



*R8/R8E Communications Receiver*

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***Service Manual***

# Addendum

This second printing of the R8/R8E Service manual contains updates to the following assemblies as noted. A keypad switch matrix diagram is also added (page 52).

REF	PART NUM	DESCRIPTION
<b>1) FRONT END BOARD</b>		
<i>ADDITIONS</i>		
R184 5.6K	3220215	RES C. FILM 5.6K, 5%, 1/4W
C258 12pF CHIP	3167507	CAP CHIP 12pF NPO 0805
<i>DELETIONS</i>		
R134 4.7K	3220210	RES C. FILM 4.7K, 5%, 1/4W
R155 4.7M	3220370	RES C. FILM 4.7M, 5%, 1/4W
CR122 1N4148	3220090	DIODE, SILICON
L130	2510082	INDUCTOR, TOROID RLD DWG B4007-46
L131	3524119	COIL, VAR 0.80μH 7MM RLD DWG B8048-4
L132	3524119	COIL, VAR 0.80μH 7MM RLD DWG B8048-4
C160 4-20pF	3205207	CAP VAR TRIMMER
C163 9pF CHIP	3166144	CAP CHIP 9pF NPO 0805
C165 9pF CHIP	3166144	CAP CHIP 9pF NPO 0805
C161 .001uF	3151405	CAP AXIAL .001MF 10% Y5P
<i>CHANGES</i>		
R143 10K (WAS 6.8K)	3220235	RES C. FILM 10K, 5%, 1/4W
R135 1M (WAS 100K)	3220355	RES C. FILM 1 MEG, 5%, 1/4W
L138	2510103 (WAS 2510082)	
L140	2510104 (WAS 2510022)	
C162 2.2pF (WAS 3.9pF)	3166136	CAP CHIP 2.2pF 50V 0805
C164 2.2pF (WAS 3.9pF)	3166136	CAP CHIP 2.2pF 50V 0805
R173 270 (WAS 390)	3220085	RES C. FILM 270, 5%, 1/4W
Q102 3SK81 (WAS 3N204)	3030286	TRANSISTOR DUAL GATE MOSFET 3SK81
<b>2) 2ND IF/AUDIO BOARD</b>		
<i>ADDITIONS</i>		
C361 .01uF	3151515	CAP AXIAL .01MF 20% Y5P
SHIELD	4560254	SHIELD POT CORE RLD DWG B8297
R384	3220330	RES C. FILM 220K, 5%, 1/4W
R385	3220145	RES C. FILM 820, 5%, 1/4W
R386	3220350	RES C. FILM 680K, 5%, 1/4W
R387	3220315	RES C. FILM 100K, 5%, 1/4W
C359	3151259	CAP AXIAL 220Pf, 10%, Y5P
C360	3151405	CAP AXIAL .001MF, 10%, Y5P
<i>DELETIONS</i>		
C291 91pF.	3151050	CAP AXIAL 91pF, 2%, NPO
<i>CHANGES</i>		
R327 5.1K (WAS 6.8K)	3220212	RES C. FILM 5.1K, 5%, 1/4W
R345 2.2K (WAS 3.3K)	3220190	RES C. FILM 2.2K, 5%, 1/4W
R375 120K (WAS 180K)	3220317	RES C. FILM 120K, 5%, 1/4W
R387 100K (WAS 150K)	3220315	RES C. FILM 100K, 5%, 1/4W
C257 68pF (WAS 100pF)	3150900	CAP AXIAL 68pF, 2%, NPO
<b>3) SYNTHESIZER BOARD</b>		
<i>ADDITIONS</i>		
R405 220	3220075	RES C. FILM 220 OHM, 5%, 1/4W
R406 220	3220075	RES C. FILM 220 OHM, 5% 1/4W
C418 56pF NPO	3150896	CAP AXIAL 56pF, 5%, NPO
<i>DELETIONS</i>		
R407 10K	3220235	RES C. FILM 10k, 5%, 1/4W
<i>CHANGES</i>		
U106 VERSION 12 SOFTWARE	4671318	I.C. 27256 E PROM W/VERSION 12 R8 SOFTWARE
R348 10K POT (WAS 20K)	3260664	RES VAR PT 10V 10K

## SAFETY INSTRUCTIONS

### SAFETY PRECAUTION

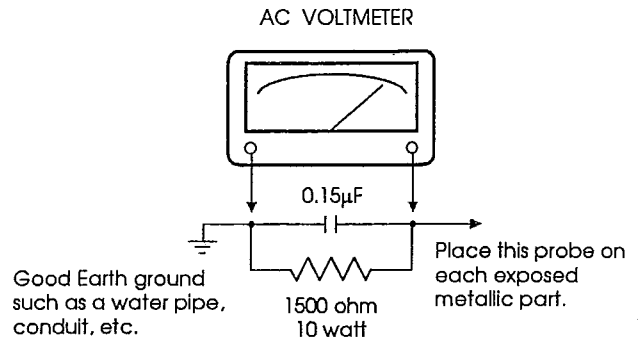
**WARNING:** Service should not be attempted by anyone unfamiliar with the necessary precautions on this unit.

The following are the necessary precautions to be observed before servicing this chassis.

1. When replacing a chassis in the cabinet, always be certain that all the protective devices are put back in place. Examples of these items are: non-metallic control knobs, insulating covers, shields, and isolation resistor-capacitor networks etc.

2. Before returning the set to the customer, always perform an AC leakage current check on the exposed metallic parts of the cabinet, as well as antennas, terminals, screw-heads, metal overlays, control shafts etc. Be sure the set is safe to operate without danger of electric shock. Plug the AC line cord directly into the 120V AC outlet (do not use a line isolation transformer during this check). Use an AC voltmeter having 5000 ohms per volt or more sensitivity in the following manner:

Connect a 1500 ohm, 10 watt resistor, paralleled by a 0.15 mF, AC type capacitor, between a known good earth ground (water pipe, conduit, etc.) and the exposed metallic parts, one at a time. Measure the AC voltage across the combination of 1500 ohms resistor and 0.15 mF capacitor, reverse the AC plug at the AC outlet and repeat AC voltage measurements for each exposed metallic part. Voltage measured must not exceed 0.3 volts RMS. This corresponds to 0.2 milliamp AC. Any value exceeding this limit constitutes a potential shock hazard and must be corrected immediately.



### PRODUCT SAFETY NOTICE

Many electrical and mechanical parts in this chassis have special safety-related characteristics. These characteristics are often passed unnoticed by a visual inspection and the protection afforded by them cannot necessarily be obtained by using replacement components rated for higher voltage, wattage, etc. Replacement parts with these safety characteristics are identified in this manual and are shaded on the schematics.

Before replacing any of these components, read the parts list in this manual carefully. The use of substitute replacement parts which do not have the same safety characteristics as specified in the parts list may create shock, fire, or other hazards.

## BEFORE ATTEMPTING SERVICE

**CAUTION:** UNPLUG RECEIVER'S POWER CORD BEFORE PLUGGING IN CABLES ON PRINTED CIRCUIT BOARDS AND OTHER COMPONENTS, THEN DOUBLE CHECK FOR CORRECT CABLE POSITIONING BEFORE APPLYING POWER.

EVEN A MOMENTARY IMPROPER CABLE CONNECTION TO PRINTED CIRCUIT BOARDS OR OTHER COMPONENTS CAN CAUSE WIDE SPREAD DAMAGE TO INTEGRATED CIRCUITS AND DISCRETE COMPONENTS. NOTE: CABLES ARE NOT KEYED IN ALL CASES TO PREVENT IMPROPER INSERTION.

POWER MUST BE DISCONNECTED FROM RECEIVER'S POWER CORD TO PREVENT POSSIBLE DAMAGE WHEN INSERTING CABLES SINCE MANY CIRCUITS REMAIN OPERATIVE WHEN THE POWER BUTTON IS 'OFF.' ALWAYS DOUBLE CHECK FOR CORRECT CABLE POSITIONING BEFORE APPLYING POWER.

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# 4 Introduction

## USING THE R8/R8E SERVICE MANUAL

This manual is divided into several sections for clarity and ease of use. Each major section is written with the assumption that the preceding portions of the manual have been read and understood by the user.

Section 1 is introductory in nature, and provides a general discussion of operating theory and module location.

Section 2 contains complete information on each functional element of the R8/R8E. This information includes detailed circuit description, parts list, component location and schematic diagram. This section of the manual is divided by major functional element such as circuit board, module chassis, etc. for the purpose of rapid circuit, component and problem identification.

Section 3 is a complete alignment procedure for the R8/R8E, and includes test equipment requirements/recommendations and test point locations.

Section 4 includes a complete description of any available R8/R8E accessories, including circuit descriptions, pictorials and schematics.

## LOCATING A MALFUNCTION

The design of the R8/R8E permits access to the Synthesizer board by removing only the bottom cover of the receiver. The Synthesizer board contains all the reference frequency generation and the entire microprocessor/digital control of the receiver. The Front End board is accessible by removing the top cover of the receiver. The Front End board contains all circuitry that converts the input signal to the 50 KHz IF prior to the main selectivity and audio detection. The FM detection circuitry is also contained on this board. The 2nd IF/Audio board is located immediately below the Front End board. It is accessible by securing the Front End board in a vertical position near the rear of the R8/R8E by positioning the routed tabs on the board into the slots provided on the top surface of the rear panel metal chassis. Note that cabling to the Front End board is designed to permit full electrical operation of the R8/R8E with the board temporarily positioned vertically. The Front Panel board is accessible by hinging the front panel down by removal of the top two screws securing the panel to the subpanel and loosening the lower two screws. Interconnection from board to board or control-to-board is with use of either flexible ribbon cable or flexible wire cable. RF signal interconnects are accomplished using coaxial pin and shield cables that mate to a board mounted coaxial connector at each termination end. Thus boards can be removed for part replacement if necessary and easily replaced for testing.

The first step in troubleshooting the R8/R8E should be isolation of the malfunction to the major board level. Refer to the **"Generalized Theory of Operation Section"** for a general discussion of theory of operation and determine which circuit board and specific section of that board would cause the problem at hand. In most cases, the problem will involve only one of the four major boards.

Once the problem has been isolated, refer to the appropriate portion of Section 2 for a full scale description of the circuit.

## GENERALIZED THEORY OF OPERATION

### Receiver Section

Incoming signals from antenna 1, antenna 2, and converter receptacles are first routed through the antenna switch module. The 50/500 Ohm antenna 2 input is matched with a 9:1 transformer prior to being routed to the antenna switch module.

The output of this module is followed by a selectable attenuator providing 10 dB of attenuation when enabled.

The signal is then sent to a 9 band, pin diode switched, bandpass filter network.

The bandpass filter output is routed through a selectable preamplifier providing a nominal 10 dB of gain when enabled. The output of the preamp is then supplied to a master lowpass filter which serves to attenuate signals above 30 MHz. The signal is then mixed with the 45.1-75 MHz 1st local oscillator (LO) to create a 45 MHz 1st intermediate frequency (IF) signal. Conversion is accomplished by a standard-level, double-balanced mixer (DBM) to provide wide dynamic range. The output of the DBM is then amplified by a low-noise, high dynamic range junction FET amplifier to insure proper receiver sensitivity. This stage is followed by a 4-pole, monolithic 45 MHz crystal filter. The purpose of this filter is to attenuate signals more than  $\pm 6$  KHz removed from the 45 MHz IF center frequency, thus protecting the remaining stages of the receiver from strong adjacent signals yet permitting sufficient bandwidth for proper narrow-band FM reception. In this manner, optimum receiver dynamic range is preserved while providing proper sensitivity.

The output of the crystal filter is then split between the FM detector circuitry and the remaining 45 MHz IF circuitry.

When the FM mode is operational, the 45 MHz 1st IF signal is demodulated by a dual conversion FM detector integrated circuit. The detected RF level is used to control an audio squelch gate. The recovered audio is routed through the squelch gate to the audio amplifier stage.

In the remaining AM, CW, RTTY, LSB, and USB modes, the signal is amplified by a tuned, dual-gate FET amplifier to which automatic gain control (AGC) voltage is also applied. The output of this amplifier stage is then routed to the image reject mixer (IRM) which converts the 45 MHz 1st IF frequency to the 50 KHz 2nd IF frequency while simultaneously helping to further suppress the image response attenuation provided by the crystal filter. The IRM uses a 45.05 MHz  $\pm$  3 KHz LO frequency to accomplish the conversion of the 45 MHz IF signal to the 50 KHz 2nd IF signal.

The 50 KHz 2nd IF signal is then applied to the main IF circuitry. The first stage of the IF is a dual-gate FET to which AGC voltage is applied. The output of this amplifier is routed to the noise blanker circuit. When activated, the noise blanker acts on short duration noise pulses removing them before they reach the 50 KHz bandpass filters which

would cause the pulses to be stretched thus rendering the blanker ineffective.

Following the noise blanker is the first of two 4-pole bandpass filter networks which provide a cascaded 8-pole response. An amplifier between the first 4-pole and second 4-pole provides another stage of AGC controlled gain as well as impedance matching for the filter sections. The two filter networks are electronically switched to provide the 6.0, 4.0, 2.3, 1.8, and 0.5 KHz IF bandwidths. Following the IF selectivity, the signal is further amplified by one last dual-gate FET which is also AGC controlled, before being demodulated either by a product detector for USB, LSB, CW, RTTY, and AM or an AM synchronous detector. The product detector utilizes a locally generated 50 KHz beat frequency oscillator (BFO) carrier that tracks with the 2nd LO. The synchronous detector generates a synthesized 50 KHz carrier that is locked to the received AM carrier. The loop time constant is sufficiently long to maintain the 50 KHz carrier during periods when the received AM signal fades.

Once detected, the recovered audio is routed to the noise blanker. As noise bursts are detected on the 50 KHz IF signal, the IF signal is turned off for the duration of the pulse. The audio is routed through the noise blanker so that the audio signal level is held at a constant level for the duration of the noise pulse. The audio is then applied to a tone control circuit which provides  $\pm 10$  dB of bass boost and bass cut as the front panel tone control is rotated to its extremes. Following the tone control, the audio is applied to the notch circuit. Audio frequencies from 500 Hz to 5 KHz are nulled by summing the audio with a 180° phase shifted and bandpassed-audio signal. The notch is disabled by turning off the bandpass filter section of the circuit.

Following the tone and notch circuits, the audio is routed to the squelch gate. The squelch reference for all modes (including FM) is the buffered AGC line with the squelch trip point set via the front panel squelch control.

The unsquelched audio is then sent to a buffer and 5 KHz lowpass filter. From this point audio is routed to two buffered line audio outputs and also to the volume control which feeds the audio power amplifier for the speaker. The output of the power amplifier passes through the headphone jack before switching between the internal and/or external speaker(s).

AGC voltage, developed prior to the demodulation, is used to control the gain of the IF stages. The same AGC signal is used to drive the S-meter circuit to provide accurate received signal strength indication. AGC decay time constants are electronically selected by front panel and microprocessor control.

### FREQUENCY CONTROL

The R8/R8E features synthesizer control of the received frequency. This allows the receiver to cover a wide frequency range without the use of range crystals or other frequency determining elements.

The reference for the synthesizer is generated by a 35 MHz crystal oscillator on the synthesizer board. This reference is used by each of three nested phase locked loops which operate over the range of 45.1 - 75.0 MHz to provide a first local oscillator signal. When this first local oscillator output is mixed with 100 KHz (150 KHz for R8E) to 30 MHz incoming signals, the result is a 45 MHz 1st IF frequency. Additionally, the 35 MHz reference is used in each loop to mix or translate signals to the appropriate frequencies. In the PLL 1 loop, the 35 MHz reference is used to translate the output of the PLL 2 loop from 6.0 MHz to 41.0 MHz. Similarly, the 35 MHz reference is doubled to produce 70 MHz which is used in PLL 2 and PLL 3 loops to translate signals. The 35 MHz reference is also divided by 10 to produce a 3.5 MHz reference for the optional VHF Converter board.

The three phase locked loops are nested such that the inner most loop (PLL 3) provides a reference signal to the middle loop (PLL 2). The middle loop in turn provides a reference signal to the outer loop (PLL 1). The inner loop voltage controlled oscillator is divided by 10 from a frequency of approximately 65 MHz to 6.5 MHz. This 6.5 MHz signal is used to lock PLL 2 on frequency. A 1 KHz frequency step change at 65 MHz becomes a 100 Hz step at 6.5 MHz and the PLL 2 voltage controlled oscillator will change by 100 Hz.

In similar fashion, the PLL 2 voltage controlled oscillator output is divided by 10 from a frequency of approximately 60 MHz to 6.0 MHz. This 6.0 MHz signal is used to lock PLL 1 on frequency. A 10 KHz frequency step change at 60 MHz becomes a 1 KHz step at 6.0 MHz and the PLL 1 voltage controlled oscillator will change by 1 KHz. A frequency step change of 1 KHz in PLL 3 is tracked out, in turn by PLL 2 and then by PLL 1. Thus a 1 KHz frequency step in PLL 3 becomes a 100 Hz step in PLL 2 and a 10 Hz step in PLL 1, the desired minimum frequency step size of the synthesizer output.

Synthesizer load numbers are generated by the microprocessor and sent to each of the three synthesizer loops. The load number is recalculated each time the frequency is changed, either by the front panel keyboard or the main tuning wheel digital encoder. The programmable divider value "N" is thus determined for each synthesizer loop. To cover the range of 45.1 - 75.0 MHz, four individual voltage controlled oscillators actually comprise VCO 1. The respective oscillator ranges are as follows: 45.10000 to 52.49999 MHz, 52.50000 to 59.99999 MHz, 60.00000 to 66.99999 MHz and 67.00000 to 75.00000 MHz. The microprocessor and related circuitry uniquely selects the proper oscillator from one of the four individual oscillators. Within software, the information corresponding to the operating frequency of the receiver is generated and sent to the front panel LCD display.

The passband tuning control is connected to a 22.525 MHz voltage controlled crystal oscillator (VCXO) which is doubled to produce 45.05 MHz. This oscillator is controlled by the front panel PASSBAND OFFSET control and microprocessor digital to analog conversion control which permits manual override of the automatic passband offsets by mode. Although this oscillator is crystal controlled, it is designed to allow its frequency to be moved over a limited range (approximately  $\pm 3$  KHz) centered on 45.05 MHz. The 45.05 MHz output is used as the injection for the image reject mixer (IRM) on the Front End board which converts the 45 MHz 1st IF signal to the 50 KHz 2nd IF frequency.

The 45.05 MHz oscillator is also mixed with the 35 MHz reference oscillator to produce a 10.05 MHz signal which is used as one input to a digital mixer. The 35 MHz reference oscillator is divided by 7 to produce a 5 MHz reference which is used as the second input to the digital mixer. The resultant output of the mixer is a 50 KHz IF signal that tunes  $\pm 3$  KHz in step with the 45.05 MHz 2nd mixer injection. This 50 KHz signal is used as the BFO to the AM and SSB product detector. Since the 45.05 MHz oscillator is used as the mixer injection which produces the 50 KHz IF signal and BFO, the 45.05 MHz output can be moved in frequency without changing the receiver operating frequency. Therefore, as the 50 KHz BFO is changed (by changing the PASSBAND OFFSET control voltage), the 45.05 MHz injection signal to the IRM is changed by an equal amount. This allows the 50 KHz 2nd IF signal to be positioned anywhere within a  $\pm 3$  KHz range with respect to the passband of two cascaded four-pole 50 KHz bandpass filters on the 2nd IF/Audio board while the receiver remains tuned to the incoming signal. This technique provides the PASSBAND OFFSET.



# Interconnect Drawing Parts List/Misc. Chassis Parts List 7

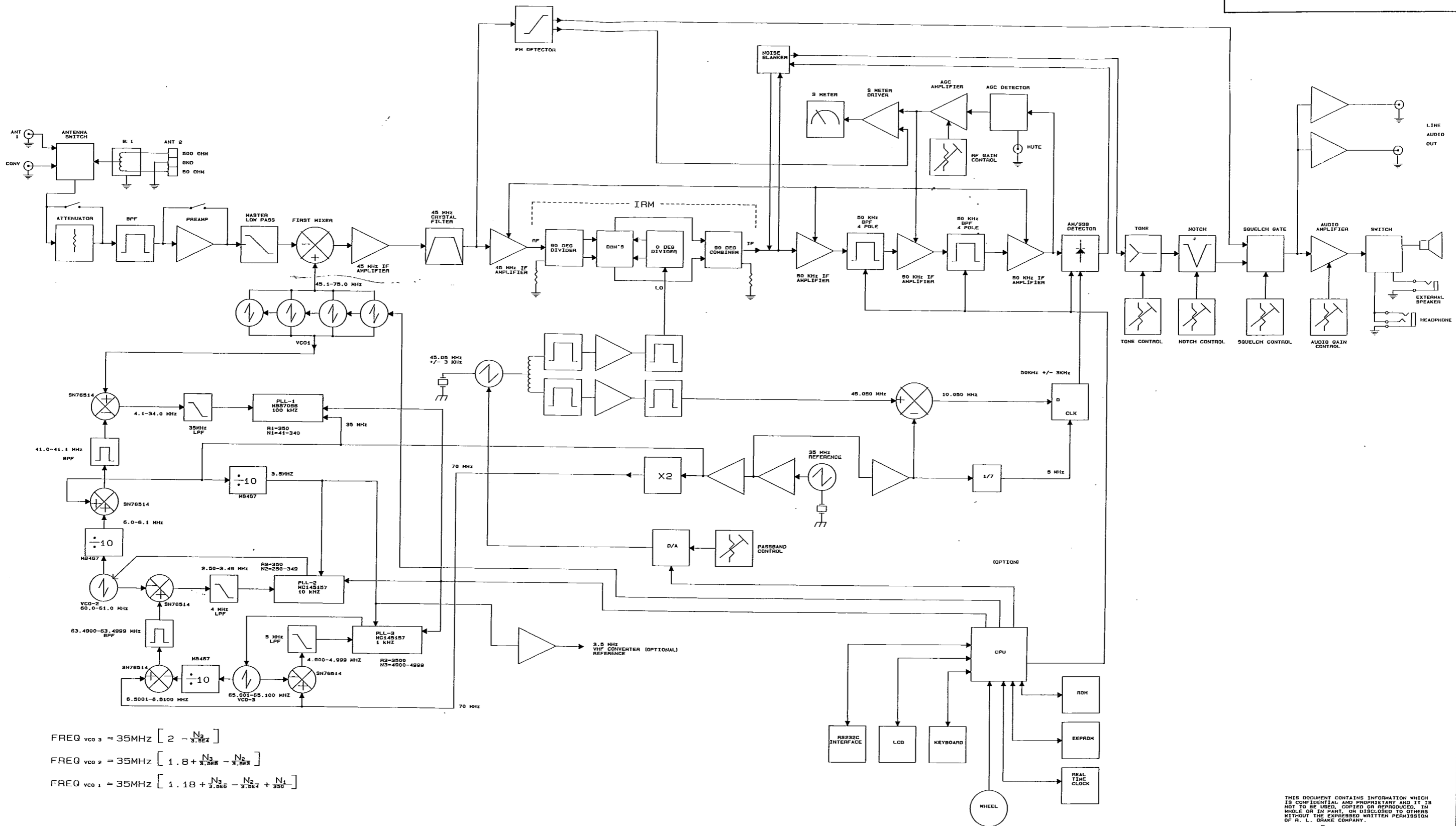
## INTERCONNECT DRAWING PARTS LIST

REF	PART NUM	DESCRIPTION
D1	3080034	DISPLAY, LCD
DS1	3470004	LAMP NEON #NE-2E/A9A
E1	3260008	ENCODER WHEEL #600-128
F1	3420127	2A SLO-BLO FUSE
F2	3420258	T400mA FUSE
J1	3281024	JACK PHONE #YKB21-5006
J2	3280011	UHF SO-239 CONNECTOR
J3	3280011	UHF SO-239 CONNECTOR
J7	3301264	2P QUICKCONNECT
KBD1	2055167	8 DIG.KEYBRD-PAD ASSY
KBD2	2055168	18 DIG.KEYBRD-PAD ASSY
MTR1	3581010	"S" METER
R1	3260005	RES VAR AF/RF GAIN 3K/10K
R2	3260006	RES VAR PBT/SQUEL. 10K/10K
R3	3260007	RES VAR TONE/NOTCH 100K
R4	3220055	RES C.FILM 100 OHM 5% 1/4W
R5	3220055	RES C.FILM 100 OHM 5% 1/4W
R6	3220075	RES C.FILM 220 OHM 5% 1/4W
R7	3220215	RES C.FILM 5.6 K 5% 1/4W
R90	3250409	RES COMP 4.7 MEG 10% 1/2W
S1	3670550	SW.VOLT.SELECT #J-R1025-01
SPK1	3640035	SPEAKER 4-OHM #C100K22MO111
T1	3690388	POWER XFMR R8

## MISCELLANEOUS CHASSIS PARTS

PART NUMBER	DESCRIPTION
3372503	JUMPER 2-CIRCUIT SHUNT
3390009	FOOT SET
3450001	KNOB TUNING
3450002	KNOB SMALL BOTTOM
3450003	KNOB SMALL TOP TAPERED
3473200	LENS (DIFFUSER) LCD LGT.
3474200	REFLECTOR LGHT.HOUSING
3476001	HOUSING (BOX) LCD LIGHT (HALF)
3712007	CORD, LINE 18/2 76'
3851290	OWNER'S MANUAL
4440595	REAR PANEL SCREENED
4445109	SCREENED FRONT PANEL
4807518	COVER, TOP BLK VINYL
4807550	COVER, BOTTOM



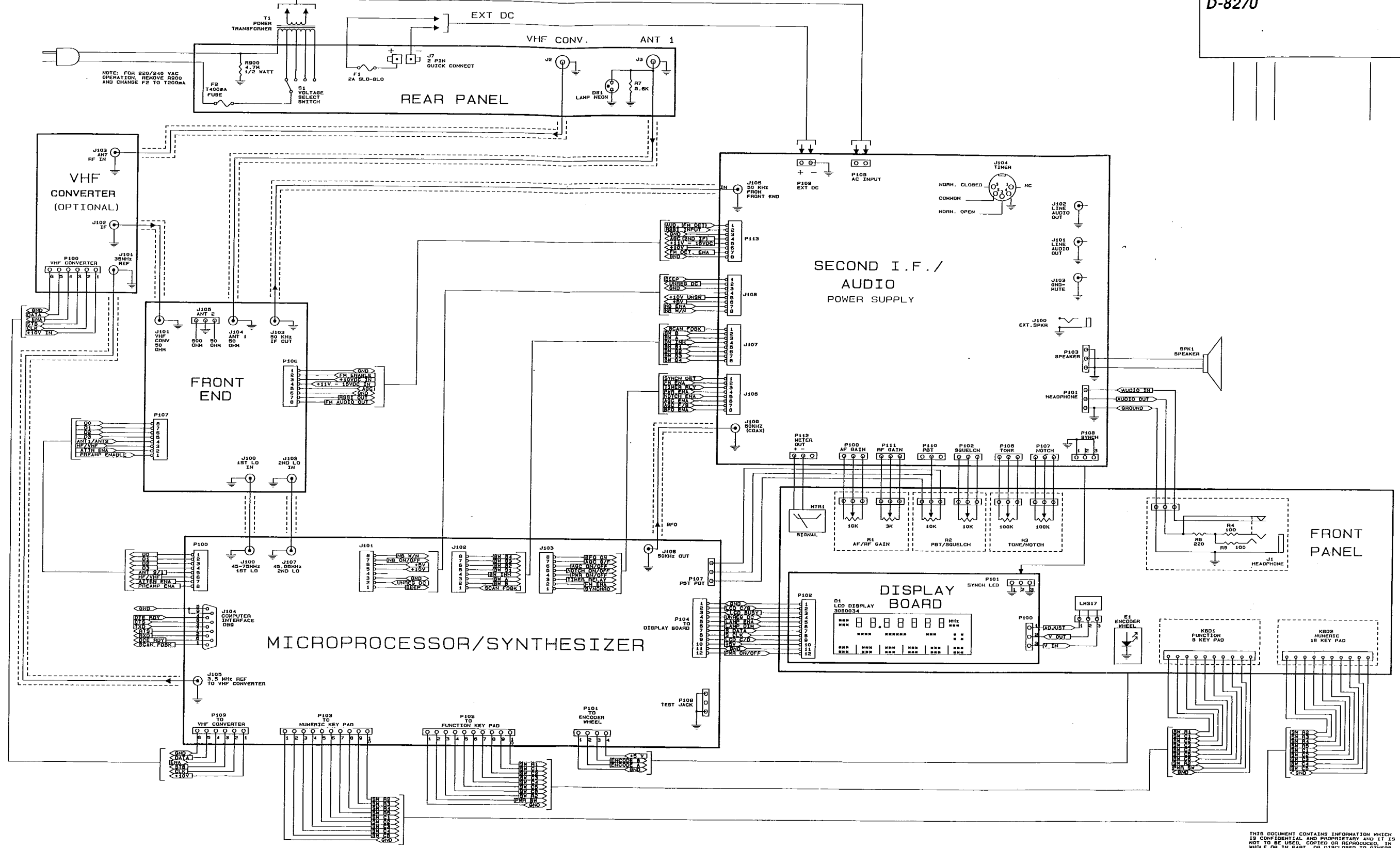


$$FREQ_{vco3} = 35MHz \left[ 2 - \frac{N_2}{3.567} \right]$$

$$FREQ_{vco2} = 35MHz \left[ 1.8 + \frac{N_2}{3.565} - \frac{N_1}{3.563} \right]$$

$$FREQ_{vco1} = 35MHz \left[ 1.18 + \frac{N_2}{3.565} - \frac{N_2}{3.567} + \frac{N_1}{350} \right]$$

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## FRONT END BOARD THEORY OF OPERATION

Incoming signals from the ANT 1 and the converter antenna receptacles are first routed through the antenna switching circuitry consisting of relay RL103 and RL101. ANT 2 is first routed through a 9:1 impedance matching transformer, then to RL103. ANT 1 is selected when both RL101 and RL103 are in the off state. When ANT 2 is selected by the user via the front panel controls, RL103 is energized by Q108 and its associated circuitry. When the converter antenna is selected RL101 is energized by Q107 and its associated circuitry. Both Q107 and Q108 receive their control signals from the microprocessor/synthesizer board via the connector P107.

The signal is then sent through a selectable attenuator which is formed by RL102, R163 and R172. When RL102 is in the off state the attenuator is bypassed. When the attenuator is selected a control signal is sent to Q109 (via connector P107) which energizes RL102 inserting R163 and R172 into the signal path forming a resistive pad providing 10 dB of attenuation. The signal is sent through a 9:1 impedance matching transformer before reaching the bandpass filters. The signal is then routed through 1 of 9 bandpass filters.

The cutoff frequencies of each filter is as follows:

0-0.5 MHz  
 0.5-1.5 MHz  
 1.5-2.5 MHz  
 2.5-4.0 MHz  
 4.0-7.5 MHz  
 7.5-10.5 MHz  
 10.5-15 MHz  
 15-22 MHz  
 22-30 MHz

Each bandpass filter has a set of PIN diodes that are normally reversed biased unless the filter is selected. The appropriate filter is automatically selected dependant on the displayed frequency. This is accomplished when U102 (74LS145) receives data from the microprocessor (via connector P107) and selects the appropriate filter by turning on one of its outputs which in turn removes the reverse bias voltage on the selected filter's pin diodes allowing the signal to pass. Following the bandpass filter, the signal is applied to a selectable preamplifier consisting of relay RL100, Q105 (2N5109) and its related circuitry. RL100 is controlled by Q106 and when energized Q105 provides 10 dB of gain when selected.

The preamplifier output is sent through the master low pass before reaching the input of the first mixer. The master low pass filter consists of the following components, C209, C220, C221, C222, C223, C224, C225, L164, L165, and L166.

At the first mixer the incoming signal is mixed with the output of the synthesizer VCO to create a 45 MHz intermediate frequency (IF) signal. The conversion is accomplished by a standard level, double-balanced mixer to provide a high dynamic range. The output of the mixer is amplified by Q104 (J310) a low noise, high dynamic range J-fet amplifier to insure adequate receiver sensitivity. This stage is tunable by adjusting the variable capacitor C197. The output is connected to L140 a matching transformer which passes the signal to the input of the 45 MHz crystal filter section which is composed of the following elements; C258, C162, C164, XF100, and XF101. After leaving the crystal filter section the signal passes through a capacitive matching network formed by C178, C179, and L138. The network is tuned by C178 and C179. After this the signal is divided into two parts, with part going to a J-Fet amplifier Q103 (J310) preceding the FM detector circuitry and the other part to Q102 an 'AGC'd' dual gate mosfet amplifier circuit which is followed by the image reject mixer circuitry.

The FM detector is comprised of the U100 (MC3362) and its accompanying circuitry. U100 is basically a complete narrowband FM receiver which provides recovered FM audio and an RSSI (Received Signal Strength Indicator) output both of which are sent to the 2nd IF/Audio board.

After leaving Q102, the 45 MHz IF enters the Image Reject Mixer circuit (IRM). The IRM provides protection from the unwanted image frequency as well as providing the 50 KHz 2nd IF frequency. The IRM is composed of 4 circuit elements: the 45 MHz 90 deg. divider formed by L146, L147, L156, L157, C189, C190, C208, C188, C191 and R140; the 0 deg. divider formed by R160, R161 and R162; the 50 KHz 90 deg. divider formed by L169, L170, L171, L172, C232, C233, C234, C241, C242 and R165; (2) double balanced mixers M1 and M2.



## FRONT END BOARD PARTS LIST

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C100	3151648	CAP AX .10 MF 50V	C162	3166135	CAP CHIP 2.2PF 50V 0805
C101	3151259	CAP AXIAL 220 PF 10% Y5P	C164	3166136	CAP CHIP 2.2PF 50V 0805
C102	3184019	CAP FILM .001 @ 100V 5%			
C103	3184019	CAP FILM .001 @ 100V 5%	C166	3151515	CAP AXIAL .01 MF 20% Y5P
C104	3151648	CAP AX .10 MF 50V	C168	3151065	CAP AXIAL 100 PF 5% GP
C105	3180109	CAP ELECTRO 22@25 20%	C169	3150550	CAP AXIAL 20.0 PF 5% NPO
C106	3151259	CAP AXIAL 220 PF 10% Y5P	C170	3150550	CAP AXIAL 20.0 PF 5% NPO
C107	3151259	CAP AXIAL 220 PF 10% Y5P	C171	3151515	CAP AXIAL .01 MF 20% Y5P
C108	3151345	CAP AXIAL 470 PF 10% Y5P	C172	3180109	CAP ELECTRO 22@25 20%
C109	3151515	CAP AXIAL .01 MF 20% Y5P	C174	3205207	CAP VAR TRIMMER 4-20 PF
C110	3151345	CAP AXIAL 470 PF 10% Y5P	C175	3151040	CAP AXIAL 82.0 PF 5% N750
C111	3151345	CAP AXIAL 470 PF 10% Y5P	C176	3150350	CAP AXIAL 10.0 PF 5% NPO
C112	3151515	CAP AXIAL .01 MF 20% Y5P	C177	3151405	CAP AXIAL .001 MF 10% Y5P
C113	3180109	CAP ELECTRO 22@25 20%	C178	3205204	CAP VAR TRIMMER 3-11 PF
C114	3151155	CAP AXIAL 150 PF 10% Y5P	C179	3205204	CAP VAR TRIMMER 3-11 PF (3501055 SHIELD)
C115	3151648	CAP AX .10 MF 50V	C180	3151515	CAP AXIAL .01 MF 20% Y5P
C116	3151648	CAP AX .10 MF 50V	C181	3150550	CAP AXIAL 20.0 PF 5% NPO
C117	3151515	CAP AXIAL .01 MF 20% Y5P	C182	3151040	CAP AXIAL 82.0 PF 5% N750
C118	3151515	CAP AXIAL .01 MF 20% Y5P	C183	3150420	CAP AXIAL 12.0 PF 5% NPO
C119	3151515	CAP AXIAL .01 MF 20% Y5P	C184	3150508	CAP AXIAL 15.0 PF 5% NPO
C121	3151295	CAP AXIAL 330 PF 10% Y5P	C185	3151515	CAP AXIAL .01 MF 20% Y5P
C122	3151155	CAP AXIAL 150 PF 10% Y5P	C186	3180109	CAP ELECTRO 22@25 20%
C123	3151155	CAP AXIAL 150 PF 10% Y5P	C187	3150550	CAP AXIAL 20.0 PF 5% NPO
C124	3151515	CAP AXIAL .01 MF 20% Y5P	C188	3205228	CAP VAR TRIMMER 10-120 PF
C125	3180109	CAP ELECTRO 22@25 20%	C189	3150595	CAP AXIAL 22.0 PF 5% NPO
C126	3151065	CAP AXIAL 100 PF 5% GP	C190	3150595	CAP AXIAL 22.0 PF 5% NPO
C127	3180012	CAP ELECTRO 1@50 20%	C191	3205228	CAP VAR TRIMMER 10-120 PF
C128	3151648	CAP AX .10 MF 50V	C192	3151155	CAP AXIAL 150 PF 10% Y5P
C129	3151648	CAP AX .10 MF 50V	C193	3151155	CAP AXIAL 150 PF 10% Y5P
C130	3151648	CAP AX .10 MF 50V	C194	3151405	CAP AXIAL .001 MF 10% Y5P
C131	3150896	CAP AXIAL 56.0 PF 5% NPO	C195	3151405	CAP AXIAL .001 MF 10% Y5P
C132	3205228	CAP VAR TRIMMER 10-120 PF	C196	3151405	CAP AXIAL .001 MF 10% Y5P
C133	3151648	CAP AX .10 MF 50V	C197	3205207	CAP VAR TRIMMER 4-20 PF
C134	3151648	CAP AX .10 MF 50V	C198	3151515	CAP AXIAL .01 MF 20% Y5P
C135	3151515	CAP AXIAL .01 MF 20% Y5P	C199	3151648	CAP AX .10 MF 50V
C136	3150595	CAP AXIAL 22.0 PF 5% NPO	C200	3151515	CAP AXIAL .01 MF 20% Y5P
C137	3151259	CAP AXIAL 220 PF 10% Y5P	C202	3150779	CAP AXIAL 43.0 PF 5% NPO
C138	3151040	CAP AXIAL 82.0 PF 5% N750	C203	3150420	CAP AXIAL 12.0 PF 5% NPO
C139	3151040	CAP AXIAL 82.0 PF 5% N750	C204	3150420	CAP AXIAL 12.0 PF 5% NPO
C140	3151515	CAP AXIAL .01 MF 20% Y5P	C205	3151515	CAP AXIAL .01 MF 20% Y5P
C141	3180109	CAP ELECTRO 22@25 20%	C206	3180109	CAP ELECTRO 22@25 20%
C142	3150595	CAP AXIAL 22.0 PF 5% NPO	C208	3150595	CAP AXIAL 22.0 PF 5% NPO
C143	3150896	CAP AXIAL 56.0 PF 5% NPO	C209	3151117	CAP AXIAL 120 PF 5% GP
C144	3151515	CAP AXIAL .01 MF 20% Y5P	C210	3180064	CAP ELECTRO 10@50 20%
C146	3151117	CAP AXIAL 120 PF 5% GP	C211	3151515	CAP AXIAL .01 MF 20% Y5P
C147	3150845	CAP AXIAL 47.0 PF 5% N750	C212	3150305	CAP AXIAL 8.2 PF 10% NPO
C148	3150845	CAP AXIAL 47.0 PF 5% N750	C213	3150690	CAP AXIAL 33.0 PF 5% NPO
C149	3151515	CAP AXIAL .01 MF 20% Y5P	C214	3150305	CAP AXIAL 8.2 PF 10% NPO
C150	3180109	CAP ELECTRO 22@25 20%	C215	3150305	CAP AXIAL 8.2 PF 10% NPO
C152	3151405	CAP AXIAL .001 MF 10% Y5P	C216	3151515	CAP AXIAL .01 MF 20% Y5P
C153	3151405	CAP AXIAL .001 MF 10% Y5P	C217	3180109	CAP ELECTRO 22@25 20%
C154	3180064	CAP ELECTRO 10@50 20%	C219	3151405	CAP AXIAL .001 MF 10% Y5P
C155	3151515	CAP AXIAL .01 MF 20% Y5P	C220	3150690	CAP AXIAL 33.0 PF 5% NPO
C156	3151405	CAP AXIAL .001 MF 10% Y5P	C221	3151185	CAP AXIAL 180 PF 10% Y5P
C157	3151405	CAP AXIAL .001 MF 10% Y5P	C222	3150845	CAP AXIAL 47.0 PF 5% N750
C158	3151425	CAP AXIAL .0022MF 20% Y5P	C223	3151185	CAP AXIAL 180 PF 10% Y5P
C159	3150030	CAP AXIAL 1.5 PF 10% GP	C224	3150350	CAP AXIAL 10 PF 5% NPO

# 14 Front End Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C225	3151117	CAP AXIAL 120 PF 5% GP	CR125	3020335	DIODE 1S2186
C226	3151648	CAP AX .10 MF 50V	CR126	3020335	DIODE 1S2186
C227	3151648	CAP AX .10 MF 50V	CR127	3020220	DIODE 1N4005-PLASTIC
C228	3151648	CAP AX .10 MF 50V	CR128	3020220	DIODE 1N4005-PLASTIC
C229	3151648	CAP AX .10 MF 50V	CR129	3020220	DIODE 1N4005-PLASTIC
C230	3151515	CAP AXIAL .01 MF 20% Y5P	CR130	3020220	DIODE 1N4005-PLASTIC
C231	3180064	CAP ELECTRO 10@50 20%	FL101	3140411	FILT. CER. RMC-2A6597HM
C232	3184046	CAP FILM .033 @ 100V 5%	J100	3280042	CONN.COAX PC MT. 90 DEG.
C233	3184046	CAP FILM .033 @ 100V 5%	J101	3280042	CONN.COAX PC MT. 90 DEG.
C234	3184042	CAP FILM .022 @ 100V 5%	J102	3280042	CONN.COAX PC MT. 90 DEG.
C235	3151648	CAP AX .10 MF 50V	J103	3280042	CONN.COAX PC MT. 90 DEG.
C236	3180064	CAP ELECTRO 10@50 20%	J104	3280042	CONN.COAX PC MT. 90 DEG.
C237	3151515	CAP AXIAL .01 MF 20% Y5P	J105	3301253	TERM.STP 3-CKT
C238	3151515	CAP AXIAL .01 MF 20% Y5P	L100	3524199	COIL RADIAL 1.0 MH
C239	3180232	CAP ELECTRO 330@25 RADIAL	L101	3524193	COIL RADIAL 150.0 UH
C240	3151648	CAP AX .10 MF 50V	L102	3524196	COIL RADIAL 270.0 UH
C241	3184042	CAP FILM .022 @ 100V 5%	L103	3524193	COIL RADIAL 150.0 UH
C242	3184042	CAP FILM .022 @ 100V 5%	L104	3524199	COIL RADIAL 1.0 MH
C243	3151648	CAP AX .10 MF 50V	L105	3524196	COIL RADIAL 270.0 UH
C244	3151648	CAP AX .10 MF 50V	L106	3524186	COIL RADIAL 68.0 UH
C245	3151648	CAP AX .10 MF 50V	L107	3524188	COIL RADIAL 82.0 UH
C246	3151459	CAP AX .0047MF +80-20 Z5U	L108	3524186	COIL RADIAL 68.0 UH
C247	3151648	CAP AX .10 MF 50V	L109	3524196	COIL RADIAL 270.0 UH
C248	3151648	CAP AX .10 MF 50V	L110	3524205	COIL AXIAL 1.1 UH
C249	3151648	CAP AX .10 MF 50V	L111	3524515	COIL VAR. SHLD
C250	3151648	CAP AX .10 MF 50V	L112	3524188	COIL RADIAL 82.0 UH
C251	3180012	CAP ELECTRO 1@50 20%	L113	3524185	COIL RADIAL 56.0 UH
C252	3151648	CAP AX .10 MF 50V	L114	3524176	COIL RADIAL 22.0 UH
C253	3151648	CAP AX .10 MF 50V	L115	3524185	COIL RADIAL 56.0 UH
C254	3151648	CAP AX .10 MF 50V	L116	3524188	COIL RADIAL 82.0 UH
C255	3151648	CAP AX .10 MF 50V	L117	3524185	COIL RADIAL 56.0 UH
C256	3151648	CAP AX .10 MF 50V	L118	3524178	COIL RADIAL 33.0 UH
C257	3151648	CAP AX .10 MF 50V	L119	3524173	COIL RADIAL 15.0 UH
C258	3167507	CAP CHIP 12pF NPO 0805	L120	3524178	COIL RADIAL 33.0 UH
CF100	3140403	FILTER CER. SFE 10.7MJZ	L121	3524185	COIL RADIAL 56.0 UH
CF101	3140405	FILTER CERAMIC CFU455E-2	L122	3524177	COIL RADIAL 27.0 UH
CR100	3020335	DIODE 1S2186	L123	3524172	COIL RADIAL 18.0 UH
CR101	3020335	DIODE 1S2186	L124	3524170	COIL RADIAL 8.2 UH
CR102	3020335	DIODE 1S2186	L125	3524172	COIL RADIAL 18.0 UH
CR103	3020335	DIODE 1S2186	L126	3524177	COIL RADIAL 27.0 UH
CR104	3020335	DIODE 1S2186	L127	3524165	COIL RADIAL 5.6 UH
CR105	3020335	DIODE 1S2186	L128	2510082	INDUCTOR TOROID
CR106	3020335	DIODE 1S2186	L129	3524165	COIL RADIAL 5.6 UH
CR107	3020335	DIODE 1S2186	L133	3524171	COIL RADIAL 10.0 UH
CR108	3020335	DIODE 1S2186	L134	3524173	COIL RADIAL 15.0 UH
CR109	3020335	DIODE 1S2186	L135	3524160	COIL RADIAL 3.3 UH
CR110	3020335	DIODE 1S2186	L136	3524173	COIL RADIAL 15.0 UH
CR111	3020335	DIODE 1S2186	L137	3524171	COIL RADIAL 10.0 UH
CR112	3020335	DIODE 1S2186	L138	2510103	INDUCTOR TOROID
CR113	3020335	DIODE 1S2186	L139	3524164	COIL RADIAL 4.7 UH
CR114	3020335	DIODE 1S2186	L140	2510104	INDUCTOR TOROID (3501056 SHIELD)
CR115	3020335	DIODE 1S2186	L141	3524168	COIL RADIAL 6.8 UH
CR116	3020335	DIODE 1S2186	L142	3524171	COIL RADIAL 10.0 UH
CR117	3020335	DIODE 1S2186	L143	3524155	COIL RADIAL 2.2 UH
CR118	3020335	DIODE 1S2186	L144	3524171	COIL RADIAL 10.0 UH
CR119	3020335	DIODE 1S2186	L145	3524168	COIL RADIAL 6.8 UH
CR120	3020335	DIODE 1S2186	L146	2510083	INDUCTOR TOROID
CR121	3020335	DIODE 1S2186	L147	2510083	INDUCTOR TOROID
CR122	3020335	DIODE 1S2186			
CR123	3020335	DIODE 1S2186			
CR124	3020335	DIODE 1S2186			

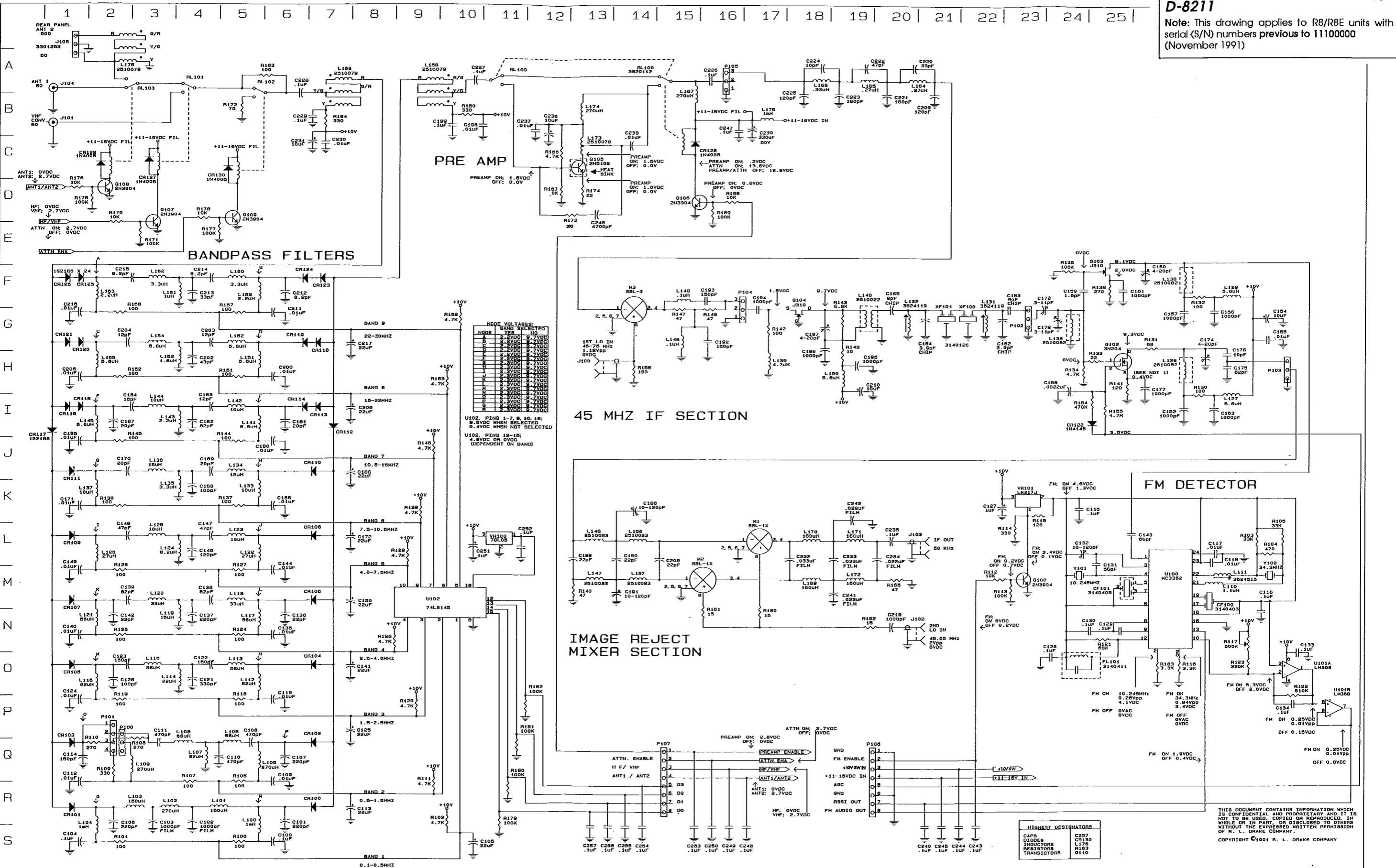


REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
L148	3524136	COIL AXIAL 0.1 UH	R107	3220055	RES C.FILM 100 OHM 5%1/4W
L149	3524136	COIL AXIAL 0.1 UH	R108	3220085	RES C.FILM 270 OHM 5%1/4W
L150	3524165	COIL RADIAL 5.6 UH	R109	3220090	RES C.FILM 330 OHM 5%1/4W
L151	3524165	COIL RADIAL 5.6 UH	R110	3220085	RES C.FILM 270 OHM 5%1/4W
L152	3524165	COIL RADIAL 5.6 UH	R111	3220210	RES C.FILM 4.7 K 5% 1/4W
L153	3524152	COIL RADIAL 1.8 UH	R112	3220235	RES C.FILM 10 K 5% 1/4W
L154	3524165	COIL RADIAL 5.6 UH	R113	3220315	RES C.FILM 100 K 5% 1/4W
L155	3524165	COIL RADIAL 5.6 UH	R114	3220090	RES C.FILM 330 OHM 5%1/4W
L156	2510083	INDUCTOR TOROID	R115	3220060	RES C.FILM 120 OHM 5%1/4W
L157	2510083	INDUCTOR TOROID	R116	3220200	RES C.FILM 3.3 K 5% 1/4W
L158	2510079	INDUCTOR TOROID	R117	3260612	RES VAR PT10V LIN 500K
L159	3524155	COIL RADIAL 2.2 UH	R118	3220055	RES C.FILM 100 OHM 5%1/4W
L160	3524160	COIL RADIAL 3.3 UH	R119	3220055	RES C.FILM 100 OHM 5%1/4W
L161	3524148	COIL RADIAL 1.0 UH	R120	3220210	RES C.FILM 4.7 K 5% 1/4W
L162	3524160	COIL RADIAL 3.3 UH	R121	3220300	RES C.FILM 68 K 5% 1/4W
L163	3524155	COIL RADIAL 2.2 UH	R122	3220347	RES C.FILM 510 K 5% 1/4W
L164	3524138	COIL RADIAL 0.27 UH	R123	3220330	RES C.FILM 220 K 5% 1/4W
L165	3524138	COIL RADIAL 0.27 UH	R124	3220055	RES C.FILM 100 OHM 5%1/4W
L166	3524140	COIL RADIAL 0.33 UH	R125	3220055	RES C.FILM 100 OHM 5%1/4W
L167	3524196	COIL RADIAL 270.0 UH	R126	3220210	RES C.FILM 4.7 K 5% 1/4W
L168	2510079	INDUCTOR TOROID	R127	3220055	RES C.FILM 100 OHM 5%1/4W
L169	3520534	CHOKE ASSY 160.0 UH	R128	3220055	RES C.FILM 100 OHM 5%1/4W
L170	3520534	CHOKE ASSY 160.0 UH	R129	3220210	RES C.FILM 4.7 K 5% 1/4W
L171	3520534	CHOKE ASSY 160.0 UH	R130	3220055	RES C.FILM 100 OHM 5%1/4W
L172	3520534	CHOKE ASSY 160.0 UH	R131	3220045	RES C.FILM 68 OHM 5%1/4W
L173	2510078	INDUCTOR TOROID	R132	3220055	RES C.FILM 100 OHM 5%1/4W
L174	3524196	COIL RADIAL 270.0 UH	R133	3220015	RES C.FILM 22 OHM 5%1/4W
L175	3524199	COIL RADIAL 1.0 MH			
L176	2510079	INDUCTOR TOROID	R135	3220355	RES C.FILM 1M 5% 1/4W
M1	3045002	I.C. BAL. MIXER SBL1-X	R136	3220085	RES C.FILM 270 OHM 5%1/4W
M2	3045002	I.C. BAL. MIXER SBL1-X	R137	3220055	RES C.FILM 100 OHM 5%1/4W
M3	3045004	I.C. BAL. MIXER SBL-3	R138	3220055	RES C.FILM 100 OHM 5%1/4W
P100	3280723	CONN P.C. 3 PIN MALE	R139	3220210	RES C.FILM 4.7 K 5% 1/4W
P101	3280724	CONN P.C. 4 PIN MALE	R140	3220035	RES C.FILM 47 OHM 5%1/4W
P102	3280723	CONN P.C. 3 PIN MALE	R141	3220060	RES C.FILM 120 OHM 5%1/4W
P103	3280723	CONN P.C. 3 PIN MALE	R142	3220055	RES C.FILM 100 OHM 5%1/4W
P104	3280723	CONN P.C. 3 PIN MALE	R143	3220235	RES C.FILM 10 K 5% 1/4W
P105	3280723	CONN P.C. 3 PIN MALE	R144	3220055	RES C.FILM 100 OHM 5%1/4W
P106	3280720	CONN P.C. 8 PIN MALE	R145	3220055	RES C.FILM 100 OHM 5%1/4W
P107	3280720	CONN P.C. 8 PIN MALE	R146	3220210	RES C.FILM 4.7 K 5% 1/4W
Q100	3030104	TRANSISTOR 2N3904	R147	3220035	RES C.FILM 47 OHM 5%1/4W
Q102	3030286	TRANSISTOR 3SK81	R148	3220035	RES C.FILM 47 OHM 5%1/4W
Q103	3030504	TRANSISTOR J-310	R149	3220005	RES C.FILM 10 OHM 5%1/4W
Q104	3030504	TRANSISTOR J-310	R150	3220090	RES C.FILM 330 OHM 5%1/4W
Q105	3030137	TRANSISTOR 2N5109 (3493040 HEAT SINK)	R151	3220055	RES C.FILM 100 OHM 5%1/4W
Q106	3030104	TRANSISTOR 2N3904	R152	3220055	RES C.FILM 100 OHM 5%1/4W
Q107	3030104	TRANSISTOR 2N3904	R153	3220210	RES C.FILM 4.7 K 5% 1/4W
Q108	3030104	TRANSISTOR 2N3904	R154	3220345	RES C.FILM 470 K 5% 1/4W
Q109	3030104	TRANSISTOR 2N3904	R156	3220070	RES C.FILM 180 OHM 5%1/4W
R100	3220055	RES C.FILM 100 OHM 5%1/4W			
R101	3220055	RES C.FILM 100 OHM 5%1/4W			
R102	3220210	RES C.FILM 4.7 K 5% 1/4W			
R103	3220275	RES C.FILM 33 K 5% 1/4W			
R104	3220110	RES C.FILM 470 OHM 5%1/4W			
R105	3220275	RES C.FILM 33 K 5% 1/4W			
R106	3220055	RES C.FILM 100 OHM 5%1/4W			

# 16 Front End Board Parts List cont'd.

REF	PART NUM	DESCRIPTION
R157	3220055	RES C.FILM 100 OHM 5%1/4W
R158	3220055	RES C.FILM 100 OHM 5%1/4W
R159	3220210	RES C.FILM 4.7 K 5% 1/4W
R160	3220010	RES C.FILM 15 OHM 5%1/4W
R161	3220010	RES C.FILM 15 OHM 5%1/4W
R162	3220010	RES C.FILM 15 OHM 5%1/4W
R163	3220055	RES C.FILM 100 OHM 5%1/4W
R164	3220090	RES C.FILM 330 OHM 5%1/4W
R165	3220035	RES C.FILM 47 OHM 5%1/4W
R166	3220210	RES C.FILM 4.7 K 5% 1/4W
R167	3220160	RES C.FILM 1.0 K 5% 1/4W
R168	3220235	RES C.FILM 10 K 5% 1/4W
R169	3220315	RES C.FILM 100 K 5% 1/4W
R170	3220235	RES C.FILM 10 K 5% 1/4W
R171	3220315	RES C.FILM 100 K 5% 1/4W
R172	3220047	RES C.FILM 75 OHM 5%1/4W
R173	3220085	RES C.FILM 270 OHM 5%1/4W
R174	3220015	RES C.FILM 22 OHM 5%1/4W
R175	3220315	RES C.FILM 100 K 5% 1/4W
R176	3220235	RES C.FILM 10 K 5% 1/4W
R177	3220315	RES C.FILM 100 K 5% 1/4W
R178	3220235	RES C.FILM 10 K 5% 1/4W
R179	3220315	RES C.FILM 100 K 5% 1/4W
R180	3220315	RES C.FILM 100 K 5% 1/4W
R181	3220315	RES C.FILM 100 K 5% 1/4W
R182	3220315	RES C.FILM 100 K 5% 1/4W
R183	3220200	RES C.FILM 3.3 K 5% 1/4W
R184	3220215	RES C. FILM 5.6K, 5%, 1/4W
RL100	3620112	RELAY TAKAMISAWA #RZ-12K
RL101	3620108	RELAY ITT #MZ12HG
RL102	3620108	RELAY ITT #MZ12HG
RL103	3620108	RELAY ITT #MZ12HG
U100	3040595	I.C. MC3362
U101	3040094	I.C. LM358
U102	3040509	I.C. 74LS145N
VR100	3040031	I.C. 78L05-ACP
VR101	3040092	I.C. LM317LZ
XF100	3140126	CRYSTAL FILTER #45U12B
XF101		( MATCHED SET OF TWO )
Y100	3120289	CRYSTAL 34.3 MHZ
Y101	3120136	CRYSTAL 10.245 MHZ

Note: This drawing applies to R8/R8E units with serial (S/N) numbers previous to 11100000 (November 1991)



**NODE VOLTAGES:**

NODE	BAND SELECTED	YES	NO
A	2.0VDC	0.7VDC	0.7VDC
B	2.0VDC	0.7VDC	0.7VDC
C	2.0VDC	0.7VDC	0.7VDC
D	2.0VDC	0.7VDC	0.7VDC
E	2.0VDC	0.7VDC	0.7VDC
F	2.0VDC	0.7VDC	0.7VDC
G	2.0VDC	0.7VDC	0.7VDC
H	2.0VDC	0.7VDC	0.7VDC
I	2.0VDC	0.7VDC	0.7VDC
J	2.0VDC	0.7VDC	0.7VDC
K	2.0VDC	0.7VDC	0.7VDC
L	2.0VDC	0.7VDC	0.7VDC
M	2.0VDC	0.7VDC	0.7VDC
N	2.0VDC	0.7VDC	0.7VDC
O	2.0VDC	0.7VDC	0.7VDC
P	2.0VDC	0.7VDC	0.7VDC
Q	2.0VDC	0.7VDC	0.7VDC
R	2.0VDC	0.7VDC	0.7VDC
S	2.0VDC	0.7VDC	0.7VDC

U102, PINS 1-7, 9, 10, 16;  
0.5VDC WHEN SELECTED  
0.4VDC WHEN NOT SELECTED

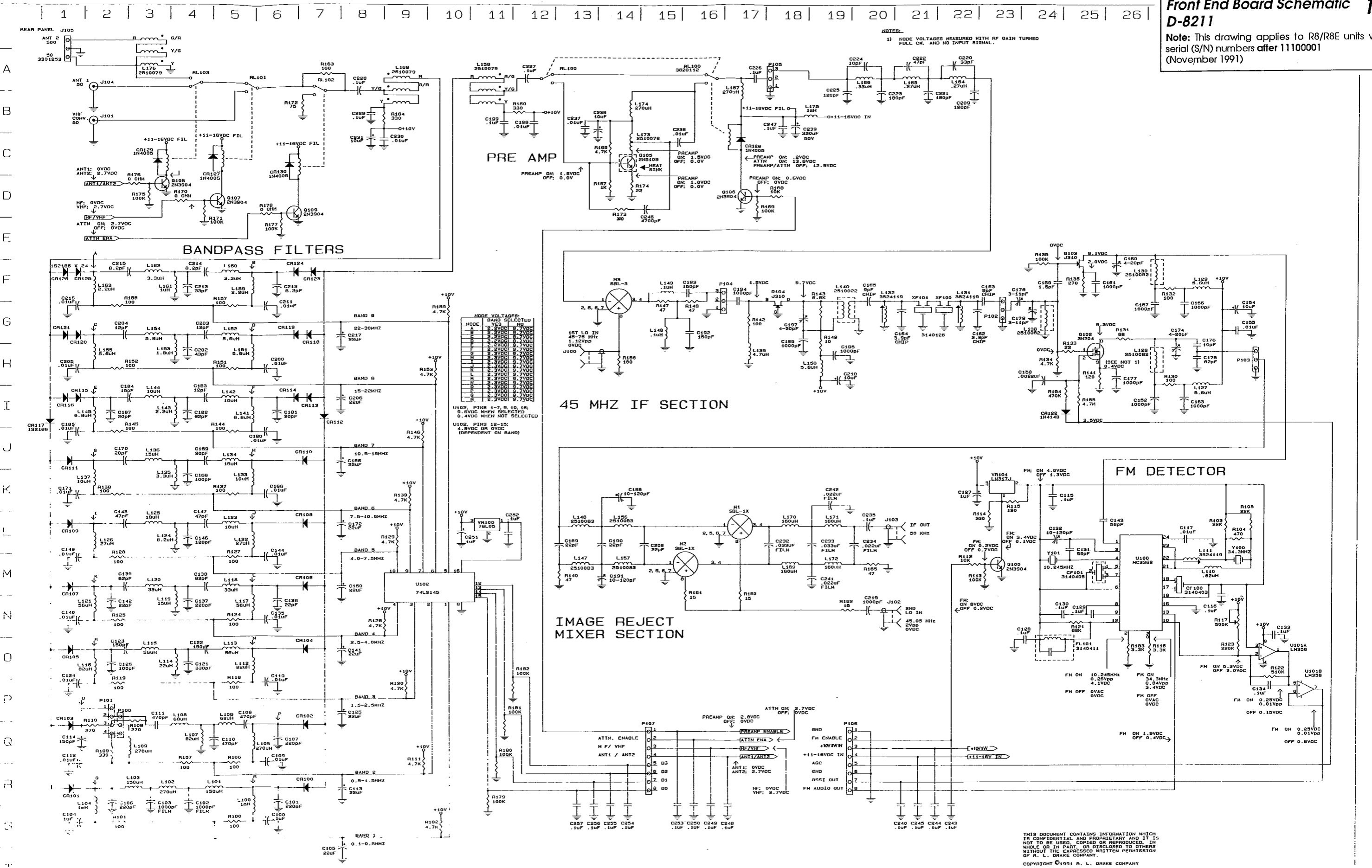
U102, PINS 12-15;  
4.0VDC ON 0VDC  
(DEPENDENT ON BAND)

**HIGHER DESIGNATORS**

CAPS	C297
DIODES	CR130
INDUCTORS	L178
RESISTORS	R183
TRANSISTORS	Q110

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Note: This drawing applies to R8/R8E units with serial (S/N) numbers after 11100001 (November 1991)



NOTES:  
1) NODE VOLTAGES MEASURED WITH RF GAIN TURNED FULL ON, AND NO INPUT SIGNAL.

NODE VOLTAGES

NODE	YES	NO
A	2.7VDC	9.7VDC
B	2.7VDC	9.7VDC
C	2.7VDC	9.7VDC
D	2.7VDC	9.7VDC
E	2.7VDC	9.7VDC
F	2.7VDC	9.7VDC
G	2.7VDC	9.7VDC
H	2.7VDC	9.7VDC
I	2.7VDC	9.7VDC
J	2.7VDC	9.7VDC
K	2.7VDC	9.7VDC
L	2.7VDC	9.7VDC
M	2.7VDC	9.7VDC
N	2.7VDC	9.7VDC
O	2.7VDC	9.7VDC
P	2.7VDC	9.7VDC
Q	2.7VDC	9.7VDC
R	2.7VDC	9.7VDC
S	2.7VDC	9.7VDC
T	2.7VDC	9.7VDC
U	2.7VDC	9.7VDC
V	2.7VDC	9.7VDC
W	2.7VDC	9.7VDC
X	2.7VDC	9.7VDC
Y	2.7VDC	9.7VDC
Z	2.7VDC	9.7VDC
AA	2.7VDC	9.7VDC
AB	2.7VDC	9.7VDC
AC	2.7VDC	9.7VDC
AD	2.7VDC	9.7VDC
AE	2.7VDC	9.7VDC
AF	2.7VDC	9.7VDC
AG	2.7VDC	9.7VDC
AH	2.7VDC	9.7VDC
AI	2.7VDC	9.7VDC
AJ	2.7VDC	9.7VDC
AK	2.7VDC	9.7VDC
AL	2.7VDC	9.7VDC
AM	2.7VDC	9.7VDC
AN	2.7VDC	9.7VDC
AO	2.7VDC	9.7VDC
AP	2.7VDC	9.7VDC
AQ	2.7VDC	9.7VDC
AR	2.7VDC	9.7VDC
AS	2.7VDC	9.7VDC
AT	2.7VDC	9.7VDC
AU	2.7VDC	9.7VDC
AV	2.7VDC	9.7VDC
AW	2.7VDC	9.7VDC
AX	2.7VDC	9.7VDC
AY	2.7VDC	9.7VDC
AZ	2.7VDC	9.7VDC
BA	2.7VDC	9.7VDC
BB	2.7VDC	9.7VDC
BC	2.7VDC	9.7VDC
BD	2.7VDC	9.7VDC
BE	2.7VDC	9.7VDC
BF	2.7VDC	9.7VDC
BG	2.7VDC	9.7VDC
BH	2.7VDC	9.7VDC
BI	2.7VDC	9.7VDC
BJ	2.7VDC	9.7VDC
BK	2.7VDC	9.7VDC
BL	2.7VDC	9.7VDC
BM	2.7VDC	9.7VDC
BN	2.7VDC	9.7VDC
BO	2.7VDC	9.7VDC
BP	2.7VDC	9.7VDC
BQ	2.7VDC	9.7VDC
BR	2.7VDC	9.7VDC
BS	2.7VDC	9.7VDC
BT	2.7VDC	9.7VDC
BU	2.7VDC	9.7VDC
BV	2.7VDC	9.7VDC
BW	2.7VDC	9.7VDC
BX	2.7VDC	9.7VDC
BY	2.7VDC	9.7VDC
BZ	2.7VDC	9.7VDC
CA	2.7VDC	9.7VDC
CB	2.7VDC	9.7VDC
CC	2.7VDC	9.7VDC
CD	2.7VDC	9.7VDC
CE	2.7VDC	9.7VDC
CF	2.7VDC	9.7VDC
CG	2.7VDC	9.7VDC
CH	2.7VDC	9.7VDC
CI	2.7VDC	9.7VDC
CJ	2.7VDC	9.7VDC
CK	2.7VDC	9.7VDC
CL	2.7VDC	9.7VDC
CM	2.7VDC	9.7VDC
CN	2.7VDC	9.7VDC
CO	2.7VDC	9.7VDC
CP	2.7VDC	9.7VDC
CQ	2.7VDC	9.7VDC
CR	2.7VDC	9.7VDC
CS	2.7VDC	9.7VDC
CT	2.7VDC	9.7VDC
CU	2.7VDC	9.7VDC
CV	2.7VDC	9.7VDC
CW	2.7VDC	9.7VDC
CX	2.7VDC	9.7VDC
CY	2.7VDC	9.7VDC
CZ	2.7VDC	9.7VDC
DA	2.7VDC	9.7VDC
DB	2.7VDC	9.7VDC
DC	2.7VDC	9.7VDC
DD	2.7VDC	9.7VDC
DE	2.7VDC	9.7VDC
DF	2.7VDC	9.7VDC
DG	2.7VDC	9.7VDC
DH	2.7VDC	9.7VDC
DI	2.7VDC	9.7VDC
DJ	2.7VDC	9.7VDC
DK	2.7VDC	9.7VDC
DL	2.7VDC	9.7VDC
DM	2.7VDC	9.7VDC
DN	2.7VDC	9.7VDC
DO	2.7VDC	9.7VDC
DP	2.7VDC	9.7VDC
DQ	2.7VDC	9.7VDC
DR	2.7VDC	9.7VDC
DS	2.7VDC	9.7VDC
DT	2.7VDC	9.7VDC
DU	2.7VDC	9.7VDC
DV	2.7VDC	9.7VDC
DW	2.7VDC	9.7VDC
DX	2.7VDC	9.7VDC
DY	2.7VDC	9.7VDC
DZ	2.7VDC	9.7VDC
EA	2.7VDC	9.7VDC
EB	2.7VDC	9.7VDC
EC	2.7VDC	9.7VDC
ED	2.7VDC	9.7VDC
EE	2.7VDC	9.7VDC
EF	2.7VDC	9.7VDC
EG	2.7VDC	9.7VDC
EH	2.7VDC	9.7VDC
EI	2.7VDC	9.7VDC
EJ	2.7VDC	9.7VDC
EK	2.7VDC	9.7VDC
EL	2.7VDC	9.7VDC
EM	2.7VDC	9.7VDC
EN	2.7VDC	9.7VDC
EO	2.7VDC	9.7VDC
EP	2.7VDC	9.7VDC
EQ	2.7VDC	9.7VDC
ER	2.7VDC	9.7VDC
ES	2.7VDC	9.7VDC
ET	2.7VDC	9.7VDC
EU	2.7VDC	9.7VDC
EV	2.7VDC	9.7VDC
EW	2.7VDC	9.7VDC
EX	2.7VDC	9.7VDC
EY	2.7VDC	9.7VDC
EZ	2.7VDC	9.7VDC
FA	2.7VDC	9.7VDC
FB	2.7VDC	9.7VDC
FC	2.7VDC	9.7VDC
FD	2.7VDC	9.7VDC
FE	2.7VDC	9.7VDC
FF	2.7VDC	9.7VDC
FG	2.7VDC	9.7VDC
FH	2.7VDC	9.7VDC
FI	2.7VDC	9.7VDC
FJ	2.7VDC	9.7VDC
FK	2.7VDC	9.7VDC
FL	2.7VDC	9.7VDC
FM	2.7VDC	9.7VDC
FN	2.7VDC	9.7VDC
FO	2.7VDC	9.7VDC
FP	2.7VDC	9.7VDC
FQ	2.7VDC	9.7VDC
FR	2.7VDC	9.7VDC
FS	2.7VDC	9.7VDC
FT	2.7VDC	9.7VDC
FU	2.7VDC	9.7VDC
FV	2.7VDC	9.7VDC
FW	2.7VDC	9.7VDC
FX	2.7VDC	9.7VDC
FY	2.7VDC	9.7VDC
FZ	2.7VDC	9.7VDC
GA	2.7VDC	9.7VDC
GB	2.7VDC	9.7VDC
GC	2.7VDC	9.7VDC
GD	2.7VDC	9.7VDC
GE	2.7VDC	9.7VDC
GF	2.7VDC	9.7VDC
GG	2.7VDC	9.7VDC
GH	2.7VDC	9.7VDC
GI	2.7VDC	9.7VDC
GJ	2.7VDC	9.7VDC
GK	2.7VDC	9.7VDC
GL	2.7VDC	9.7VDC
GM	2.7VDC	9.7VDC
GN	2.7VDC	9.7VDC
GO	2.7VDC	9.7VDC
GP	2.7VDC	9.7VDC
GQ	2.7VDC	9.7VDC
GR	2.7VDC	9.7VDC
GS	2.7VDC	9.7VDC
GT	2.7VDC	9.7VDC
GU	2.7VDC	9.7VDC
GV	2.7VDC	9.7VDC
GW	2.7VDC	9.7VDC
GX	2.7VDC	9.7VDC
GY	2.7VDC	9.7VDC
GZ	2.7VDC	9.7VDC
HA	2.7VDC	9.7VDC
HB	2.7VDC	9.7VDC
HC	2.7VDC	9.7VDC
HD	2.7VDC	9.7VDC
HE	2.7VDC	9.7VDC
HF	2.7VDC	9.7VDC
HG	2.7VDC	9.7VDC
HH	2.7VDC	9.7VDC
HI	2.7VDC	9.7VDC
HJ	2.7VDC	9.7VDC
HK	2.7VDC	9.7VDC
HL	2.7VDC	9.7VDC
HM	2.7VDC	9.7VDC
HN	2.7VDC	9.7VDC
HO	2.7VDC	9.7VDC
HP	2.7VDC	9.7VDC
HQ	2.7VDC	9.7VDC
HR	2.7VDC	9.7VDC
HS	2.7VDC	9.7VDC
HT	2.7VDC	9.7VDC
HU	2.7VDC	9.7VDC
HV	2.7VDC	9.7VDC
HW	2.7VDC	9.7VDC
HX	2.7VDC	9.7VDC
HY	2.7VDC	9.7VDC
HZ	2.7VDC	9.7VDC
IA	2.7VDC	9.7VDC
IB	2.7VDC	9.7VDC
IC	2.7VDC	9.7VDC
ID	2.7VDC	9.7VDC
IE	2.7VDC	9.7VDC
IF	2.7VDC	9.7VDC
IG	2.7VDC	9.7VDC
IH	2.7VDC	9.7VDC
II	2.7VDC	9.7VDC
IJ	2.7VDC	9.7VDC
IK	2.7VDC	9.7VDC
IL	2.7VDC	9.7VDC
IM	2.7VDC	9.7VDC
IN	2.7VDC	9.7VDC
IO	2.7VDC	9.7VDC
IP	2.7VDC	9.7VDC
IQ	2.7VDC	9.7VDC
IR	2.7VDC	9.7VDC
IS	2.7VDC	9.7VDC
IT	2.7VDC	9.7VDC
IU	2.7VDC	9.7VDC
IV	2.7VDC	9.7VDC
IW	2.7VDC	9.7VDC
IX	2.7VDC	9.7VDC
IY	2.7VDC	9.7VDC
IZ	2.7VDC	9.7VDC
JA	2.7VDC	9.7VDC
JB	2.7VDC	9.7VDC
JC	2.7VDC	9.7VDC
JD	2.7VDC	9.7VDC
JE	2.7VDC	9.7VDC
JF	2.7VDC	9.7VDC
JG	2.7VDC	9.7VDC
JH	2.7VDC	9.7VDC
JI	2.7VDC	9.7VDC
JJ	2.7VDC	9.7VDC
JK	2.7VDC	9.7VDC
JL	2.7VDC	9.7VDC
JM	2.7VDC	9.7VDC
JN	2.7VDC	9.7VDC
JO	2.7VDC	9.7VDC
JP	2.7VDC	9.7VDC
Q	2.7VDC	9.7VDC
R	2.7VDC	9.7VDC
S	2.7VDC	9.7VDC
T	2.7VDC	9.7VDC
U	2.7VDC	9.7VDC
V	2.7VDC	9.7VDC
W	2.7VDC	9.7VDC
X	2.7VDC	9.7VDC
Y	2.7VDC	9.7VDC
Z	2.7VDC	9.7VDC

U102, PINS 1-7, 9, 10, 16;  
2.7VDC WHEN SELECTED  
0.4VDC WHEN NOT SELECTED

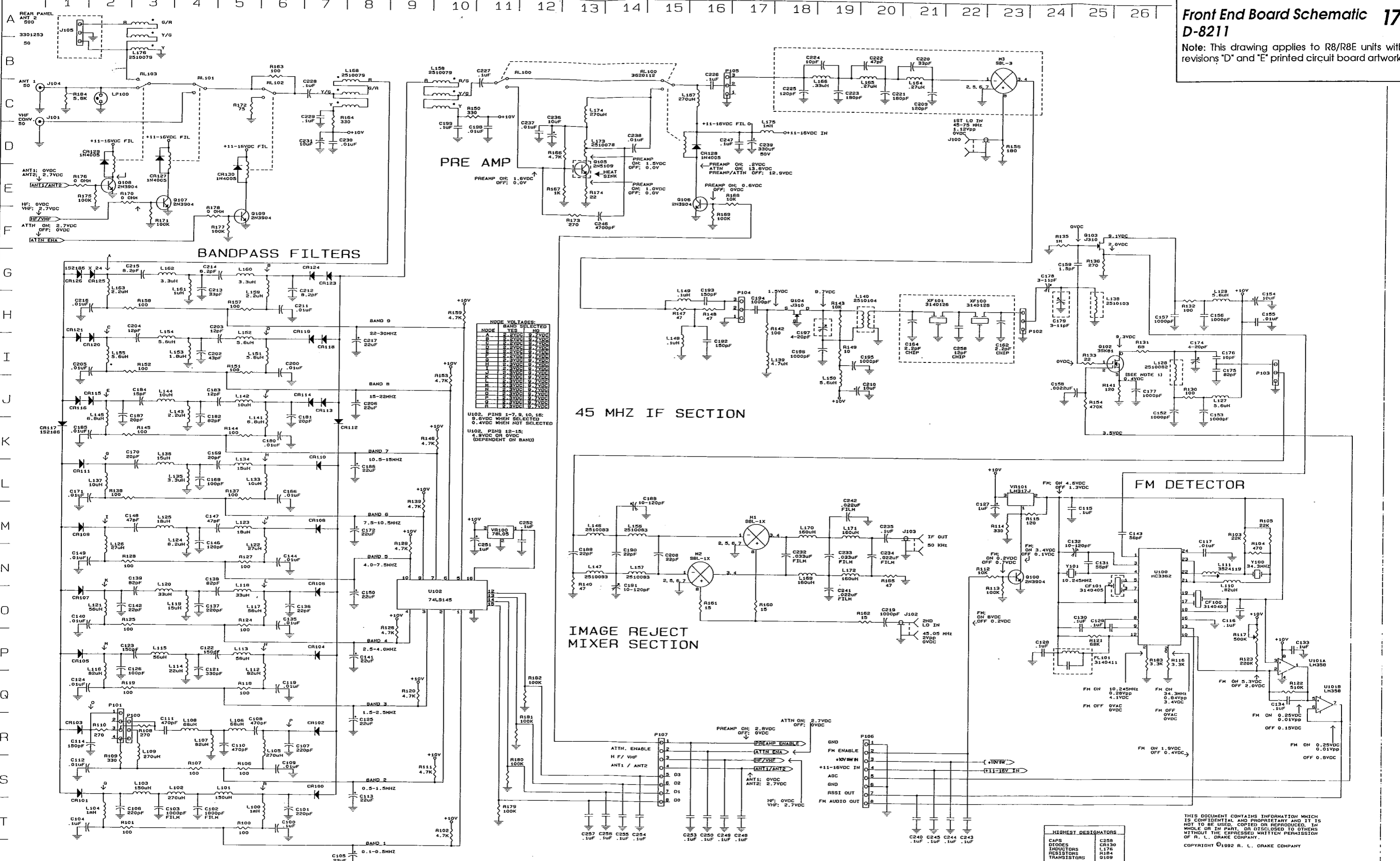
U102, PINS 12-15;  
4.9VDC OR 0VDC  
(DEPENDENT ON BAND)

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# Front End Board Schematic 17

## D-8211

Note: This drawing applies to R8/R8E units with revisions "D" and "E" printed circuit board artwork.



**NODE VOLTAGES:**

NODE	BAND SELECTED	YES	NO
A	22-30MHZ	8.7VDC	8.7VDC
B	15-22MHZ	8.7VDC	8.7VDC
C	10.5-15MHZ	8.7VDC	8.7VDC
D	7.5-10.5MHZ	8.7VDC	8.7VDC
E	4.0-7.5MHZ	8.7VDC	8.7VDC
F	2.5-4.0MHZ	8.7VDC	8.7VDC
G	1.5-2.5MHZ	8.7VDC	8.7VDC
H	0.5-1.5MHZ	8.7VDC	8.7VDC
I	0.1-0.5MHZ	8.7VDC	8.7VDC
J	22-30MHZ	8.7VDC	8.7VDC
K	15-22MHZ	8.7VDC	8.7VDC
L	10.5-15MHZ	8.7VDC	8.7VDC
M	7.5-10.5MHZ	8.7VDC	8.7VDC
N	4.0-7.5MHZ	8.7VDC	8.7VDC
O	2.5-4.0MHZ	8.7VDC	8.7VDC
P	1.5-2.5MHZ	8.7VDC	8.7VDC
Q	0.5-1.5MHZ	8.7VDC	8.7VDC
R	0.1-0.5MHZ	8.7VDC	8.7VDC

U102, PINS 1-7, 9, 10, 16:  
9.5VDC WHEN SELECTED  
0.4VDC WHEN NOT SELECTED

U102, PINS 12-15:  
4.5VDC OR 0VDC  
(DEPENDENT ON BAND)

**HIGHEST DESIGNATORS**

CAPS	C258
DIODES	CR120
INDUCTORS	L176
RESISTORS	R184
TRANSISTORS	Q109

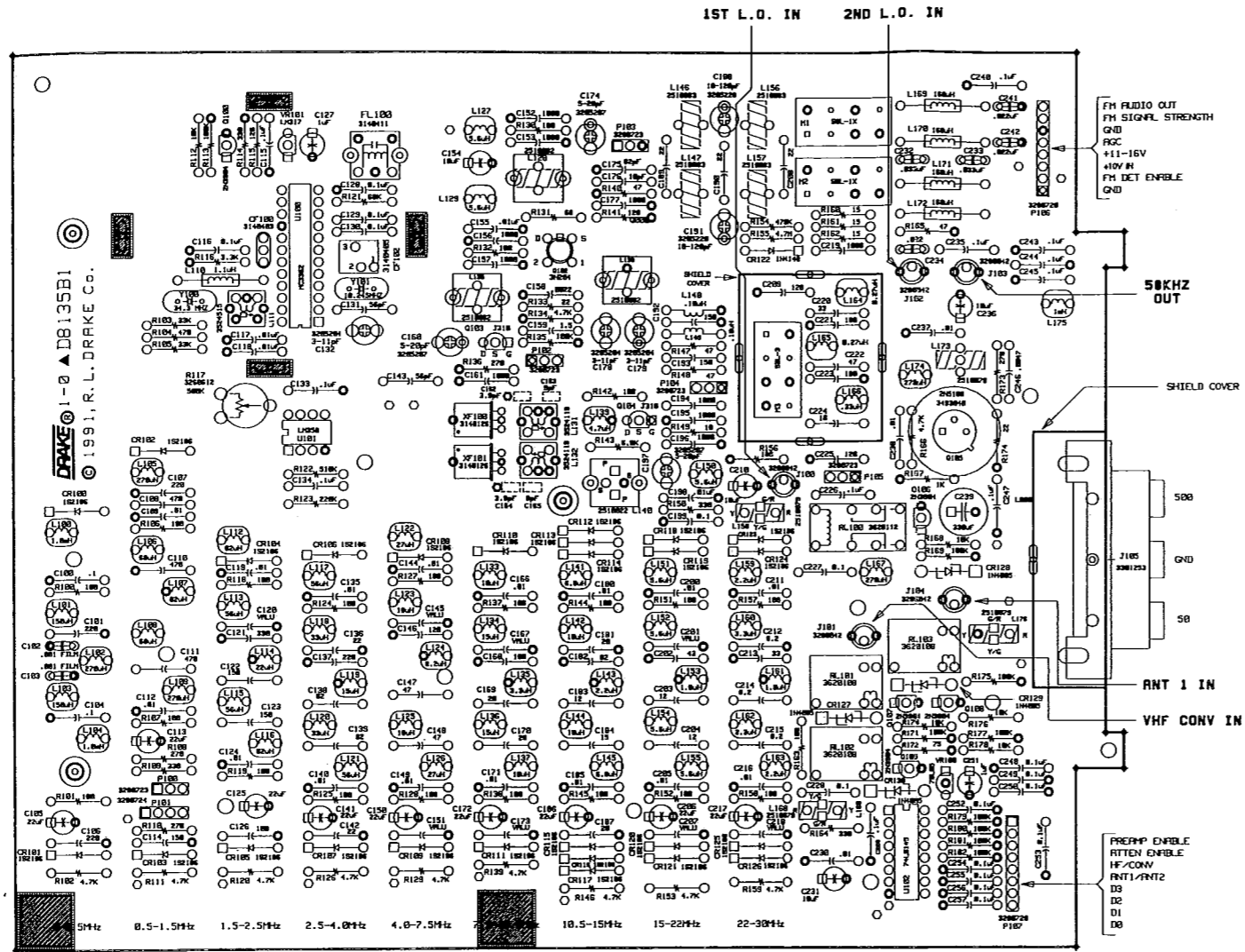
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Note: This drawing applies to R8/R8E units with serial (S/N) numbers previous to 11100000 (November 1991)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

R  
B  
C  
D  
E  
F  
G  
H  
J  
K  
L  
M  
N  
P  
Q  
R  
S  
T  
U



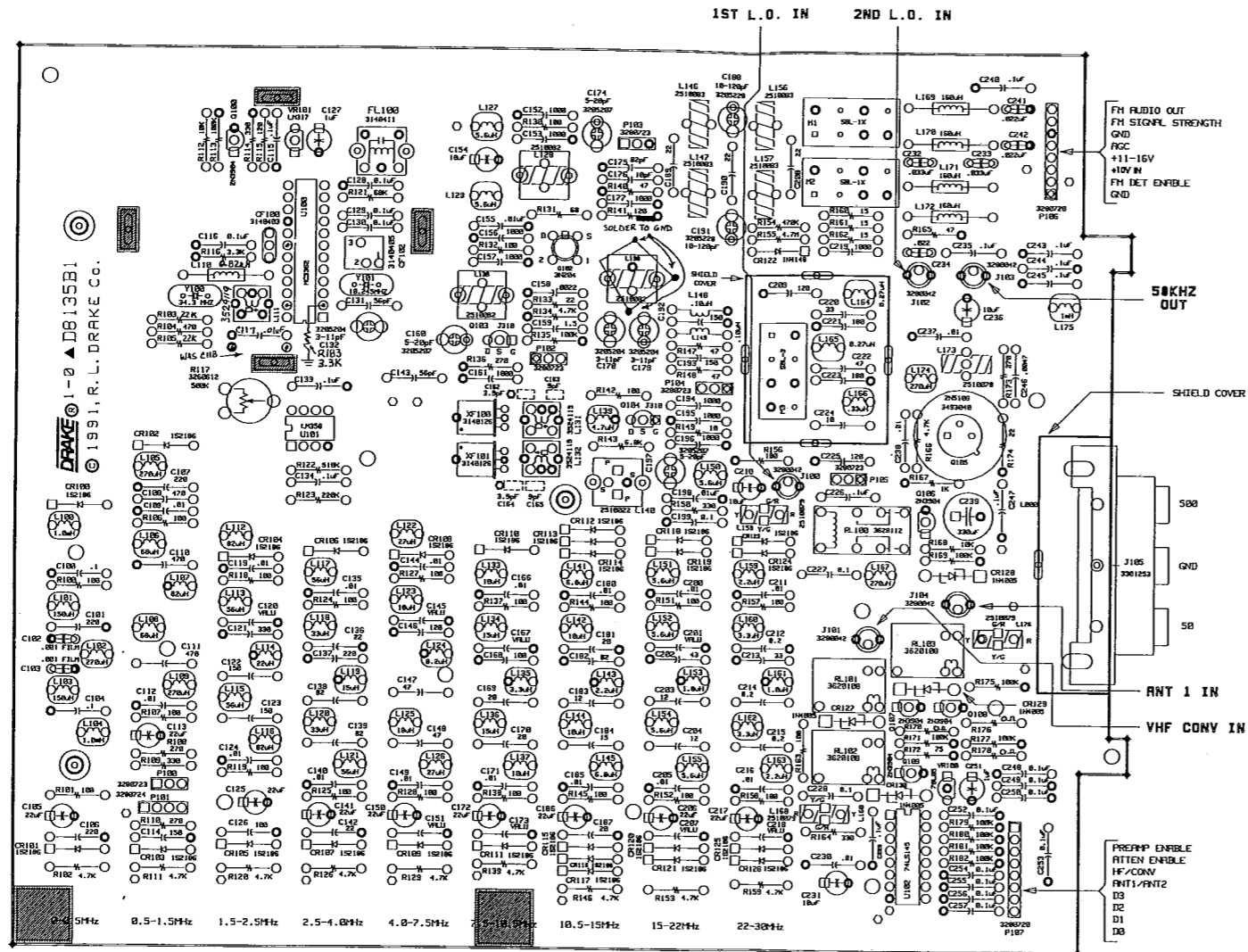
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Note: This drawing applies to R8/R8E units with serial (S/N) numbers after 111000001 (November 1991)

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |

A  
B  
C  
D  
E  
F  
G  
H  
J  
K  
L  
M  
N  
P  
Q  
R  
S  
T  
U



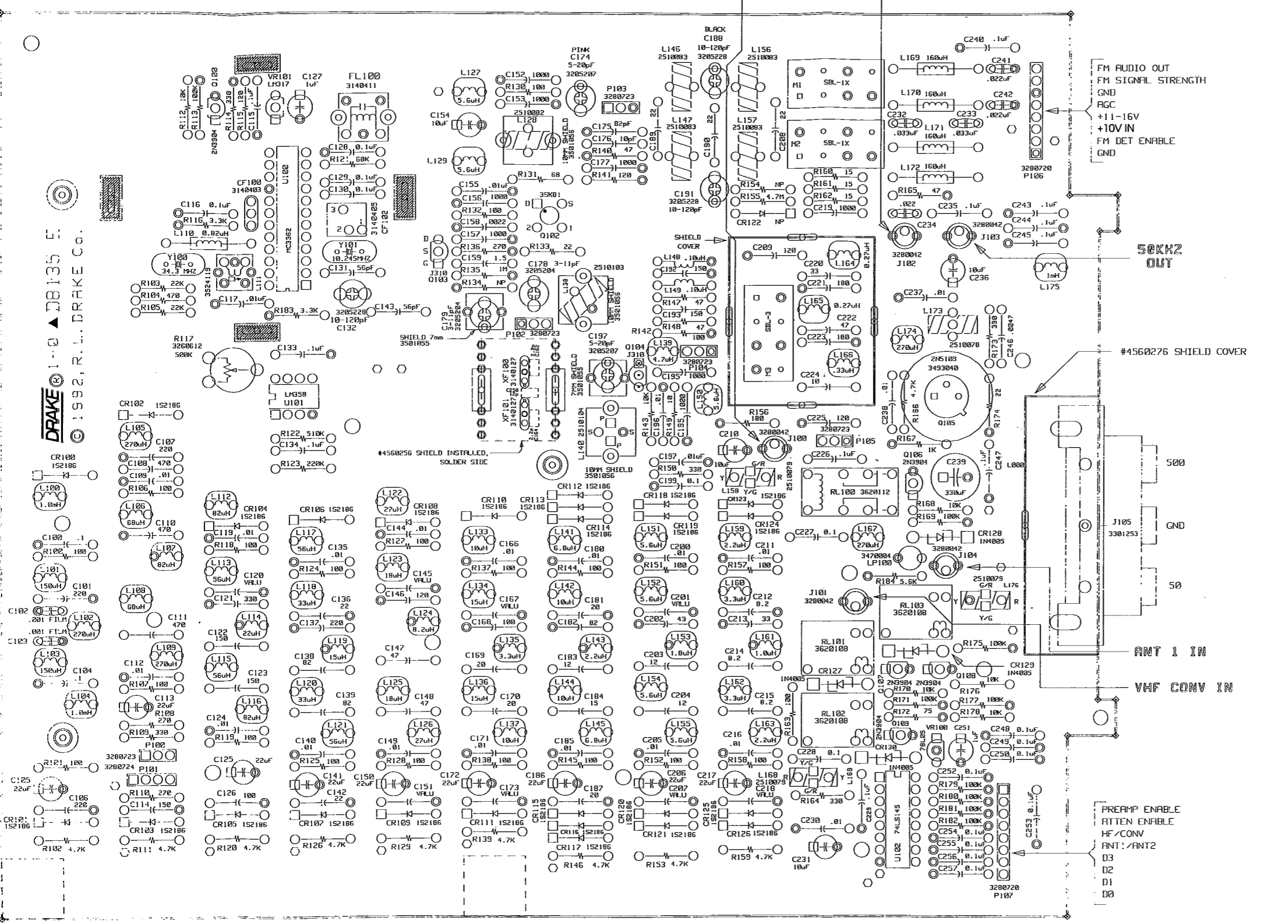
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SCHEMATIC REF. D8211		ASSEMBLY PARTS, TOP SIDE VIEW.	
<small>UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS PERCENTS ±.15 ±.015 ±.1</small>	<small>REV. NO.</small> 930	<b>DRAKE® R. L. DRAKE CO.</b>	
<small>APPROVALS</small> <small>DATE</small> <small>DESIGNED BY</small> <small>DATE</small>	<small>APPROVALS</small> <small>DATE</small> <small>DESIGNED BY</small> <small>DATE</small>	<b>R8 FRONT END</b>	
<small>FINISH</small> SOLDER PLATE	<small>SIZE</small> D	<small>ENG. NO.</small> 8135	<small>REV.</small> B2
<small>DO NOT SCALE DRAWING</small>	<small>SCALE</small> 1.5:1	<small>PART NO.</small> 2100830	<small>SHEET</small> 4 OF 4

Note: This drawing applies to R8/R8E units with Revisions "D" and "E" printed circuit board artwork.

1ST L.O. IN 2ND L.O. IN



DRAKE 1-10-8135 E  
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0-0.5MHz 0.5-1.5MHz 1.5-2.5MHz 2.5-4.0MHz 4.0-7.5MHz 7.5-10.5MHz 10.5-15MHz 15-22MHz 22-30MHz

FM AUDIO OUT  
FM SIGNAL STRENGTH  
GND  
AGC  
+11-16V  
+10V IN  
FM DET ENABLE  
GND

50KHZ OUT

#4560276 SHIELD COVER

500

GND

50

ANT 1 IN

VHF CONV IN

PREAMP ENABLE  
ATTN ENABLE  
HF/CONV  
ANT1/ANT2  
D3  
D2  
D1  
D0

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## THEORY OF OPERATION 2ND IF

1. Noise Blanker
2. Step Variable BPF
3. IF AMP and AGC Generator
4. AM and SSB Detectors
5. Audio Processing
6. -5V Generator

## 1. Noise Blanker

The noise blanker IC U117 incorporates internally an AGC'd amplifier strip, AGC control, peak detector, noise differentiator, time controlled RF gate, and time controlled audio hold circuits. Pin outs are provided for externally connected timing elements.

Noise bursts entering along with the IF signal are differentiated and trigger the RF gate off. Triggering threshold is raised by paralleling the differentiating cap C355 with a resistor. Switching a 1K resistor (R366) disables the triggering completely. Once triggered the gate off time is determined by the RF blank resistance (R362 and R361). The triggering of the RF gate is followed by the triggering of the audio hold after an externally programmed delay (R340) passes. The audio hold time, determined by R341 and C337, is selected to span the "hole" created after gating off the RF carrier.

## 2. Step Variable BPF

The BPF has five bandwidth selections which default in response to the mode of transmission selected (i.e. 6 KHz for AM). The other bandwidths can be evoked in sequence from the default BW. Pass band tuning can be utilized to skew the signal reception to either side of the passband center for improved channel rejection and/or frequency response.

The BPF results from the cascade of two four-pole Chebyshev (BPF) sections isolated by one stage of AGC'd amplification. Centered at 50 KHz, all bandwidths are designed around fixed inductor values of 9.5 mH. Coupling and shunt capacitor values are switched via analog gates (U111, 113, 114 and 115) and discrete transistors respectively. In addition, the loading of the filter is switched similarly. Switching a source resistor in the JFET amp stage preceding the BPF compensates for the insertion loss of the 6 KHz bandwidth filter network.

## 3. IF AMP and AGC Generator

The AGC'd IF amplifier is comprised of three mosfet stages. Each stage has a different gain control time delay to insure stability of the loop. The output stage has the least and the input stage has the most delay. The gain control signal is generated as follows. The output of the last mosfet stage Q110 is rectified in the class "C" biased stage (Q130) which reduces the bias applied to the OP amp U116A. The output

of U116A is applied directly through three individual delay networks to the 50 KHz mosfet stages. The mosfets employ reverse AGC (e.g. a negative going control signal reduces the gain). A fourth gain control path is buffered by a second OP-amp (U116B) which outputs to the 45 MHz mosfet stage on the "front end" board. The biasing of U116B allows its gain control signal to the front end to maximize the signal - to-noise ratio over the range of operation.

The "AGC OFF" circuitry shunts the IF output that would be rectified by Q130 and thus maintains maximum gain as set by the front panel control. The mute circuitry rebias the OP-amps to the negative supply thus maintaining minimum gain. AGC fast/slow circuitry switches a resistor (R303) in and out of the delay network at the output of Q130. The "S" meter drive current is derived from the AGC output and is shaped via diodes and variable resistors so that the meter accurately displays received signal strength.

The external muting feature is accomplished by applying ground to J103, the rear panel mute jack. Grounding J103 turns Q150 off thereby turning Q151 off which forces the AGC line to -5 VDC. The net result is full AGC on the IF amplifier stages reducing IF gain to its minimum level. Q149 and associated components provide for an automatic mute when power is first applied to the receiver to permit the active AGC level to be established smoothly.

## 4. AM and SSB Detectors

The 50 KHz signal splits into two paths following the last MOSFET stage (Q110). One path enters the double balanced demodulator IC (U103) and the other enters a carrier limiter and regenerator strip to provide carrier port injection to U103 for AM mode detection. Carrier limiting is provided through a linear stage (Q108) and a digital gate (U109A). The output symmetry/threshold of the digital gate is set by a variable resistor (R158) in the positive feedback network of U109A. The limited carrier is split into two paths at the Q109A stage. One path is coupled thru R150 and CR101 to the carrier input of U103 for non-synchronous AM detection. CR101 conducts in this AM detection mode since the 'BFO ENABLE' line is low and the 'SYNCH DET' line is high which holds Q101 and Q102 in an OFF state. Since pin 12 of U108 is at a high state with the limited carrier clocking pin 11 of U108, the 'Q' output is high, thereby turning Q104 to an ON state which prevents any 100 KHz carrier (Synchronous mode) from being applied to pin 3 of U108. With pin 9 of U108 in a high state, pin 8 is in a low state which grounds CR104 and keeps CR102 reverse biased as additional isolation to any 50 KHz regenerated carrier at pin 5 of U108. Note also, with the logic high state applied to the 'SYNCH DET' line, Q140, Q132 and Q162 are ON. This condition provides a short time constant to the PLL generated 100 KHz local carrier (U112) to permit relatively fast acquisition of the carrier if the synchronous mode of detection is selected.

For synchronous AM detection, the 'SYNCH DET' line is driven to a logic low by the system microprocessor and related circuitry. The 'BFO ENA' line remains in a logic low state as for AM detection. The limited 50 KHz carrier is doubled by U109B & D and applied to the 100 KHz PLL circuit (U112) which can provide an uninterrupted carrier that frequency tracks the original. Note that Q140, Q132 and Q162 are OFF, thereby providing a long time constant to the PLL generated 100 KHz local carrier. With Q104 OFF, three succeeding stages of U110 phase shift the (100 KHz) PLL carrier and apply it to the clock input pin 3 of U108. The output signal at pin 5 of U108 is (divided by two) a 50 KHz synchronous carrier that is conducted thru CR102 to the carrier input of U103. Pin 8 of U108 is a logic high which results in a reverse biased CR104 and a +5 VDC level applied thru R189 to illuminate the front panel 'SYNCHRO' LED.

For SSB operation, the 'BFO ENA' line is set at a logic high state which turns Q101 ON, thereby clamping the limited carrier input of U109A to 0.7 VDC and setting the output of U109A to zero. The logic high on the 'BFO ENA' line inhibits the PLL circuit, U112. Also, with Q102 turned ON, Q104 is ON and no output is possible from U110. With no limited carrier or synchronous locally generated carrier present at the junction of CR101 and CR102, the 50 KHz BFO carrier from J109 is sent to the carrier input of U103.

Regardless of the detection mode, the demodulated audio is present at pin 6 of U103.

### 5. Audio Processing

The detected audio from the demodulator IC passes through the audio hold circuit of the noise blanker IC. The hold function is only available in the AM mode. Leaving the hold circuit, the audio passes through the tone control circuit (U106), which allows  $\pm 10$  dB boost and cut of the bass response.

The audio notch follows the tone control. The notching frequency is made variable by employing a variable BPF (U107B) in a split signal network that cancels at the BP center frequency. The notch is disabled by switching off the signal to the BPF.

The audio then enters the squelch gate (U105A). The squelch reference is the buffered AGC line from (U102B) and the squelch trip point is set via the front panel control. The squelch trip signal selects a terminated input resulting in muted audio. This selector IC feeds the AM or FM audio to a buffer (U107A) and 5 KHz low pass filter (U100A). The output of the LPF is split into three paths: two buffered line audio outputs and a volume controlled audio power amp (U104). The output of the power amp passes through the headphone jack before switching between the internal and/or external speaker (s).

### 6. -5 VDC Generator

The -5 volt supply is utilized in the MOSFET gain control circuitry. It is generated by a free running 115 KHz multivibrator oscillator composed of crosscoupled transistor stages Q116 and Q121. Transistor stage Q120 provides reliable pullup to the 10V supply on positive excursions of the output signal. Q120 also provides reliable startup of the oscillator due to the initial charging of C231. When +10 volts supply is applied, C231 begins charging until a level sufficient to turn on Q121 is reached. The action of turning on Q121 turns Q116 and Q120 off which in turn sends a pulse thru C230 to turn Q120 on and the cycle begins again. The resulting output pulses are rectified by CR116 and CR124 and applied to filter capacitor C299. A zener diode CR123 regulates the output voltage to -5 VDC. The output is further filtered by C253 and L110 prior to being sent to the AGC circuits.

## SECOND IF BOARD PARTS LIST

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C100	3180064	CAP ELECTRO 10@50 20%	C155	3184019	CAP FILM .001 @ 100V 5%
C101	3180109	CAP ELECTRO 22@25 20%	C156	3180064	CAP ELECTRO 10@50 20%
C102	3180018	CAP ELECTRO 2.2@50	C157	3151648	CAP AX .10 MF 50V
C103	3151650	CAP AX .1 MF 100V MET.FILM	C158	3150690	CAP AXIAL 33.0 PF 5% NPO
C104	3180109	CAP ELECTRO 22@25 20%	C159	3151405	CAP AXIAL .001 MF 10% Y5P
C105	3151425	CAP AXIAL .0022MF 20% Y5P	C160	3150690	CAP AXIAL 33.0 PF 5% NPO
C106	3151433	CAP AXIAL .0033MF 20% Y5R	C161	3151405	CAP AXIAL .001 MF 10% Y5P
C107	3151459	CAP AX .0047MF +80-20 Z5U	C162	3151648	CAP AX .10 MF 50V
C108	3151040	CAP AXIAL 82.0 PF 5% N750	C163	3151050	CAP AXIAL 91.0 PF 2% NPO
C109	3180064	CAP ELECTRO 10@50 20%	C164	3151405	CAP AXIAL .001 MF 10% Y5P
C110	3151515	CAP AXIAL .01 MF 20% Y5P	C165	3151405	CAP AXIAL .001 MF 10% Y5P
C111	3180018	CAP ELECTRO 2.2@50	C166	3151364	CAP AXIAL 680 PF 2% NPO
C112	3180109	CAP ELECTRO 22@25 20%	C168	3151064	CAP AXIAL 100 PF 2% NPO
C113	3180241	CAP ELECTRO 470@16	C169	3150420	CAP AXIAL 12.0 PF 5% NPO
C114	3180012	CAP ELECTRO 1@50 20%	C170	3150783	CAP AXIAL 51.0 PF 2% NPO
C115	3151648	CAP AX .10 MF 50V	C171	3150750	CAP AXIAL 39.0 PF 5% NPO
C116	3184060	CAP FILM .047 @ 50V 5%	C172	3150420	CAP AXIAL 12.0 PF 5% NPO
C117	3180018	CAP ELECTRO 2.2@50	C173	3150420	CAP AXIAL 12.0 PF 5% NPO
C118	3180064	CAP ELECTRO 10@50 20%	C174	3150540	CAP AXIAL 18.0 PF 5% NPO
C119	3151648	CAP AX .10 MF 50V	C175	3150779	CAP AXIAL 43.0 PF 5% NPO
C120	3151648	CAP AX .10 MF 50V	C176	3150640	CAP AXIAL 27.0 PF 5% NPO
C121	3180018	CAP ELECTRO 2.2@50	C177	3151405	CAP AXIAL .001 MF 10% Y5P
C122	3180018	CAP ELECTRO 2.2@50	C178	3151425	CAP AXIAL .0022MF 20% Y5P
C123	3151648	CAP AX .10 MF 50V	C179	3151648	CAP AX .10 MF 50V
C124	3151648	CAP AX .10 MF 50V	C180	3180018	CAP ELECTRO 2.2@50
C125	3180239	CAP ELECTRO 470@25 RADIAL	C181	3184019	CAP FILM .001 @ 100V 5%
C126	3180239	CAP ELECTRO 470@25 RADIAL	C182	3180109	CAP ELECTRO 22@25 20%
C127	3180018	CAP ELECTRO 2.2@50	C183	3180109	CAP ELECTRO 22@25 20%
C128	3180018	CAP ELECTRO 2.2@50	C184	3180152	CAP ELECTRO 100@50
C129	3180064	CAP ELECTRO 10@50 20%	C185	3151648	CAP AX .10 MF 50V
C130	3180064	CAP ELECTRO 10@50 20%	C186	3180018	CAP ELECTRO 2.2@50
C131	3151065	CAP AXIAL 100 PF 5% GP	C187	3151050	CAP AXIAL 91.0 PF 2% NPO
C132	3180064	CAP ELECTRO 10@50 20%	C188	3151405	CAP AXIAL .001 MF 10% Y5P
C133	3151648	CAP AX .10 MF 50V	C189	3151405	CAP AXIAL .001 MF 10% Y5P
C134	3150690	CAP AXIAL 33.0 PF 5% NPO	C190	3151364	CAP AXIAL 680 PF 2% NPO
C135	3150690	CAP AXIAL 33.0 PF 5% NPO	C191	3151260	CAP RADIAL 220 PF 5% N470
C136	3151405	CAP AXIAL .001 MF 10% Y5P	C193	3151425	CAP AXIAL .0022MF 20% Y5P
C137	3151587	CAP AX .047 MF +80-20 Z5U	C194	3151260	CAP RADIAL 220 PF 5% N470
C138	3180064	CAP ELECTRO 10@50 20%	C195	3151155	CAP AXIAL 150 PF 10% Y5P
C139	3151260	CAP RADIAL 220 PF 5% N470	C196	3180018	CAP ELECTRO 2.2@50
C140	3184039	CAP FILM .015 @ 100V 5%	C197	3180064	CAP ELECTRO 10@50 20%
C141	3180064	CAP ELECTRO 10@50 20%	C198	3150245	CAP AXIAL 6.8 PF 10% NPO
C142	3184150	CAP FILM 2.2 @ 100V 10%	C199	3151260	CAP RADIAL 220 PF 5% N470
C143	3180348	CAP ELECTRO 6800@25 RAD'L	C200	3180018	CAP ELECTRO 2.2@50
C144	3180348	CAP ELECTRO 6800@25 RAD'L	C201	3180241	CAP ELECTRO 470@16
C145	3151648	CAP AX .10 MF 50V	C202	3180109	CAP ELECTRO 22@25 20%
C146	3180018	CAP ELECTRO 2.2@50	C203	3180109	CAP ELECTRO 22@25 20%
C147	3180018	CAP ELECTRO 2.2@50	C204	3180018	CAP ELECTRO 2.2@50
C148	3180064	CAP ELECTRO 10@50 20%	C205	3180064	CAP ELECTRO 10@50 20%
C149	3151432	CAP RAD. .0033MF 2% NPO	C206	3150245	CAP AXIAL 6.8 PF 10% NPO
C150	3151433	CAP AXIAL .0033MF 20% Y5R	C207	3150640	CAP AXIAL 27.0 PF 5% NPO
C151	3180064	CAP ELECTRO 10@50 20%	C208	3150779	CAP AXIAL 43.0 PF 5% NPO
C152	3180152	CAP ELECTRO 100@50	C209	3150540	CAP AXIAL 18.0 PF 5% NPO
C153	3151648	CAP AX .10 MF 50V	C210	3150420	CAP AXIAL 12.0 PF 5% NPO
C154	3180064	CAP ELECTRO 10@50 20%	C211	3150420	CAP AXIAL 12.0 PF 5% NPO
			C212	3150750	CAP AXIAL 39.0 PF 5% NPO
			C213	3150783	CAP AXIAL 51.0 PF 2% NPO
			C214	3151064	CAP AXIAL 100 PF 2% NPO

## 22 Second IF Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C215	3150420	CAP AXIAL 12.0 PF 5% NPO	C275	3150640	CAP AXIAL 27.0 PF 5% NPO
C216	3151648	CAP AX .10 MF 50V	C276	3150350	CAP AXIAL 10.0 PF 5% NPO
C217	3180018	CAP ELECTRO 2.2@50	C277	3151405	CAP AXIAL .001 MF 10% Y5P
C218	3150420	CAP AXIAL 12.0 PF 5% NPO	C278	3151364	CAP AXIAL 680 PF 2% NPO
C219	3150690	CAP AXIAL 33.0 PF 5% NPO	C279	3151260	CAP RADIAL 220 PF 5% N470
C220	3150750	CAP AXIAL 39.0 PF 5% NPO	C280	3151260	CAP RADIAL 220 PF 5% N470
C221	3150350	CAP AXIAL 10.0 PF 5% NPO	C281	3150245	CAP AXIAL 6.8 PF 10% NPO
C222	3151405	CAP AXIAL .001 MF 10% Y5P	C282	3151064	CAP AXIAL 100 PF 2% NPO
C223	3151260	CAP RADIAL 220 PF 5% N470	C283	3150420	CAP AXIAL 12.0 PF 5% NPO
C224	3151364	CAP AXIAL 680 PF 2% NPO	C284	3150783	CAP AXIAL 51.0 PF 2% NPO
C225	3151065	CAP AXIAL 100 PF 5% GP	C285	3150750	CAP AXIAL 39.0 PF 5% NPO
C226	3151295	CAP AXIAL 330 PF 10% Y5P	C286	3150420	CAP AXIAL 12.0 PF 5% NPO
C227	3151648	CAP AX .10 MF 50V	C287	3150420	CAP AXIAL 12.0 PF 5% NPO
C228	3180241	CAP ELECTRO 470@16	C288	3150540	CAP AXIAL 18.0 PF 5% NPO
C229	3151405	CAP AXIAL .001 MF 10% Y5P	C289	3150779	CAP AXIAL 43.0 PF 5% NPO
C230	3151405	CAP AXIAL .001 MF 10% Y5P	C290	3150640	CAP AXIAL 27.0 PF 5% NPO
C231	3151362	CAP AXIAL 680 PF 10% Y5P	C293	3180018	CAP ELECTRO 2.2@50
C232	3151648	CAP AX .10 MF 50V	C294	3151515	CAP AXIAL .01 MF 20% Y5P
C233	3150420	CAP AXIAL 12.0 PF 5% NPO	C295	3151515	CAP AXIAL .01 MF 20% Y5P
C234	3150640	CAP AXIAL 27.0 PF 5% NPO	C296	3180109	CAP ELECTRO 22@25 20%
C235	3150750	CAP AXIAL 39.0 PF 5% NPO	C297	3180109	CAP ELECTRO 22@25 20%
C236	3150350	CAP AXIAL 10.0 PF 5% NPO	C298	3180064	CAP ELECTRO 10@50 20%
C237	3151405	CAP AXIAL .001 MF 10% Y5P	C299	3180109	CAP ELECTRO 2.2@25 20%
C238	3151364	CAP AXIAL 680 PF 2% NPO	C300	3180018	CAP ELECTRO 2.2@50
C239	3151260	CAP RADIAL 220 PF 5% N470	C301	3151648	CAP AX .10 MF 50V
C240	3151648	CAP AX .10 MF 50V	C302	3180064	CAP ELECTRO 10@50 20%
C241	3151064	CAP AXIAL 100 PF 2% NPO	C303	3150420	CAP AXIAL 12.0 PF 5% NPO
C242	3150640	CAP AXIAL 27.0 PF 5% NPO	C304	3150750	CAP AXIAL 39.0 PF 5% NPO
C243	3150540	CAP AXIAL 18.0 PF 5% NPO	C305	3150640	CAP AXIAL 27.0 PF 5% NPO
C244	3151405	CAP AXIAL .001 MF 10% Y5P	C306	3150350	CAP AXIAL 10.0 PF 5% NPO
C245	3151364	CAP AXIAL 680 PF 2% NPO	C307	3151405	CAP AXIAL .001 MF 10% Y5P
C246	3150168	CAP AXIAL 5.6 PF 10% NPO	C308	3151364	CAP AXIAL 680 PF 2% NPO
C247	3150896	CAP AXIAL 56.0 PF 5% NPO	C309	3150595	CAP AXIAL 22.0 PF 5% NPO
C248	3151648	CAP AX .10 MF 50V	C310	3151260	CAP RADIAL 220 PF 5% N470
C249	3151648	CAP AX .10 MF 50V	C311	3150640	CAP AXIAL 27.0 PF 5% NPO
C250	3151648	CAP AX .10 MF 50V	C312	3150779	CAP AXIAL 43.0 PF 5% NPO
C251	3151648	CAP AX .10 MF 50V	C313	3150540	CAP AXIAL 18.0 PF 5% NPO
C252	3151425	CAP AXIAL .0022MF 20% Y5P	C314	3150420	CAP AXIAL 12.0 PF 5% NPO
C253	3180152	CAP ELECTRO 100@50	C315	3150420	CAP AXIAL 12.0 PF 5% NPO
C254	3151362	CAP AXIAL 680 PF 10% Y5P	C316	3150750	CAP AXIAL 39.0 PF 5% NPO
C255	3151648	CAP AX .10 MF 50V	C317	3150783	CAP AXIAL 51.0 PF 2% NPO
C256	3151648	CAP AX .10 MF 50V	C318	3150420	CAP AXIAL 12.0 PF 5% NPO
C257	3150900	CAP AXIAL 68 PF 2% NPO	C319	3151064	CAP AXIAL 100 PF 2% NPO
C258	3150640	CAP AXIAL 27.0 PF 5% NPO	C320	3151050	CAP AXIAL 91.0 PF 2% NPO
C259	3150540	CAP AXIAL 18.0 PF 5% NPO	C321	3151648	CAP AX .10 MF 50V
C260	3150350	CAP AXIAL 10.0 PF 5% NPO	C322	3180064	CAP ELECTRO 10@50 20%
C261	3150896	CAP AXIAL 56.0 PF 5% NPO	C323	3151515	CAP AXIAL .01 MF 20% Y5P
C262	3151405	CAP AXIAL .001 MF 10% Y5P	C324	3180018	CAP ELECTRO 2.2@50
C263	3151364	CAP AXIAL 680 PF 2% NPO	C325	3151515	CAP AXIAL .01 MF 20% Y5P
C264	3150168	CAP AXIAL 5.6 PF 10% NPO	C326	3151345	CAP AXIAL 470 PF 10% Y5P
C265	3151260	CAP RADIAL 220 PF 5% N470	C327	3151515	CAP AXIAL .01 MF 20% Y5P
C266	3150245	CAP AXIAL 6.8 PF 10% NPO	C328	3180002	CAP ELECTRO .22@50 L.LEAK
C267	3151648	CAP AX .10 MF 50V	C329	3180002	CAP ELECTRO .22@50 L.LEAK
C268	3151648	CAP AX .10 MF 50V	C330	3151405	CAP AXIAL .001 MF 10% Y5P
C269	3151648	CAP AX .10 MF 50V	C331	3151405	CAP AXIAL .001 MF 10% Y5P
C270	3151648	CAP AX .10 MF 50V	C332	3180064	CAP ELECTRO 10@50 20%
C271	3180018	CAP ELECTRO 2.2@50	C333	3180007	CAP ELECTRO .47@50
C272	3180064	CAP ELECTRO 10@50 20%	C334	3180064	CAP ELECTRO 10@50 20%
C273	3150420	CAP AXIAL 12.0 PF 5% NPO	C335	3151648	CAP AX .10 MF 50V
C274	3150750	CAP AXIAL 39.0 PF 5% NPO	C336	3151648	CAP AX .10 MF 50V
			C337	3151432	CAP RAD. .0033MF 2% NPO

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C338	3180064	CAP ELECTRO 10@50 20%	HS1	2150019	HT.SINK(5073B)-TDA2003 ASSY
C339	3180064	CAP ELECTRO 10@50 20%	J100	3281025	JACK PHONE #YKB21-5012
C340	3151648	CAP AX .10 MF 50V	J101	3281695	RECEPTACLE PHONO 1P PC MT
C341	3180064	CAP ELECTRO 10@50 20%	J102	3281695	RECEPTACLE PHONO 1P PC MT
C342	3151648	CAP AX .10 MF 50V	J103	3281695	RECEPTACLE PHONO 1P PC MT
C343	3180064	CAP ELECTRO 10@50 20%	J104	3281505	RECEPTACLE DIN 5 PIN
C344	3151515	CAP AXIAL .01 MF 20% Y5P	J105	3280042	CONN.COAX PC MT. 90 DEG
C345	3180064	CAP ELECTRO 10@50 20%	J106	3280746	CONN P.C. 8 PIN FEMALE
C346	3151515	CAP AXIAL .01 MF 20% Y5P	J107	3280746	CONN P.C. 8 PIN FEMALE
C347	3180064	CAP ELECTRO 10@50 20%	J108	3280746	CONN P.C. 8 PIN FEMALE
C348	3180018	CAP ELECTRO 2.2@50	J109	3280043	CONN.COAX PC MT. 45 DEG
C349	3151065	CAP AXIAL 100 PF 5% GP	L100	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C350	3151065	CAP AXIAL 100 PF 5% GP	L101	3524114	COIL VAR 10.0 MH 10% C11265
C351	3151425	CAP AXIAL .0022MF 20% Y5P	L102	3524241	COIL RAD'L 47 MH C7679 (SCL)
C352	3151648	CAP AX .10 MF 50V	L103	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C353	3151345	CAP AXIAL 470 PF 10% Y5P	L104	3520590	CHOK ASSY 270.0 UH
C354	3180152	CAP ELECTRO 100@50	L105	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C355	3180012	CAP ELECTRO 1@50 20%	L106	3524241	COIL RAD'L 47 MH C7679 (SCL)
C356	3180018	CAP ELECTRO 2.2@50	L107	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C357	3151515	CAP AXIAL .01 MF 20% Y5P	L108	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C358	3180241	CAP ELECTRO 470@16	L109	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C359	3151259	CAP AXIAL 220pF, 10%, Y5P	L110	3520590	CHOK ASSY 270.0 UH
C360	3151405	CAP AXIAL .001 MF, 10%, Y5P	L111	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
C361	3151515	CAP AXIAL .01 MF, 20%, Y5P	L112	2055127	9.5mH POT CORE ASSY (4560254 SHIELD)
CR100	3020090	DIODE 1N4148	L113	3524241	COIL RAD'L 47 MH C7679 (SCL)
CR101	3020090	DIODE 1N4148	P100	3280723	CONN P.C. 3 PIN MALE
CR102	3020090	DIODE 1N4148	P101	3280723	CONN P.C. 3 PIN MALE
CR103	3020090	DIODE 1N4148	P102	3280723	CONN P.C. 3 PIN MALE
CR104	3020090	DIODE 1N4148	P103	3280723	CONN P.C. 3 PIN MALE
CR105	3020090	DIODE 1N4148	P105	3290752	CONN P.C. LG 2 PIN MALE
CR106	3024811	DIODE 6A2	P106	3280723	CONN P.C. 3 PIN MALE
CR107	3024811	DIODE 6A2	P107	3280723	CONN P.C. 3 PIN MALE
CR108	3024811	DIODE 6A2	P108	3280723	CONN P.C. 3 PIN MALE
CR109	3024811	DIODE 6A2	P109	3290752	CONN P.C. LG 2 PIN MALE
CR110	3020220	DIODE 1N4005-PLASTIC	P110	3280723	CONN P.C. 3 PIN MALE
CR111	3024811	DIODE 6A2	P111	3280723	CONN P.C. 3 PIN MALE
CR112	3020090	DIODE 1N4148	P112	3280723	CONN P.C. 3 PIN MALE
CR113	3020090	DIODE 1N4148	P113	3280720	CONN P.C. 8 PIN MALE
CR114	3020220	DIODE 1N4005-PLASTIC	Q100	3030104	TRANSISTOR 2N3904
CR115	3020220	DIODE 1N4005-PLASTIC	Q101	3030104	TRANSISTOR 2N3904
CR116	3020401	DIODE 1SS97-2-ND4973-7E	Q102	3030104	TRANSISTOR 2N3904
CR118	3020090	DIODE 1N4148	Q103	3030104	TRANSISTOR 2N3904
CR119	3020090	DIODE 1N4148	Q104	3030104	TRANSISTOR 2N3904
CR120	3020050	DIODE 1N751A 5.1V 5% .5W	Q105	3030495	TRANSISTOR J270
CR121	3020220	DIODE 1N4005-PLASTIC	Q106	3030292	TRANSISTOR MPSA13
CR122	3020220	DIODE 1N4005-PLASTIC	Q107	3030104	TRANSISTOR 2N3904
CR123	3020050	DIODE 1N751A 5.1V 5% .5W	Q108	3030104	TRANSISTOR 2N3904
CR124	3020401	DIODE 1SS97-2-ND4973-7E	Q109	3030286	TRANSISTOR 3SK81
CR125	3020090	DIODE 1N4148	Q110	3030286	TRANSISTOR 3SK81
CR126	3020050	DIODE 1N751A 5.1V 5% .5W	Q111	3030104	TRANSISTOR 2N3904
CR127	3020090	DIODE 1N4148	Q112	3030104	TRANSISTOR 2N3904
CR128	3020090	DIODE 1N4148	Q113	3030104	TRANSISTOR 2N3904
CR129	3020090	DIODE 1N4148			
CR130	3020090	DIODE 1N4148			
CR131	3020090	DIODE 1N4148			
CR132	3020401	DIODE 1SS97-2-ND4973-7E			
CR133	3020090	DIODE 1N4148			
CR134	3020220	DIODE 1N4005-PLASTIC			
CR135	3020090	DIODE 1N4148			
CR136	3020090	DIODE 1N4148			

# 24 Second IF Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
Q114	3030104	TRANSISTOR 2N3904	R112	3220160	RES C.FILM 1.0 K 5% 1/4W
Q115	3030104	TRANSISTOR 2N3904	R113	3220330	RES C.FILM 220 K 5% 1/4W
Q116	3030104	TRANSISTOR 2N3904	R114	3220310	RES C.FILM 82 K 5% 1/4W
Q117	3030104	TRANSISTOR 2N3904	R115	3260672	RES VAR PT10V 50K
Q118	3030104	TRANSISTOR 2N3904	R116	3220235	RES C.FILM 10 K 5% 1/4W
Q119	3030104	TRANSISTOR 2N3904	R117	3220235	RES C.FILM 10 K 5% 1/4W
Q120	3030111	TRANSISTOR 2N4125	R118	3220235	RES C.FILM 10 K 5% 1/4W
Q121	3030104	TRANSISTOR 2N3904	R119	3220160	RES C.FILM 1.0 K 5% 1/4W
Q122	3030104	TRANSISTOR 2N3904	R120	3220160	RES C.FILM 1.0 K 5% 1/4W
Q123	3030104	TRANSISTOR 2N3904	R121	3220145	RES C.FILM 820 OHM 5%1/4W
Q124	3030104	TRANSISTOR 2N3904	R122	3220160	RES C.FILM 1.0 K 5% 1/4W
Q125	3030104	TRANSISTOR 2N3904	R123	3220235	RES C.FILM 10 K 5% 1/4W
Q126	3030104	TRANSISTOR 2N3904	R124	3220195	RES C.FILM 2.7 K 5% 1/4W
Q127	3030104	TRANSISTOR 2N3904	R125	3220195	RES C.FILM 2.7 K 5% 1/4W
Q128	3030104	TRANSISTOR 2N3904	R126	3220170	RES C.FILM 1.2 K 5% 1/4W
Q129	3030104	TRANSISTOR 2N3904	R127	3220015	RES C.FILM 22 OHM 5%1/4W
Q130	3030104	TRANSISTOR 2N3904	R128	3220315	RES C.FILM 100 K 5% 1/4W
Q131	3030111	TRANSISTOR 2N4125	R129	3220285	RES C.FILM 47 K 5% 1/4W
Q132	3030121	TRANSISTOR 2N4402	R130	3220315	RES C.FILM 100 K 5% 1/4W
Q133	3030104	TRANSISTOR 2N3904	R131	3220045	RES C.FILM 68 OHM 5%1/4W
Q134	3030104	TRANSISTOR 2N3904	R132	3220006	RES C.FILM 1.5 OHM 5%1/4W
Q135	3030104	TRANSISTOR 2N3904	R133	3220235	RES C.FILM 10 K 5% 1/4W
Q136	3030104	TRANSISTOR 2N3904	R134	3220235	RES C.FILM 10 K 5% 1/4W
Q137	3030104	TRANSISTOR 2N3904	R135	3220160	RES C.FILM 1.0 K 5% 1/4W
Q138	3030104	TRANSISTOR 2N3904	R136	3220355	RES C.FILM 1.0 MEG 5%1/4W
Q139	3030495	TRANSISTOR J270	R137	3220355	RES C.FILM 1.0 MEG 5%1/4W
Q140	3030104	TRANSISTOR 2N3904	R138	3220235	RES C.FILM 10 K 5% 1/4W
Q141	3030104	TRANSISTOR 2N3904	R139	3260688	RES VAR PT10V LIN 2K
Q142	3030104	TRANSISTOR 2N3904	R140	3220345	RES C.FILM 470 K 5% 1/4W
Q143	3030104	TRANSISTOR 2N3904	R141	3220115	RES C.FILM 510 OHM 5%1/4W
Q144	3030104	TRANSISTOR 2N3904	R142	3220090	RES C.FILM 330 OHM 5%1/4W
Q145	3030104	TRANSISTOR 2N3904	R143	3220240	RES C.FILM 12 K 5% 1/4W
Q146	3030104	TRANSISTOR 2N3904	R144	3220282	RES C.FILM 39 K 5% 1/4W
Q147	3030104	TRANSISTOR 2N3904	R145	3220315	RES C.FILM 100 K 5% 1/4W
Q148	3030292	TRANSISTOR MPSA 13	R146	3220315	RES C.FILM 100 K 5% 1/4W
Q149	3030104	TRANSISTOR 2N3904	R147	3220235	RES C.FILM 10 K 5% 1/4W
Q150	3030104	TRANSISTOR 2N3904	R148	3220000	RES M.FILM 0.0 OHM 1%1/4W
Q151	3030111	TRANSISTOR 2N4125	R149	3220235	RES C.FILM 10 K 5% 1/4W
Q152	3030104	TRANSISTOR 2N3904	R150	3220160	RES C.FILM 1.0 K 5% 1/4W
Q153	3030104	TRANSISTOR 2N3904	R151	3220160	RES C.FILM 1.0 K 5% 1/4W
Q154	3030104	TRANSISTOR 2N3904	R152	3220160	RES C.FILM 1.0 K 5% 1/4W
Q155	3030286	TRANSISTOR 3SK81	R153	3220190	RES C.FILM 2.2 K 5% 1/4W
Q156	3030104	TRANSISTOR 2N3904	R154	3220190	RES C.FILM 2.2 K 5% 1/4W
Q157	3030504	TRANSISTOR J-310	R155	3220350	RES C.FILM 680 K 5% 1/4W
Q158	3030104	TRANSISTOR 2N3904	R156	3220315	RES C.FILM 100 K 5% 1/4W
Q159	3030104	TRANSISTOR 2N3904	R157	3220285	RES C.FILM 47 K 5% 1/4W
Q160	3030104	TRANSISTOR 2N3904	R158	3260672	RES VAR PT10V 50K
Q161	3030111	TRANSISTOR 2N4125	R159	3220315	RES C.FILM 100 K 5% 1/4W
Q162	3030201	TRANS 2N5953 TO92 (NS PACK.97)	R161	3220300	RES C.FILM 68 K 5% 1/4W
R100	3220004	RES C.FILM 6.8 OHM 5%1/4W	R162	3220275	RES C.FILM 33 K 5% 1/4W
R101	3220140	RES C.FILM 680 OHM 5%1/4W	R164	3220315	RES C.FILM 100 K 5% 1/4W
R102	3220110	RES C.FILM 470 OHM 5%1/4W	R165	3220235	RES C.FILM 10 K 5% 1/4W
R103	3220275	RES C.FILM 33 K 5% 1/4W	R166	3220295	RES C.FILM 56 K 5% 1/4W
R104	3220275	RES C.FILM 33 K 5% 1/4W	R167	3220235	RES C.FILM 10 K 5% 1/4W
R105	3220275	RES C.FILM 33 K 5% 1/4W	R168	3220230	RES C.FILM 8.2 K 5% 1/4W
R106	3220235	RES C.FILM 10 K 5% 1/4W	R169	3220235	RES C.FILM 10 K 5% 1/4W
R107	3220315	RES C.FILM 100 K 5% 1/4W	R170	3220170	RES C.FILM 1.2 K 5% 1/4W
R108	3220235	RES C.FILM 10 K 5% 1/4W	R171	3220215	RES C.FILM 5.6 K 5% 1/4W
R109	3220200	RES C.FILM 3.3 K 5% 1/4W	R172	3220000	RES M.FILM 0.0 OHM 1%1/4W
R110	3220275	RES C.FILM 33 K 5% 1/4W	R173	3220315	RES C.FILM 100 K 5% 1/4W
R111	3220200	RES C.FILM 3.3 K 5% 1/4W	R174	3220075	RES C.FILM 220 OHM 5%1/4W
			R175	3220005	RES C.FILM 10 OHM 5%1/4W

# Second IF Board Parts List cont'd. 25

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
R176	3220240	RES C.FILM 12 K 5% 1/4W	R239	3220275	RES C.FILM 33 K 5% 1/4W
R177	3220235	RES C.FILM 10 K 5% 1/4W	R240	3220260	RES C.FILM 22 K 5% 1/4W
R178	3220285	RES C.FILM 47 K 5% 1/4W	R241	3220235	RES C.FILM 10 K 5% 1/4W
R179	3220235	RES C.FILM 10 K 5% 1/4W	R242	3220235	RES C.FILM 10 K 5% 1/4W
R180	3220315	RES C.FILM 100 K 5% 1/4W	R243	3220260	RES C.FILM 22 K 5% 1/4W
R181	3220315	RES C.FILM 100 K 5% 1/4W	R244	3220275	RES C.FILM 33 K 5% 1/4W
R182	3250487	RES M.FILM 100 K 1% 1/4 W	R245	3220005	RES C.FILM 10 OHM 5% 1/4W
R183	3250488	RES M.FILM 200 K 1% 1/4 W	R246	3220235	RES C.FILM 10 K 5% 1/4W
R184	3260668	RES VAR PT10V 20K	R247	3220235	RES C.FILM 10 K 5% 1/4W
R185	3220090	RES C.FILM 330 OHM 5% 1/4W	R248	3220355	RES C.FILM 1.0 MEG 5% 1/4W
R186	3220210	RES C.FILM 4.7 K 5% 1/4W	R249	3220210	RES C.FILM 4.7 K 5% 1/4W
R187	3220200	RES C.FILM 3.3 K 5% 1/4W	R250	3220235	RES C.FILM 10 K 5% 1/4W
R188	3220245	RES C.FILM 15 K 5% 1/4W	R251	3220235	RES C.FILM 10 K 5% 1/4W
R189	3220175	RES C.FILM 1.5 K 5% 1/4W	R252	3220275	RES C.FILM 33 K 5% 1/4W
R190	3220065	RES C.FILM 150 OHM 5% 1/4W	R253	3220235	RES C.FILM 10 K 5% 1/4W
R191	3220000	RES M.FILM 0.0 OHM 1% 1/4W	R254	3220235	RES C.FILM 10 K 5% 1/4W
R192	3220160	RES C.FILM 1.0 K 5% 1/4W	R255	3220380	RES C.FILM 10 MEG 10% 1/4W
R193	3220275	RES C.FILM 33 K 5% 1/4W	R256	3220260	RES C.FILM 22 K 5% 1/4W
R194	3220345	RES C.FILM 470 K 5% 1/4W	R257	3220260	RES C.FILM 22 K 5% 1/4W
R195	3220230	RES C.FILM 8.2 K 5% 1/4W	R258	3220260	RES C.FILM 22 K 5% 1/4W
R196	3220295	RES C.FILM 56 K 5% 1/4W	R259	3220260	RES C.FILM 22 K 5% 1/4W
R197	3220345	RES C.FILM 470 K 5% 1/4W	R260	3220235	RES C.FILM 10 K 5% 1/4W
R198	3220295	RES C.FILM 56 K 5% 1/4W	R261	3220260	RES C.FILM 22 K 5% 1/4W
R199	3220352	RES C.FILM 820 K 5% 1/4W	R262	3220275	RES C.FILM 33 K 5% 1/4W
R200	3220235	RES C.FILM 10 K 5% 1/4W	R263	3220275	RES C.FILM 33 K 5% 1/4W
R201	3220235	RES C.FILM 10 K 5% 1/4W	R264	3220260	RES C.FILM 22 K 5% 1/4W
R202	3220380	RES C.FILM 10 MEG 10% 1/4W	R265	3220235	RES C.FILM 10 K 5% 1/4W
R203	3220275	RES C.FILM 33 K 5% 1/4W	R266	3220275	RES C.FILM 33 K 5% 1/4W
R204	3220300	RES C.FILM 68 K 5% 1/4W	R267	3220260	RES C.FILM 22 K 5% 1/4W
R205	3220310	RES C.FILM 82 K 5% 1/4W	R268	3220235	RES C.FILM 10 K 5% 1/4W
R206	3220295	RES C.FILM 56 K 5% 1/4W	R269	3220235	RES C.FILM 10 K 5% 1/4W
R208	3220235	RES C.FILM 10 K 5% 1/4W	R270	3220380	RES C.FILM 10 MEG 10% 1/4W
R209	3260612	RES VAR PT10V LIN 500K	R272	3220260	RES C.FILM 22 K 5% 1/4W
R210	3220190	RES C.FILM 2.2 K 5% 1/4W	R273	3220260	RES C.FILM 22 K 5% 1/4W
R211	3220075	RES C.FILM 220 OHM 5% 1/4W	R274	3220260	RES C.FILM 22 K 5% 1/4W
R212	3220315	RES C.FILM 100 K 5% 1/4W	R275	3220260	RES C.FILM 22 K 5% 1/4W
R213	3220315	RES C.FILM 100 K 5% 1/4W	R276	3220245	RES C.FILM 15 K 5% 1/4W
R214	3220345	RES C.FILM 470 K 5% 1/4W	R277	3220275	RES C.FILM 33 K 5% 1/4W
R215	3220235	RES C.FILM 10 K 5% 1/4W	R278	3220255	RES C.FILM 18 K 5% 1/4W
R216	3220235	RES C.FILM 10 K 5% 1/4W	R280	3220340	RES C.FILM 330 K 5% 1/4W
R217	3220380	RES C.FILM 10 MEG 10% 1/4W	R281	3220160	RES C.FILM 1.0 K 5% 1/4W
R218	3220275	RES C.FILM 33 K 5% 1/4W	R282	3220235	RES C.FILM 10 K 5% 1/4W
R219	3220300	RES C.FILM 68 K 5% 1/4W	R283	3220235	RES C.FILM 10 K 5% 1/4W
R220	3220310	RES C.FILM 82 K 5% 1/4W	R284	3220090	RES C.FILM 330 OHM 5% 1/4W
R221	3220295	RES C.FILM 56 K 5% 1/4W	R285	3260664	RES VAR PT10V 10K
R222	3220330	RES C.FILM 220 K 5% 1/4W	R286	3220315	RES C.FILM 100 K 5% 1/4W
R223	3220040	RES C.FILM 56 OHM 5% 1/4W	R287	3220315	RES C.FILM 100 K 5% 1/4W
R224	3220315	RES C.FILM 100 K 5% 1/4W	R288	3220275	RES C.FILM 33 K 5% 1/4W
R225	3220040	RES C.FILM 56 OHM 5% 1/4W	R289	3220315	RES C.FILM 100 K 5% 1/4W
R226	3220205	RES C.FILM 3.9 K 5% 1/4W	R290	3220235	RES C.FILM 10 K 5% 1/4W
R227	3220045	RES C.FILM 68 OHM 5% 1/4W	R291	3220380	RES C.FILM 10 MEG 10% 1/4W
R228	3220045	RES C.FILM 68 OHM 5% 1/4W	R292	3220260	RES C.FILM 22 K 5% 1/4W
R229	3220235	RES C.FILM 10 K 5% 1/4W	R293	3220260	RES C.FILM 22 K 5% 1/4W
R230	3220235	RES C.FILM 10 K 5% 1/4W	R294	3220260	RES C.FILM 22 K 5% 1/4W
R231	3220380	RES C.FILM 10 MEG 10% 1/4W	R295	3220260	RES C.FILM 22 K 5% 1/4W
R232	3220260	RES C.FILM 22 K 5% 1/4W	R296	3220275	RES C.FILM 33 K 5% 1/4W
R233	3220260	RES C.FILM 22 K 5% 1/4W	R297	3220245	RES C.FILM 15 K 5% 1/4W
R234	3220260	RES C.FILM 22 K 5% 1/4W	R298	3220235	RES C.FILM 10 K 5% 1/4W
R235	3220260	RES C.FILM 22 K 5% 1/4W	R299	3220235	RES C.FILM 10 K 5% 1/4W
R236	3220275	RES C.FILM 33 K 5% 1/4W	R300	3220295	RES C.FILM 56 K 5% 1/4W
R237	3220260	RES C.FILM 22 K 5% 1/4W	R302	3220365	RES C.FILM 3.3 MEG 5% 1/4W
R238	3220235	RES C.FILM 10 K 5% 1/4W			

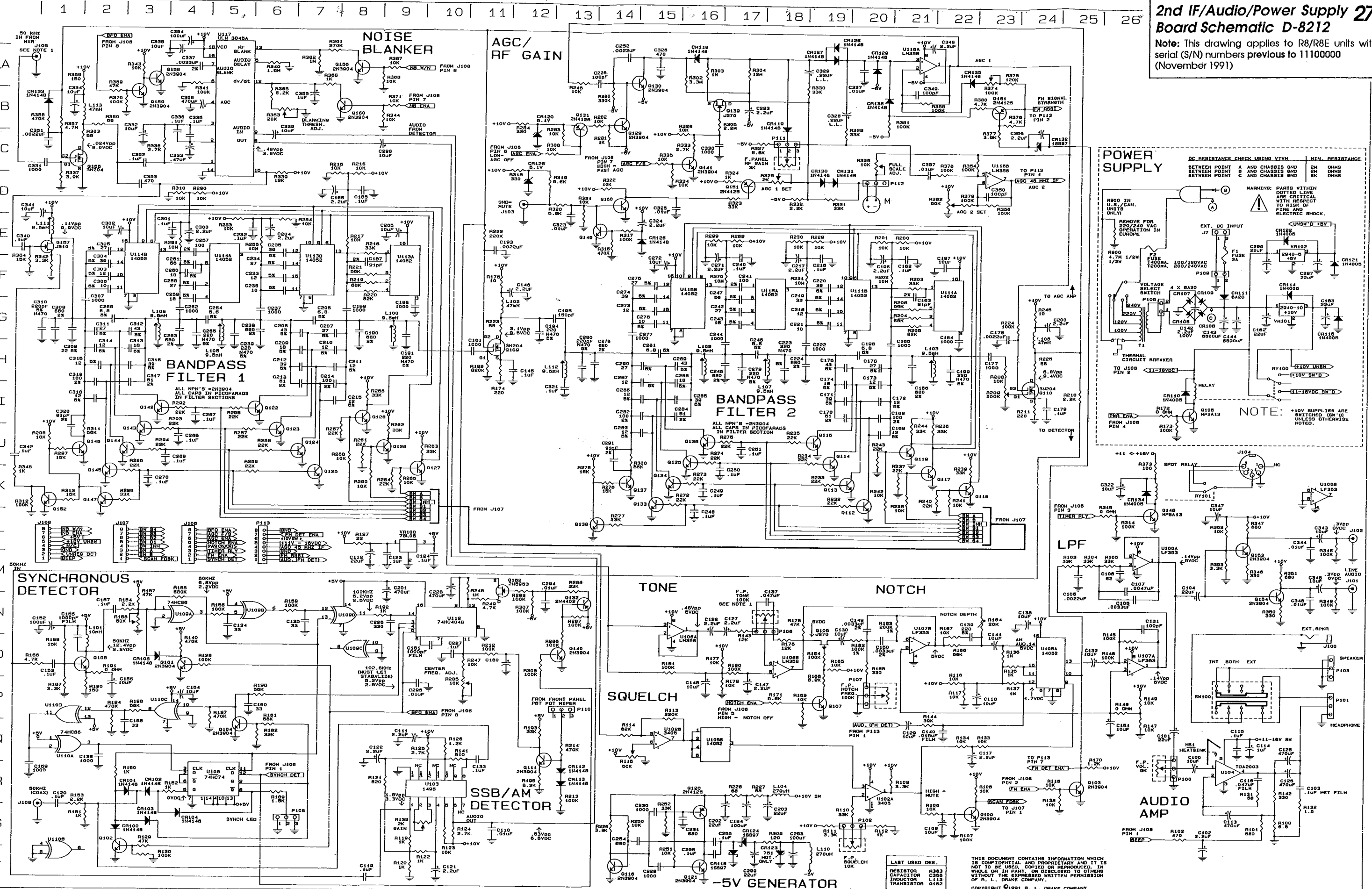
# 26 Second IF Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
R303	3220355	RES C.FILM 1.0 MEG 5%1/4W	R366	3220160	RES C.FILM 1.0 K 5% 1/4W
R304	3220384	RES C.FILM 12 MEG 10%1/4W	R367	3220235	RES C.FILM 10 K 5% 1/4W
R305	3220360	RES C.FILM 2.2 MEG 5%1/4W	R368	3220235	RES C.FILM 10 K 5% 1/4W
R306	3220235	RES C.FILM 10 K 5% 1/4W	R369	3220285	RES C.FILM 47 K 5% 1/4W
R307	3220315	RES C.FILM 100 K 5% 1/4W	R370	3220315	RES C.FILM 100 K 5% 1/4W
R308	3220315	RES C.FILM 100 K 5% 1/4W	R371	3220235	RES C.FILM 10 K 5% 1/4W
R309	3220060	RES C.FILM 120 OHM 5%1/4W	R373	3220055	RES C.FILM 100 OHM 5%1/4W
R310	3220235	RES C.FILM 10 K 5% 1/4W	R374	3260620	RES VAR PT10V LIN 100K
R311	3220295	RES C.FILM 56 K 5% 1/4W	R375	3220317	RES C.FILM 120 K 5% 1/4W
R312	3220315	RES C.FILM 100 K 5% 1/4W	R376	3220210	RES C.FILM 4.7 K 5% 1/4W
R313	3220245	RES C.FILM 15 K 5% 1/4W	R377	3220205	RES C.FILM 3.9 K 5% 1/4W
R314	3220315	RES C.FILM 100 K 5% 1/4W	R378	3220315	RES C.FILM 100 K 5% 1/4W
R315	3220000	RES M.FILM 0.0 OHM 1%1/4W	R379	3220315	RES C.FILM 100 K 5% 1/4W
R316	3220345	RES C.FILM 470 K 5% 1/4W	R380	3220210	RES C.FILM 4.7 K 5% 1/4W
R317	3220315	RES C.FILM 100 K 5% 1/4W	R381	3220315	RES C.FILM 100 K 5% 1/4W
R318	3220090	RES C.FILM 330 OHM 5%1/4W	R382	3260672	RES VAR PT10V 50K
R319	3220215	RES C.FILM 5.6 K 5% 1/4W	R383	3220040	RES C.FILM 56 OHM 5%1/4W
R320	3220215	RES C.FILM 5.6 K 5% 1/4W	R384	3220330	RES C.FILM 220 K 5% 1/4W
R321	3220235	RES C.FILM 10 K 5% 1/4W	R385	3220145	RES C.FILM 820 K 5% 1/4W
R322	3220235	RES C.FILM 10 K 5% 1/4W	R386	3220350	RES C.FILM 680 K 5% 1/4W
R323	3220275	RES C.FILM 33 K 5% 1/4W	R387	3220315	RES C.FILM 100 K 5% 1/4W
R324	3220160	RES C.FILM 1.0 K 5% 1/4W	RY100	3620112	RELAY TAKAMISAWA #RZ-12K
R325	3260688	RES VAR PT10V LIN 2K	RY101	3620108	RELAY IIT #MZ12HG
R327	3220212	RES C.FILM 5.1 K 5% 1/4W	SW100	3670541	SW SLIDE DP3T #SLY-23-05P
R328	3220235	RES C.FILM 10 K 5% 1/4W	U100	3040097	I.C. LF353N
R329	3220275	RES C.FILM 33 K 5% 1/4W	U102	3040131	I.C. MC3405
R330	3220275	RES C.FILM 33 K 5% 1/4W	U103	3040112	I.C. 1496P
R331	3220275	RES C.FILM 33 K 5% 1/4W	U104	3040551	I.C. TDA2003
R332	3220190	RES C.FILM 2.2 K 5% 1/4W	U105	3041054	I.C. 14052
R333	3220195	RES C.FILM 2.7 K 5% 1/4W	U106	3040094	I.C. LM358
R334	3220235	RES C.FILM 10 K 5% 1/4W	U107	3040097	I.C. LF353N
R335	3220235	RES C.FILM 10 K 5% 1/4W	U108	3040011	I.C. 74HC74
R336	3260664	RES VAR PT10V 10K	U109	3040033	I.C. 74HC86
R337	3220205	RES C.FILM 3.9 K 5% 1/4W	U110	3040033	I.C. 74HC86
R338	3220195	RES C.FILM 2.7 K 5% 1/4W	U111	3041054	I.C. 14052
R339	3220240	RES C.FILM 12 K 5% 1/4W	U112	3040029	I.C. 74HC4046
R340	3220357	RES C.FILM 1.5 MEG 5%1/4W	U113	3041054	I.C. 14052
R341	3220315	RES C.FILM 100 K 5% 1/4W	U114	3041054	I.C. 14052
R342	3220200	RES C.FILM 3.3 K 5% 1/4W	U115	3041054	I.C. 14052
R343	3220235	RES C.FILM 10 K 5% 1/4W	U116	3040094	I.C. LM358
R344	3220235	RES C.FILM 10 K 5% 1/4W	U117	3040075	I.C. ULN3845A
R345	3220190	RES C.FILM 2.2 K 5% 1/4W	VR100	3040031	I.C. 78L05-ACP
R346	3220315	RES C.FILM 100 K 5% 1/4W	VR101	3040164	I.C. 2940-10
R347	3220140	RES C.FILM 680 OHM 5%1/4W	VR102	3040160	I.C. 2940-5
R348	3220090	RES C.FILM 330 OHM 5%1/4W			
R349	3220315	RES C.FILM 100 K 5% 1/4W			
R350	3220090	RES C.FILM 330 OHM 5%1/4W			
R351	3220140	RES C.FILM 680 OHM 5%1/4W			
R352	3220235	RES C.FILM 10 K 5% 1/4W			
R353	3220200	RES C.FILM 3.3 K 5% 1/4W			
R354	3220315	RES C.FILM 100 K 5% 1/4W			
R355	3220315	RES C.FILM 100 K 5% 1/4W			
R356	3220320	RES C.FILM 150 K 5% 1/4W			
R357	3220370	RES C.FILM 4.7 MEG 5%1/4W			
R358	3220345	RES C.FILM 470 K 5% 1/4W			
R359	3220065	RES C.FILM 150 OHM 5%1/4W			
R360	3220040	RES C.FILM 56 OHM 5%1/4W			
R361	3220335	RES C.FILM 270 K 5% 1/4W			
R362	3220355	RES C.FILM 1.0 MEG 5%1/4W			
R363	3260668	RES VAR PT10V 20K			
R364	3220245	RES C.FILM 15 K 5% 1/4W			
R365	3220230	RES C.FILM 8.2 K 5% 1/4W			



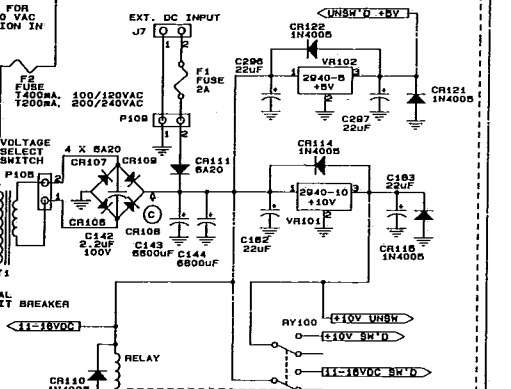
# 2nd IF/Audio/Power Supply 27 Board Schematic D-8212

Note: This drawing applies to R8/R8E units with serial (S/N) numbers previous to 11100000 (November 1991)



DC RESISTANCE CHECK USING VTVM		MIN. RESISTANCE	
BETWEEN POINT A AND CHASSIS GND	2M	OHMS	
BETWEEN POINT B AND CHASSIS GND	5M	OHMS	
BETWEEN POINT C AND CHASSIS GND	5K	OHMS	

WARNING: PARTS WITHIN DOTTED LINE ARE CRITICAL WITH RESPECT TO RISK OF FIRE AND ELECTRIC SHOCK.



NOTE: +10V SUPPLIES ARE SWITCHED ON UNLESS OTHERWISE NOTED.

LAST USED DES.	
RESISTOR	R333
CAPACITOR	C385
INDUCTOR	L113
TRANSISTOR	Q162

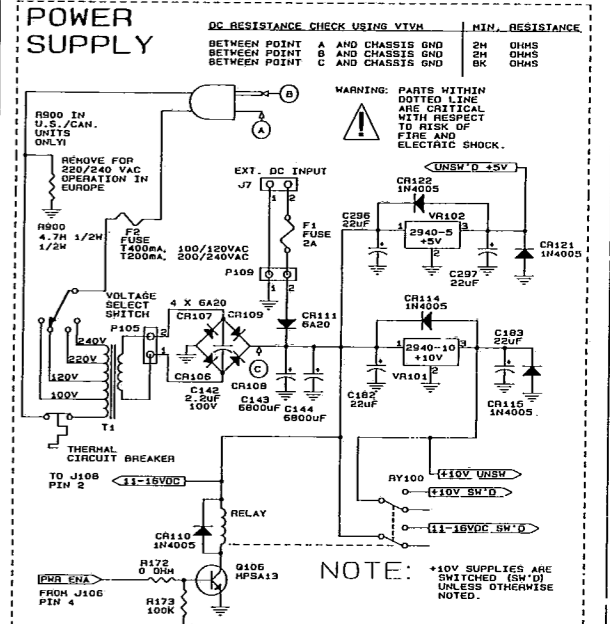
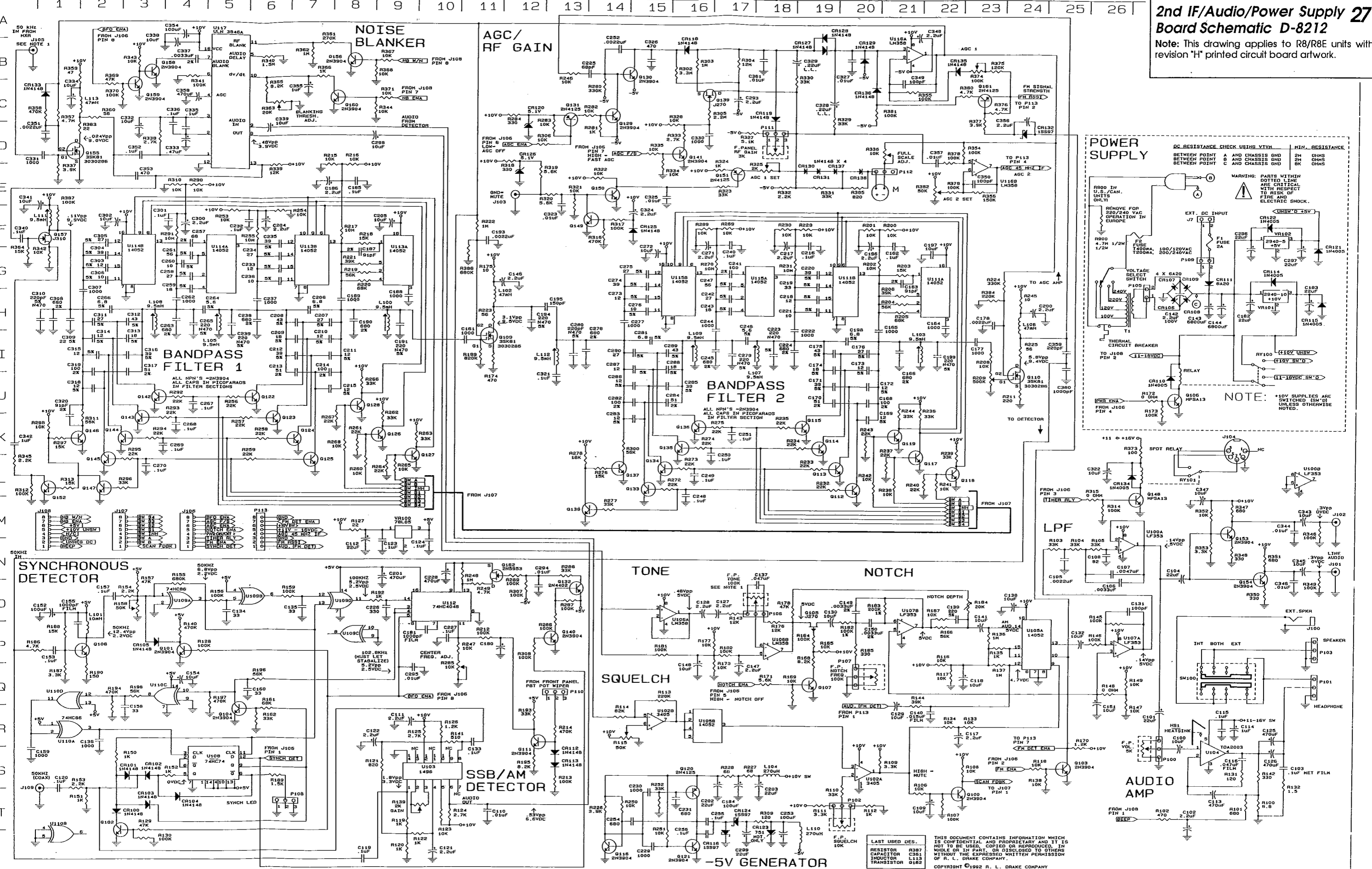
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# 2nd IF/Audio/Power Supply 27

## Board Schematic D-8212

Note: This drawing applies to R8/R8E units with revision "H" printed circuit board artwork.



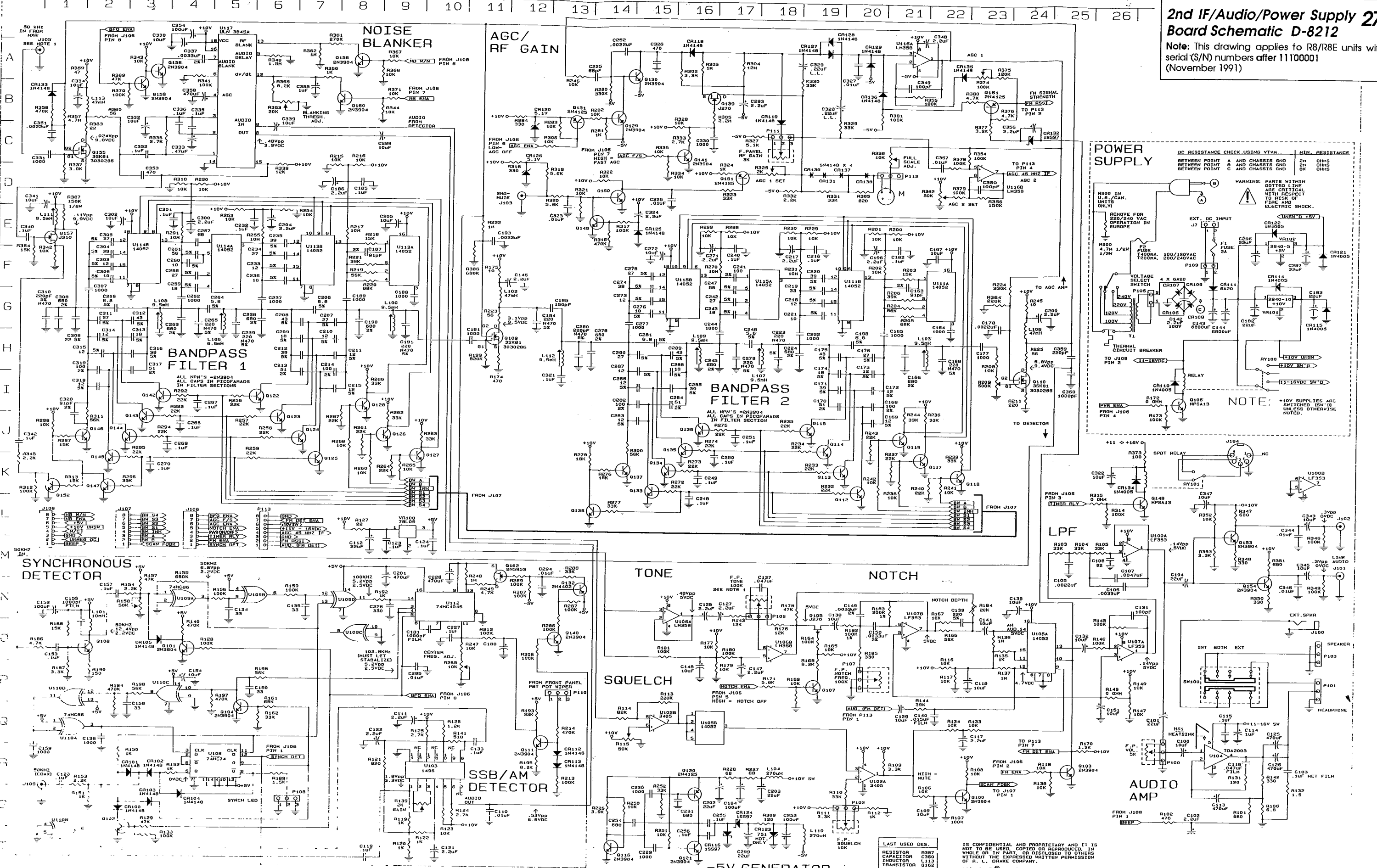
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CAPACITOR R387  
RESISTOR C361  
TRANSISTOR D182

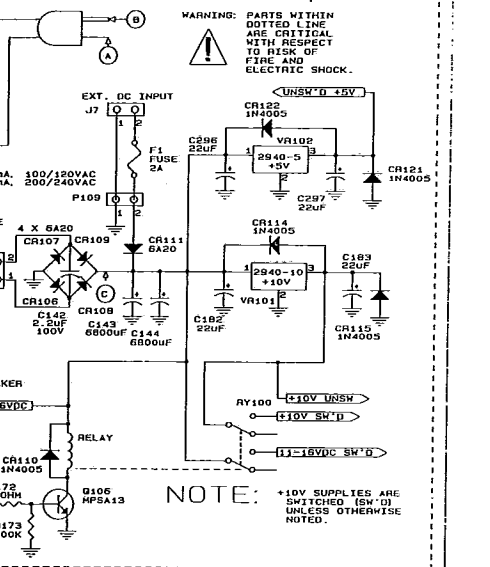
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# 2nd IF/Audio/Power Supply 27 Board Schematic D-8212

Note: This drawing applies to R8/R8E units with serial (S/N) numbers after 11100001 (November 1991)



DC RESISTANCE CHECK USING VTM	MIN. RESISTANCE
BETWEEN POINT A AND CHASSIS GND	2M OHMS
BETWEEN POINT B AND CHASSIS GND	2M OHMS
BETWEEN POINT C AND CHASSIS GND	8K OHMS



NOTE: +10V SUPPLIES ARE SWITCHED (SW'D) UNLESS OTHERWISE NOTED.

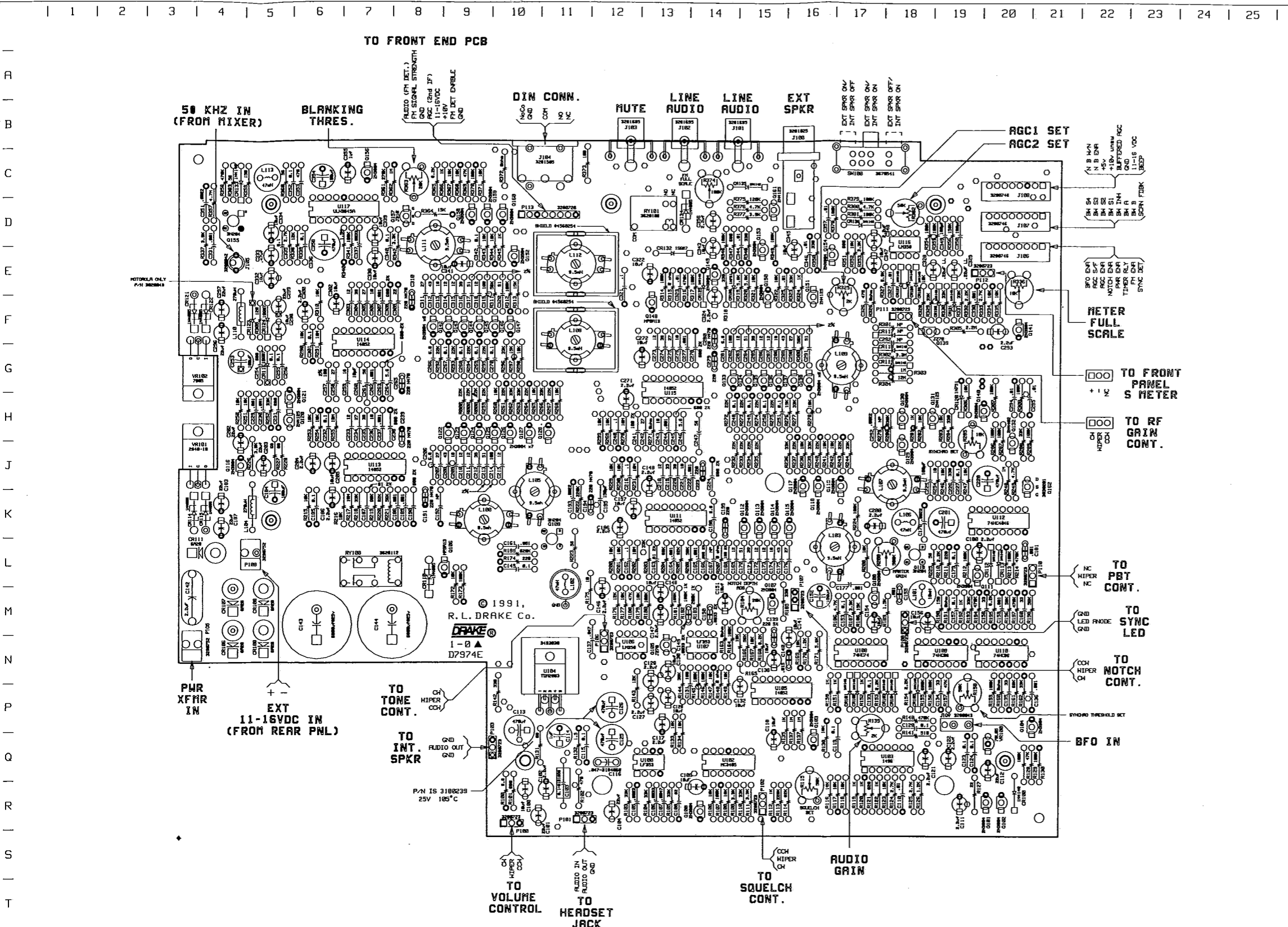
LAST USED DES.  
RESISTOR R387  
CAPACITOR C380  
INDUCTOR L113  
TRANSISTOR Q162

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-5V GENERATOR

# 2nd IF/Audio/Power Supply 28 Board Pictorial D-7974

Note: This drawing applies to R8/R8E units with serial (S/N) numbers previous to 11100000 (November 1991)



**NOTES**

- 0162 2N5482 (2030200) MAY BE REPLACED WITH 2N5953 (3030201), BUT BODY ROTATION WILL BE DIFFERENT. SEE CHART AT RIGHT FOR MORE INFORMATION.
- C149 AND C150 MUST BE 2% PARTS AS NOTED (ZONE H-14)

2N5484	2N5953
3030200	3030201
SDG	DSG
PRINTING DIMENSIONS TOP VIEW	

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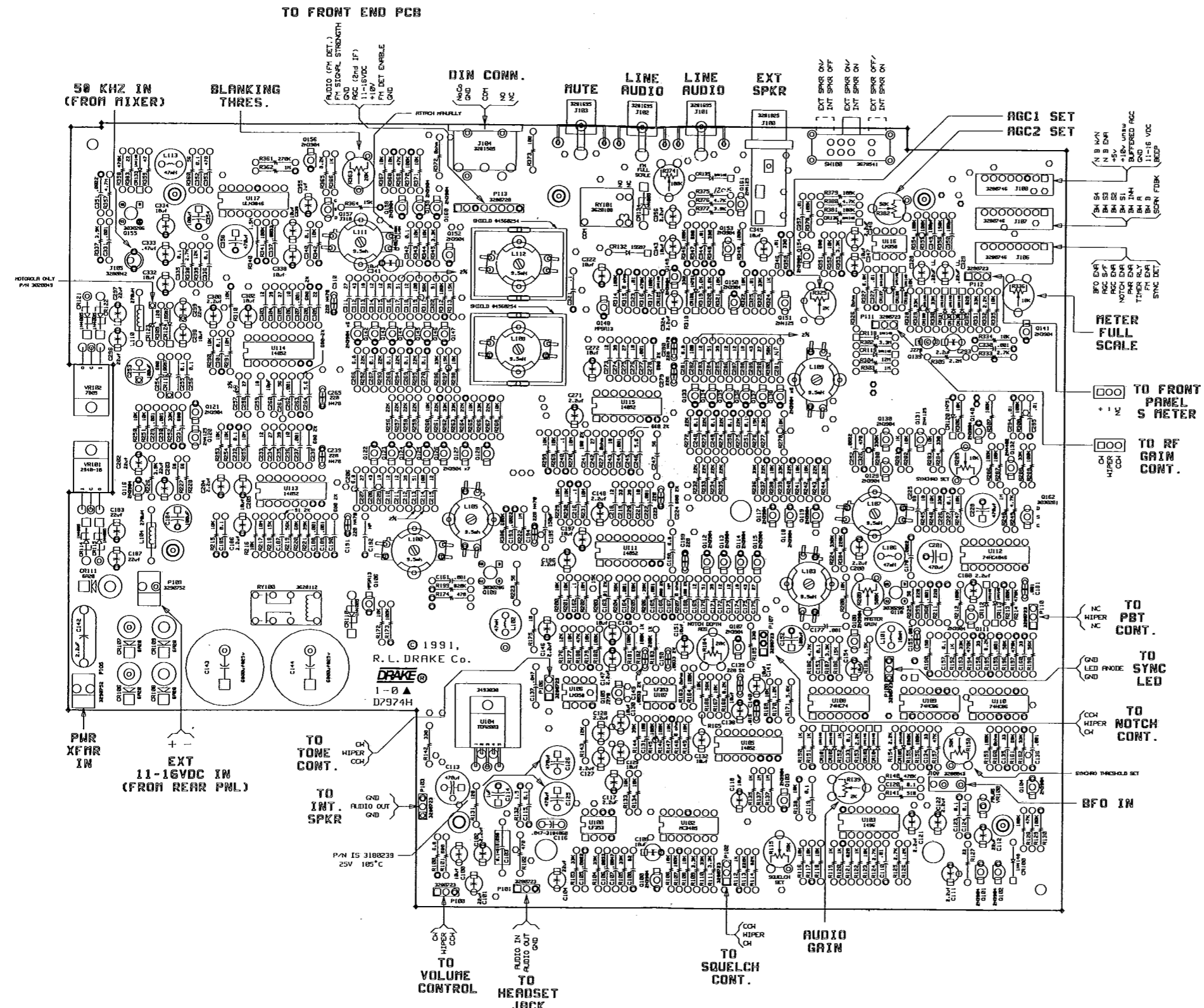
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# 2nd IF/Audio/Power Supply 28 Board Pictorial D-7974

Note: This drawing applies to R8/R8E units with serial (S/N) numbers after 11100001 (November 1991)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

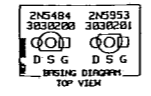
R  
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DRAKE  
1-0  
D7974H

**NOTES**

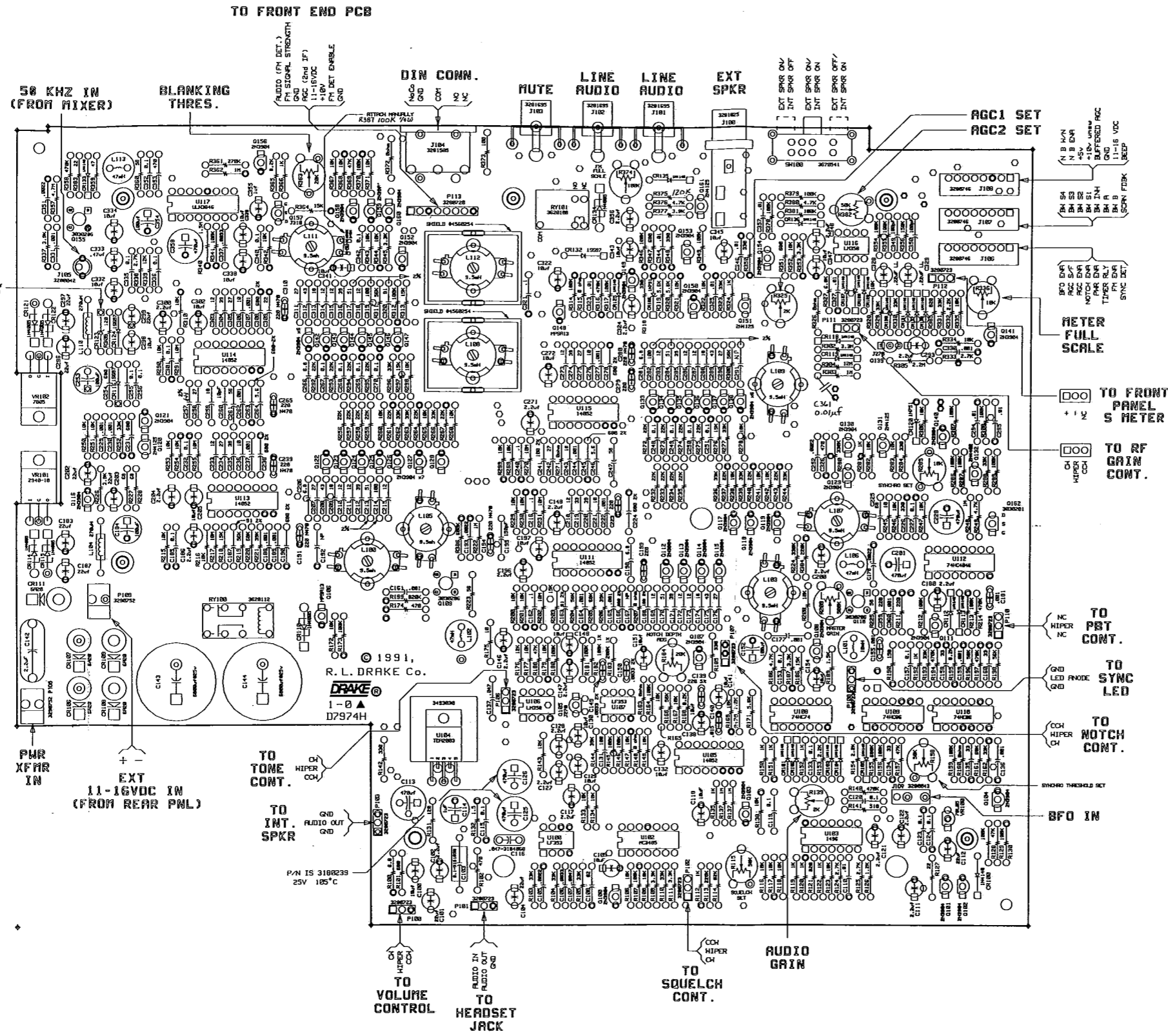
- 0162 2N5482 (2030200) MAY BE REPLACED WITH 2N5953 (3030201), BUT BODY ROTATION WILL BE DIFFERENT. SEE CHART AT RIGHT FOR MORE INFORMATION.
- C149 AND C150 MUST BE 2% PARTS AS NOTED (ZONE M-14)



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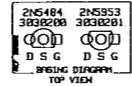
# 2nd IF/Audio/Power Supply 28 Board Pictorial D-7974

Note: This drawing applies to R8/R8E units with Revision "H" printed circuit board artwork.



### NOTES

- 0162 2N5482 (2030200) MAY BE REPLACED WITH 2N5953 (3030201), BUT BODY ROTATION WILL BE DIFFERENT. SEE CHART AT RIGHT FOR MORE INFORMATION.
- C149 AND C150 MUST BE 2% PARTS AS NOTED (ZONE M-14)



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## SYNTHESIZER/MICROPROCESSOR THEORY OF OPERATION

The synthesizer/microprocessor board provides several RF signals and all the logic control signals required by other boards in the R8/R8E receiver. The RF signals provided by the synth/ $\mu$ P board include:

- 1) VCO or 1st LO which is a 45-75 MHz signal to the 1st mixer on the Front End board.
- 2) 2nd LO which is a 45.05 MHz signal to the 2nd mixer on the Front End board.
- 3) BFO or beat frequency oscillator which is a 50 KHz signal required for SSB reception by the AM detector on the 2nd IF/AUDIO/POWER SUPPLY board.
- 4) VHF REF which is a 3.5 MHz reference signal to the PLL on the optional VHF converter board.

Logic control signals required by other boards include:

- 1) Serial clock and data to the front panel display driver.
- 2) Front panel keyboard scanning.
- 3) Serial clock and data to optional VHF converter.
- 4) Latched, steady state control voltages to 2nd IF/AUDIO/POWER SUPPLY board for bandwidth selection, AGC ON/OFF and SLOW/FAST, Notch ON/OFF, Power ON/OFF etc.
- 5) Latched, steady state control voltages to Front End board for BPF selection, preamp/atten enable, ant 1/2/converter.

Let's discuss the circuits involved with generating the 4 RF signals, beginning with the 1st LO. **Note that for most of the discussion that follows, the circuitry is located on the 'SYNTHESIZER CIRCUITS' schematic.**

### 1st LO

The VCO output or 1st LO is generated or synthesized by 3 nested phase locked loops (PLL'S), producing an injection signal that tunes from 45.1 MHz to 75.0 MHz in 10 Hz steps. This provides HF band reception from 100 KHz to 30 MHz in 10 Hz steps with the 1st IF frequency at 45.0 MHz.

Four distinct circuits are used to generate the 1st LO:

- 1) Reference oscillator
- 2) PLL3
- 3) PLL2
- 4) PLL1

Before discussing the specifics of these individual circuits, a brief overview of how the PLL circuits are interconnected is in order.

The PLL's are nested such that the inner most loop (PLL3) provides a reference signal to the middle loop (PLL2), and the middle loop provides a reference signal to the outer loop (PLL1). The inner loop VCO output is divided by 10 from approximately 65 MHz to 6.5 MHz by U122. This 6.5 MHz signal is used by the middle loop to lock the middle loop VCO on frequency. A 1 KHz step at 65 MHz becomes a 100 Hz step at 6.5 MHz and the middle loop VCO will move or shift 100 Hz.

Similarly, the middle loop VCO output is divided by 10 from approximately 60 MHz to 6.0 MHz by U123. This 6.0 MHz signal is used by the outer loop to lock the outer loop VCO on frequency. A 10 KHz step at 60 MHz becomes a 1 KHz step at 6.0 MHz and the outer loop VCO will move or shift 1 KHz. Likewise, a 1 KHz step in the inner loop becomes a 100 Hz step in the middle loop, which becomes a 10 Hz step at the outer loop VCO frequency. In other words, the middle loop tracks out any frequency changes in the inner loop, and the outer loop tracks out any changes in the middle loop. And the outer loop VCO frequency is the desired synthesized output.

### REFERENCE OSCILLATOR

All three loops are phase locked to the highly stable, temperature compensated, crystal controlled, 35 MHz reference oscillator. The reference oscillator consists of a 35 MHz crystal (Y103), transistor Q140, and associated components. Resistors R299, R279 and R296 provide bias to the transistor. Capacitor C367 has a N750 temperature coefficient and provides the major temperature compensation. Variable inductor L155 provides the frequency tuning adjustment. Transistors Q137, Q141, Q139 and associated components provide buffering and reverse isolation.

For the outer loop (PLL1), the 35 MHz is routed through capacitor C363, coax W1 and capacitor C172 to U109 Pin 8. For PLL2 and PLL3, the reference frequency is divided by 10 from 35 MHz to 3.5 MHz by U130. This 3.5 MHz reference signal is coupled to PLL2, U126 Pin 1, through capacitor C316 and to PLL3, U125 Pin 1, through C314. The 3.5 MHz signal is also the reference signal for the optional VHF converter. This signal path will be discussed later.

Additionally, the 35 MHz reference is used in each loop to mix or translate signals to appropriate frequencies. In the outer loop, U117 uses the 35 MHz reference to translate the output of the middle loop from 6.0 MHz to 41.0 MHz. Similarly, in PLL2 and PLL3, U121 and U128 use 70 MHz to translate signals. The 70 MHz is obtained by doubling the frequency of the 35 MHz reference. The 35 MHz to 70 MHz doubler circuit consists of diode CR124, variable coil L154, transistor Q138 and associated components.

### INNER LOOP PLL3

PLL3 is the inner most loop and provides the smallest step size and finest resolution. Its main component is U125: MC145157. U125 consists of 2 programmable dividers and a phase comparator. The programmable dividers are programmed by the  $\mu$ P through the serial data bus. The reference signal at Pin 1 is divided by R3. The VCO signal at Pin 8 is divided by N3. Since R3 is constant, the  $\mu$ P loads R3 only during the power-on sequence which is initiated by depressing the front panel power button. N3 is variable and needs to be loaded whenever the frequency changes. A 1 KHz step is achieved by changing N3. The step size of PLL3 is determined by the reference signal into Pin 1 of U125 and the division ratio R3 as follows:

Step size = reference frequency divided by R3.  
 The reference signal at Pin 1 is 3.5 MHz, and R3 = 3500, giving a minimum step size of 1 KHz. This also represents the frequency at which the phase comparator inside U125 compares the VCO signal at Pin 8 to the reference signal.

The output of the phase comparator is a DC tuning voltage at Pin 5 used to tune the VCO. The tuning voltage is filtered by the loop filter, a LPF consisting of U124, R229, R228, C280 and C281. The loop filter output voltage at Pin 7 of U124, is applied to varactors CR118 and CR119 in the VCO. This VCO, VCO3, consisting of transistors Q124 and associated components, tunes from 65.001 MHz to 65.100 MHz in 1 KHz steps. Capacitors C250, C251, C253, C254, variable inductor L134 and varactors CR118 and CR119 determine the frequency of oscillation.

The VCO3 output is filtered by a LPF and buffered by Q130 and Q122. After Q130, the VCO3 output is mixed with 70 MHz at U128 and translated from the 65.001-65.100 MHz range to the 4.999-4.900 MHz range. The 4.999-4.900 MHz signal is the VCO signal presented to U125 Pin 8. A 5 MHz LPF after U128 filters off the undesired mixing products and Q132 provides enough gain to ensure U125 sees at least a 1 volt PTP signal at Pin 8.

U125 must divide the 4.999-4.900 MHz VCO signal down to 1 KHz for the internal phase comparison. This division ratio, N3, is calculated by the  $\mu$ P and loaded into U125. N3 will be an integer number within the following limits:

$$4900 \leq N3 \leq 4999.$$

Returning to the VCO3 output and Q122, after Q122 the VCO3 output is divided by 10 at U122. The output of U122 at Pin 4 is considered the PLL3 output. The PLL3 output signal covers the range from 6.5001 MHz to 6.5100 MHz in 100 Hz steps and is used by the middle loop (PLL2) to lock the middle loop VCO.

The frequency relationships of PLL3 are given by the following equations:

$$\text{Let } f_{REF} = 35 \text{ MHz reference signal}$$

$$\begin{aligned} f_{VCO3} &= 2 \times f_{REF} - f_{REF}/10 \times 1/R3 \times N3 \\ &= f_{ref} (2 - N3/35000) \end{aligned}$$

$$\begin{aligned} \text{PLL3} &= f_{VCO3} \div 10 \\ &= (f_{REF}/10) (2 - N3/35000) \end{aligned}$$

## MIDDLE LOOP PLL2

PLL2 is similar to PLL3 but provides the medium step size and resolution. Its main component is U126 : MC145157. U126 is identical to U125 in PLL3 and consists of 2 programmable dividers and a phase comparator. The programmable dividers are programmed by the  $\mu$ P through the serial data bus. The reference signal at Pin 1 is divided by R2. The VCO signal at Pin 8 is divided by N2. R2, like R3, is constant and the  $\mu$ P loads R2 only during the power-on sequence. N2, like N3, is variable and needs to be loaded whenever the frequency changes. A 10 KHz step is achieved by changing N2, and a 100 Hz step is obtained via PLL3. The step size of PLL2 is determined by the reference signal and R2:

$$\text{Step size} = \text{ref signal}/R2$$

The reference signal at Pin 1 is 3.5 MHz, R2 = 350, giving a PLL2 step size of 10 KHz. This also represents the frequency at which the phase comparison is performed inside U126.

The output of the phase comparator is a DC tuning voltage at Pin 5, and it is used to tune the VCO. The tuning voltage is filtered by the loop filter, a LPF consisting of U127, R230 and R231, C285 and C286. The loop filter output voltage at Pin 1 of U127, is applied to varactors CR121 and CR120 in the VCO. This VCO, VCO2, consisting of transistor Q125 and associated components, tunes from 60 to 61 MHz. Capacitors C258, C259, C261 and C262, variable inductor L135, and varactors CR120 and 121 determine the frequency of oscillation.

The VCO2 output is filtered by a LPF and buffered by Q123 and Q131. After Q131, the VCO2 output is mixed with a 63 MHz signal and translated to approximately 3 MHz by U129. The 63 MHz signal is directly related to the PLL3 frequency. The PLL3 output is mixed with 70 MHz at U121. A 63 MHz BPF selects the desired mixing product and completes the translation of the PLL3 output from the 6.5001 - 6.5100 MHz range to 63.4999 - 63.4900 MHz range. U129 mixes the 63.49 MHz signal and the 60-61 MHz VCO2 signal and produces a 2.50 - 3.49 MHz signal. A 4 MHz LPF after U129 filters off the undesired mixing product and Q133 provides enough gain to ensure U126 sees at least a 1V PTP signal at Pin 8.



The internal divider must divide the 2.50 - 3.49 MHz signal down to 10 KHz. This division ratio, N2, is calculated by the  $\mu$ P and loaded into U126. N2 will be an integer number within the following limits:

$$250 \leq N2 \leq 349$$

Returning to the VCO output and Q123, after Q123 the VCO2 output is divided by 10 at U123. The output of U123 at Pin 4 is considered the PLL2 output. The PLL2 output signal covers the range from 6.0 - 6.1 MHz in 10 Hz steps and is used by the outer loop PLL1 to lock the outer loop VCO.

The frequency relationships of PLL2 are given by the following equations:

$$\begin{aligned} f_{vco2} &= (2 \times (f_{ref}) - PLL3) - f_{ref}/10 \times 1/R2 \times N2 \\ &= 2 \times (f_{ref}) - (f_{ref}/10)(2 - N3/35000) - f_{ref}/10 \times 1/350 \times N2 \\ &= f_{ref} (2 - 1/10(2 - N3/35000) - N2/3500) \\ &= f_{ref} (1.8 + N3/350000 - N2/3500) \end{aligned}$$

$$\begin{aligned} PLL2 &= f_{vco2}/10 \\ &= (f_{ref}/10)(2 - 1/10(2 - N3/35000) - N2/3500) \\ &= (f_{ref})(1/10)(1.8 + N3/350000 - N2/3500) \\ &= f_{ref} (0.18 + N3/3500000 - N2/35000) \end{aligned}$$

#### OUTER LOOP PLL1

PLL1 is the outer phase-locked loop used to synthesize the 1st LO signal. The output signal of the outer loop VCO, VCO1, is the desired 1st LO signal. VCO1 is actually 4 different oscillators, each covering a different frequency band. The correct oscillator is selected and enabled by the  $\mu$ P control signals (VCO1 - VCO3). The main component in PLL1 is U109: MB87086. U109 is similar to U125 and U126, consisting of 2 programmable dividers and a phase comparator. The programmable dividers are programmed by the  $\mu$ P through the serial data bus. The reference signal at Pin 8 is divided by R1. The VCO signal at Pin 1 is divided by N1. R1, like R3 and R2, is constant and the  $\mu$ P loads R1 only during the power-on sequence. N1 is variable and needs to be updated whenever the frequency changes. A 100 KHz step is achieved by changing N1, and a 10 Hz step is obtained via PLL2.

The step size obtained by PLL1 is determined by the reference signal and R1:

$$\text{Step size} = \text{ref signal} \div R1$$

The reference signal at Pin 8 is 35 MHz, R1 = 350, resulting in a step size of 100 KHz. This also is the frequency at which the phase comparison is performed inside U109.

The output of the phase comparator is two pulsed control signals at Pins 15 and 16. Both control signals are normally at +5 volts and pulse low (0.2 volts) when active. The pulsewidth determines the amount of correction and is derived from the relative phase information. Pin 15 provides the "UP" pulse and Pin 16 is the "DOWN" pulse. The charge pump and loop filter produce a DC tuning voltage

from the UP and DOWN pulses.

There are actually 2 different charge pump/loop filter combinations that tune the 4 oscillators of VCO1. The low band oscillator covers the range from 45.00000 to 52.49999 MHz, and has its own charge pump and loop filter. The low band oscillator consists of transistor Q107 and associated components. The low band charge pump consists of Q113, Q114 and Q115 and associated components. The low band loop filter consists of R170, C165 and C163.

The high band charge pump (Q116, Q117 and Q118) and the high band loop filter (R173, C169 and C170) tune the remaining 3 oscillators. Q108 tunes from 52.50000 to 59.99999 MHz; Q109 tunes from 60.00000 to 66.99999 MHz; and Q110 tunes from 67.00000 to 75.00000 MHz.

The VCO1 output is buffered by Q106 and filtered by a LPF. After the LPF, the signal path branches into two directions. Q111, Q100 and Q101 provide gain and reverse isolation at J100. J100 is the 1st LO output port to the front end board. Q112 and Q119 buffer the VCO1 to U116. The VCO1 output is mixed with a 41 MHz signal and translated from the 45.1 - 75.0 MHz range to the 4.1 - 34.0 MHz range by U116. The 41 MHz signal is directly related to the PLL2 frequency. The PLL2 output is mixed with 35 MHz at U117. A 41 MHz BPF selects the desired mixing product and completes the translation of the PLL2 output from the 6.0 - 6.1 MHz range to the 41.0 - 41.1 MHz range. A 35 MHz LPF after U116 filters off the undesired mixing products. Q120 and Q121 provide enough gain to ensure U109 sees at least 1 volt PTP at Pin 1.

The programmable divider inside U109 must divide the 4.1 - 34.0 MHz signal down to 100 KHz. This division ratio, N1, is calculated by the  $\mu$ P and loaded into U109.

N1 will be an integer number within the following limits:  
 $41 \leq N1 \leq 340$

The frequencies in PLL 1 are as follows:

$$\begin{aligned} f_{vco1} &= \text{desired 1st LO output} \\ &= f_{ref}/R1 \times N1 + (f_{ref} + PLL2) \\ &= f_{ref} (N1/350) + f_{ref} + f_{ref} (0.18 + N3/3.5E6 - N2/3.5E4) \\ &= f_{ref} (1.18 + N1/350 - N2/3.5E4 + N3/3.5E6) \end{aligned}$$

### 2nd LO/PBT (PASS BAND TUNING)

The 2nd LO is a 45.05 MHz signal that is sent to the Front End board and digital mixer circuit. The 2nd LO frequency actually varies depending on mode and front panel PBT adjustment, thus providing IF shifting. The 45.05 MHz signal is produced by doubling a varactor tuned, crystal controlled 22.525 MHz oscillator. The oscillator consists of a 22.525 MHz crystal (Y102), transistor Q126 and associated components. It is not referenced back to the 35 MHz reference signal thus requiring its own temperature compensation. Capacitor C268 has a N1500 temperature coefficient and provides the major temperature compensation. Variable coil L131 provides the frequency tuning adjustment. Varactor CR117 provides a fine tune frequency adjustment. Fine tuning can be accomplished in two ways:

- 1) Front panel PBT adjustment
- 2)  $\mu$ P controlled DAC

**Note that in the following text, circuit references to digital control can be located on the 'MICROPROCESSOR CIRCUITS' schematic.**

The front panel PBT control is a user adjustment which provides approximately  $\pm 2.5$  KHz shift at 45.05 MHz. The  $\mu$ P controlled DAC provides programmable offsets which can be different for each mode.

The  $\mu$ P controlled DAC for PBT tuning is actually a variable gain amplifier. U103 (MN5450), under  $\mu$ P control through the serial data bus, switches a combination of 8 precision 1% resistors to ground changing the gain of amp U110A: (LM358). Each mode (AM, CW, USB, etc.) can be programmed with a unique combination, allowing a different factory programmed PBT frequency for each mode. Additional tuning is available to the user through the front panel PBT adjustment which sets a reference voltage at U110A Pin 3. Both DAC and front panel PBT changes will affect the tuning voltage output at U110A Pin 1.

Q128 and Q129 disable the 45.05 MHz signal when in the FM mode. Tuned circuits around L138, L139, L141, L151 and L152 are tuned to 45.05 MHz thus enhancing the 2nd harmonic. L140 allows the signal to be split into two paths. Q135 amplifies the 45.05 MHz signal which is then coupled

to J107. Connector J107 is the 2nd LO output port to the front end board. Q134 amplifies the 45.05 MHz signal which is coupled into the digital mixer circuit.

### BFO/DIGITAL MIXER

The digital mixer combines the 45.05 MHz 2nd LO signal and the 35 MHz reference signal to produce the 50 KHz BFO signal. The BFO signal is used in CW, RTTY, USB and LSB modes. Because the BFO signal is directly related to the 45.05 MHz signal, as the PBT is varied, the operating frequency does not change but rather IF shifting occurs.

Q142 amplifies the 35 MHz reference signal to the 4.5 volt PTP levels required by the digital integrated circuits. Likewise, Q143 amplifies the 45.05 MHz signal to 4.5 volts PTP. U132D mixes 35 MHz and 45.05 MHz and produces 10.05 MHz at Pin 11. U131 and U132A combine to divide the 35 MHz reference signal by 7 producing a 5 MHz signal at U131 Pin 12. U132B together with the input phase shift circuit (L150, C350, C351 and R285) double the 5 MHz signal to 10 MHz at U132B Pin 6. U132C mixes the 10 MHz signal from Pin 6 and the 10.05 MHz signal from Pin 11 to produce the 50 KHz BFO signal at Pin 8. A LPF reduces the undesired higher frequency products and provides a cleaner 50 KHz signal to J106.

$$f_{\text{BFO}} = f_{\text{2nd LO}} - f_{\text{REF}} - (2 \times 5 \text{ MHz})$$

### VHF REFERENCE

The VHF reference is a 3.5 MHz signal derived from the 35 MHz reference oscillator and sent to the optional VHF converter board via J105. The 35 MHz reference signal is divided by 10 by U130. The 3.5 MHz output at U130 Pin 4 is buffered by Q136. A LPF reduces harmonic content and provides a sinusoidal 3.5 MHz signal to J105.

# Synthesizer and Microprocessor Board Parts List 33

## SYNTHESIZER AND MICROPROCESSOR BOARD PARTS LIST

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C100	3151648	CAP AX .10 MF 50V	C160	3180012	CAP ELECTRO 1@50 20%
C101	3151405	CAP AXIAL .001 MF 10% Y5P	C161	3180012	CAP ELECTRO 1@50 20%
C102	3151648	CAP AX .10 MF 50V	C162	3151515	CAP AXIAL .01 MF 20% Y5P
C103	3151405	CAP AXIAL .001 MF 10% Y5P	C163	3184068	CAP FILM .1 @ 100V 10%
C104	3180241	CAP ELECTRO 470@16	C164	3180152	CAP ELECTRO 100@50
C105	3151259	CAP AXIAL 220 PF 10% Y5P	C165	3183011	CAP TANT.RAD'L 1.0@35 10%
C106	3150350	CAP AXIAL 10.0 PF 5% NPO	C166	3180109	CAP ELECTRO 22@25 20%
C107	3180109	CAP ELECTRO 22@25 20%	C167	3151515	CAP AXIAL .01 MF 20% Y5P
C108	3150305	CAP AXIAL 8.2 PF 10% NPO	C168	3180152	CAP ELECTRO 100@50
C109	3150690	CAP AXIAL 33.0 PF 5% NPO	C169	3183011	CAP TANT.RAD'L 1.0@35 10%
C110	3151648	CAP AX .10 MF 50V	C170	3184068	CAP FILM .1 @ 100V 10%
C111	3150305	CAP AXIAL 8.2 PF 10% NPO	C171	3151065	CAP AXIAL 100 PF 5% GP
C112	3150595	CAP AXIAL 22.0 PF 5% NPO	C172	3151515	CAP AXIAL .01 MF 20% Y5P
C113	3151648	CAP AX .10 MF 50V	C173	3151065	CAP AXIAL 100 PF 5% GP
C114	3150305	CAP AXIAL 8.2 PF 10% NPO	C174	3150350	CAP AXIAL 10.0 PF 5% NPO
C115	3150420	CAP AXIAL 12.0 PF 5% NPO	C175	3150779	CAP AXIAL 43.0 PF 5% NPO
C116	3151648	CAP AX .10 MF 50V	C176	3151515	CAP AXIAL .01 MF 20% Y5P
C117	3150305	CAP AXIAL 8.2 PF 10% NPO	C177	3150040	CAP AXIAL 2.7 PF 10% GP
C118	3150350	CAP AXIAL 10.0 PF 5% NPO	C178	3150078	CAP AXIAL 3.9 PF 10% NPO
C119	3151648	CAP AX .10 MF 50V	C179	3150115	CAP AXIAL 4.7 PF 10% NPO
C120	3180241	CAP ELECTRO 470@16	C180	3150030	CAP AXIAL 1.5 PF 10% GP
C121	3150078	CAP AXIAL 3.9 PF 10% NPO	C181	3150040	CAP AXIAL 2.7 PF 10% GP
C122	3150690	CAP AXIAL 33.0 PF 5% NPO	C182	3150040	CAP AXIAL 2.7 PF 10% GP
C123	3151648	CAP AX .10 MF 50V	C183	3150350	CAP AXIAL 10.0 PF 5% NPO
C124	3150350	CAP AXIAL 10.0 PF 5% NPO	C184	3151405	CAP AXIAL .001 MF 10% Y5P
C125	3150305	CAP AXIAL 8.2 PF 10% NPO	C185	3151065	CAP AXIAL 100 PF 5% GP
C126	3150640	CAP AXIAL 27.0 PF 5% NPO	C186	3151405	CAP AXIAL .001 MF 10% Y5P
C127	3150305	CAP AXIAL 8.2 PF 10% NPO	C187	3180295	CAP ELECTRO 1000@16 RAD'L
C128	3150640	CAP AXIAL 27.0 PF 5% NPO	C188	3150030	CAP AXIAL 1.5 PF 10% GP
C129	3150350	CAP AXIAL 10.0 PF 5% NPO	C189	3150779	CAP AXIAL 43.0 PF 5% NPO
C130	3150640	CAP AXIAL 27.0 PF 5% NPO	C190	3150030	CAP AXIAL 1.5 PF 10% GP
C131	3150350	CAP AXIAL 10.0 PF 5% NPO	C191	3150779	CAP AXIAL 43.0 PF 5% NPO
C132	3150640	CAP AXIAL 27.0 PF 5% NPO	C192	3150350	CAP AXIAL 10.0 PF 5% NPO
C133	3151405	CAP AXIAL .001 MF 10% Y5P	C193	3151515	CAP AXIAL .01 MF 20% Y5P
C134	3151648	CAP AX .10 MF 50V	C194	3180012	CAP ELECTRO 1@50 20%
C135	3151648	CAP AX .10 MF 50V	C195	3180109	CAP ELECTRO 22@25 20%
C136	3151405	CAP AXIAL .001 MF 10% Y5P	C196	3151515	CAP AXIAL .01 MF 20% Y5P
C137	3150640	CAP AXIAL 27.0 PF 5% NPO	C197	3151515	CAP AXIAL .01 MF 20% Y5P
C138	3150899	CAP AXIAL 68.0 PF 5% NPO	C198	3151515	CAP AXIAL .01 MF 20% Y5P
C139	3150640	CAP AXIAL 27.0 PF 5% NPO	C199	3180012	CAP ELECTRO 1@50 20%
C140	3151425	CAP AXIAL .0022MF 20% Y5P	C200	3180012	CAP ELECTRO 1@50 20%
C141	3150899	CAP AXIAL 68.0 PF 5% NPO	C201	3151515	CAP AXIAL .01 MF 20% Y5P
C142	3150896	CAP AXIAL 56.0 PF 5% NPO	C202	3180064	CAP ELECTRO 10@50 20%
C143	3150750	CAP AXIAL 39.0 PF 5% NPO	C203	3180064	CAP ELECTRO 10@50 20%
C144	3150750	CAP AXIAL 39.0 PF 5% NPO	C204	3180064	CAP ELECTRO 10@50 20%
C145	3151405	CAP AXIAL .001 MF 10% Y5P	C205	3180064	CAP ELECTRO 10@50 20%
C146	3151405	CAP AXIAL .001 MF 10% Y5P	C206	3151515	CAP AXIAL .01 MF 20% Y5P
C147	3151405	CAP AXIAL .001 MF 10% Y5P	C207	3180012	CAP ELECTRO 1@50 20%
C148	3151405	CAP AXIAL .001 MF 10% Y5P	C208	3180109	CAP ELECTRO 22@25 20%
C149	3151405	CAP AXIAL .001 MF 10% Y5P	C209	3151515	CAP AXIAL .01 MF 20% Y5P
C150	3151405	CAP AXIAL .001 MF 10% Y5P	C210	3151515	CAP AXIAL .01 MF 20% Y5P
C151	3151425	CAP AXIAL .0022MF 20% Y5P	C211	3151515	CAP AXIAL .01 MF 20% Y5P
C152	3151405	CAP AXIAL .001 MF 10% Y5P	C212	3151515	CAP AXIAL .01 MF 20% Y5P
C153	3151405	CAP AXIAL .001 MF 10% Y5P	C213	3151515	CAP AXIAL .01 MF 20% Y5P
C154	3151065	CAP AXIAL 100 PF 5% GP	C214	3180012	CAP ELECTRO 1@50 20%
C155	3151515	CAP AXIAL .01 MF 20% Y5P	C215	3180012	CAP ELECTRO 1@50 20%
C156	3151515	CAP AXIAL .01 MF 20% Y5P	C216	3150350	CAP AXIAL 10.0 PF 5% NPO
C157	3180109	CAP ELECTRO 22@25 20%	C217	3150750	CAP AXIAL 39.0 PF 5% NPO
C158	3180012	CAP ELECTRO 1@50 20%	C218	3150040	CAP AXIAL 2.7 PF 10% GP
C159	3151515	CAP AXIAL .01 MF 20% Y5P			

# 34 Synthesizer and Microprocessor Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C219	3150595	CAP AXIAL 22.0 PF 5% NPO	C281	3184042	CAP FILM .022 @ 100V 5%
C220	3150350	CAP AXIAL 10.0 PF 5% NPO	C282	3151515	CAP AXIAL .01 MF 20% Y5P
C221	3150896	CAP AXIAL 56.0 PF 5% NPO	C283	3151648	CAP AX .10 MF 50V
C222	3150595	CAP AXIAL 22.0 PF 5% NPO	C284	3151515	CAP AXIAL .01 MF 20% Y5P
C223	3150350	CAP AXIAL 10.0 PF 5% NPO	C285	3184042	CAP FILM .022 @ 100V 5%
C224	3151515	CAP AXIAL .01 MF 20% Y5P	C286	3184021	CAP FILM .0047 @ 50V 5%
C225	3150350	CAP AXIAL 10.0 PF 5% NPO	C287	3151515	CAP AXIAL .01 MF 20% Y5P
C226	3180012	CAP ELECTRO 1@50 20%	C288	3151515	CAP AXIAL .01 MF 20% Y5P
C227	3151648	CAP AX .10 MF 50V	C289	3151515	CAP AXIAL .01 MF 20% Y5P
C228	3151405	CAP AXIAL .001 MF 10% Y5P	C290	3180109	CAP ELECTRO 22@25 20%
C229	3151405	CAP AXIAL .001 MF 10% Y5P	C291	3180109	CAP ELECTRO 22@25 20%
C230	3150595	CAP AXIAL 22.0 PF 5% NPO	C292	3151405	CAP AXIAL .001 MF 10% Y5P
C231	3150896	CAP AXIAL 56.0 PF 5% NPO	C293	3151515	CAP AXIAL .01 MF 20% Y5P
C232	3180064	CAP ELECTRO 10@50 20%	C294	3150420	CAP AXIAL 12.0 PF 5% NPO
C233	3150595	CAP AXIAL 22.0 PF 5% NPO	C295	3150779	CAP AXIAL 43.0 PF 5% NPO
C234	3180012	CAP ELECTRO 1@50 20%	C296	3150350	CAP AXIAL 10.0 PF 5% NPO
C235	3150750	CAP AXIAL 39.0 PF 5% NPO	C297	3150350	CAP AXIAL 10.0 PF 5% NPO
C236	3150040	CAP AXIAL 2.7 PF 10% GP	C298	3150779	CAP AXIAL 43.0 PF 5% NPO
C237	3150690	CAP AXIAL 33.0 PF 5% NPO	C299	3150420	CAP AXIAL 12.0 PF 5% NPO
C238	3180064	CAP ELECTRO 10@50 20%	C300	3180012	CAP ELECTRO 1@50 20%
C239	3180012	CAP ELECTRO 1@50 20%	C301	3180109	CAP ELECTRO 22@25 20%
C240	3151648	CAP AX .10 MF 50V	C302	3151515	CAP AXIAL .01 MF 20% Y5P
C241	3151405	CAP AXIAL .001 MF 10% Y5P	C303	3151515	CAP AXIAL .01 MF 20% Y5P
C242	3151405	CAP AXIAL .001 MF 10% Y5P	C304	3151515	CAP AXIAL .01 MF 20% Y5P
C243	3180012	CAP ELECTRO 1@50 20%	C305	3151515	CAP AXIAL .01 MF 20% Y5P
C244	3151515	CAP AXIAL .01 MF 20% Y5P	C306	3151515	CAP AXIAL .01 MF 20% Y5P
C245	3150350	CAP AXIAL 10.0 PF 5% NPO	C307	3180012	CAP ELECTRO 1@50 20%
C246	3150350	CAP AXIAL 10.0 PF 5% NPO	C308	3180012	CAP ELECTRO 1@50 20%
C247	3150115	CAP AXIAL 4.7 PF 10% NPO	C309	3150690	CAP AXIAL 33.0 PF 5% NPO
C248	3150245	CAP AXIAL 6.8 PF 10% NPO	C310	3150899	CAP AXIAL 68.0 PF 5% NPO
C249	3150115	CAP AXIAL 4.7 PF 10% NPO	C311	3150690	CAP AXIAL 33.0 PF 5% NPO
C250	3150350	CAP AXIAL 10.0 PF 5% NPO	C312	3151515	CAP AXIAL .01 MF 20% Y5P
C251	3150508	CAP AXIAL 15.0 PF 5% NPO	C313	3151515	CAP AXIAL .01 MF 20% Y5P
C252	3180109	CAP ELECTRO 22@25 20%	C314	3151515	CAP AXIAL .01 MF 20% Y5P
C253	3150305	CAP AXIAL 8.2 PF 10% NPO	C315	3180109	CAP ELECTRO 22@25 20%
C254	3150115	CAP AXIAL 4.7 PF 10% NPO	C316	3151515	CAP AXIAL .01 MF 20% Y5P
C255	3151405	CAP AXIAL .001 MF 10% Y5P	C317	3151515	CAP AXIAL .01 MF 20% Y5P
C256	3151648	CAP AX .10 MF 50V	C318	3151345	CAP AXIAL 470 PF 10% Y5P
C257	3151405	CAP AXIAL .001 MF 10% Y5P	C319	3150779	CAP AXIAL 43.0 PF 5% NPO
C258	3150350	CAP AXIAL 10.0 PF 5% NPO	C320	3151117	CAP AXIAL 120 PF 5% GP
C259	3150305	CAP AXIAL 8.2 PF 10% NPO	C321	3150779	CAP AXIAL 43.0 PF 5% NPO
C260	3180109	CAP ELECTRO 22@25 20%	C322	3151515	CAP AXIAL .01 MF 20% Y5P
C261	3150508	CAP AXIAL 15.0 PF 5% NPO	C323	3180012	CAP ELECTRO 1@50 20%
C262	3150350	CAP AXIAL 10.0 PF 5% NPO	C324	3151515	CAP AXIAL .01 MF 20% Y5P
C263	3150115	CAP AXIAL 4.7 PF 10% NPO	C325	3151515	CAP AXIAL .01 MF 20% Y5P
C264	3150245	CAP AXIAL 6.8 PF 10% NPO	C326	3151515	CAP AXIAL .01 MF 20% Y5P
C265	3150115	CAP AXIAL 4.7 PF 10% NPO	C327	3180012	CAP ELECTRO 1@50 20%
C266	3150350	CAP AXIAL 10.0 PF 5% NPO	C328	3151515	CAP AXIAL .01 MF 20% Y5P
C267	3151405	CAP AXIAL .001 MF 10% Y5P	C329	3180012	CAP ELECTRO 1@50 20%
C268	3164032	CAP DISC 33.0 PF 5%	C330	3180109	CAP ELECTRO 22@25 20%
C269	3164160	CAP DISC 330 PF 5%	C331	3151648	CAP AX .10 MF 50V
C270	3150350	CAP AXIAL 10.0 PF 5% NPO	C332	3151405	CAP AXIAL .001 MF 10% Y5P
C271	3150779	CAP AXIAL 43.0 PF 5% NPO	C333	3151405	CAP AXIAL .001 MF 10% Y5P
C272	3150350	CAP AXIAL 10.0 PF 5% NPO	C334	3151405	CAP AXIAL .001 MF 10% Y5P
C273	3151515	CAP AXIAL .01 MF 20% Y5P	C335	3151515	CAP AXIAL .01 MF 20% Y5P
C274	3151405	CAP AXIAL .001 MF 10% Y5P	C336	3151345	CAP AXIAL 470 PF 10% Y5P
C275	3180109	CAP ELECTRO 22@25 20%	C337	3151418	CAP AXIAL .0015MF 20% Y5P
C276	3180109	CAP ELECTRO 22@25 20%	C338	3151345	CAP AXIAL 470 PF 10% Y5P
C277	3151515	CAP AXIAL .01 MF 20% Y5P	C339	3151648	CAP AX .10 MF 50V
C278	3151515	CAP AXIAL .01 MF 20% Y5P	C340	3151405	CAP AXIAL .001 MF 10% Y5P
C279	3151515	CAP AXIAL .01 MF 20% Y5P	C341	3151648	CAP AX .10 MF 50V
C280	3184068	CAP FILM .1 @ 100V 10%			

# Synthesizer and Microprocessor Board Parts List cont'd. 35

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C342	3151405	CAP AXIAL .001 MF 10% Y5P	C405	3151648	CAP AX .10 MF 50V
C343	3151405	CAP AXIAL .001 MF 10% Y5P	C406	3151648	CAP AX .10 MF 50V
C344	3151405	CAP AXIAL .001 MF 10% Y5P	C407	3151648	CAP AX .10 MF 50V
C345	3151648	CAP AX .10 MF 50V	C409	3166105	CAP CHIP .01UF 60V 8MM
C346	3151405	CAP AXIAL .001 MF 10% Y5P	C410	3166105	CAP CHIP .01UF 60V 8MM
C347	3180109	CAP ELECTRO 22@25 20%	C411	3166105	CAP CHIP .01UF 60V 8MM
C348	3151405	CAP AXIAL .001 MF 10% Y5P	C412	3166105	CAP CHIP .01UF 60V 8MM
C349	3151405	CAP AXIAL .001 MF 10% Y5P	C413	3166105	CAP CHIP .01UF 60V 8MM
C350	3151345	CAP AXIAL 470 PF 10% Y5P	C414	3166105	CAP CHIP .01UF 60V 8MM
C351	3150690	CAP AXIAL 33.0 PF 5% NPO	C415	3166105	CAP CHIP .01UF 60V 8MM
C352	3151405	CAP AXIAL .001 MF 10% Y5P	C416	3166105	CAP CHIP .01UF 60V 8MM
C353	3150690	CAP AXIAL 33.0 PF 5% NPO	C417	3151405	CAP AXIAL .001 MF 10% Y5P
C354	3150750	CAP AXIAL 39.0 PF 5% NPO	C418	3150896	CAP AXIAL 56 pF, 5%, NPO
C355	3151405	CAP AXIAL .001 MF 10% Y5P	CR100	3020090	DIODE 1N4148
C356	3150420	CAP AXIAL 12.0 PF 5% NPO	CR101	3020090	DIODE 1N4148
C357	3151405	CAP AXIAL .001 MF 10% Y5P	CR102	3020090	DIODE 1N4148
C358	3150420	CAP AXIAL 12.0 PF 5% NPO	CR103	3020090	DIODE 1N4148
C359	3180109	CAP ELECTRO 22@25 20%	CR104	3020088	DIODE 1N4099 6.8V 5% .25W
C360	3150690	CAP AXIAL 33.0 PF 5% NPO	CR105	3020335	DIODE 1S2186
C361	3151515	CAP AXIAL .01 MF 20% Y5P	CR106	3020335	DIODE 1S2186
C362	3150245	CAP AXIAL 6.8 PF 10% NPO	CR107	3020335	DIODE 1S2186
C363	3151405	CAP AXIAL .001 MF 10% Y5P	CR108	3020335	DIODE 1S2186
C364	3151345	CAP AXIAL 470 PF 10% Y5P	CR109	3024711	VARIABLE ITC310
C365	3151515	CAP AXIAL .01 MF 20% Y5P	CR110	3024711	VARIABLE ITC310
C366	3151155	CAP AXIAL 150 PF 10% Y5P	CR111	3024711	VARIABLE ITC310
C367	3150845	CAP AXIAL 47.0 PF 5% N750	CR112	3024711	VARIABLE ITC310
C368	3151515	CAP AXIAL .01 MF 20% Y5P	CR113	3020090	DIODE 1N4148
C369	3180109	CAP ELECTRO 22@25 20%	CR114	3020401	DIODE 1SS97-2-ND4973-7E
C370	3151648	CAP AX .10 MF 50V	CR115	3020401	DIODE 1SS97-2-ND4973-7E
C371	3151155	CAP AXIAL 150 PF 10% Y5P	CR116	3020090	DIODE 1N4148
C372	3151515	CAP AXIAL .01 MF 20% Y5P	CR117	3020278	DIODE MV209/1SV101
C373	3151648	CAP AX .10 MF 50V	CR118	3024700	VARIABLE 1S2208B
C374	3151515	CAP AXIAL .01 MF 20% Y5P	CR119	3024700	VARIABLE 1S2208B
C375	3151117	CAP AXIAL 120 PF 5% GP	CR120	3024700	VARIABLE 1S2208B
C376	3151648	CAP AX .10 MF 50V	CR121	3024700	VARIABLE 1S2208B
C377	3151405	CAP AXIAL .001 MF 10% Y5P	CR122	3020401	DIODE 1SS97-2-ND4973-7E
C378	3180109	CAP ELECTRO 22@25 20%	CR123	3020401	DIODE 1SS97-2-ND4973-7E
C379	3150899	CAP AXIAL 68.0 PF 5% NPO	CR124	3020401	DIODE 1SS97-2-ND4973-7E
C380	3150750	CAP AXIAL 39.0 PF 5% NPO	CR125	3020401	DIODE 1SS97-2-ND4973-7E
C381	3150690	CAP AXIAL 33.0 PF 5% NPO	CR126	3020401	DIODE 1SS97-2-ND4973-7E
C382	3150899	CAP AXIAL 68.0 PF 5% NPO	CR127	3020220	DIODE 1N4005-PLASTIC
C383	3151648	CAP AX .10 MF 50V	CR128	3020120	DIODE 1N4740A 10V 5% 1W
C384	3151515	CAP AXIAL .01 MF 20% Y5P	CR129	3020401	DIODE 1SS97-2-ND4973-7E
C385	3180109	CAP ELECTRO 22@25 20%	CR130	3020156	DIODE 1N5228B 3.9V 5% .5W
C386	3180012	CAP ELECTRO 1@50 20%	CR131	3020110	DIODE 1N4734A 5.6V 5% 1W
C387	3180002	CAP ELECTRO .22@50 L.LEAK	CR132	3020110	DIODE 1N4734A 5.6V 5% 1W
C388	3151648	CAP AX .10 MF 50V	CR133	3020110	DIODE 1N4734A 5.6V 5% 1W
C389	3180295	CAP ELECTRO 1000@16 RAD'L	J100	3280042	CONN.COAX PC MT. 90 DEG.
C390	3151648	CAP AX .10 MF 50V	J101	3280746	CONN P.C. 8 PIN FEMALE
C391	3151648	CAP AX .10 MF 50V	J102	3280746	CONN P.C. 8 PIN FEMALE
C392	3150690	CAP AXIAL 33.0 PF 5% NPO	J103	3280746	CONN P.C. 8 PIN FEMALE
C393	3150690	CAP AXIAL 33.0 PF 5% NPO	J104	3280756	CONN RT ANG DB9
C394	3151648	CAP AX .10 MF 50V	J105	3280042	CONN.COAX PC MT. 90 DEG.
C395	3151648	CAP AX .10 MF 50V	J106	3280042	CONN.COAX PC MT. 90 DEG.
C396	3151648	CAP AX .10 MF 50V	J107	3280042	CONN.COAX PC MT. 90 DEG.
C397	3151648	CAP AX .10 MF 50V	L100	3524165	COIL RADIAL 5.6 UH
C398	3151648	CAP AX .10 MF 50V	L101	3524165	COIL RADIAL 5.6 UH
C399	3151648	CAP AX .10 MF 50V	L102	3524165	COIL RADIAL 5.6 UH
C400	3151648	CAP AX .10 MF 50V	L103	3524165	COIL RADIAL 5.6 UH
C401	3151648	CAP AX .10 MF 50V	L104	3524165	COIL RADIAL 5.6 UH
C402	3205205	CAP VAR TRIM. 3.3-20.5 PF	L105	3524138	COIL RADIAL 0.27 UH
C403	3150690	CAP AXIAL 33.0 PF 5% NPO	L106	3524215	COIL AXIAL 0.15 UH
C404	3151648	CAP AX .10 MF 50V			

# 36 Synthesizer and Microprocessor Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
L107	3524215	COIL AXIAL 0.15 UH	P105	3280723	CONN P.C. 3 PIN MALE
L108	3524118	COIL VAR 0.35 UH	P106	3280723	CONN P.C. 3 PIN MALE
L109	3524165	COIL RADIAL 5.6 UH	P107	3280723	CONN P.C. 3 PIN MALE
L110	3524118	COIL VAR 0.35 UH	P108	3280723	CONN P.C. 3 PIN MALE
L111	3524165	COIL RADIAL 5.6 UH	P109	3280726	CONN P.C. 6 PIN MALE
L112	3524116	COIL VAR 0.25 UH	P110	3280723	CONN P.C. 3 PIN MALE
L113	3524165	COIL RADIAL 5.6 UH	Q100	3030061	TRANSISTOR 2N3563
L114	3524116	COIL VAR 0.25 UH	Q101	3030061	TRANSISTOR 2N3563
L115	3524165	COIL RADIAL 5.6 UH	Q102	3030104	TRANSISTOR 2N3904
L116	3524156	COIL RADIAL 2.7 UH	Q103	3030104	TRANSISTOR 2N3904
L117	3524155	COIL RADIAL 2.2 UH	Q104	3030104	TRANSISTOR 2N3904
L118	3524156	COIL RADIAL 2.7 UH	Q105	3030104	TRANSISTOR 2N3904
L119	3524156	COIL RADIAL 2.7 UH	Q106	3030061	TRANSISTOR 2N3563
L120	3524104	COIL VAR 7-1/2T 7M VIOLET	Q107	3030507	TRANSISTOR 2SK192
L121	3524104	COIL VAR 7-1/2T 7M VIOLET	Q108	3030507	TRANSISTOR 2SK192
L122	3524104	COIL VAR 7-1/2T 7M VIOLET	Q109	3030507	TRANSISTOR 2SK192
L123	3524111	COIL VAR 0.19 UH	Q110	3030507	TRANSISTOR 2SK192
L124	3524176	COIL RADIAL 22.0 UH	Q111	3030061	TRANSISTOR 2N3563
L125	3524176	COIL RADIAL 22.0 UH	Q112	3030061	TRANSISTOR 2N3563
L126	3524176	COIL RADIAL 22.0 UH	Q113	3030111	TRANSISTOR 2N4125
L127	3524176	COIL RADIAL 22.0 UH	Q114	3030104	TRANSISTOR 2N3904
L128	3524111	COIL VAR 0.19 UH	Q115	3030104	TRANSISTOR 2N3904
L129	3524111	COIL VAR 0.19 UH	Q116	3030104	TRANSISTOR 2N3904
L130	3524165	COIL RADIAL 5.6 UH	Q117	3030111	TRANSISTOR 2N4125
L131	3524529	COIL VAR. SHLD	Q118	3030104	TRANSISTOR 2N3904
L132	3524152	COIL RADIAL 1.8 UH	Q119	3030061	TRANSISTOR 2N3563
L133	3524152	COIL RADIAL 1.8 UH	Q120	3030061	TRANSISTOR 2N3563
L134	3524117	COIL VAR 0.50 UH	Q121	3030061	TRANSISTOR 2N3563
L135	3524117	COIL VAR 0.50 UH	Q122	3030061	TRANSISTOR 2N3563
L136	3524152	COIL RADIAL 1.8 UH	Q123	3030061	TRANSISTOR 2N3563
L137	3524152	COIL RADIAL 1.8 UH	Q124	3030061	TRANSISTOR 2N3563
L138	3524104	COIL VAR 7-1/2T 7M VIOLET (3501055 SHIELD)	Q125	3030061	TRANSISTOR 2N3563
L139	3524104	COIL VAR 7-1/2T 7M VIOLET (3501055 SHIELD)	Q126	3030061	TRANSISTOR 2N3563
L140	2510078	INDUCTOR TOROID	Q127	3030061	TRANSISTOR 2N3563
L141	3524104	COIL VAR 7-1/2T 7M VIOLET (3501055 SHIELD)	Q128	3030104	TRANSISTOR 2N3904
L142	3524177	COIL RADIAL 27.0 UH	Q129	3030104	TRANSISTOR 2N3904
L143	3524177	COIL RADIAL 27.0 UH	Q130	3030061	TRANSISTOR 2N3563
L144	3524181	COIL RADIAL 39.0 UH	Q131	3030061	TRANSISTOR 2N3563
L145	3524181	COIL RADIAL 39.0 UH	Q132	3030104	TRANSISTOR 2N3904
L146	3524165	COIL RADIAL 5.6 UH	Q133	3030104	TRANSISTOR 2N3904
L147	3524160	COIL RADIAL 3.3 UH	Q134	3030061	TRANSISTOR 2N3563
L148	3524160	COIL RADIAL 3.3 UH	Q135	3030061	TRANSISTOR 2N3563
L149	2510084	INDUCTOR TOROID	Q136	3030061	TRANSISTOR 2N3563
L150	3524172	COIL RADIAL 18.0 UH	Q137	3030061	TRANSISTOR 2N3563
L151	3524104	COIL VAR 7-1/2T 7M VIOLET (3501055 SHIELD)	Q138	3030061	TRANSISTOR 2N3563
L152	3524104	COIL VAR 7-1/2T 7M VIOLET (3501055 SHIELD)	Q139	3030061	TRANSISTOR 2N3563
L153	3524138	COIL RADIAL 0.27 UH	Q140	3030061	TRANSISTOR 2N3563
L154	3524111	COIL VAR 0.19 UH	Q141	3030061	TRANSISTOR 2N3563
L155	3524515	COIL VAR. SHLD	Q142	3030061	TRANSISTOR 2N3563
L156	3524156	COIL RADIAL 2.7 UH	Q143	3030061	TRANSISTOR 2N3563
L157	3524165	COIL RADIAL 5.6 UH	Q144	3030104	TRANSISTOR 2N3904
L158	3524176	COIL RADIAL 22.0 UH	Q145	3030121	TRANSISTOR 2N4402
P100	3280720	CONN P.C. 8 PIN MALE	Q146	3030104	TRANSISTOR 2N3904
P101	3280724	CONN P.C. 4 PIN MALE	Q147	3030104	TRANSISTOR 2N3904
P102	3280718	CONN P.C. 10 PIN MALE	Q148	3030104	TRANSISTOR 2N3904
P103	3280718	CONN P.C. 10 PIN MALE	Q149	3030104	TRANSISTOR 2N3904
P104	3280719	CONN P.C. 12 PIN MALE	Q150	3030104	TRANSISTOR 2N3904
			Q151	3030104	TRANSISTOR 2N3904
			Q152	3030104	TRANSISTOR 2N3904
			Q153	3030104	TRANSISTOR 2N3904
			Q154	3030104	TRANSISTOR 2N3904
			Q155	3030104	TRANSISTOR 2N3904

# Synthesizer and Microprocessor Board Parts List cont'd. 37

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
R100	3220015	RES C.FILM 22 OHM 5%1/4W	R162	3220125	RES C.FILM 560 OHM 5%1/4W
R101	3220245	RES C.FILM 15 K 5% 1/4W	R163	3220100	RES C.FILM 390 OHM 5%1/4W
R102	3220085	RES C.FILM 270 OHM 5%1/4W	R164	3220055	RES C.FILM 100 OHM 5%1/4W
R103	3220235	RES C.FILM 10 K 5% 1/4W	R165	3220190	RES C.FILM 2.2 K 5% 1/4W
R104	3220235	RES C.FILM 10 K 5% 1/4W	R166	3220175	RES C.FILM 1.5 K 5% 1/4W
R105	3220055	RES C.FILM 100 OHM 5%1/4W	R167	3220085	RES C.FILM 270 OHM 5%1/4W
R106	3220065	RES C.FILM 150 OHM 5%1/4W	R168	3220235	RES C.FILM 10 K 5% 1/4W
R107	3220035	RES C.FILM 47 OHM 5%1/4W	R169	3220235	RES C.FILM 10 K 5% 1/4W
R108	3220285	RES C.FILM 47 K 5% 1/4W	R170	3220085	RES C.FILM 270 OHM 5%1/4W
R109	3220210	RES C.FILM 4.7 K 5% 1/4W	R171	3220005	RES C.FILM 10 OHM 5%1/4W
R110	3220285	RES C.FILM 47 K 5% 1/4W	R172	3220005	RES C.FILM 10 OHM 5%1/4W
R111	3220210	RES C.FILM 4.7 K 5% 1/4W	R173	3220085	RES C.FILM 270 OHM 5%1/4W
R112	3220285	RES C.FILM 47 K 5% 1/4W	R174	3220070	RES C.FILM 180 OHM 5%1/4W
R113	3220210	RES C.FILM 4.7 K 5% 1/4W	R175	3220055	RES C.FILM 100 OHM 5%1/4W
R114	3220285	RES C.FILM 47 K 5% 1/4W	R176	3220070	RES C.FILM 180 OHM 5%1/4W
R115	3220235	RES C.FILM 10 K 5% 1/4W	R177	3220215	RES C.FILM 5.6 K 5% 1/4W
R116	3220235	RES C.FILM 10 K 5% 1/4W	R178	3220145	RES C.FILM 820 OHM 5%1/4W
R117	3220070	RES C.FILM 180 OHM 5%1/4W	R179	3220160	RES C.FILM 1.0 K 5% 1/4W
R118	3220055	RES C.FILM 100 OHM 5%1/4W	R180	3220060	RES C.FILM 120 OHM 5%1/4W
R119	3220055	RES C.FILM 100 OHM 5%1/4W	R181	3220195	RES C.FILM 2.7 K 5% 1/4W
R120	3220055	RES C.FILM 100 OHM 5%1/4W	R182	3220235	RES C.FILM 10 K 5% 1/4W
R121	3220235	RES C.FILM 10 K 5% 1/4W	R183	3220140	RES C.FILM 680 OHM 5%1/4W
R122	3220110	RES C.FILM 470 OHM 5%1/4W	R184	3220055	RES C.FILM 100 OHM 5%1/4W
R123	3220110	RES C.FILM 470 OHM 5%1/4W	R185	3220055	RES C.FILM 100 OHM 5%1/4W
R124	3220110	RES C.FILM 470 OHM 5%1/4W	R186	3220045	RES C.FILM 68 OHM 5%1/4W
R125	3220110	RES C.FILM 470 OHM 5%1/4W	R187	3220055	RES C.FILM 100 OHM 5%1/4W
R126	3220055	RES C.FILM 100 OHM 5%1/4W	R188	3220055	RES C.FILM 100 OHM 5%1/4W
R127	3220235	RES C.FILM 10 K 5% 1/4W	R189	3220315	RES C.FILM 100 K 5% 1/4W
R128	3220320	RES C.FILM 150 K 5% 1/4W	R190	3220110	RES C.FILM 470 OHM 5%1/4W
R129	3220320	RES C.FILM 150 K 5% 1/4W	R191	3220180	RES C.FILM 1.8 K 5% 1/4W
R130	3220320	RES C.FILM 150 K 5% 1/4W	R192	3220180	RES C.FILM 1.8 K 5% 1/4W
R131	3220320	RES C.FILM 150 K 5% 1/4W	R193	3220110	RES C.FILM 470 OHM 5%1/4W
R132	3220320	RES C.FILM 150 K 5% 1/4W	R194	3220055	RES C.FILM 100 OHM 5%1/4W
R133	3220320	RES C.FILM 150 K 5% 1/4W	R195	3220315	RES C.FILM 100 K 5% 1/4W
R134	3220320	RES C.FILM 150 K 5% 1/4W	R196	3220055	RES C.FILM 100 OHM 5%1/4W
R135	3220320	RES C.FILM 150 K 5% 1/4W	R197	3220235	RES C.FILM 10 K 5% 1/4W
R136	3220160	RES C.FILM 1.0 K 5% 1/4W	R198	3220230	RES C.FILM 8.2 K 5% 1/4W
R137	3220060	RES C.FILM 120 OHM 5%1/4W	R199	3220300	RES C.FILM 68 K 5% 1/4W
R138	3220235	RES C.FILM 10 K 5% 1/4W	R200	3220285	RES C.FILM 47 K 5% 1/4W
R139	3220055	RES C.FILM 100 OHM 5%1/4W	R201	3220315	RES C.FILM 100 K 5% 1/4W
R140	3220055	RES C.FILM 100 OHM 5%1/4W	R202	3220110	RES C.FILM 470 OHM 5%1/4W
R141	3220235	RES C.FILM 10 K 5% 1/4W	R203	3220110	RES C.FILM 470 OHM 5%1/4W
R142	3220160	RES C.FILM 1.0 K 5% 1/4W	R204	3220130	RES C.FILM 620 OHM 5%1/4W
R143	3220160	RES C.FILM 1.0 K 5% 1/4W	R205	3220110	RES C.FILM 470 OHM 5%1/4W
R144	3220160	RES C.FILM 1.0 K 5% 1/4W	R206	3220240	RES C.FILM 12 K 5% 1/4W
R145	3220160	RES C.FILM 1.0 K 5% 1/4W	R207	3220235	RES C.FILM 10 K 5% 1/4W
R146	3220015	RES C.FILM 22 OHM 5%1/4W	R208	3220315	RES C.FILM 100 K 5% 1/4W
R147	3220115	RES C.FILM 510 OHM 5%1/4W	R209	3220260	RES C.FILM 22 K 5% 1/4W
R148	3220055	RES C.FILM 100 OHM 5%1/4W	R210	3220260	RES C.FILM 22 K 5% 1/4W
R149	3220270	RES C.FILM 27 K 5% 1/4W	R211	3220315	RES C.FILM 100 K 5% 1/4W
R150	3220235	RES C.FILM 10 K 5% 1/4W	R212	3220235	RES C.FILM 10 K 5% 1/4W
R151	3220070	RES C.FILM 180 OHM 5%1/4W	R213	3220240	RES C.FILM 12 K 5% 1/4W
R152	3220085	RES C.FILM 270 OHM 5%1/4W	R214	3220110	RES C.FILM 470 OHM 5%1/4W
R153	3220175	RES C.FILM 1.5 K 5% 1/4W	R215	3220130	RES C.FILM 620 OHM 5%1/4W
R154	3220190	RES C.FILM 2.2 K 5% 1/4W	R216	3220215	RES C.FILM 5.6 K 5% 1/4W
R155	3220085	RES C.FILM 270 OHM 5%1/4W	R217	3220085	RES C.FILM 270 OHM 5%1/4W
R156	3220100	RES C.FILM 390 OHM 5%1/4W	R218	3220245	RES C.FILM 15 K 5% 1/4W
R157	3220180	RES C.FILM 1.8 K 5% 1/4W	R219	3220055	RES C.FILM 100 OHM 5%1/4W
R158	3220110	RES C.FILM 470 OHM 5%1/4W	R220	3220055	RES C.FILM 100 OHM 5%1/4W
R159	3220160	RES C.FILM 1.0 K 5% 1/4W	R221	3220315	RES C.FILM 100 K 5% 1/4W
R160	3220160	RES C.FILM 1.0 K 5% 1/4W	R222	3220110	RES C.FILM 470 OHM 5%1/4W
R161	3220060	RES C.FILM 120 OHM 5%1/4W	R223	3220055	RES C.FILM 100 OHM 5%1/4W

# 38 Synthesizer and Microprocessor Board Parts List cont'd.

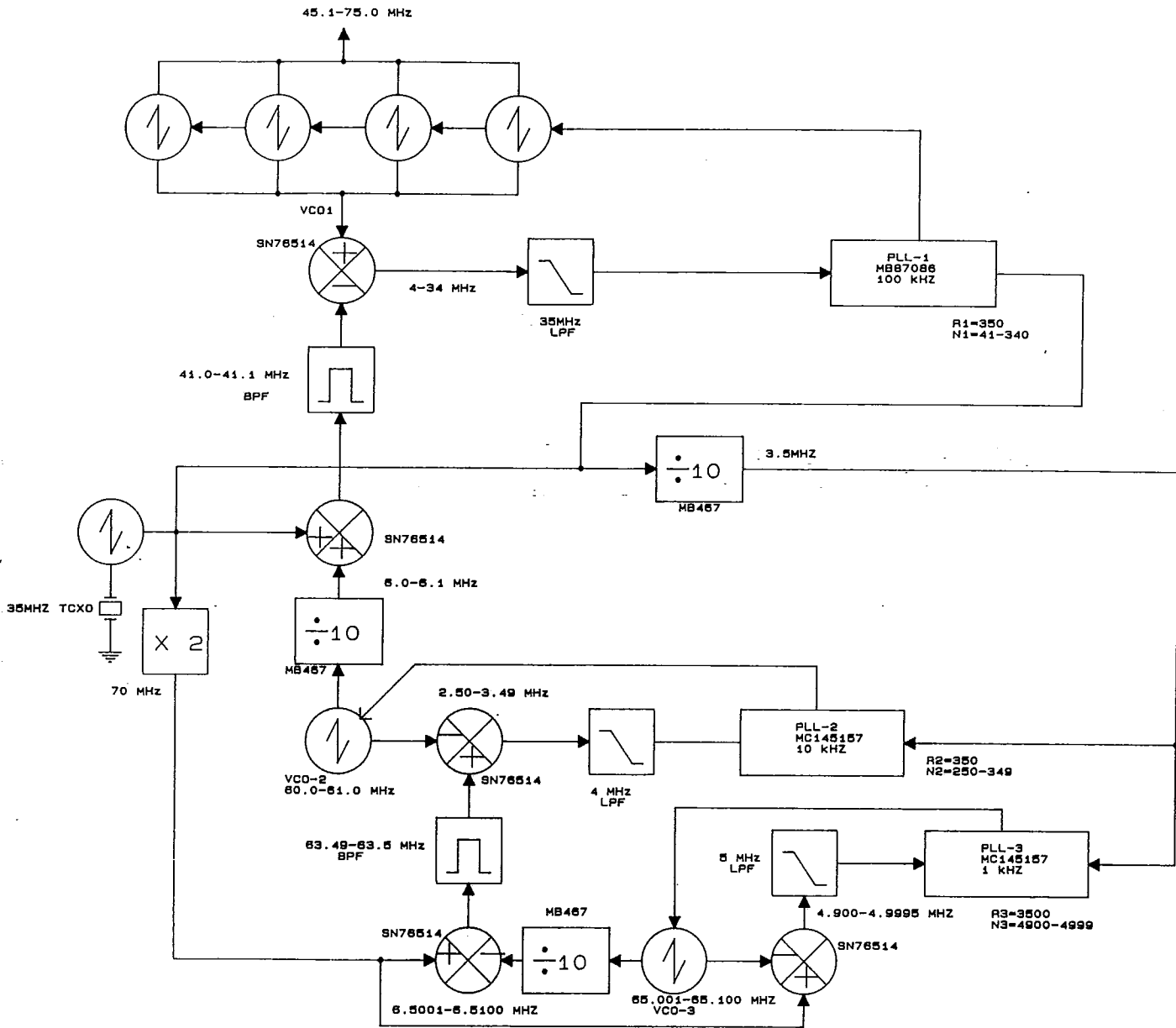
REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
R224	3220055	RES C.FILM 100 OHM 5%1/4W	R286	3220160	RES C.FILM 1.0 K 5% 1/4W
R225	3220235	RES C.FILM 10 K 5% 1/4W	R287	3220075	RES C.FILM 220 OHM 5%1/4W
R226	3220205	RES C.FILM 3.9 K 5% 1/4W	R288	3220015	RES C.FILM 22 OHM 5%1/4W
R227	3220140	RES C.FILM 680 OHM 5%1/4W	R289	3220055	RES C.FILM 100 OHM 5%1/4W
R228	3220275	RES C.FILM 33 K 5% 1/4W	R290	3220015	RES C.FILM 22 OHM 5%1/4W
R229	3220220	RES C.FILM 6.8 K 5% 1/4W	R291	3220160	RES C.FILM 1.0 K 5% 1/4W
R230	3220235	RES C.FILM 10 K 5% 1/4W	R292	3220190	RES C.FILM 2.2 K 5% 1/4W
R231	3220245	RES C.FILM 15 K 5% 1/4W	R293	3220230	RES C.FILM 8.2 K 5% 1/4W
R232	3220140	RES C.FILM 680 OHM 5%1/4W	R294	3220055	RES C.FILM 100 OHM 5%1/4W
R233	3220205	RES C.FILM 3.9 K 5% 1/4W	R295	3220235	RES C.FILM 10 K 5% 1/4W
R234	3220235	RES C.FILM 10 K 5% 1/4W	R296	3220190	RES C.FILM 2.2 K 5% 1/4W
R235	3220055	RES C.FILM 100 OHM 5%1/4W	R297	3220055	RES C.FILM 100 OHM 5%1/4W
R236	3220055	RES C.FILM 100 OHM 5%1/4W	R298	3220055	RES C.FILM 100 OHM 5%1/4W
R237	3220110	RES C.FILM 470 OHM 5%1/4W	R299	3220235	RES C.FILM 10 K 5% 1/4W
R238	3220315	RES C.FILM 100 K 5% 1/4W	R300	3220005	RES C.FILM 10 OHM 5%1/4W
R239	3220055	RES C.FILM 100 OHM 5%1/4W	R301	3220055	RES C.FILM 100 OHM 5%1/4W
R240	3220055	RES C.FILM 100 OHM 5%1/4W	R302	3220085	RES C.FILM 270 OHM 5%1/4W
R241	3220055	RES C.FILM 100 OHM 5%1/4W	R303	3220210	RES C.FILM 4.7 K 5% 1/4W
R242	3220235	RES C.FILM 10 K 5% 1/4W	R304	3220075	RES C.FILM 220 OHM 5%1/4W
R243	3220055	RES C.FILM 100 OHM 5%1/4W	R305	3220210	RES C.FILM 4.7 K 5% 1/4W
R244	3220055	RES C.FILM 100 OHM 5%1/4W	R306	3220075	RES C.FILM 220 OHM 5%1/4W
R245	3220210	RES C.FILM 4.7 K 5% 1/4W	R307	3220115	RES C.FILM 510 OHM 5%1/4W
R246	3220260	RES C.FILM 22 K 5% 1/4W	R308	3220075	RES C.FILM 220 OHM 5%1/4W
R247	3220075	RES C.FILM 220 OHM 5%1/4W	R309	3220210	RES C.FILM 4.7-K 5% 1/4W
R248	3220145	RES C.FILM 820 OHM 5%1/4W	R310	3220210	RES C.FILM 4.7 K 5% 1/4W
R249	3220110	RES C.FILM 470 OHM 5%1/4W	R311	3220315	RES C.FILM 100 K 5% 1/4W
R250	3220235	RES C.FILM 10 K 5% 1/4W	R312	3220315	RES C.FILM 100 K 5% 1/4W
R251	3220145	RES C.FILM 820 OHM 5%1/4W	R313	3220210	RES C.FILM 4.7 K 5% 1/4W
R252	3220055	RES C.FILM 100 OHM 5%1/4W	R314	3220055	RES C.FILM 100 OHM 5%1/4W
R253	3220210	RES C.FILM 4.7 K 5% 1/4W	R315	3220235	RES C.FILM 10 K 5% 1/4W
R254	3220055	RES C.FILM 100 OHM 5%1/4W	R316	3220315	RES C.FILM 100 K 5% 1/4W
R255	3220190	RES C.FILM 2.2 K 5% 1/4W	R317	3220315	RES C.FILM 100 K 5% 1/4W
R256	3220230	RES C.FILM 8.2 K 5% 1/4W	R318	3220235	RES C.FILM 10 K 5% 1/4W
R257	3220005	RES C.FILM 10 OHM 5%1/4W	R319	3220285	RES C.FILM 47 K 5% 1/4W
R258	3220025	RES C.FILM 33 OHM 5%1/4W	R320	3220260	RES C.FILM 22 K 5% 1/4W
R259	3220002	RES C.FILM 3.3 OHM 5%1/4W	R321	3220160	RES C.FILM 1.0 K 5% 1/4W
R260	3220002	RES C.FILM 3.3 OHM 5%1/4W	R322	3220110	RES C.FILM 470 OHM 5%1/4W
R261	3220025	RES C.FILM 33 OHM 5%1/4W	R323	3220190	RES C.FILM 2.2 K 5% 1/4W
R262	3220005	RES C.FILM 10 OHM 5%1/4W	R324	3220285	RES C.FILM 47 K 5% 1/4W
R263	3220230	RES C.FILM 8.2 K 5% 1/4W	R325	3220315	RES C.FILM 100 K 5% 1/4W
R264	3220190	RES C.FILM 2.2 K 5% 1/4W	R326	3220285	RES C.FILM 47 K 5% 1/4W
R265	3220045	RES C.FILM 68 OHM 5%1/4W	R327	3220210	RES C.FILM 4.7 K 5% 1/4W
R266	3220015	RES C.FILM 22 OHM 5%1/4W	R328	3220285	RES C.FILM 47 K 5% 1/4W
R267	3220045	RES C.FILM 68 OHM 5%1/4W	R329	3220315	RES C.FILM 100 K 5% 1/4W
R268	0000000	NO PART	R330	3220255	RES C.FILM 18 K 5% 1/4W
R269	3220055	RES C.FILM 100 OHM 5%1/4W	R331	3220200	RES C.FILM 3.3 K 5% 1/4W
R270	3220235	RES C.FILM 10 K 5% 1/4W	R332	3220330	RES C.FILM 220 K 5% 1/4W
R271	3220215	RES C.FILM 5.6 K 5% 1/4W	R333	3220210	RES C.FILM 4.7 K 5% 1/4W
R272	3220180	RES C.FILM 1.8 K 5% 1/4W	R334	3220110	RES C.FILM 470 OHM 5%1/4W
R273	3220035	RES C.FILM 47 OHM 5%1/4W	R335	3220100	RES C.FILM 390 OHM 5%1/4W
R274	3220085	RES C.FILM 270 OHM 5%1/4W	R336	3250468	RES M.FILM 40.2K 1% 1/4 W
R275	3220055	RES C.FILM 100 OHM 5%1/4W	R337	3250463	RES M.FILM 20.0K 1% 1/4 W
R276	3220220	RES C.FILM 6.8 K 5% 1/4W	R338	3250496	RES M.FILM 324 K 1% 1/4 W
R277	3220235	RES C.FILM 10 K 5% 1/4W	R339	3250491	RES M.FILM 162 K 1% 1/4 W
R278	3220075	RES C.FILM 220 OHM 5%1/4W	R340	3250486	RES M.FILM 80.6K 1% 1/4 W
R279	3220235	RES C.FILM 10 K 5% 1/4W	R341	3220235	RES C.FILM 10 K 5% 1/4W
R281	3220190	RES C.FILM 2.2 K 5% 1/4W	R342	3220160	RES C.FILM 1.0 K 5% 1/4W
R282	3220220	RES C.FILM 6.8 K 5% 1/4W	R343	3220190	RES C.FILM 2.2 K 5% 1/4W
R283	3220235	RES C.FILM 10 K 5% 1/4W	R344	3220190	RES C.FILM 2.2 K 5% 1/4W
R284	3220055	RES C.FILM 100 OHM 5%1/4W	R345	3250425	RES M.FILM 10.0K 1% 1/4 W
R285	3220195	RES C.FILM 2.7 K 5% 1/4W	R346	3250361	RES M.FILM.4.99K 1% 1/4 W
			R347	3250325	RES M.FILM 2.49K 1% 1/4 W



# Synthesizer and Microprocessor Board Parts List cont'd. 39

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
R348	3260664	RES VAR PT10V 10K	RP100	3221220	RES PACK 11X10K 12-PIN SIP
R349	3220275	RES C.FILM 33 K 5% 1/4W	RP101	3221220	RES PACK 11X10K 12-PIN SIP
R350	3220315	RES C.FILM 100 K 5% 1/4W	RP102	3221220	RES PACK 11X10K 12-PIN SIP
R351	3220235	RES C.FILM 10 K 5% 1/4W	RP103	3221220	RES PACK 11X10K 12-PIN SIP
R352	3220335	RES C.FILM 270 K 5% 1/4W	RP104	3221220	RES PACK 11X10K 12-PIN SIP
R353	3220285	RES C.FILM 47 K 5% 1/4W	U100	3040011	I.C. 74HC74
R354	3220285	RES C.FILM 47 K 5% 1/4W	U101	3040247	I.C. RE5VA45AX
R355	3220315	RES C.FILM 100 K 5% 1/4W	U102	3040120	I.C. 3302P
R356	3260664	RES VAR PT10V 10K	U103	3042130	I.C. MM5450
R357	3220235	RES C.FILM 10 K 5% 1/4W	U104	3042004	I.C. 8049
R358	3220235	RES C.FILM 10 K 5% 1/4W	U105	3040009	I.C. 74HC573
R359	3220260	RES C.FILM 22 K 5% 1/4W	U106	4671318	I.C. 27256 EPROM W/R8 VERSION
R360	3220320	RES C.FILM 150 K 5% 1/4W		3282128	12 SOFTWARE (SOCKET 28 PIN)
R361	3220235	RES C.FILM 10 K 5% 1/4W	U107	3040007	I.C. 74HC174
R362	3220285	RES C.FILM 47 K 5% 1/4W	U108	3042026	I.C. TC8521AP
R363	3220235	RES C.FILM 10 K 5% 1/4W	U109	3041166	I.C. MB87086 PLL
R364	3220110	RES C.FILM 470 OHM 5%1/4W	U110	3040094	I.C. LM358
R365	3220110	RES C.FILM 470 OHM 5%1/4W	U111	3040003	I.C. 74HC139
R366	3220210	RES C.FILM 4.7 K 5% 1/4W	U112	3040007	I.C. 74HC174
R367	3220210	RES C.FILM 4.7 K 5% 1/4W	U113	3040005	I.C. 74HC244
R368	3220210	RES C.FILM 4.7 K 5% 1/4W	U114	3040006	I.C. 74HC273
R369	3220210	RES C.FILM 4.7 K 5% 1/4W	U115	3041042	I.C. KM28C16
R370	3220210	RES C.FILM 4.7 K 5% 1/4W	U116	3040480	I.C. 76514N/TL-442CN
R371	3220315	RES C.FILM 100 K 5% 1/4W	U117	3040480	I.C. 76514N/TL-442CN
R372	3220315	RES C.FILM 100 K 5% 1/4W	U118	3041168	I.C. 145407 P
R373	3220245	RES C.FILM 15 K 5% 1/4W	U119	3040157	I.C. TCF-6000
R374	3220315	RES C.FILM 100 K 5% 1/4W	U120	3040157	I.C. TCF-6000
R375	3220275	RES C.FILM 33 K 5% 1/4W	U121	3040480	I.C. 76514N/TL-442CN
R376	3220285	RES C.FILM 47 K 5% 1/4W	U122	3045007	I.C. MB467 1/10
R377	3220235	RES C.FILM 10 K 5% 1/4W	U123	3045007	I.C. MB467 1/10
R378	3220315	RES C.FILM 100 K 5% 1/4W	U124	3040097	I.C. LF353N
R379	3220235	RES C.FILM 10 K 5% 1/4W	U125	3041167	I.C. 145157 PLL
R380	3220285	RES C.FILM 47 K 5% 1/4W	U126	3041167	I.C. 145157 PLL
R381	3220230	RES C.FILM 8.2 K 5% 1/4W	U127	3040097	I.C. LF353N
R382	3220210	RES C.FILM 4.7 K 5% 1/4W	U128	3040480	I.C. 76514N/TL-442CN
R383	3220215	RES C.FILM 5.6 K 5% 1/4W	U129	3040480	I.C. 76514N/TL-442CN
R384	3220235	RES C.FILM 10 K 5% 1/4W	U130	3045007	I.C. MB467 1/10
R385	3220235	RES C.FILM 10 K 5% 1/4W	U131	3041064	I.C. 74F163
R386	3220260	RES C.FILM 22 K 5% 1/4W	U132	3041063	I.C. 74F86
R387	3220320	RES C.FILM 150 K 5% 1/4W	VR100	3040031	I.C. 78LO5-ACP
R388	3220235	RES C.FILM 10 K 5% 1/4W	VR101	3040031	I.C. 78LO5-ACP
R389	3220235	RES C.FILM 10 K 5% 1/4W	VR102	3040031	I.C. 78LO5-ACP
R390	3220235	RES C.FILM 10 K 5% 1/4W	W1A	2715645	COAX 178 7.75 3/16X1/8X3/16
R391	3220160	RES C.FILM 1.0 K 5% 1/4W	W2A	2715643	COAX 178 6.0 3/16X1/8X3/16
R392	3220315	RES C.FILM 100 K 5% 1/4W	Y100	3120003	RESONATOR CRYSTAL 6.0 MHZ
R393	3220315	RES C.FILM 100 K 5% 1/4W	Y101	3120285	CRYSTAL 32.768 KHZ
R394	3220315	RES C.FILM 100 K 5% 1/4W	Y102	3120288	CRYSTAL 22.525 MHZ
R395	3220315	RES C.FILM 100 K 5% 1/4W	Y103	3120292	CRYSTAL 35.00 MHZ
R396	3220110	RES C.FILM 470 OHM 5%1/4W			
R397	3220315	RES C.FILM 100 K 5% 1/4W			
R398	3220315	RES C.FILM 100 K 5% 1/4W			
R399	3220345	RES C.FILM 470 K 5% 1/4W			
R400	3220345	RES C.FILM 470 K 5% 1/4W			
R401	3220345	RES C.FILM 470 K 5% 1/4W			
R402	3220345	RES C.FILM 470 K 5% 1/4W			
R403	3220345	RES C.FILM 470 K 5% 1/4W			
R404	3220345	RES C.FILM 470 K 5% 1/4W			
R405	3220075	RES C.FILM 220 OHM 5%1/4W			
R406	3220075	RES C.FILM 220 OHM 5%1/4W			
R408	3220075	RES C.FILM 220 OHM 5%1/4W			





$$VCO_3 = f_{STD} \left[ 2 - \frac{N_3}{3.6E4} \right]$$

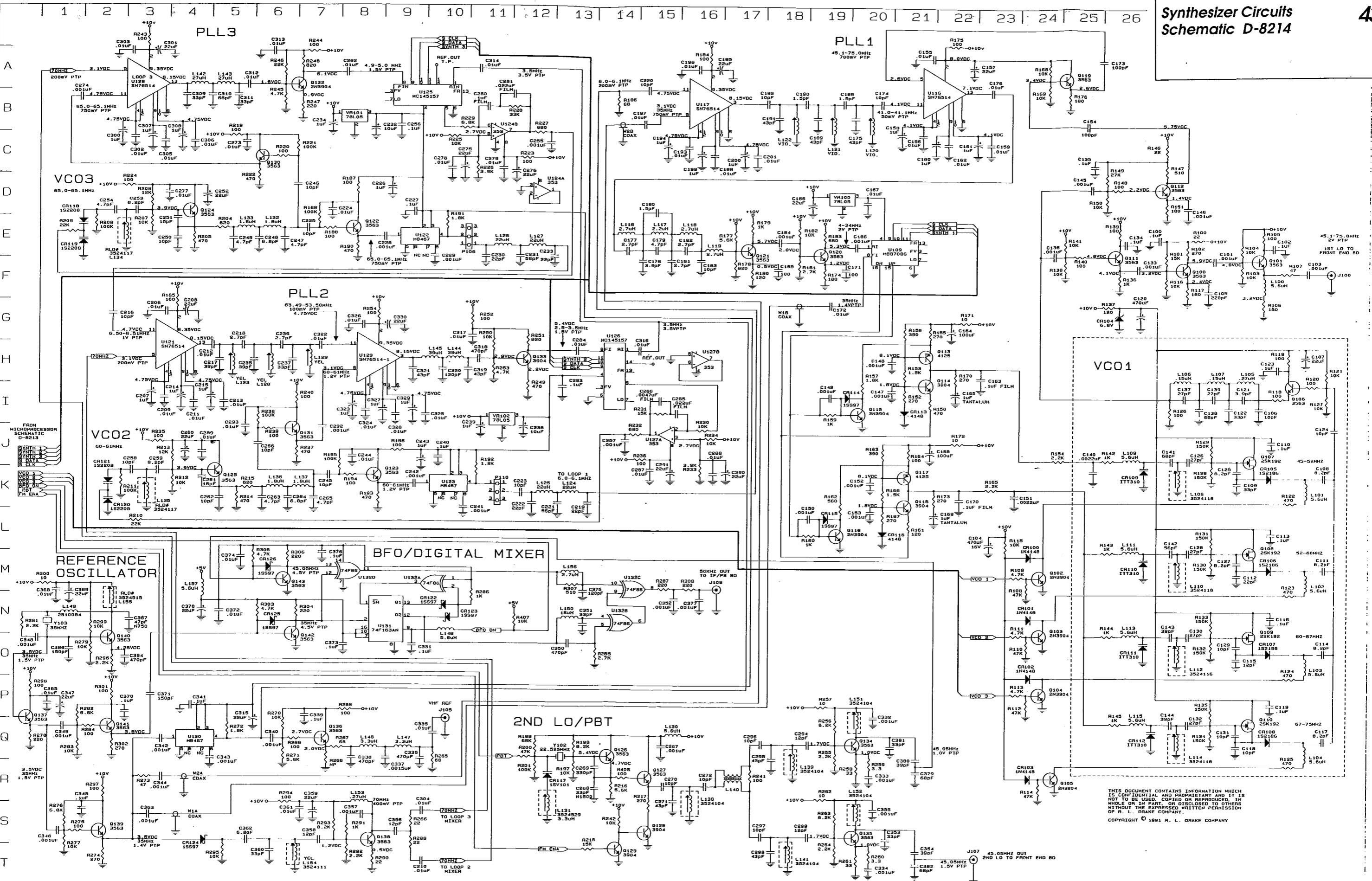
$$VCO_2 = f_{STD} \left[ 1.8 + \frac{N_3}{3.6E5} - \frac{N_2}{3.6E3} \right]$$

$$VCO_1 = f_{STD} \left[ 1.18 + \frac{N_3}{3.6E5} - \frac{N_2}{3.6E4} + \frac{N_1}{350} \right]$$

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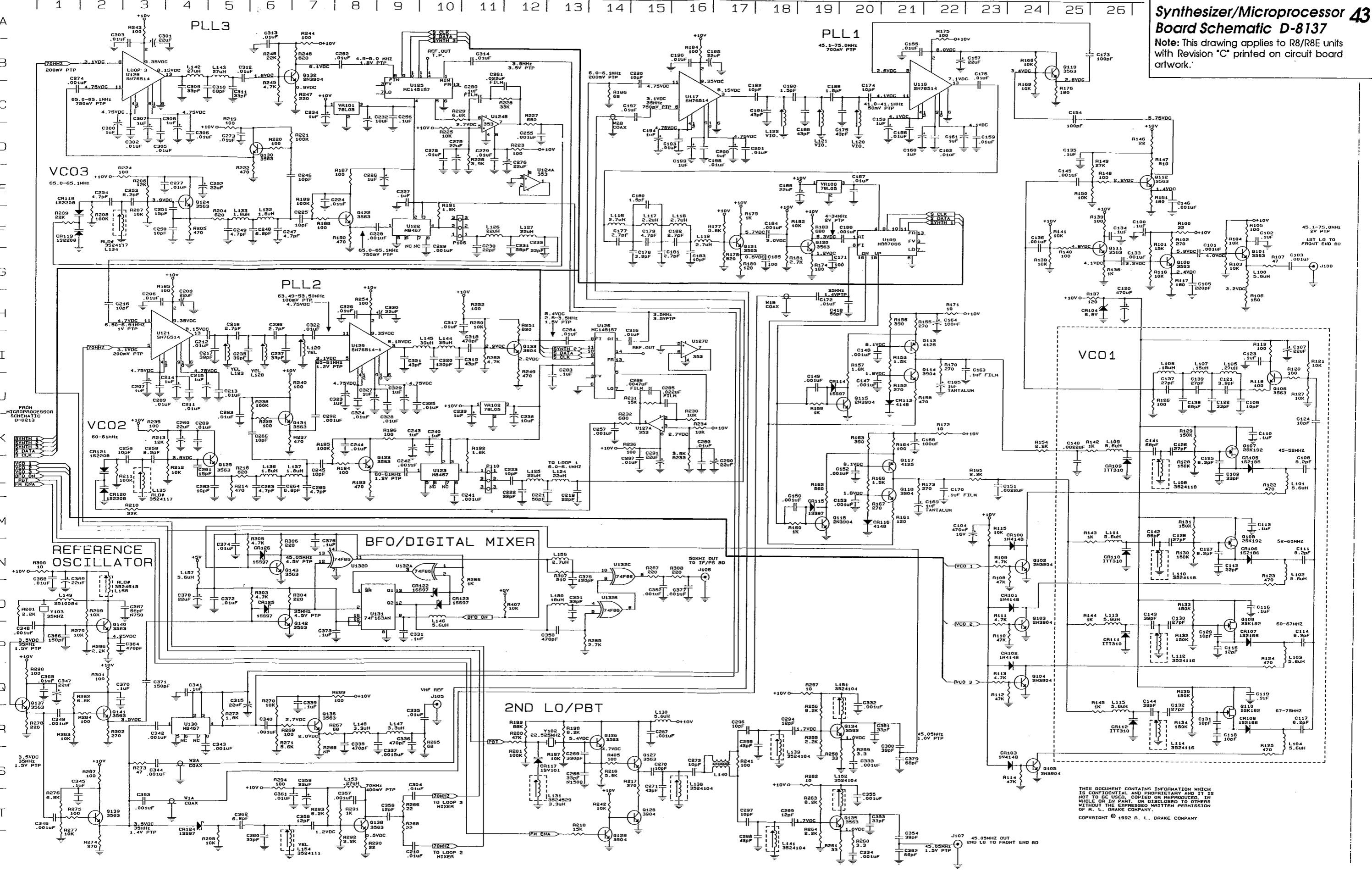
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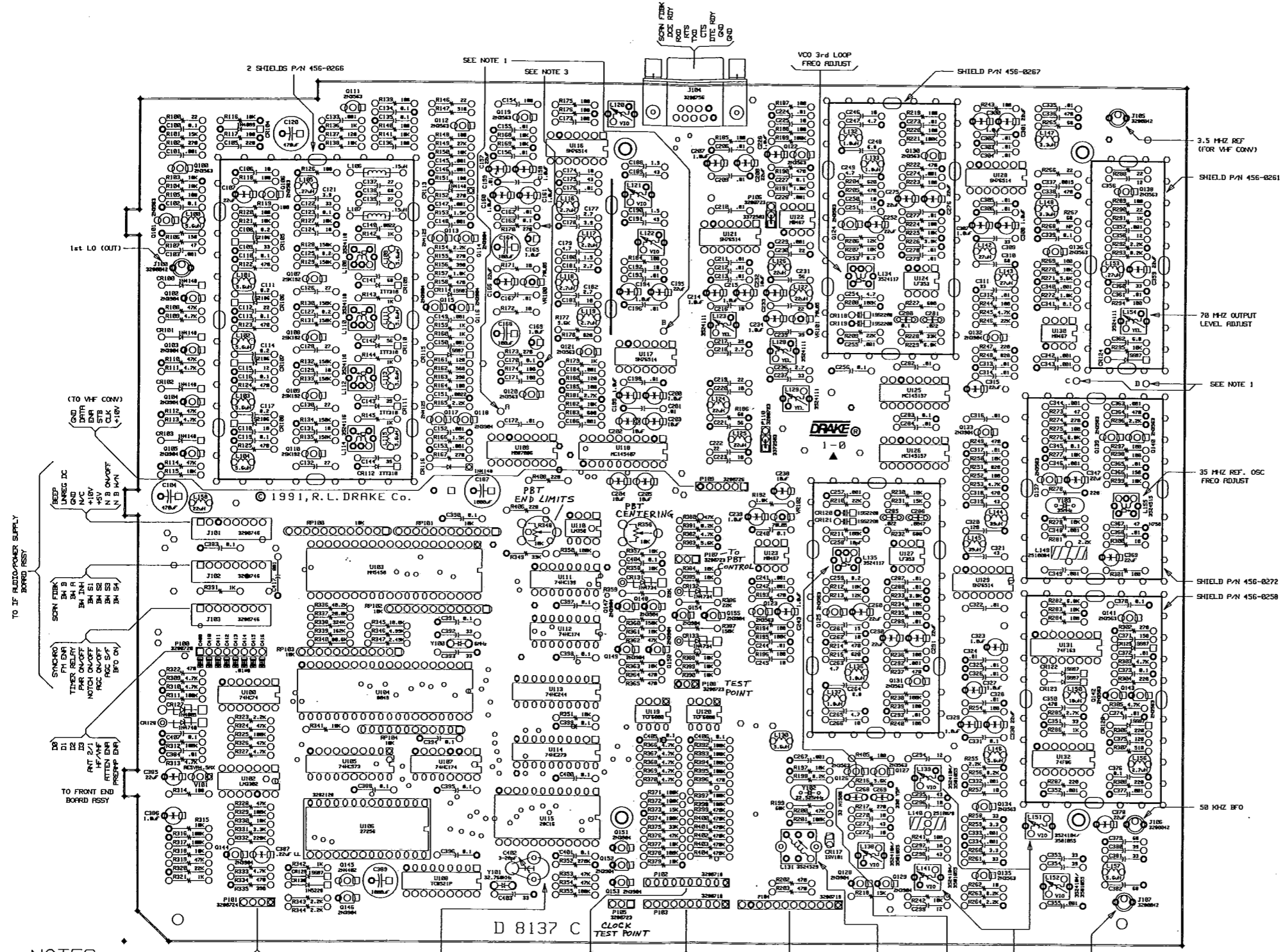
Note: This drawing applies to R8/R8E units with Revision "C" printed on circuit board artwork.



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NOTES:

- 1-ON COMP SIDE, SOLDER CORX P/N 271-5645 BETWEEN POINTS A AND D. SOLDER CORX P/N 271-5643 BETWEEN POINTS B AND C. SOLDER SHIELDS OF CORX TO GND AT EACH TERMINATION POINT.
- 2-SOLDER METAL SHIELDS TO COMP GND PLANE ALONG ENTIRE SEPH.
- 3-C163 AND C178 ARE .1UF FILM P/N 318-4068

To ENCODER

REAL TIME CLOCK REFERENCE SET

D 8137 C

CLOCK TEST POINT

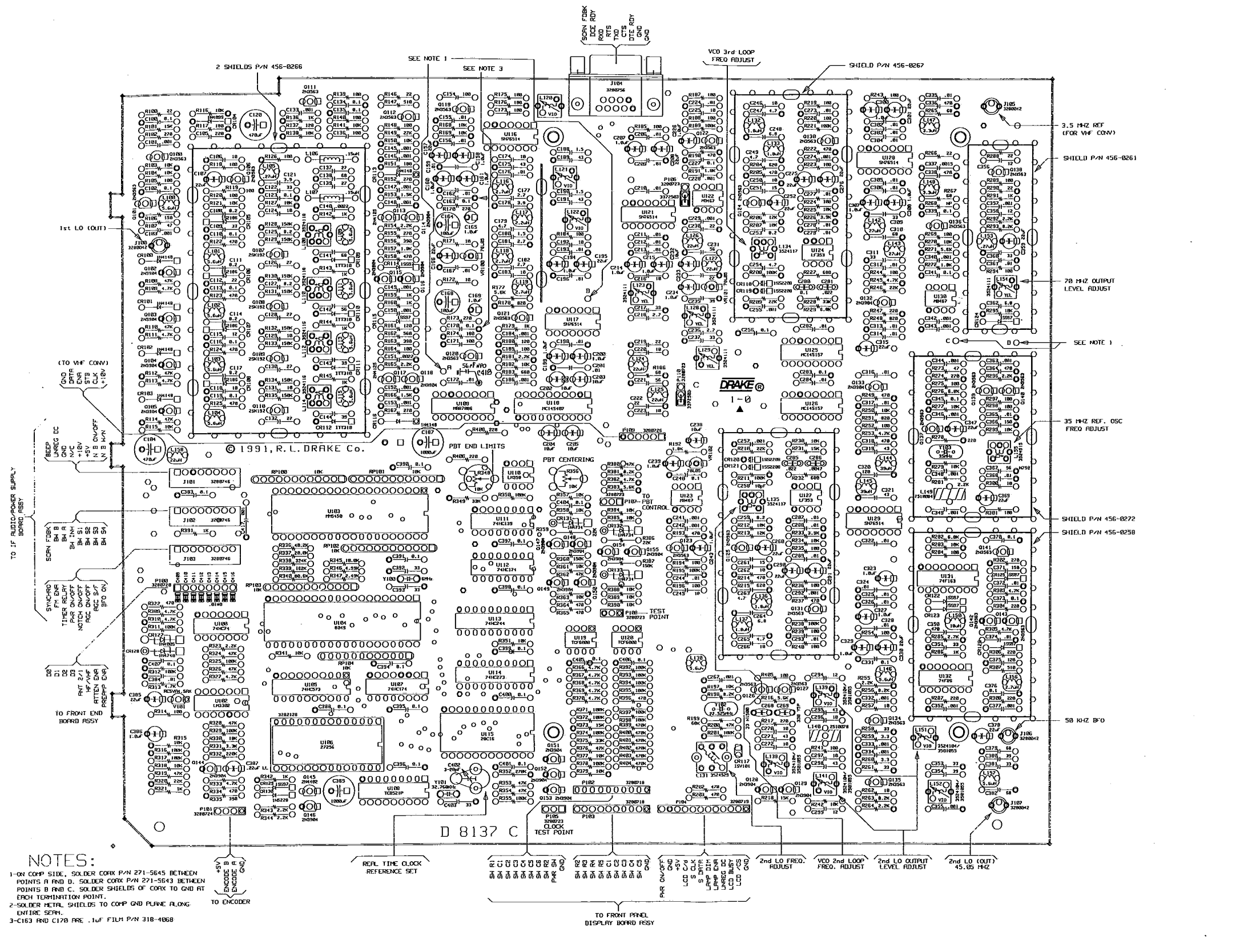
TO FRONT PANEL DISPLAY BOARD

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# Synthesizer/Microprocessor 44 Board Pictorial D-8137

Note: This drawing applies to R8/R8E units with Revision "C" printed on circuit board artwork.



- NOTES:**
- ON COMP SIDE, SOLDER CORX P/N 271-5645 BETWEEN POINTS A AND D. SOLDER CORX P/N 271-5643 BETWEEN POINTS B AND C. SOLDER SHIELDS OF CORX TO GND AT EACH TERMINATION POINT.
  - SOLDER METAL SHIELDS TO COMP GND PLANE ALONG ENTIRE SEAM.
  - C163 FND C170 FRC .1uF FILM P/N 318-1068

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## DIGITAL SECTION - THEORY OF OPERATION

1. Microprocessor and Memory
2. Radio Controls
3. Front and Rear Panel I/O Theory of Operation

### 1. Microprocessor and Memory

The R8/R8E is controlled by an 8049 microcontroller, U104, executing software stored in a 27256 32k EPROM, U106. The address range of the controller is expanded by using two lines from U107 as the high address lines. The System is driven by a 6 MHz oscillator, giving an execution speed of 400 KHz. Nonvolatile memory is in the EEPROM, U115, which retains memory channels, current radio settings, etc. even with loss of power. A real time clock chip, U108, provides the time for the clock and timer functions. It will continue to keep time for approximately 20 minutes with loss of power due to holding capacitor C389 which provides supply voltage to the chip for that long. U111 provides address decoding for the entire system.

At power on, the entire system is reset by the /RESET line being held low momentarily. This is generated by comparators U102C and U102D. The length of the reset pulse is set primarily by the time constant of R332 and C387 discharging through the output of U102C. At power down, this circuitry also generates a low voltage reset signal, triggered by U101. The reset signal is preceded by an interrupt signal from Q144, which allows the controller to save the present radio settings to U115 and do other housekeeping functions to allow an orderly power up when power is restored.

Software execution is such that all functions are performed once every 25 msec. The sequence includes reading the keypad/wheel inputs, setting the radio control lines, setting all frequency synthesizers, and updating the display.

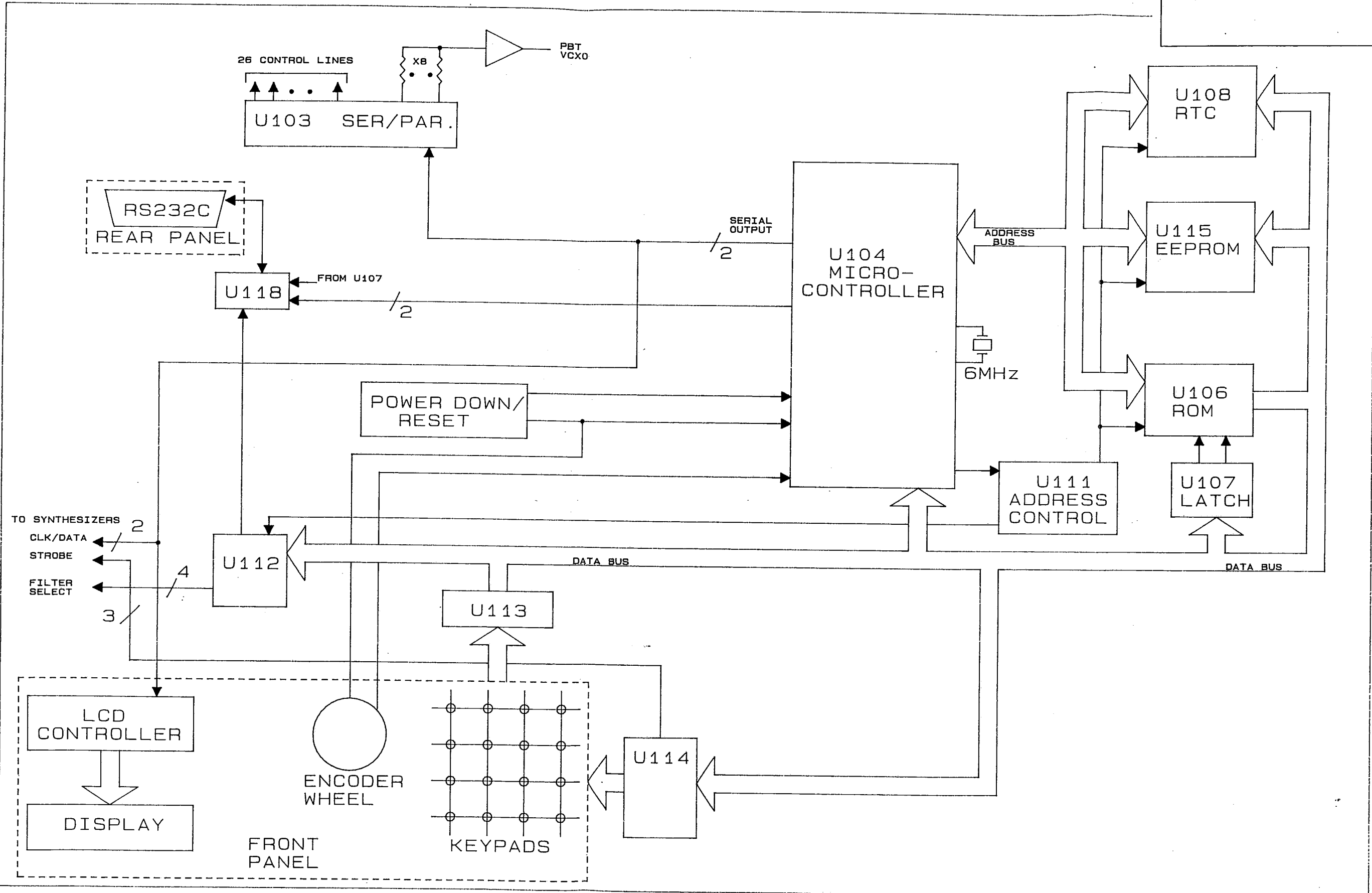
### 2. Radio Controls

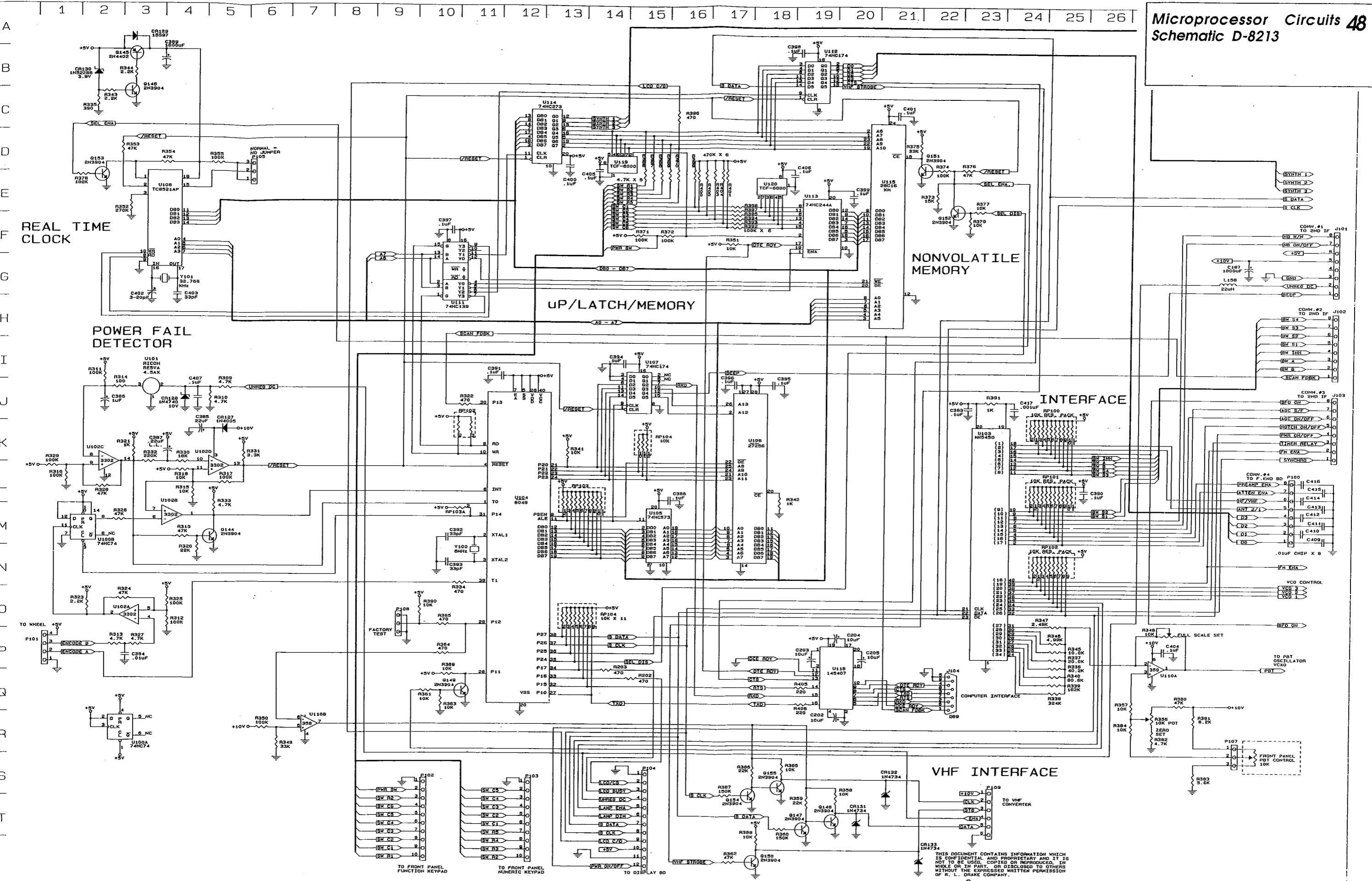
The three frequency synthesizers are all serviced via the same serial port at U104, pins 37 and 38. Data is latched into the appropriate synthesizer to update their information every 25 msec. The remaining radio controls are provided by U103, a 34 bit serial-to-parallel converter. Each output is open-drain with current sink limiting set by R391.

The last 8 output bits of U103 drive a digital-to-analog converter. The outputs are weighted and summed to provide the reference voltage for the pass band filter tuning. This voltage is factory calibrated for each mode of operation (am, fm, etc.) and stored in the EEPROM, U115. Front panel adjustment around the reference voltage is added at U110a.

If the VHF converter option is installed it will be detected by the presence of 5 VDC at P109, pin 4. If the radio is set to a frequency in this band, the converter will be serviced in the normal operating loop of the software. Serial data will be sent to the converter using the serial clock and data lines from U104. These lines are gated to the converter by using U104 pin 29 to switch the pull-up voltage to the buffers driving P109 pins 2 and 5.







REAL TIME  
CLOCK

POWER FAIL  
DETECTOR

UP/LATCH/MEMORY

NONVOLATILE  
MEMORY

INTERFACE

VHF INTERFACE

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### 3. Front & Rear Panel I/O Theory of Operation

The two front panel keypads are both part of one key matrix which is scanned by the controller every 25 msec. Rows are scanned using U114 and column outputs are read from U113. Each key generates a unique row/column combination which is then read and acted on by the controller software. The power on/off key is not part of the scanned matrix and is read every 25 msec. All keys are debounced in software.

The encoder wheel interface provides two output waveforms which are square waves 90 degrees out of phase. When the wheel is turned, the encoder B line clocks a high into the output of U100B, which causes an interrupt via U104 pin 6. When the controller services the interrupt, the high is cleared by a momentary low to U100B pin 13. After clearing the high, the controller looks at the other encoder line on its T1 input (pin 39) to determine which direction the wheel is being turned. The frequency can then be updated accordingly.

The display is a 4 backplane LCD, controlled by a NEC 7225 driver. The driver is serially loaded using U104 pins 37 and 38, and contains the actual display memory. The 111 display segments are partitioned into three groups and data for each group is updated once every 75 msec. Controller U104 sets the LED backlight for the display by using two lines from U103 to control the current through the LEDs. Note that the synchro LED is driven directly by the synchronous detector circuitry.

Outputs for the RS232 interface serial port are provided by U107 and U112, while inputs are direct to U104. The DTE RDY line is used only for detecting the presence of a terminal, while RTS and CTS provide the handshaking for proper data transmission. When a terminal is detected by a low at U113 pin 17, the software stops scanning the front panel keypad and begins providing handshaking signals on the CTS line. Thus, the keypad is disabled when a terminal puts the DTE RDY line low. All bit timing and formatting for 9600 baud, even parity, 1 start bit, and 1 stop bit is done internally by the controller. U118 provides inversion and level shifting to translate 0-5 volt logic to +/- 10 volt RS232 signals. Pin 1 of J104 provides a 0-5 VDC carrier detect signal for use in scanning from a terminal or PC.

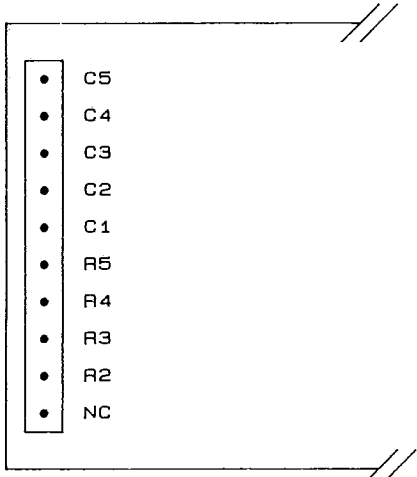
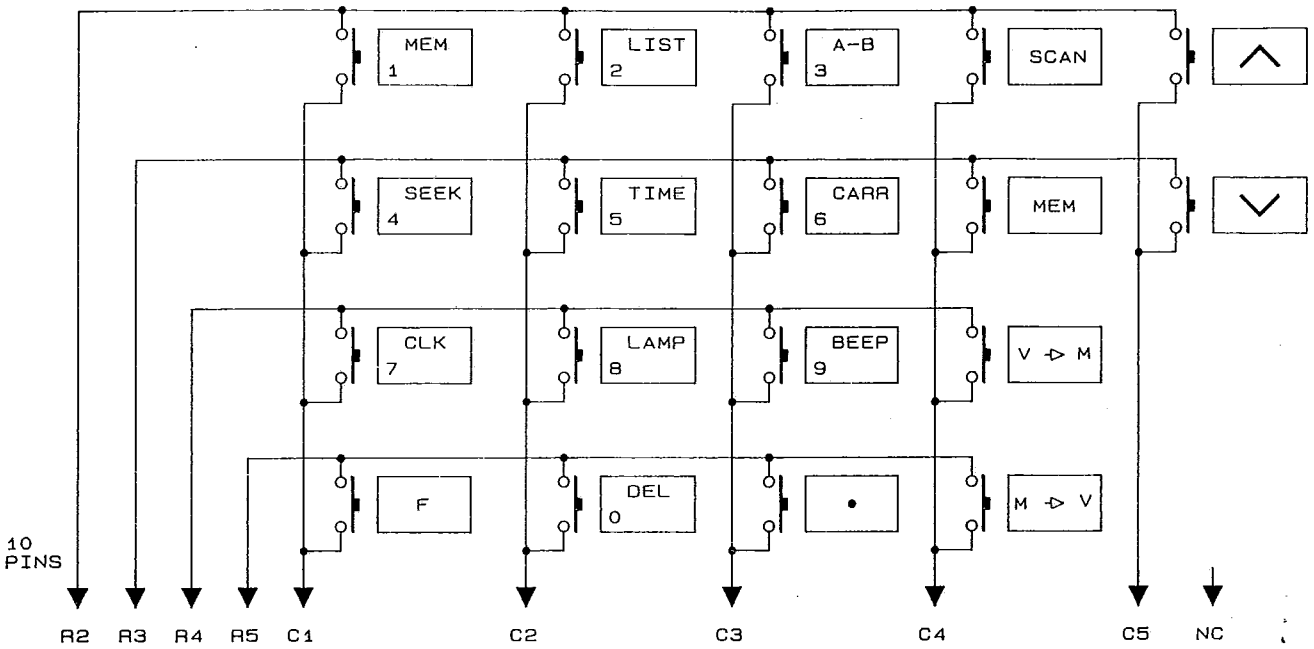


## FRONT PANEL BOARD PARTS LIST

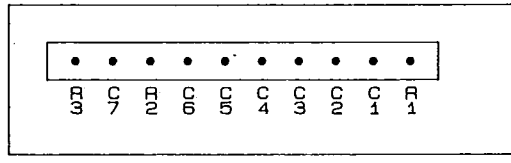
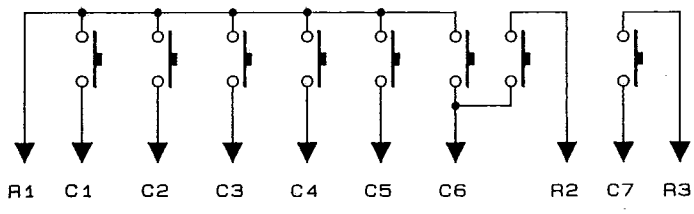
REF	PART NUM	DESCRIPTION
C100	3151648	CAP AX.10 MF 50V
C101	3151648	CAP AX.10 MF 50V
C102	3151648	CAP AX.10 MF 50V
C103	3151648	CAP AX.10 MF 50V
C104	3180012	CAP ELECTRO 1 @ 50 20%
C105	3151582	CAP AXIAL .022 MF 30% Y5P
P100	3280723	CONN P.C. 3 PIN MALE
P101	3280723	CONN P.C. 3 PIN MALE
P102	3280719	CONN. P.C. 12 PIN MALE
Q100	3030121	TRANSISTOR 2N4402
Q101	3030104	TRANSISTOR 2N3904
Q102	3030104	TRANSISTOR 2N3904
Q103	3030104	TRANSISTOR 2N3904
Q104	3030104	TRANSISTOR 2N3904
Q105	3030104	TRANSISTOR 2N3904
R100	3220235	RES C.FILM 10 K 5% 1/4W
R101	3220235	RES C.FILM 10 K 5% 1/4W
R102	3220315	RES C.FILM 100 K 5% 1/4W
R103	3220260	RES C.FILM 22 K 5% 1/4W
R104	3220110	RES C.FILM 470 OHM 5% 1/4W
R105	3220170	RES C.FILM 1.2 K 5% 1/4W
R106	3220170	RES C.FILM 1.2 K 5% 1/4W
R107	3220170	RES C.FILM 1.2 K 5% 1/4W
R108	3220315	RES C.FILM 100 K 5% 1/4W
R109	3250109	RES W.W. 8.0 OHM 10% 5W
R110	3220325	RES C.FILM 180 K 5% 1/4W
R111	3220140	RES C.FILM 680 OHM 5% 1/4W
R112	3220170	RES C.FILM 1.2 K 5% 1/4W
R113	3220190	RES C.FILM 2.2 K 5% 1/4W
R114	3220315	RES C.FILM 100 K 5% 1/4W
R115	3220315	RES C.FILM 100 K 5% 1/4W
R116	3220210	RES C.FILM 4.7 K 5% 1/4W
R117	3220210	RES C.FILM 4.7 K 5% 1/4W
R118	3220075	RES C.FILM 220 OHM 5% 1/4W
R119	3220315	RES C.FILM 100 K 5% 1/4W
R120	3220210	RES C.FILM 4.7 K 5% 1/4W
U100	3040155	I.C. UPD7225
CR100	3472065	GREEN L.E.D. LITE-ON LTL 4231-001 (or equivalent)
.	.	.
.	.	.
CR157	3472065	GREEN L.E.D. LITE-ON LTL 4231-001
CR158	3472064	RED L.E.D. LITE-ON LTL 4231 (or equivalent)
VR100	3040102	I.C. LM317T

# 52 Keyboard Switch Matrix Diagram

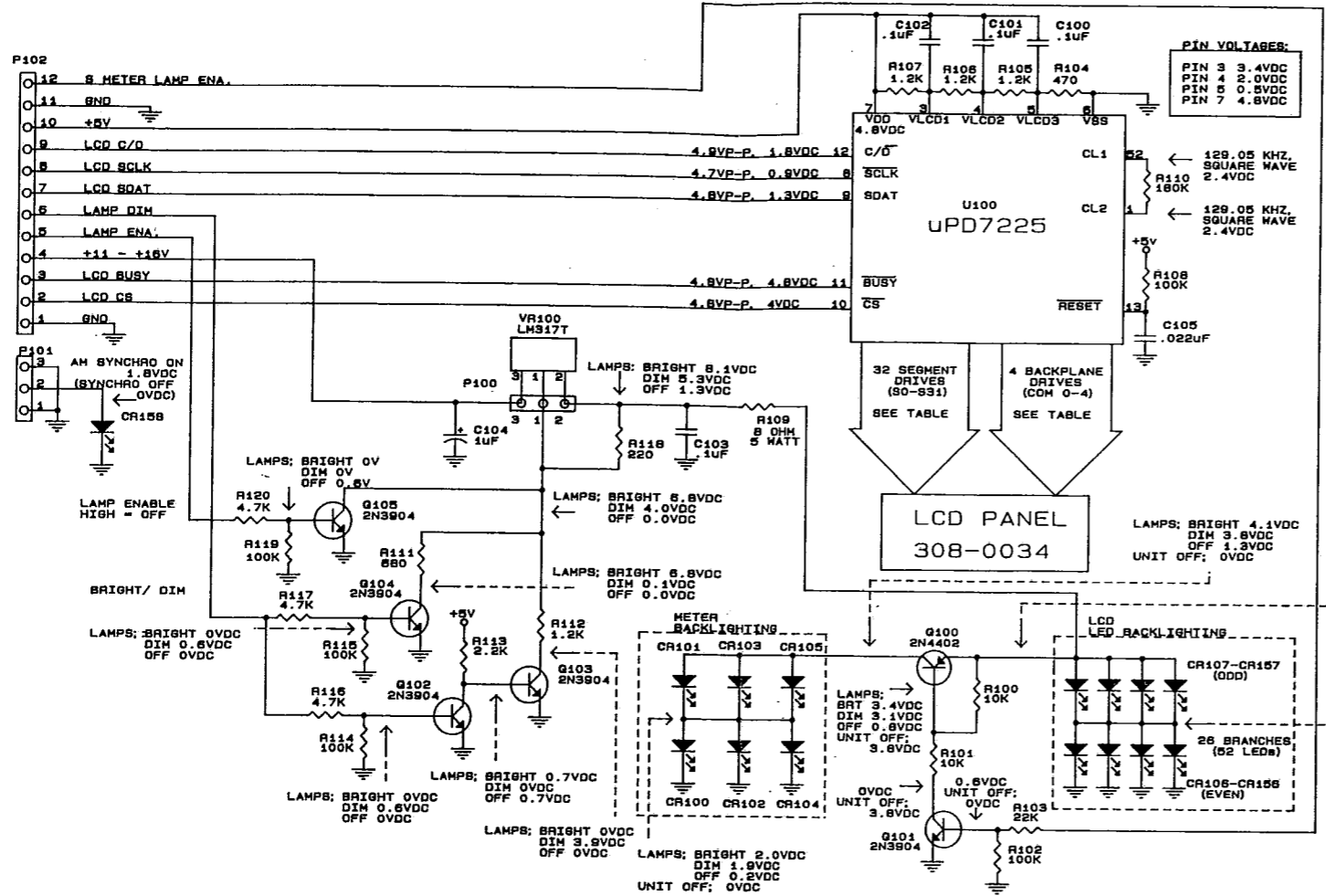
18 KEYPAD SCHEMATIC - PC ART D-7977



8 KEYPAD SCHEMATIC  
PC ART #D-7977







**PIN VOLTAGES:**

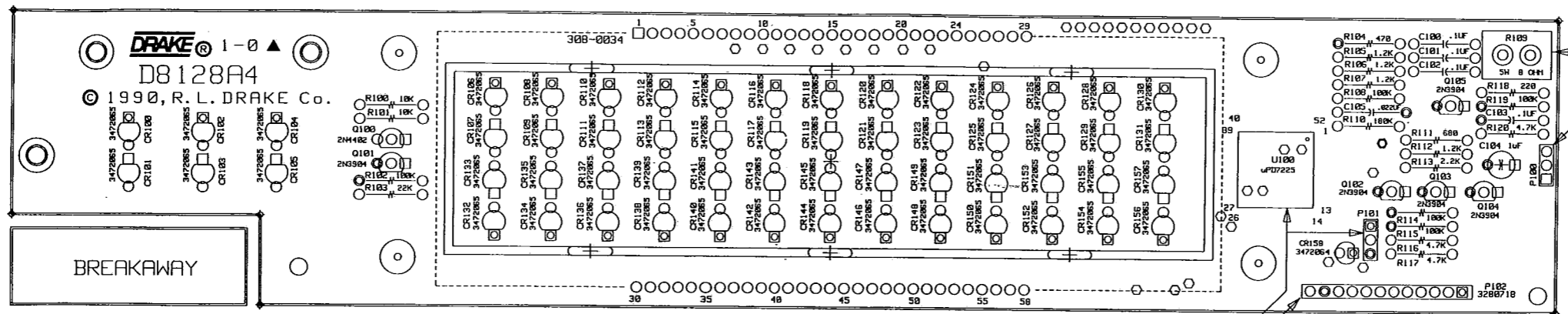
PIN 3	3.4VDC
PIN 4	2.0VDC
PIN 4	0.5VDC
PIN 7	4.8VDC

CONTROLLER		LCD				
Pin #	UP7225	Pin #	COM 0	COM 1	COM 2	COM 3
15	COM 0	1	COM 0	-	-	-
16	COM 1	2	-	COM 1	-	-
17	COM 2	3	-	-	COM 2	-
18	COM 3	4	COM 0	-	-	-
19	COM 0	5	-	-	-	COM 3
20	S0	6	LD BATT	-	-	-
21	S1	7	ERROR	-	-	-
22	S3	8	1D	1E	1F	1F
23	S2	9	-	1C	1B	1A
24	S5	10	2D	2E	2F	2F
25	S4	11	DP1	2C	2B	2A
26	S7	12	3D	3E	3F	3F
27	S6	13	CL1	3C	3B	3A
28	S9	14	DP2	4E	4F	4F
29	S8	15	4D	4C	4B	4A
30	S11	16	5D	5E	5F	5F
31	S10	17	CL2	5C	5B	5A
32	S13	18	6D	6E	6F	6F
33	S12	19	-	6C	6B	6A
34	S15	20	7D	7E	7F	7F
35	S14	21	-	7C	7B	7A
36	S20	22	-	-	MEH	MHz
37	S17	23	8D	8E	8F	8F
38	S16	24	-	8C	8B	8A
39	S19	25	9D	9E	9F	9F
40	S18	26	-	9C	9B	9A
41	S20	27	NOYCH	SCAN	-	-
42	S0	28	-	1	2	3
43	S1	29	-	4	5	6

CONTROLLER		LCD				
Pin #	UP7225	Pin #	COM 0	COM 1	COM 2	COM 3
18	COM 3	30	-	-	-	COM 3
17	COM 2	31	-	-	COM 2	-
41	S21	32	[A]	[B]	-	-
42	S22	33	#1	-	-	-
42	S22	34	-	-	#3	#2
42	S22	35	#1	-	-	-
42	S22	36	-	-	#3	#2
43	S23	37	[2]	[1]	-	[CONV]
44	S24	38	[NB]	[N]	-	[N]
45	S25	39	[TIMES]	[OFF]	-	[ON]
46	S26	40	[ATTN]	[OFF]	-	[PRE]
42	S22	41	#1	-	-	-
42	S22	42	-	-	#3	#2
47	S27	43	[FAST]	-	[SLOW]	[OFF]
42	S22	44	#1	-	-	-
18	COM 3	45	-	-	-	COM 3
17	COM 2	46	-	-	COM 2	-
42	S22	47	-	-	#3	#2
42	S22	48	#1	-	-	-
48	S28	49	[2.3]	[6.0]	-	[0.3]
42	S22	50	#1	-	-	-
49	S29	51	[4.0]	-	-	[1.0]
42	S22	52	-	-	#3	#2
42	S22	53	#1	-	#3	#2
50	S30	54	[LSR]	[AH]	[CW]	-
42	S22	55	#1	-	-	-
51	S31	56	[USB]	-	[FM]	[RTTY]
-	-	57	-	-	-	-
15	COM 0	58	COM 0	-	-	-

#1 : A, B, 1, 2, CONV, PRE, ATTN, OFF, SLOW, FAST, OFF, 0.5, 2.3, 1.0, 6.0, 4.0, LSB, USB, CW, RTTY, AM, FM, [111].  
 #2 : VFO, ANT, RF, AGC, BW-KHZ, MODE.  
 #3 : A-B, NB, TIMER, NOTCH, STEP, LOCK.

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MOUNT THESE PARTS ON SOLDER SIDE

MOUNT THESE PARTS ON SOLDER SIDE

**ASSEMBLY NOTES**

- NOTE THE ITEMS INDICATED THAT ARE INSTALLED ON THE CIRCUIT SIDE.

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# *ALIGNMENT*



## I. POWER SUPPLY VOLTAGE CHECKS AND SETTING CLOCK/TIMER

### A. Power Supply Voltage Check

1. With the R8 unit turned on, measure the following voltage busses at 108 volts and 132 volts AC Line voltage. Measure at 216 volts and 265 volts AC Line voltage for R8E.

Switched unregulated =	11.7 min	14.3 max
10 volts	= 9.5 min	10.5 max
5 volts	= 4.75 min	5.25 max
-5 volts	= -4.50 min	5.50 max

### B. Setting Oscillator for Clock/Timer

1. Jumper together pins 1 and 2 of test connector P-105, and connect a reciprocal counter to this jumper.
2. Adjust trimmer C-402 for a counter reading of 16.00000 Hz.
3. Remove the shorting jumper on test terminals of P105 installed in step 1.

## II. SYNTHESIZER AND PBT ALIGNMENT AND TEST

### A. 35 MHz Reference Oscillator

1. Attach an accurate counter to PIN 1 of U-130 on the synthesizer board and adjust coil L-155 for a frequency of 35.00000 MHz  $\pm$  10 Hz.
2. Using an accurate oscilloscope, measure the level at pin 1 of U-130 with the counter load removed. It should measure at least 1 volt PTP, with 1.5 volts PTP being typical.
3. Using the oscilloscope, measure the level at J-105. Again, it should measure at least 1 volt PTP, with 1.5 volts PTP being typical.
4. Using the counter, measure the frequency at J-105. The frequency should be 3.5 MHz  $\pm$  10 Hz.
5. Using the oscilloscope, measure the level of the 70 MHz signal at pin 5 of U-128. Adjust the yellow coil L-154 for maximum level. The level must be greater than 100 mV PTP and is typically 200 mV PTP.

### B. PBT Adjustments

1. Ground the center pin of the "Factory Test" connector P-108. (Center pin connects to pin 29 of the uP through a 470 ohm resistor). This causes the frequency up and down buttons to control the PBT tuning voltage.
2. Preset the front panel PBT control to the 12:00 o'clock position.
3. Attach a high impedance voltmeter to the PBT tuning voltage line (pin 1 of U110A) and adjust the frequency up and down buttons for maximum voltage. Then adjust the Full Scale Set DAC pot (R-348) for 8 volts.

4. Adjust the frequency up and down buttons for minimum voltage. Then adjust the Zero Set DAC pot (R356) for 2 VDC  $\pm$  0.1 VDC. This step will interact with step 3. Thus, repeat step 3 and 4 until no further improvement can be obtained.

5. Attach an accurate counter to the 2nd LO output jack (J107) and, using the frequency up and down buttons, adjust the PBT voltage to 5 volts  $\pm$  0.1 volt. Then adjust the 22.525 MHz PBT oscillator coil (L-131) for a counter frequency of 45.05 MHz  $\pm$  100 Hz.

6. Using the oscilloscope, measure the level of the 45.05 MHz signal at the junction of C-380 and C-379. Adjust 3 violet coils L-138, L-139, and L-151 for maximum level. Approximately 1 volt PTP should be seen here after these coils are tuned.

7. Measure the RF voltage at the 2nd LO output jack (J-107), and adjust L-138, L-141, and L-152 for maximum level. After these coils are tuned, typical voltage swing on the oscilloscope would be:

- 1.5 V PTP if J-107 is loaded with 50 ohms.
- 2.5 V PTP if J-107 is unloaded.
- Minimum level is 1.0 V PTP with J-107 loaded.

8. Store the PBT offsets for each mode by using the following procedure:

- (a) Select the desired mode using the MODE button on the front panel.
- (b) Select the desired frequency using the frequency up and down buttons.
- (c) Once the frequency is selected, store the offset using the "V -> M" button.
- (d) Repeat these steps for each mode as indicated in the following table:

<u>MODE</u>	<u>FREQ</u>
AM	45.0500 MHz
FM	45.0500 MHz
USB	45.0486 MHz
LSB	45.0514 MHz
CW	45.0492 MHz
RTTY	45.0522 MHz

(e) After having completed the above steps, the jumper on the "Factory Test" connector should be removed. This will return the frequency up and down buttons to the function of changing the receiver frequency as opposed to the PBT frequency.

### C. Loop 3 Adjustments

1. Use the front panel controls to set the frequency of the unit to 7.00000 MHz.
2. Adjust the loop 3 VCO coil (L-134) for a tuning voltage of 5 VDC  $\pm$  0.1 VDC as measured at the junction of 22K ohm resistor R-209 and 680 ohm resistor R-227. Insure that the VCO is running at 65.1 MHz by measuring with a counter at pin 11 of U-128.

3. Set the frequency to 7.49999 MHz in CW mode and ensure that the VCO frequency is 65.0 MHz and the tuning voltage is greater than 4.0 VDC and less than 5.0 VDC.

4. Attach a scope and counter to pin 11 of mixer IC U-129 through a high impedance probe and adjust the three yellow coils (L-123, L-128, and L-129) to produce peak output at 63.5 MHz. The level after peaking should be approximately 100 mV PTP.

### D. Loop 2 Adjustments

1. Adjust the loop 2 oscillator coil (L-135) for a VCO tuning voltage of 6 VDC  $\pm$  0.1 VDC as measured at the junction of 22K ohm resistor R-210 and 680 ohm resistor R-232.

2. Verify that the oscillator frequency is 61 MHz, measured with a counter and a high impedance probe at pin 1 of U-123.

3. Set the frequency to 7.50000 MHz in the CW mode and ensure that the VCO frequency is 60 MHz and the tuning voltage is greater than 3.0 VDC and less than 6.0 VDC.

4. Measure the 3.49 MHz signal level at pin 8 of U-126 and repeak the three yellow coils (L-123, L-128, and L-129) for maximum level. Approximately 1.5 volts PTP should be observed at this point.

5. Pre-tune VCO-1 coil (L-108), 3.5 turns down from flush with top of shield can. Set frequency to 7.49999 MHz in the CW mode.

6. Measure the 11.4 MHz level at pin 1 of U-109 using an oscilloscope with high impedance probe and adjust the three violet coils L-120 thru L-122 for maximum level. Approximately 2 volts PTP should be seen at this point.

### E. Loop 1 Adjustments

1. Tune radio to 7.49999 MHz (VCO at 52.49999 MHz) and adjust the low band (VCO-1) VCO coil (L-108) so that the tuning voltage is 8.05  $\pm$  0.05 VDC as measured at the junction of 2.2K ohm resistor R-154 and 1K ohm resistor R-142. Measure the VCO frequency at J 100. The frequency should be 52.49999 MHz

2. Tune the radio to 0.10000 MHz (VCO at 45.10000 MHz) and insure that the tuning voltage is greater than 3.0 VDC. (For R8E model, tune the radio to 0.15000 MHz (VCO at 45.15000 MHz) and insure that the tuning voltage is greater than 3.05 VDC.)

3. Tune the radio to 14.99999 MHz (VCO at 59.99999 MHz) and adjust the low-mid band (VCO-2) VCO coil (L-110) so that the tuning voltage is 8.05 VDC  $\pm$  0.05 VDC as measured at the junction of 2.2K ohm resistor R-165 and 1K ohm resistor R-143.

4. Tune the radio to 7.50000 MHz (VCO at 52.00000 MHz) and insure that the tuning voltage is greater than 3.0 VDC.

5. Tune the radio to 21.99999 MHz (VCO at 66.99999 MHz) and adjust the hi-mid band (VCO-3) VDC coil (L-112) so that the tuning voltage is 8.05 VDC  $\pm$  0.05 VDC as measured at the junction of 2.2K ohm resistor R-165 and 1K ohm resistor R-144.

6. Tune the radio to 15.00000 MHz (VCO at 60.00000 MHz) and insure that the tuning voltage is greater than 3.0 VDC.

7. Tune the radio to 30.00000 MHz (VCO at 75.00000 MHz) and adjust the high band (VCO-4) VCO coil (L-114) so that the tuning voltage is 8.05 VDC  $\pm$  0.05 VDC as measured at the junction of 2.2K ohm resistor R-154 and 1K ohm resistor R-145.

8. Tune the radio to 22.00000 MHz (VCO at 67.00000 MHz) and insure that the tuning voltage is greater than 3.0 VDC.

9. Measure the VCO output level at J-100 for each frequency listed below. Output level should be 7 dBm  $\pm$  3 dB.

- 0.10000 MHz
- 7.49999 MHz
- 7.50000 MHz
- 14.99999 MHz
- 15.00000 MHz
- 21.99999 MHz
- 22.00000 MHz
- 30.00000 MHz

### F. 50 KHz BFO Checks

1. With the receiver in the CW, SSB, or RTTY modes, measure the output of the 50 KHz phone jack J-106 using an oscilloscope.

2. The level at this point should be approximately 1.5 volts PTP and the frequency should be as shown on the following table  $\pm$  .005%.

<u>MODE</u>	<u>FREQ</u>
USB	48.6 MHz
LSB	51.4 MHz
CW	49.2 MHz
RTTY	52.2 MHz

3. Observe that the output at this jack drops to zero on the AM and FM modes.

### III. FRONT END BOARD ALIGNMENT AND TEST

#### A. Check of Front End Bandpass Filters

1. Calibrate a spectrum analyzer and tracking oscillator with a through connection. Set the tracking oscillator level to -30dBm and adjust the top of the screen to -20 dBm, sweeping from 0 to 110 MHz. As an alternate method, a signal generator and RF voltmeter can be used, using the same levels as mentioned above.
2. Connect the tracking oscillator (or signal generator) output to the "ANT 1" jack (J-104).
3. Connect the spectrum analyzer (or RF voltmeter) to P105 so that the 45 MHz IF section is disconnected and Pin 2 of P101 is terminated in 50 ohms.
4. Select each of the 9 front end bandpass filters by tuning the receiver to the frequency listed on the following chart. Filter ripple should not exceed 2 dB and the minimum and maximum frequencies for each filter should be 4 dB +/- .5 dB below the through connection reference set up in step 1.

BAND	FREQUENCY RANGE	RCVR FREQ
1	0.1 - 0.5 MHz (0.15 - 0.5 MHz on R8E)	.3 MHz (.3MHz)
2	0.5 - 1.5 MHz	.7 MHz
3	1.5 - 2.5 MHz	2.0 MHz
4	2.5 - 4.0 MHz	3.5 MHz
5	4.0 - 7.5 MHz	7.0 MHz
6	7.5 - 10.5 MHz	9.0 MHz
7	10.5 - 15.0 MHz	12.0 MHz
8	15.0 - 22.0 MHz	20.0 MHz
9	22.0 - 30.0 MHz	28.0 MHz

5. The sketch shown below gives an approximate representation of how each filter should appear on the spectrum analyzer.

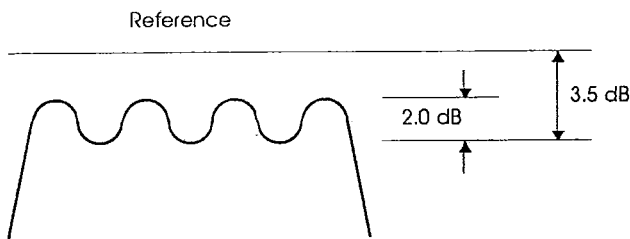


Figure 1.

B. With the 22-30 MHz band selected, enable the **attenuator** and check for a 10 dB drop in spectrum analyzer or RF voltmeter response. Then disable the attenuator.

C. Enable the **preamp** and check for a 10 dB increase in spectrum analyzer or RF voltmeter response. Then disable the preamp.

#### D. Antenna Switching Checks

1. Select the "ANT 2, 50 OHMS" antenna jack (J105) from the front panel, connect the tracking oscillator or signal generator to J105, and repeat steps B and C.
2. Connect the tracking oscillator or signal generator to the "ANT 2, 500 OHMS" antenna jack (J3) using an appropriate impedance adaptor, and repeat steps B and C. This test can also be performed at the 500 ohm terminal, but a 50-500 ohm balun must be used for proper impedance matching.
3. Temporarily connect pins 1 and 4 on P-109 together with a 10K resistor. This fools the  $\mu$ P into thinking that a VHF board is installed. Select the "VHF CONV, 50" jack from the front panel and connect the tracking oscillator or signal generator to the "VHF CONV, 50" Jack. Then repeat steps B and C. Remove the 10K Ohm short connecting pins 1 and 4 of P-109.

#### F. 45 MHz IF Section Alignment And Tests

1. Calibrate a spectrum analyzer and tracking oscillator (or signal generator and RF voltmeter with 50 ohm termination) with a thru connection. Set the tracker level at -40 dBm and adjust the top of the screen reference for -20 dBm, centered on 45 MHz. 10 KHz per division.
2. Connect the tracking generator (or signal generator) output to the Pin 2 of P-104 which connects to the crystal filter section input. Pin 3 of P-104 which connects to the SBL-3 mixer output, should not be connected to anything.
3. Connect the spectrum analyzer (or RF voltmeter) to the terminal of P-102 which attaches to the output of the crystal filter. The pin connecting to the input of the next stage should not be connected to anything.
4. Tune trimmer capacitor C-197 for maximum response, and alternately adjust L-132, L-131, and if required, C-197 for best response. The response should appear as shown in the sketch which follows. Note that the ideal response would be flat. However, tilt, as shown in the sketch, is the more likely response and is acceptable within the limits shown.

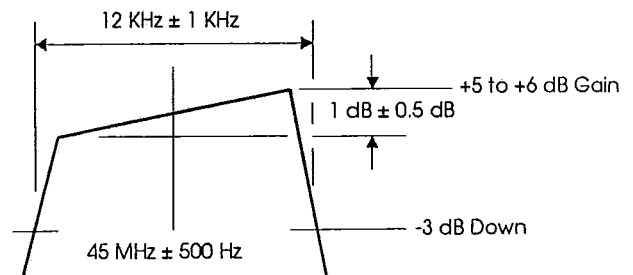


Figure 2.

5. Disconnect the spectrum analyzer from P-102 and connect to the P-103 terminal which connects to the output of the 45 MHz IF section. The center terminal which connects to the next section should not be connected to anything. Adjust the spectrum analyzer for a -10 dBm reference (add 10 dB of attenuation).

6. Add a shorting shunt to P-102 so as to connect the two ungrounded pins.

7. Adjust the front panel RF Gain control until the AGC voltage as measured on pin 5 of P-106 is 0 volts.

8. Adjust trimmer cap C-174 for maximum response.

9. Alternately adjust C-178, C-179, for best response as illustrated in Figure 2.

10. Advance the RF Gain to the fully clockwise position and note that the minimum gain between P-104 and P-103 is +25 dB. Then rotate the RF Gain control counterclockwise and observe that the gain can be reduced a minimum of 40 dB. (In other words, stage gain should be variable from approximately -15 dB to +25 dB). Also check for lack of passband shape distortion over the AGC range.

11. Remove the test equipment from P-104 and insure that jumpers are installed on P-105, P-104, and P-102 so as to establish a signal path from the antenna up to P-103.

## F. Image Reject Mixer Section Alignment And Tests

1. Calibrate a spectrum analyzer and a signal generator by establishing a thru connection between the generator and the analyzer. Set the generator level to -20 dBm and adjust top of the screen reference for -20 dBm. Accurately set the frequency of the signal generator to 45 MHz.

2. Connect the signal generator to P-103. The stages preceding P-103 should be disconnected.

3. Connect the spectrum analyzer input to 50 KHz output jack J103, and make sure that 45.05 MHz signal is being supplied to 2nd LO IN jack J102 at a level of approximately +10 dBm.

4. Locate the 50 KHz output response on the spectrum analyzer, and tune capacitors C-188 and C-191 for maximum response.

5. Switch the signal generator frequency to 45.1 MHz and retune C-188 and C-191 for minimum.

6. Repeat steps 4 and 5 for maximum rejection at 45.1 MHz input and maximum output at 45.0 MHz input. **The minimum rejection should be 30 dB.**

7. Set signal generator to 45 MHz and check for a maximum insertion loss of 10 dB.

8. Remove generator and spectrum analyzer, and connect a jumper on P-103 so that it connects the output of the 45 MHz IF section to the Image Reject Mixer section input.

## G. F.M. Detector Alignment And Checks

1. Connect a SINAD meter and a 4 ohm load to the receiver's audio output.

2. Connect a signal generator to the ANT 1 terminal (J-104) and set for 29 MHz, -50dBm output, FM modulated, 1 KHz tone, 3.5 KHz deviation. Tune the receiver to 29 MHz, select the FM mode.

3. Insure that jumpers are in place on P-105, P-104 and P-102 so as to establish a signal path through the receiver to the FM detector.

4. Connect a counter (high impedance input) to pin 20 of the MC3362 IC (U-100) and adjust L-111 for 34.300 MHz +/- 10 Hz.

5. Connect a counter (high impedance input) to pin 4 of the MC3362 IC (U-100) and adjust C-132 for 10.244 MHz +/- 10 Hz.

6. A 1 KHz tone should be heard at the output of the receiver.

7. Adjust the generator level to -100 dBm and adjust FL-101 for best SINAD.

8. Reduce generator level to -113 dBm and adjust C-160 for best SINAD.

9. Check for a minimum of 12 dB SINAD at -113 dBm input.

## H. FM Squelch Adjustment

1. With equipment still connected as per the preceding section, switch the signal generator level "off".

2. Adjust the FM signal level threshold pot (R-117 on the Front End board) to read 2.0 volts DC on pin 7 of the LM358 IC (U-101).

3. Set the signal generator output to +60 dB above 0.5 uv (-55 dBm) and set the FM Full Scale Pot (R-374 -- 100K ohms on 2nd IF/Audio board) for full scale S-Meter reading.



#### IV. SECOND I.F./ AUDIO BOARD TUNE UP AND TEST

##### A. 50 KHz IF Filter Tune Up

###### Prerequisites

- (1.) Digital control inputs
- (2.) 50 KHz Spectrum Analyzer and Tracking Generator
- (3.) Buffer from output MOSFET (Q2) to Analyzer (input impedance 2 K ohms or higher at 50 KHz).
- (4.) 50 KHz  $\pm$  10 Hz source at approximately -30 dBm.

1. Connect tracking generator to the IF input jack (J-3) and select the narrowest bandwidth (i.e. 500Hz) with the digital control inputs.

2. A low level peak should be visible on the analyzer display. Adjust the tuning slugs on all of the pot cores to peak the response. Ensure that the output is not into compression which will cause flattening of the passband. Repeak if necessary.

3. Select 2.3 KHz bandwidth and note the symmetry about 50 KHz. Select 4 KHz bandwidth and note symmetry about 50 KHz. The symmetry about 50 KHz will not be perfect but ripple peak symmetry across the band should be obtained.

4. Switch back to the 2.3 KHz bandwidth and, if needed, touch up the necessary pot cores that affect the response only a minimum amount so that the 500 Hz bandwidth is not grossly affected. Switch to the 500 Hz bandwidth. The peak of the response should be within 4 dB of the 2.3 KHz bandwidth's response. If not, readjust.

5. Switch to the 4 KHz bandwidth and adjust the necessary pot cores that flatten the passband as above. Ripple should be maintained below 2.9 dB PTP. The -6 dB points may end up slightly skewed to the low side when done. Switch to the 500 Hz bandwidth. The peak of the response should be within 4 dB of the 4 KHz bandwidth's peak. If not, readjust.

6. Step through all BW's noting symmetry, passband flatness, and relative loss. Relative loss between any two bandwidths should be less than 5 dB. The -6dB bandwidth should be within  $\pm$ 10% except on 500 Hz bandwidth where bandwidths over 370 Hz are acceptable. All shape factors (-6 dB/-60dB) should be less than 1:2.2 except for the 500 Hz bandwidth where anything less than 1:40 is acceptable.

##### B. A.G.C. and S-Meter Setup

The Signal Generator referred to in this section is attached to the antenna 1 input.

Preset the following pots as indicated.

Preset AGC 1 (R-325) to 2.8 VDC at Pin 1 of U-116A  
 Preset AGC 2 (R-382) to 4.1 VDC at Pin 7 of U-116A  
 Preset IF Gain (R-209) to the "12 O'clock" position  
 Preset Full Scale (R-336) to the "4 O'clock" position

1. Select the AM mode with the frequency set to 14.2 MHz. Preamp should be off.

2. Set the signal generator level for -103 dBm at 60% AM modulation with a 1 KHz tone.

3. Adjust the IF gain pot (R-209) for an S-3 reading on the S-meter.

4. Set the Signal Generator level for -13 dBm.

5. Adjust the S-Meter Full Scale pot (R-336) for a +60 dB/S-9 reading on the S-meter.

6. Set the signal generator level for -73 dBm.

7. Adjust the AGC 1 set pot (R-325) for an S-9 reading on the S-meter.

8. Repeat steps 3 through 7 until no further improvement can be made.

9. Set the signal generator level for -53 dBm.

10. Adjust the AGC-2 set pot (R-382) for a +20 dB/S-9 reading on the S-meter.

11. Repeat steps 3-10, if necessary, until little additional improvement in S-meter tracking is obtained. With an S-9 reading obtained at a -73 dBm generator input level, increases of signal level input in 10 dB steps should result in S-meter tracking for +10, +20, ... +60/S-9 readings.

##### C. SSB-AM Squelch Setup

1. Select AM mode, and set the frequency as desired.

2. Set the signal generator to the same frequency as the receiver.

3. Set the level for +50 dB/S-9 on the S-meter.

4. Set the front panel Squelch pot for full clockwise rotation (maximum squelch level).

5. Adjust the squelch threshold pot (R-115) until the receiver just squelches and then back it off until the receiver just unsquelches.

## D. Recovered Audio Output Tests

### Prerequisites

- (1.) I.F. filter has been tuned.
- (2.) 4 ohm load for external speaker,  $> = 4.7$  K ohm load for line outputs.
- (3.) Oscilloscope
- (4.) -50 dBm 50 KHz signal 100% AM modulated with 1 KHz sinewave.
- (5.) Volume pot, RF Gain pot, Tone pot. (These items will be connected already if board is installed in a receiver unit).

1. Preset POWER on, NB off, FM disabled, AGC slow, AGC enabled, BFO disabled, SYNCH DET disabled, NOTCH disabled.

2. Set the BW to 6 KHz, VOLUME to max, EXTERNAL SPEAKER selected, TONE to midrange, and RF GAIN to maximum.

3. Input the modulated 50 KHz signal into the IF strip through phono jack.

4. Monitor with an oscilloscope the 1 KHz demodulated sinewave dropped across the 4 ohm load.

5. With the VOLUME control at maximum, adjust the detector gain pot (R-139) to obtain a 8 Volt PTP undistorted sinewave across the 4 ohm load. This is equivalent to 2.37 watts.

6. Check the two line audio outputs for at least .85 Volts PTP sinewaves into 4.7K ohm loads. This is equivalent to approximately 300 mv rms.

## E. Synchronous Detector Setup

1. Select AM mode, and set the frequency as desired.

2. Center the PBT pot to 12 o'clock.

3. Set the signal generator to the same frequency as the receiver, and set the level for -50 dBm.

4. Adjust the VCO center frequency pot (R-285) for 2.5 VDC  $\pm$  0.01 V on pin 9 of IC U-112.

5. Attach an oscilloscope to pin 3 of U-109 and reduce the signal generator level to zero.

6. Adjust R-158 for 50% duty cycle of the observed square wave. Then remove oscilloscope.

7. Adjust the Signal Generator level to a level 20 dB below the AGC threshold and engage synchro detector. Observe that it locks up satisfactorily and that the front pane SYNCHRO LED comes on.

## F. Notch Null Adjustments

### Prerequisites

- (1.) Place unit in SSB mode and tune in an external signal generator signal for a beat note at 1.5 KHz.
- (2.) Enable Notch.

1. With the above 1.5 KHz sinewave displayed on an oscilloscope connected to the audio output, and the front panel NOTCH control fully clockwise, adjust the level so that the signal spans the 8 vertical divisions of the oscilloscope.

2. Notch out the signal with the front panel NOTCH control.

3. Adjust the Notch Depth pot (R-184) to further reduce the signal.

4. Repeat steps 2 and 3 for maximum null. The signal should be less than 1/5 of one of the 8 major divisions which corresponds to  $> 32$  dB of attenuation.

5. Check notch at 500 Hz and 3 KHz modulation where attenuation should be greater than 30 dB.

6. Notch attenuation for modulation above 2.5 KHz should be at least 30 dB.

## G. Noise Blanker Check and Adjustment

### Prerequisites

- (1.) I.F. and audio circuits operational
- (2.) Signal Generator set for 2.1 MHz at approximately a -95 dBm output level.
- (3.) Pulse Generator set for 250 Hz repetition rate, pulse width of 55 usec and output level set to 0.5 - 1.0 Vpp.

1. Combine the signal generator and pulse generator outputs into the 50 ohm antenna input of the R8/R8E receiver. Turn the Power ON to the receiver.

2. Set the receiver for LSB mode, 2.3 KHz BW, AGC slow, Preamp Off, Noise Blanker Off, RF Gain fully clockwise and select the 'Antenna 1' input. Tune the receiver to a frequency of 2.1 MHz.

3. Monitor the audio by connecting an oscilloscope to the External Speaker output at the rear panel of the receiver.

4. With the Pulse generator disabled, but connected to the receiver, tune the R8/R8E to receive a 1 KHz beat note at a received level of 'S5'.

5. Enable the Pulse generator and increase its level to yield a +10dB/S9 S-meter reading on the R8/R8E.

6. Enable the noise blanker. The S-meter reading should reduce to an S-5 reading.

7. Switch to the AM mode and remove both the signal generator and pulse generator inputs. Observe the audio on the oscilloscope. If horizontal bars appear in the receiver noise output, adjust the Noise Blanker Threshold pot (R-363) to a point that the bars are just eliminated. Recheck the blanking as done previously (in step 6) to insure that the noise blanker operates properly. Note that the Threshold pot (R-363) is adjusted only to prevent false triggering and has no effect on the blanking depth.



*VHF CONVERTER  
ACCESSORY*

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## VHF BLOCK CONVERTER THEORY OF OPERATION

### RF Section

The signal input from the CONV ANT terminal is amplified and filtered as it passes through the preselector. The preselection filters divide the frequencies into two bands: low band and high band. Low band is a fixed band pass filter that passes 35 thru 54 MHz. High band is a voltage tuned band pass filter that covers 108 thru 174 MHz in 15 discrete steps. Both bands share the same amplifiers: Q110 and Q107. The signals mix (MX101: DBM50A) with one of six fixed local oscillator frequencies. This divides the covered RF frequency range into six RF blocks. The RF blocks are:

35 - 54.000 MHz  
108 - 124.999 MHz  
125 - 138.999 MHz  
139 - 151.999 MHz  
152 - 163.999 MHz  
164 - 174.000 MHz

The converted IF block is passed on to the R8/R8E front end board.

### CONTROL

A 35 bit control code is sent from the R8/R8E via the data line. The control code contains the information required to select the correct preselector band, the filter tune voltage, the VCO select bits and the PLL A and N words. The 35 bit control code is fed serially through U105 (74HC595), then through U103 (74HC595) and finally to the PLL chip U102 (MB1504). When all 35 bits have been clocked in, the enable is strobed to latch the data. Now U105 contains the tunable filter code and works in conjunction with RP100 (R/2R SIP) and U106 (LPC662) as a D/A converter to generate the filter tune voltage. U103 (74HC595) contains the band select bits for the preselector filters and PLL VCO's. U102 is set up for the desired LO frequency.

### SYNTHESIZER

The synthesizer is a single loop design that is phased locked to the 3.5 MHz crystal reference from the R8/R8E. The heart of the synthesizer is U102 (MB1504). The VCO signal is fed back through the buffer Q101 to U102 where it is compared with the reference, this generates an error voltage which is sent to the loop filter. The output of the loop filter controls the VCO frequency so that it maintains lock to the crystal reference. The locked VCO signals are sent through the buffer amp Q106 to drive the LO port of MX101.

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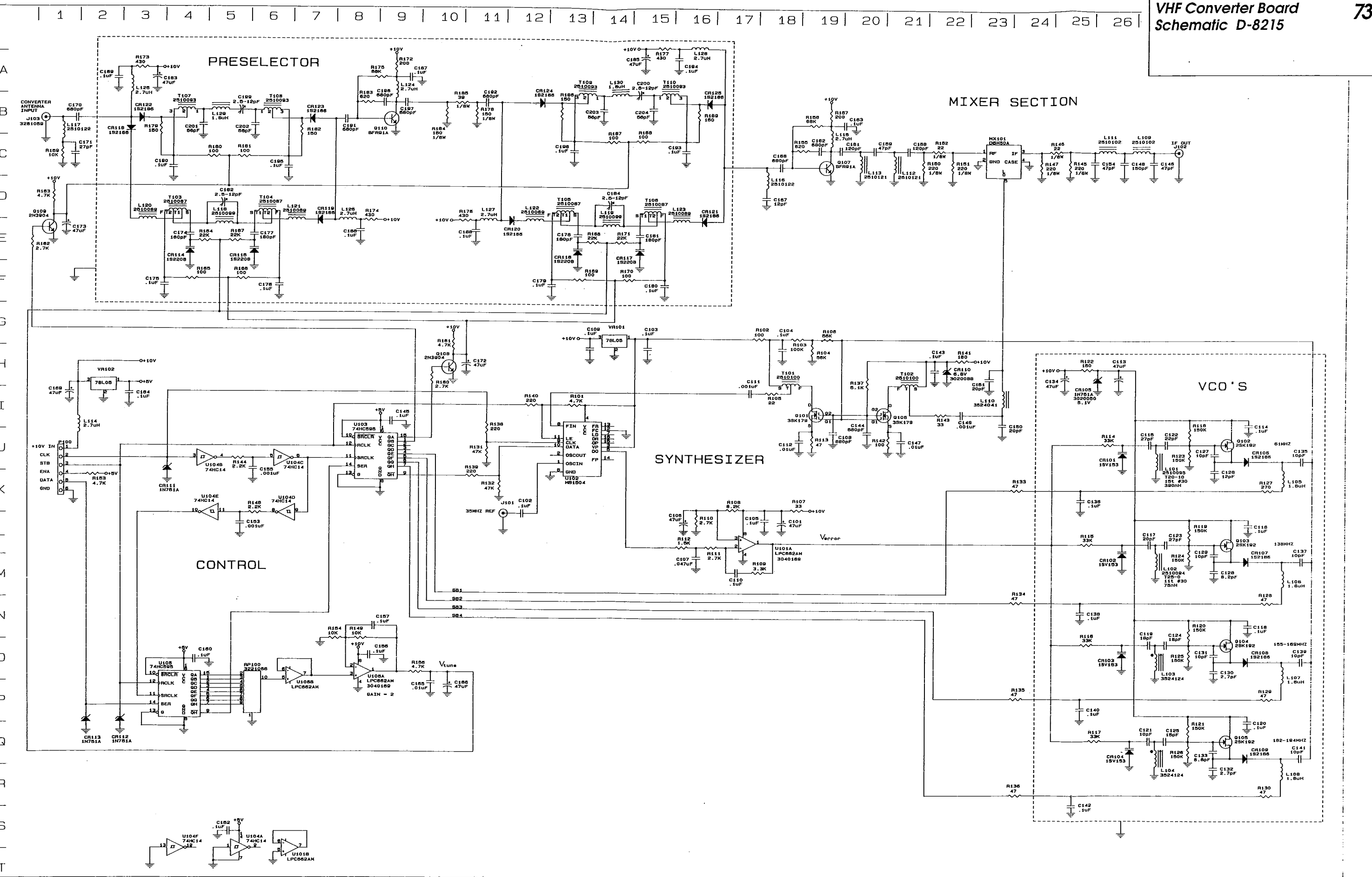
REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
C101	3180125	CAP ELECTRO 47@16 RADIAL	C163	3151649	CAP RAD .10 MF 50V
C102	3151649	CAP RAD .10 MF 50V	C164	3151649	CAP RAD .10 MF 50V
C103	3151649	CAP RAD .10 MF 50V	C165	3151515	CAP AXIAL .01 MF 20% Y5P
C104	3151649	CAP RAD .10 MF 50V	C166	3180125	CAP ELECTRO 47@16 RADIAL
C105	3151649	CAP RAD .10 MF 50V	C167	3164012	CAP DISC 12.0 5% NPO 50V
C106	3180125	CAP ELECTRO 47@16 RADIAL	C168	3164165	CAP DISC 680 10% Y5P 50V
C107	3151587	CAP AX .047 MF +80-20 Z5U	C169	3180125	CAP ELECTRO 47@16 RADIAL
C108	3164165	CAP DISC 680 10% Y5P 50V	C170	3164165	CAP DISC 680 10% Y5P 50V
C109	3151649	CAP RAD .10 MF 50V	C171	3164027	CAP DISC 27.0 5% NPO 50V
C110	3151649	CAP RAD .10 MF 50V	C172	3180125	CAP ELECTRO 47@16 RADIAL
C111	3164190	CAP DISC .001 22% Z5U 50V	C173	3180125	CAP ELECTRO 47@16 RADIAL
C112	3151515	CAP AXIAL .01 MF 20% Y5P	C174	3164153	CAP DISC 180 5% NPO 50V
C113	3180125	CAP ELECTRO 47@16 RADIAL	C175	3151649	CAP RAD .10 MF 50V
C114	3151649	CAP RAD .10 MF 50V	C176	3151649	CAP RAD .10 MF 50V
C115	3164027	CAP DISC 27.0 5% NPO 50V	C177	3164153	CAP DISC 180 5% NPO 50V
C116	3151649	CAP RAD .10 MF 50V	C178	3164153	CAP DISC 180 5% NPO 50V
C117	3164020	CAP DISC 20.0 5% NPO 50V	C179	3151649	CAP RAD .10 MF 50V
C118	3151649	CAP RAD .10 MF 50V	C180	3151649	CAP RAD .10 MF 50V
C119	3164018	CAP DISC 18.0 5% NPO 50V	C181	3164153	CAP DISC 180 5% NPO 50V
C120	3151649	CAP RAD .10 MF 50V	C182	3205199	CAP VAR TRIMMER 2.5-12PF
C121	3164010	CAP DISC 10.0 5% NPO 50V	C183	3180125	CAP ELECTRO 47@16 RADIAL
C122	3164022	CAP DISC 22.0 5% NPO 50V	C184	3205199	CAP VAR TRIMMER 2.5-12PF
C123	3164027	CAP DISC 27.0 5% NPO 50V	C185	3180125	CAP ELECTRO 47@16 RADIAL
C124	3164018	CAP DISC 18.0 5% NPO 50V	C186	3151649	CAP RAD .10 MF 50V
C125	3164015	CAP DISC 15.0 5% NPO 50V	C187	3151649	CAP RAD .10 MF 50V
C126	3164012	CAP DISC 12.0 5% NPO 50V	C188	3151649	CAP RAD .10 MF 50V
C127	3164010	CAP DISC 10.0 5% NPO 50V	C189	3151649	CAP RAD .10 MF 50V
C128	3164008	CAP DISC 8.2 5% NPO 50V	C190	3151649	CAP RAD .10 MF 50V
C129	3164010	CAP DISC 10.0 5% NPO 50V	C191	3164165	CAP DISC 680 10% Y5P 50V
C130	3164003	CAP DISC 2.7 5% NPO 50V	C192	3164165	CAP DISC 680 10% Y5P 50V
C131	3164010	CAP DISC 10.0 5% NPO 50V	C193	3151649	CAP RAD .10 MF 50V
C132	3164003	CAP DISC 2.7 5% NPO 50V	C194	3151649	CAP RAD .10 MF 50V
C133	3164006	CAP DISC 6.8 5% NPO 50V	C195	3151649	CAP RAD .10 MF 50V
C134	3180125	CAP ELECTRO 47@16 RADIAL	C196	3164165	CAP DISC 680 10% Y5P 50V
C135	3164010	CAP DISC 10.0 5% NPO 50V	C197	3164165	CAP DISC 680 10% Y5P 50V
C136	3151649	CAP RAD .10 MF 50V	C198	3151649	CAP RAD .10 MF 50V
C137	3164010	CAP DISC 10.0 5% NPO 50V	C199	3205199	CAP VAR TRIMMER 2.5-12PF
C138	3151649	CAP RAD .10 MF 50V	C200	3205199	CAP VAR TRIMMER 2.5-12PF
C139	3164010	CAP DISC 10.0 5% NPO 50V	C201	3164056	CAP DISC 56.0 5% NPO 50V
C140	3151649	CAP RAD .10 MF 50V	C202	3164056	CAP DISC 56.0 5% NPO 50V
C141	3164010	CAP DISC 10.0 5% NPO 50V	C203	3164056	CAP DISC 56.0 5% NPO 50V
C142	3151649	CAP RAD .10 MF 50V	C204	3164056	CAP DISC 56.0 5% NPO 50V
C143	3151649	CAP RAD .10 MF 50V	C205	3150168	CAP RAD 5.6 10% NPO 50V
C144	3164165	CAP DISC 680 10% Y5P 50V	J101	3280042	CONN.COAX PC MT.#TMP-J01X-
C145	3151649	CAP RAD .10 MF 50V	J102	3280042	CONN.COAX PC MT.#TMP-J01X-
C146	3164047	CAP DISC 47.0 5% NPO 50V	J103	3280042	CONN.COAX PC MT.#TMP-J01X-
C147	3151515	CAP AXIAL .01 MF 20% Y5P	L101	2510095	INDUCTOR TOROID
C148	3164150	CAP DISC 150 10% Y5P 50V	L102	2510094	INDUCTOR TOROID
C149	3164190	CAP DISC .001 22% Z5U 50V	L103	3524124	COIL VAR 0.046UH BRASS COR
C150	3164020	CAP DISC 20.0 5% NPO 50V	L104	3524124	COIL VAR 0.046UH BRASS COR
C151	3164020	CAP DISC 20.0 5% NPO 50V	L105	3520501	CHOKE ASSY 1.8UH
C152	3151649	CAP RAD .10 MF 50V	L106	3520501	CHOKE ASSY 1.8UH
C153	3164190	CAP DISC .001 22% Z5U 50V	L107	3520501	CHOKE ASSY 1.8UH
C154	3164047	CAP DISC 47.0 5% NPO 50V	L108	3520501	CHOKE ASSY 1.8UH
C155	3164190	CAP DISC .001 22% Z5U 50V	L109	2510102	INDUCTOR TOROID
C156	3151649	CAP RAD .10 MF 50V	L110	3524041	COIL AIR 1-1/2T .125".I.D.
C157	3151649	CAP RAD .10 MF 50V	L111	2510102	INDUCTOR TOROID
C158	3164145	CAP DISC 120 10% Y5P 50V	L112	2510121	INDUCTOR TOROID
C159	3164047	CAP DISC 47.0 5% NPO 50V	L113	2510121	INDUCTOR TOROID
C160	3151649	CAP RAD .10 MF 50V	L114	3520503	CHOKE ASSY 2.7 UH
C161	3164145	CAP DISC 120 10% Y5P 50V	L115	3520503	CHOKE ASSY 2.7 UH
C162	3164165	CAP DISC 680 10% Y5P 50V	L116	2510122	INDUCTOR TOROID

# 70 VHF Converter Board Parts List cont'd.

REF	PART NUM	DESCRIPTION	REF	PART NUM	DESCRIPTION
L117	2510122	INDUCTOR TOROID	R137	3220612	RES C.FILM 5.1 K 5% 1/4W
L118	2510099	INDUCTOR TOROID	R138	3220475	RES C.FILM 220 OHM 5%1/4W
L119	2510099	INDUCTOR TOROID	R139	3220475	RES C.FILM 220 OHM 5%1/4W
L120	2510089	INDUCTOR TOROID	R140	3220475	RES C.FILM 220 OHM 5%1/4W
L121	2510089	INDUCTOR TOROID	R141	3220470	RES C.FILM 180 OHM 5%1/4W
L122	2510089	INDUCTOR TOROID	R142	3220455	RES C.FILM 100 OHM 5%1/4W
L123	2510089	INDUCTOR TOROID	R143	3220425	RES C.FILM 33 OHM 5%1/4W
L124	3520503	CHOKE ASSY 2.7 UH	R144	3220590	RES C.FILM 2.2 K 5% 1/4W
L125	3520503	CHOKE ASSY 2.7 UH	R145	3220475	RES C.FILM 220 OHM 5%1/4W
L126	3520503	CHOKE ASSY 2.7 UH	R146	3220415	RES C.FILM 22 OHM 5%1/4W
L127	3520503	CHOKE ASSY 2.7 UH	R147	3220475	RES C.FILM 220 OHM 5%1/4W
L128	3520503	CHOKE ASSY 2.7 UH	R148	3220590	RES C.FILM 2.2 K 5% 1/4W
L129	3520501	CHOKE ASSY 1.8UH	R149	3220635	RES C.FILM 10 K 5% 1/4W
L130	3520501	CHOKE ASSY 1.8UH	R150	3250212	RES C.FILM 220 OHM 5%1/8W
L131	3524219	COIL AXIAL .47UH	R151	3250212	RES C.FILM 220 OHM 5%1/8W
P100	3280726	P.C. CONNECTOR 6 PIN	R152	3250129	RES C.FILM 22 OHM 5%1/8W
Q101	3030283	TRANSISTOR 3SK179	R153	3220610	RES C.FILM 4.7 K 5% 1/4W
Q102	3030507	TRANSISTOR 2SK192	R154	3220635	RES C.FILM 10 K 5% 1/4W
Q103	3030507	TRANSISTOR 2SK192	R155	3220530	RES C.FILM 620 OHM 5%1/4W
Q104	3030507	TRANSISTOR 2SK192	R156	3220610	RES C.FILM 4.7 K 5% 1/4W
Q105	3030507	TRANSISTOR 2SK192	R157	3220473	RES C.FILM 200 OHM 5%1/4W
Q106	3030283	TRANSISTOR 3SK179	R158	3220700	RES C.FILM 68 K 5% 1/4W
Q107	3030302	TRANSISTOR BFR91A	R159	3220635	RES C.FILM 10 K 5% 1/4W
Q108	3030104	TRANSISTOR 2N3904	R160	3220595	RES C.FILM 2.7 K 5% 1/4W
Q109	3030104	TRANSISTOR 2N3904	R161	3220610	RES C.FILM 4.7 K 5% 1/4W
Q110	3030302	TRANSISTOR BFR91A	R162	3220595	RES C.FILM 2.7 K 5% 1/4W
R101	3220610	RES C.FILM 4.7 K 5% 1/4W	R163	3220610	RES C.FILM 4.7 K 5% 1/4W
R102	3220455	RES C.FILM 100 OHM 5%1/4W	R164	3220660	RES C.FILM 22 K 5% 1/4W
R103	3220713	RES C.FILM 100 K 5% 1/4W	R165	3220455	RES C.FILM 100 OHM 5%1/4W
R104	3220695	RES C.FILM 56 K 5% 1/4W	R166	3220455	RES C.FILM 100 OHM 5%1/4W
R105	3220415	RES C.FILM 22 OHM 5%1/4W	R167	3220660	RES C.FILM 22 K 5% 1/4W
R106	3220695	RES C.FILM 56 K 5% 1/4W	R168	3220660	RES C.FILM 22 K 5% 1/4W
R107	3220425	RES C.FILM 33 OHM 5%1/4W	R169	3220455	RES C.FILM 100 OHM 5%1/4W
R108	3220630	RES C.FILM 8.2 K 5% 1/4W	R170	3220455	RES C.FILM 100 OHM 5%1/4W
R109	3220600	RES C.FILM 3.3 K 5% 1/4W	R171	3220660	RES C.FILM 22 K 5% 1/4W
R110	3220595	RES C.FILM 2.7 K 5% 1/4W	R172	3220473	RES C.FILM 200 OHM 5%1/4W
R111	3220595	RES C.FILM 2.7 K 5% 1/4W	R173	3220505	RES C.FILM 430 OHM 5%1/4W
R112	3220575	RES C.FILM 1.5 K 5% 1/4W	R174	3220505	RES C.FILM 430 OHM 5%1/4W
R113	3220435	RES C.FILM 47 OHM 5%1/4W	R175	3220700	RES C.FILM 68 K 5% 1/4W
R114	3220675	RES C.FILM 33 K 5% 1/4W	R176	3220505	RES C.FILM 430 OHM 5%1/4W
R115	3220675	RES C.FILM 33 K 5% 1/4W	R177	3220505	RES C.FILM 430 OHM 5%1/4W
R116	3220675	RES C.FILM 33 K 5% 1/4W	R178	3250206	RES C.FILM 150 OHM 5%1/8W
R117	3220675	RES C.FILM 33 K 5% 1/4W	R179	3220465	RSE C.FILM 150 OHM 5%1/4W
R118	3220720	RES C.FILM 150 K 5% 1/4W	R180	3220455	RES C.FILM 100 OHM 5%1/4W
R119	3220720	RES C.FILM 150 K 5% 1/4W	R181	3220455	RES C.FILM 100 OHM 5%1/4W
R120	3220720	RES C.FILM 150 K 5% 1/4W	R182	3220465	RSE C.FILM 150 OHM 5%1/4W
R121	3220720	RES C.FILM 150 K 5% 1/4W	R183	3220530	RES C.FILM 620 OHM 5%1/4W
R122	3220465	RSE C.FILM 150 OHM 5%1/4W	R184	3250206	RES C.FILM 150 OHM 5%1/8W
R123	3220720	RES C.FILM 150 K 5% 1/4W	R185	3250141	RES C.FILM 39 OHM 5%1/8W
R124	3220720	RES C.FILM 150 K 5% 1/4W	R186	3220465	RSE C.FILM 150 OHM 5% 1/4W
R125	3220720	RES C.FILM 150 K 5% 1/4W	R187	3220455	RES C.FILM 100 OHM 5%1/4W
R126	3220720	RES C.FILM 150 K 5% 1/4W	R188	3220455	RES C.FILM 100 OHM 5%1/4W
R127	3220485	RES C.FILM 270 OHM 5%1/4W	R189	3220465	RSE C.FILM 150 OHM 5%1/4W
R128	3220435	RES C.FILM 47 OHM 5%1/4W			
R129	3220435	RES C.FILM 47 OHM 5%1/4W			
R130	3220435	RES C.FILM 47 OHM 5%1/4W			
R131	3220685	RES C.FILM 47 K 5% 1/4W			
R132	3220685	RES C.FILM 47 K 5% 1/4W			
R133	3220435	RES C.FILM 47 OHM 5%1/4W			
R134	3220435	RES C.FILM 47 OHM 5%1/4W			
R135	3220435	RES C.FILM 47 OHM 5%1/4W			
R136	3220435	RES C.FILM 47 OHM 5%1/4W			

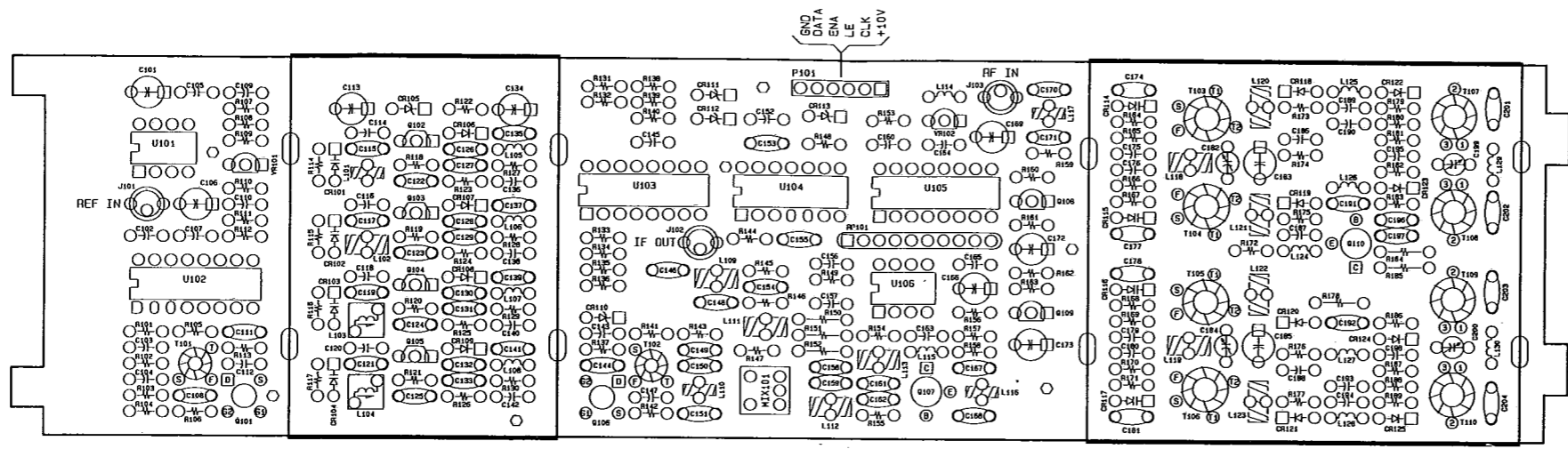
REF	PART NUM	DESCRIPTION
T101	2510100	INDUCTOR TOROID
T102	2510100	INDUCTOR TOROID
T103	2510087	INDUCTOR TOROID
T104	2510087	INDUCTOR TOROID
T105	2510087	INDUCTOR TOROID
T106	2510087	INDUCTOR TOROID
T107	2510093	INDUCTOR TOROID
T108	2510093	INDUCTOR TOROID
T109	2510093	INDUCTOR TOROID
T110	2510093	INDUCTOR TOROID
U101	3040169	I.C. LPC662AIN
U102	3045012	I.C. MB1504
U103	3040018	I.C. 74HC595N
U104	3040016	I.C. 74HC14
U105	3040018	I.C. 74HC595N
U106	3040169	I.C. LPC662AIN
CR101	3024701	VARACTOR 1SV153
CR102	3024701	VARACTOR 1SV153
CR103	3024701	VARACTOR 1SV153
CR104	3024701	VARACTOR 1SV153
CR105	3020050	DIODE 1N751A 5.1V 5% .5W
CR106	3020335	DIODE 1S2186
CR107	3020335	DIODE 1S2186
CR108	3020335	DIODE 1S2186
CR109	3020335	DIODE 1S2186
CR110	3020088	DIODE 1N4099 6.8V 5% .25W
CR111	3020050	DIODE 1N751A 5.1V 5% .5W
CR112	3020050	DIODE 1N751A 5.1V 5% .5W
CR113	3020050	DIODE 1N751A 5.1V 5% .5W
CR114	3024700	VARACTOR 1S2208B
CR115	3024700	VARACTOR 1S2208B
CR116	3024700	VARACTOR 1S2208B
CR117	3024700	VARACTOR 1S2208B
CR118	3020335	DIODE 1S2186
CR119	3020335	DIODE 1S2186
CR120	3020335	DIODE 1S2186
CR121	3020335	DIODE 1S2186
CR122	3020335	DIODE 1S2186
CR123	3020335	DIODE 1S2186
CR124	3020335	DIODE 1S2186
CR125	3020335	DIODE 1S2186
MX101	3045009	I.C. BALANCED MOD DBM50A
RP100	3221066	RES PACK #BLA8-154F R2R 8-BIT
VR101	3040031	I. C. 78LO5-ACP
VR102	3040031	I. C. 78LO5-ACP





1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25

A  
B  
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D  
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## VHF CONVERTER ALIGNMENT

### VCO Test and Tune

1. Set the R8/R8E to the frequency listed in Table 1.
2. Probe pin 1 of U101A with a DVM set to measure voltage.

3. For VCO1 and VCO2 adjustment is not necessary, however, the voltage should be checked to assure that the loop is in lock.

4. VCO3 and VCO4 should be adjusted at the high end of their tuning range, then checked at the lower end for proper control voltage.

5. Proceed with tuning per Table 1.

R8/R8E FREQUENCY (MHz)	(VOM READING) VERROR	EXECUTE STEPS IN THIS ORDER	ACTION REQUIRED
VCO 1 45	4.0 ± 2.0 V	1	Check voltage at pin 1.
VCO 2 115	4.0 ± 2.0 V	2	Check voltage at pin 1.
VCO 3 145	8.0 ± 0.1 V	3	Tune L103 for desired voltage at pin 1.
VCO 4 132	2.5 ± 0.5 V	4	Check voltage at pin 1.
VCO 5 168	8.2 ± 0.1 V	5	Tune L104 for desired voltage at pin 1.
VCO 6 157	2.0 ± 0.5 V	6	Check voltage at pin 1.

Table 1

### Preselector Tuning and Checks

#### A. Low Band (35 - 54 MHz)

1. Connect a Spectrum Analyzer and Tracking Generator to the VHF Converter so that the Tracking Generator output connects to the Converter Antenna input jack (J-103) and the Spectrum Analyzer input connects to pin 1 of mixer MX101. (See Figure 3).

(a) Tracking Generator level should be no higher than -30 dBm.

(b) Spectrum Analyzer settings should be as follows:

- Bandwidth = 300 KHz
- Scan Width = 5 MHz/Division - Low Band
- = 10 MHz/Division - High Band
- Input Atten = 10 dB
- Center Freq = 45 MHz
- Scan Time = 2 mSec
- Log Ref = 0 dBm

2. Set the R8/R8E to a test frequency 45 MHz. Now the low band filters will be selected and their frequency response displayed on the analyzer.

3. Adjust the trimmer caps (C199 & C200) in the two low band filters until the desired response is achieved (as shown in Figure 4).

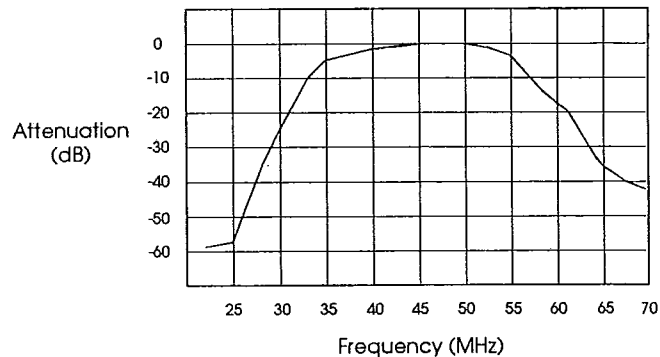


Figure 4 Low-Band FILTER RESPONSE

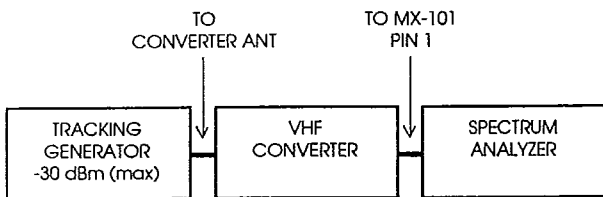
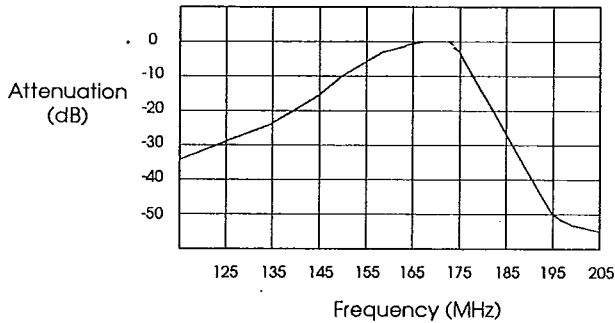


Figure 3

## B. High Band (108 - 174 MHz)

1. Leave equipment connected as in Low Band Tuning procedure.
2. Set the R8/R8E to 168 MHz. Now the high band filters will be selected and their frequency response displayed on the analyzer.
3. Adjust the Trimmer caps in the two high band filters (C-182 and C-184) until the filter displays the desired response (as shown in Figure 5).



**Figure 5 High-Band FILTER RESPONSE**

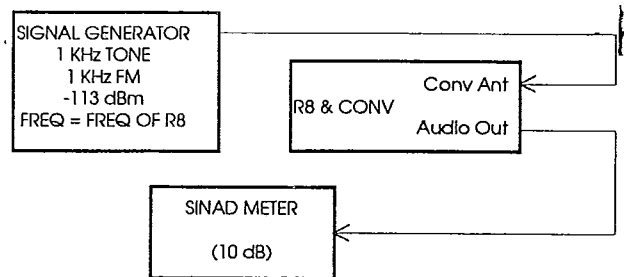
4. Set the R8/R8E to 108 MHz and observe the filter response. It should be optimum without further adjustment.

## Sensitivity and Microphonics Test

1. Install the converter in a R8/R8E Receiver. This must be done to eliminate electrical noise which would cause inaccurate results.
2. Measure 12dB SINAD at the following frequencies shown in the table using the setup shown in Figure 6. Make sure that the converter meets or exceeds the specification and that it is not microphonic at each frequency.

To check for microphonics, tap lightly on the VCO shield while noting that the recovered audio remains a clear 1 KHz tone.

<u>R8/R8E Frequency</u>	<u>Sensitivity</u>
45.123 MHz	Better than 12 dB SINAD
115.234 MHz	
132.345 MHz	
145.456 MHz	
157.567 MHz	
168.678 MHz	



**Figure 6 Sensitivity Test**



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# VHF CONVERTER INSTALLATION INSTRUCTIONS

**CAUTION:** Refer installation to qualified service technician to prevent personal injury or damage to the equipment.

Prior to starting installation of your new VHF converter, carefully unpack the converter PC board assembly and its associated cables and mounting hardware. You will need to use a Phillips screwdriver during installation.

NOTE: A magnetized screwdriver facilitates the removal and installation of screws in the procedure that follows.

Identify the following items:

- (1) #1001590 VHF Converter Assembly
- (1) #3711160 Coaxial Cable, 8' Length
- (1) #3711168 Coaxial Cable, 26' Length
- (1) #2707293 6-Conductor Cable, 17' Length
- (1) #4350171 Retaining Bracket
- (1) #3320244 Screw 4-40 x 1/4" Pan Head Phillips

Install the VHF Converter assembly as follows:

## DISCONNECT THE R8 RECEIVER FROM THE AC POWER SOURCE!

1) Remove the top cover from the R8 receiver by removing (5) #6-32 x 1/4" Pan Head Phillips BLACK screws. Retain the cover and screws for reassembly.

2) Remove the bottom cover from the R8 receiver by removing (6) 4-40 x 1/4" Pan Head Phillips screws. Retain the cover and screws for reassembly.

3) Identify the (6) conductor cable (17' length) and plug it onto the VHF converter assembly (Figure 1) being careful to align the connector with the RED conductor on Pin 1 of the VHF converter assembly.

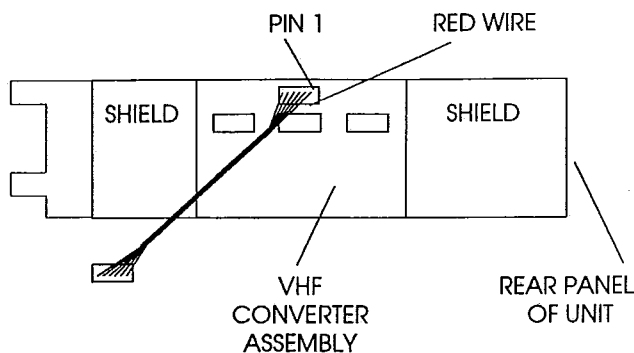


FIGURE 1

4) Route the free end of the 6-conductor VHF converter cable vertically down behind front panel (near Volume Control) to the board assembly exposed by removal of bottom cover. See figure 2.

5) Position the VHF converter assembly into the chassis as illustrated (Figure 2). The board mounted components should face toward the outside edge of the R8 with the larger of the two component side shields toward the rear panel of the R8. Align the two tabs into the slots located on rear panel of the R8. Reposition any cables at rear panel, as necessary, to allow converter assembly to fit at the rear panel wall.

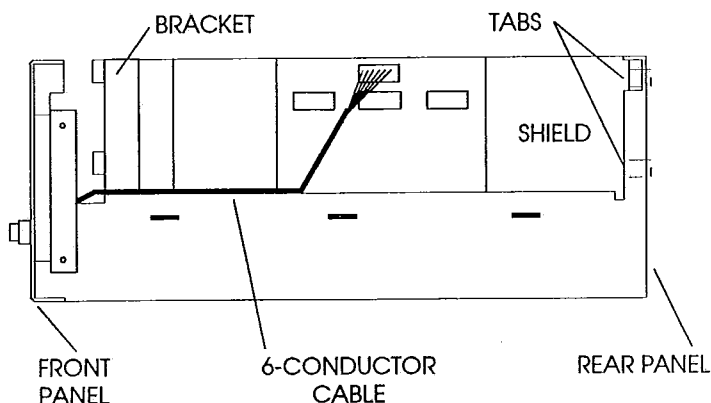


FIGURE 2 R8 SIDE VIEW

Locate the Retaining Bracket and position to edge of the VHF Converter assembly as shown. Use the supplied #4-40 x 1/4 Pan Head Phillips screw to secure the bracket to the R8 chassis (Figure 3).

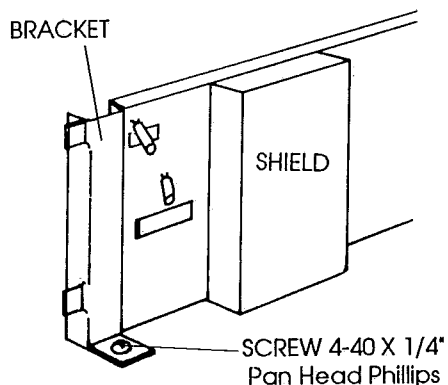


FIGURE 3

6) With the converter assembly now secured in the chassis with 6-conductor cable attached, position the R8 so it rests on its left-hand side (facing front of receiver). Locate the unconnected end of the 6-conductor cable and connect it to the synthesizer board connector in the orientation shown in Figure 4. Be careful to align the **RED** conductor on **PIN 1** of the synthesizer board assembly connector header. Position the cable assembly so that it routes as shown. Reduce any excess slack cable length near the VHF converter to provide the proper routing on its approach to the synthesizer board connector header.

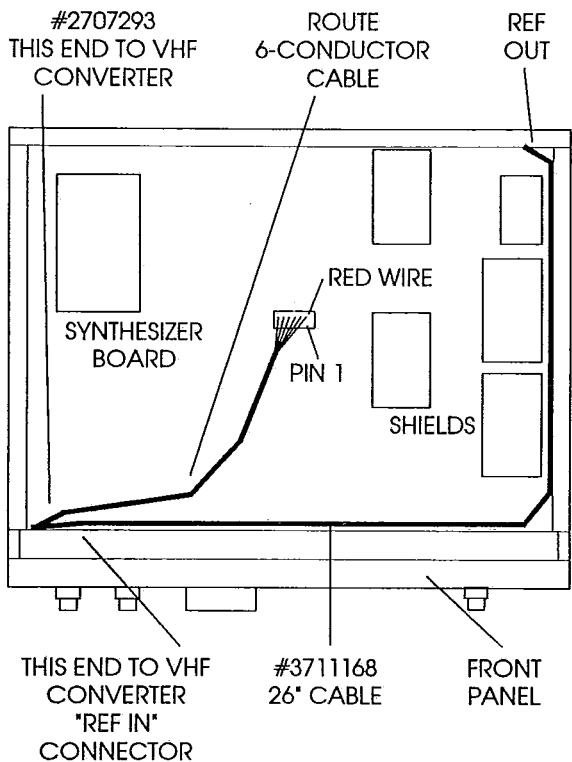


FIGURE 4 R8 BOTTOM VIEW

7) Connect the supplied 26" 'REF' coaxial cable #3711168 to the 'REF OUT' connector located near the right rear corner of the synthesizer board. Position the cable as shown in Figure 4, routing the free end of the coax cable along the front panel (near volume control) and up to the VHF Converter assembly end nearest the front panel.

8) Position the R8 receiver so it rests on its bottom chassis with front panel facing towards you. Plug the unconnected end of the 26" 'REF' coaxial cable #3711168, into the 'REF IN' connector located on the VHF converter assembly as shown in Figure 5.

9) Locate the factory installed coaxial cable connected to the rear panel 'CONV' antenna input connector. Disconnect the terminal end of this coax from the Front End Board connector. Plug the coax cable into the 'RF IN' terminal of the VHF Converter as shown in Figure 5.

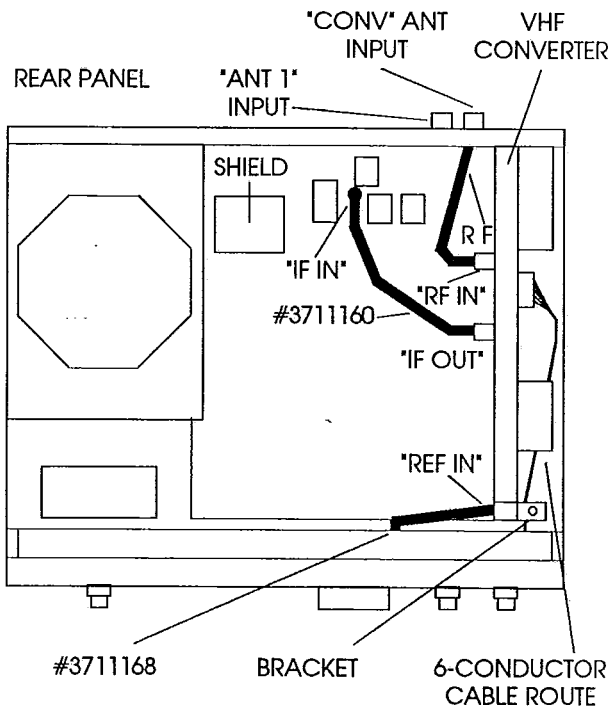


FIGURE 5 R8 TOP VIEW

10) Identify the 8" Coaxial Cable, #3711160. Plug in one end of the cable to the 'IF IN' terminal on the Front End board assembly and plug the other end into the 'IF OUT' terminal of the VHF Converter assembly.

The VHF Converter electrical installation is complete at this point. Prior to applying AC power to the R8 receiver for testing, proceed as follows:

11) Position the R8 with the bottom of the unit facing up, front panel toward you. Place the bottom cover on the unit oriented with the lever feet toward the front panel of the R8. Secure the bottom cover using (6) #4-40 x 1/4" Pan Head Phillips screws that were removed in step #2.

**NOTE:** You may wish to secure the bottom cover with (2) screws until after unit system check, but note that **AC power is active at all times in the R8 whenever it is connected to a source of AC power.**

12) Position the R8 with the top of the unit facing up, front panel towards you. Install the top cover using the (5) #6-32 x 1/4" Pan Head Phillips BLACK screws retained in step #1.

### **UNIT SYSTEM CHECK**

13) Connect the R8 to a source of AC power. Press the 'POWER' button to place the R8 in the 'ON' mode. The unit should automatically switch to the converter antenna input if any frequency in

the range of either 35 - 55 MHz or 108 - 174 MHz is selected. (If the above action does not occur, check the 6-conductor cable assembly of the VHF converter). Once proper operation is noted, tune in a known active signal in either the range of 35 - 55 MHz or 108 - 174 MHz. Select the proper mode, bandwidth and other parameters as appropriate.

**HINT:** In many areas of the U.S., the NOAA weather stations are active on one of the following frequencies: 162.475 MHz, 162.550 MHz or 162.625 MHz. One of those or a similar type station could be tuned in as a convenient operational check.

Once correct operation is verified, disconnect the R8 from the AC Power Source. Secure the top and bottom covers with remaining screws if this has not already been completed in steps #11 and #12.

The R8 with VHF Converter is now ready for operation.

---

### **VHF OPERATION**

Operation of the R8 in the VHF Bands of 35-55 MHz and 108-174 MHz is accomplished by entering the desired frequency directly as described on page 12 of the Owner's Manual, "DIRECT FREQUENCY ENTRY". Additionally, the R8 automatically will tune to the 35-55 MHz band followed by the 108-174 MHz band as the main tuning dial is tuned above 30 MHz. All reception modes are supported in the two VHF bands.

<b>SPECIFICATIONS:</b>	(Apply to the operation of the VHF Converter assembly installed in the R8 receiver)
Frequency Range	35-55 MHz 108-174 MHz
Antenna Impedance	50 ohms
Sensitivity: SSB, CW (+10dB S+N/N)	Less than 0.25 $\mu$ V (2.3 KHz Bandwidth)
Sensitivity: AM (+10 dB S+N/N) (1 KHz, 30% mod)	Less than 1.0 $\mu$ V
Sensitivity: FM (12 dB SINAD)	Less than 0.5 $\mu$ V
Frequency Stability	Better than $\pm 10$ ppm, -10 <sup>o</sup> to +50 <sup>o</sup> C (determined by the R8 master reference oscillator)
Power Requirements	+10 VDC @ 150 mA
FCC Approval	Part 15 Certification
Weight	6.7 Oz. (0.2 Kg)
Size	Length 9-5/8" (24.4 cm) Width 2-1/2" (6.4 cm) Height 1-1/8" (2.9 cm)

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# ***DRAKE***

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