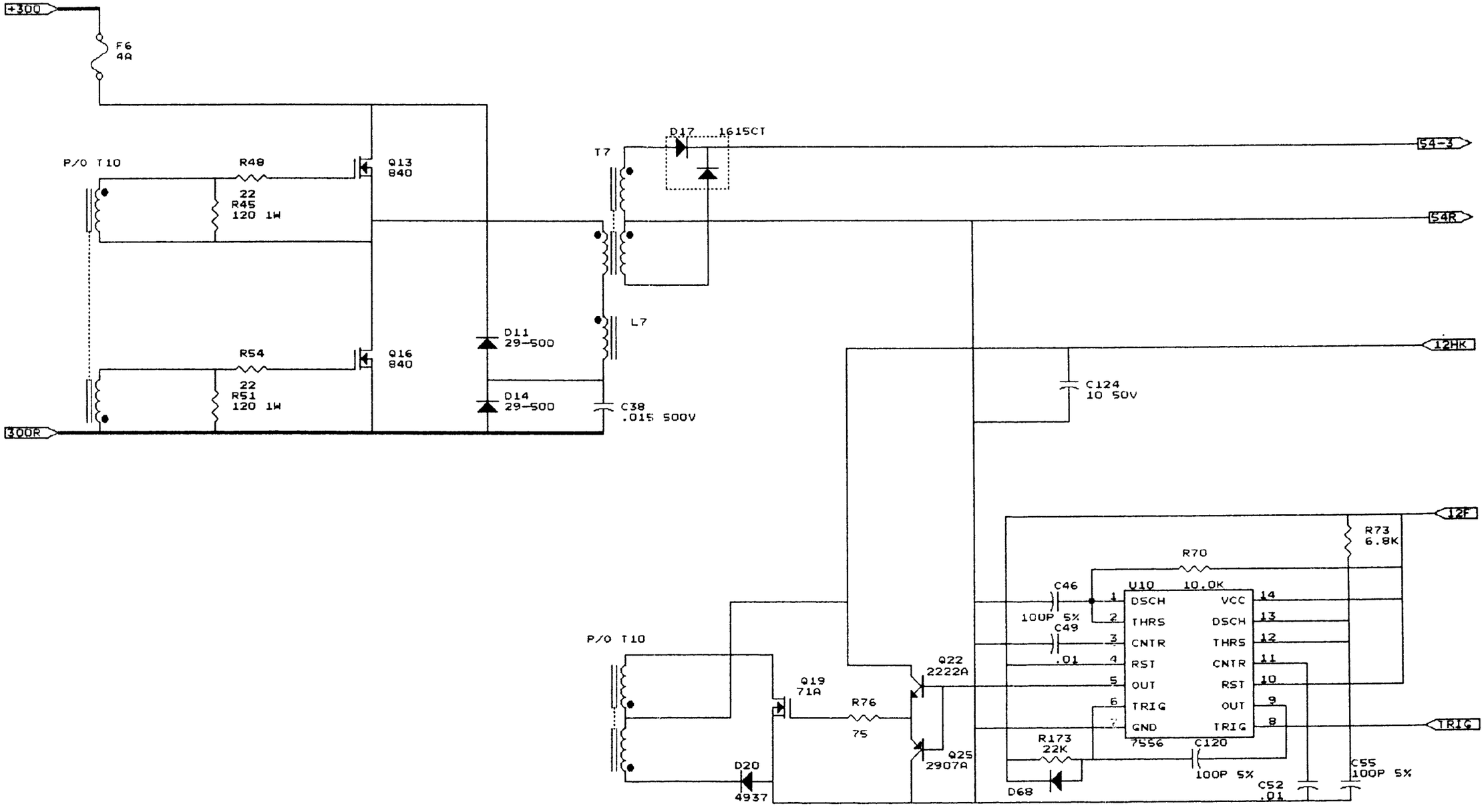
FO-36. Schematic Diagram, TCS-5 Power Supply 5060-1150-02 (Sheet 6 of 9)



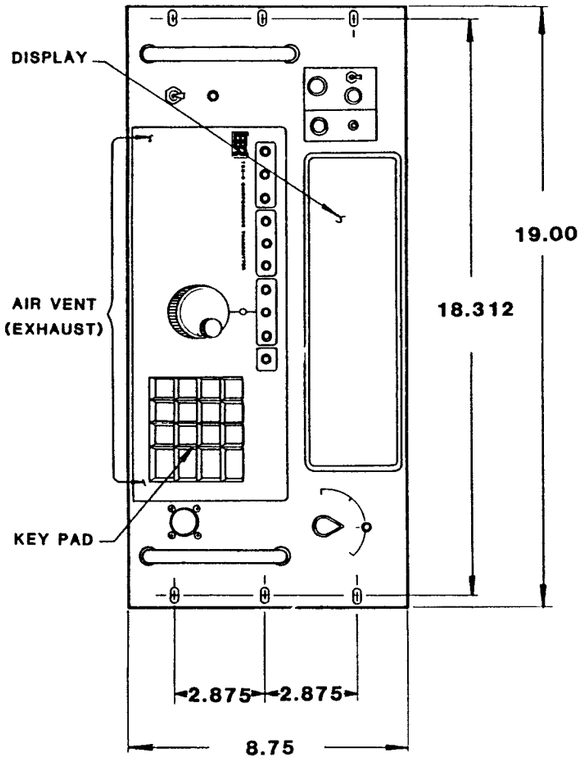
FO-36. Schematic Diagram, TCS-5 Power Supply 5060-1150-02 (Sheet 7 of 9)

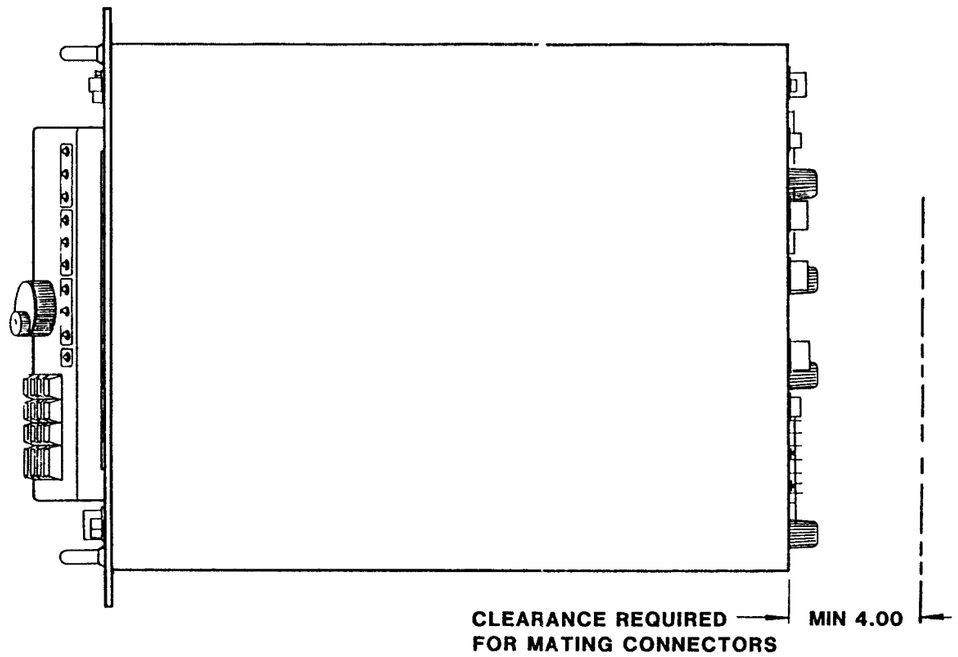


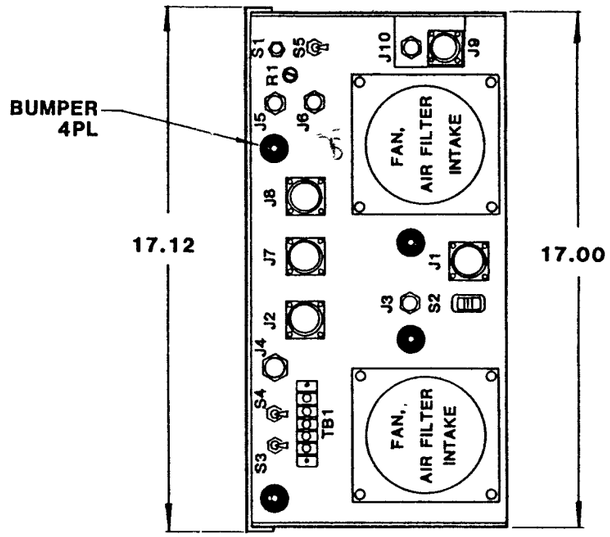
FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 8 of 9)

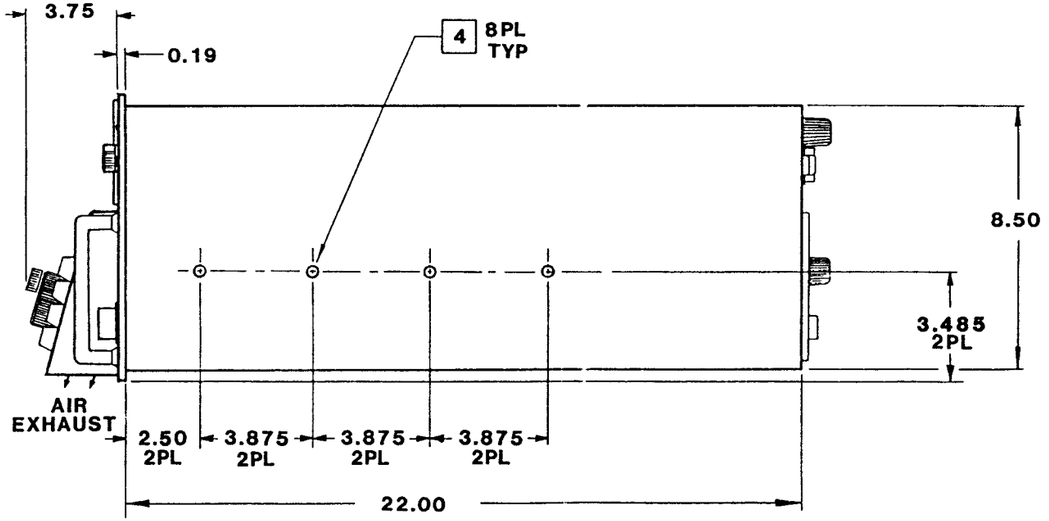


FO-36. Schematic Diagram,
TCS-5 Power Supply
5060-1150-02 (Sheet 9 of 9)









S1: RESET	**J1:** AC POWER INPUT (MS-3102A-16-10P)
S2: VOLTAGE SELECTOR	**J2:** BATTERY INPUT (MS-3102A-14S-06P)
S3: AUDIO LINE IN LEVEL	**J3:** EXCT OUT (BNC)
S4: BATTERY ON/OFF	**J4:** RECEIVER AUDIO IN (BNC)
S5: POWER AMPLIFIER INT / EXT	**J5:** 5MHz IN (BNC)
R1: FREQUENCY STANDARD ADJUST	**J6:** 5MHz OUT (BNC)
TB1: AUDIO LINE IN ,& EXT KEY	**J7:** REMOTE I/O (MS-27508E14F35S)
	J8: ANTENNA CONTROL OUT (MS-27508E12F35S)
	J9: TRANSMIT RF OUT TO ANT. (N)
	J10: ANT. TO RECEIVER (BNC)

4 THREADED INSERTS FOR CHASSIS SLIDES (BRPN 7102-0073) SUITABLE FOR MOUTING IN RETMA/EIA 19 INCH WIDE CABINETS WITH MOUNTING RAILS 25 TO 30 INCHES DEEP. (SLIDES NOT INCLUDED)

3. HEAT LOAD: 650 WATTS MAX.IN TRANSMIT 200 WATTS MAX. IN STAND BY.
2. WEIGHT: 80 lbs (36.32Kg) MAX.
1. DIMENSIONS IN INCHES.

NOTES: UNLESS OTHERWISE SPECIFIED.

FO-37. Envelope Drawing,
TCS-5 Chirpsounder Transmitter
BR Drawing No. 1220-0908 Rev D