

STEPHENS ENGINEERING ASSOCIATES, INC.





**HF SINGLE SIDEBAND RADIOTELEPHONE  
MODEL SEA 322**

# **INSTRUCTION AND MAINTENANCE MANUAL**

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## 1. GENERAL INFORMATION

### 1.1 DESCRIPTION

The SEA 322 is a compact, all solid-state, 150 Watt PEP, HF SSB transceiver for the marine and HF radio service.

The SEA 322 covers the 2 to 23 MHz frequency range with channel restrictions which are determined only by the rules regarding the appropriate radio service. As normally programmed, the SEA 322 frequency memory contains all normally assigned ITU and TELEX channels and has space available for any additional channels which might be desired.

The SEA 322 is fully synthesized with 100 Hz resolution and the channel frequencies are controlled by a precision crystal housed in a temperature stabilized holder. The transceiver is designed to operate from a 13.6 Volt, negative ground power system. The SEA 322 makes use of a unique new SEA designed communications control buss (SEAbuss) which supports all radiotelephone functions. This makes the radiotelephone completely compatible with an extremely wide variety of control options. In normal Marine or HF service, the radiotelephone is usually controlled with the standard SEA 322 control terminal. This terminal is actually a small dedicated computer system with a custom designed liquid crystal display and a dedicated software package which configures the system as a general purpose HF radiotelephone.

The controller is designed for shipboard mounting in a rigorous environment and is attractively styled in a modern injection molded polycarbonate case. Keypad and display are lighted with variable illumination for operator convenience.

The SEAbuss is designed as a general purpose communications system control buss and incorporates a number of unique and useful features:

1. Both audio and data are independently supported, each on its own balanced, low impedance twisted pair.
2. The SEAbuss is designed to allow direct paralleling of up to four (4) control terminals without expansion.
3. The SEAbuss allows the direct interconnection of general purpose computer/controller in a mix and match system. This allows many unique options such as multiple remote control locations and direct radiotelephone to computer interfacing. The computer interface allows extreme flexibility in HF communications system design. Features such as SITOR, SELCAL and the like may be implemented without modification of the basic radiotelephone.
4. The SEAbuss may be considered an "open" buss. For details regarding buss protocol, contact the SEA, Inc. factory.

- 1.2 EQUIPMENT FURNISHED
  - 1.2.1 SEA 322 TRANSCEIVER
  - 1.2.2 TRANSCEIVER MOUNTING BRACKET
  - 1.2.3 SEA 322 CONTROLLER
  - 1.2.4 CONTROLLER GIMBAL BRACKET
  - 1.2.5 MICROPHONE AND MICROPHONE CLIP
  - 1.2.6 POWER CONNECTOR
  - 1.2.7 INTERCONNECTION CABLE (25')
  - 1.2.8 INSTRUCTION AND MAINTENANCE MANUAL
  - 1.2.9 SEA 322 OPERATOR'S MANUAL
- 1.3 MECHANICAL INFORMATION
- 1.4 TRANSCEIVER UNIT SPECIFICATIONS
  - 1.4.1 DIMENSIONS  
(HEIGHT-WIDTH-DEPTH)  
In: 4.60 x 13.50 x 9.95  
mm: 116.84 x 342.9 x 252.73
  - 1.4.2 WEIGHT  
Lbs: 9.47  
Kgs: 4.3
- 1.5 CONTROLLER SPECIFICATIONS
  - 1.5.1 DIMENSIONS  
(HEIGHT-WIDTH-DEPTH)  
In: 5.53 x 13.35 x 3.20  
mm: 140.46 x 339.09 x 81.28
  - 1.5.2 WEIGHT  
Lbs: 3.56  
Kgs: 1.6

## 1.6 ELECTRICAL SPECIFICATIONS

## 1.6.1 GENERAL

Type Acceptance	FCC Parts 80, 87, 90
Frequency Range	2-23 MHz
Circuitry	Double Conversion, 72.5 MHz 1st I.F., 10.7 MHz 2nd I.F.
Terminal Operating Controls	21 Key Keypad
Channel Capacity	604 channels in factory programmed memory, 99 channels in field programmed memory. (2182.0 KHz already programmed into channel "0 EMER")
Operating Temperature Range	-30 degrees to + 60 degrees C
Frequency Stability	10 Hz
Operating Modes	A3A, A3J, 2182.0 KHz A3H in E0, 0.3F1 (SITOR)
Primary Voltage	13.6 DC $\pm$ 15%, negative ground
Current Drain:	
Receive Standby	1A
Receive, Full Audio	1.5A
Transmit, Average Voice	11A
Transmit, Two Tone	17A
RF Impedance	50 Ohms

## 1.6.2 TRANSMITTER

Power Output	A3A, A3J, 150 Watts PEP
Intermodulation	-32 dB below PEP

Spurious Emissions	-65 dB below PEP
Carrier Suppression	-55 dB below PEP
Undesired Sideband Suppression	-60 dB below PEP @ 1000 Hz
Audio Response	400 Hz to 2600 Hz to -6 dB points

1.6.3 RECEIVER

Sensitivity: SSB	<1 microvolt for 12 dB SINAD
Selectivity: SSB	400 Hz to 2600 Hz to -6 dB points
Selectivity: TELEX	500 Hz bandwidth to -6 dB points, centered on 1700 Hz
AGC	Less than 6 dB audio level change from 10 10 uV to 100 mV, fast attack slow release
Intermodulation	At least -80 dB
Spurious Responses	At least -90 dB
Audio Power	4 Watts at less than 10% distortion

2. OPERATION

2.1 WARM UP CAUTION

Do not attempt to transmit until the radiotelephone is warmed up for at least 3 minutes. Transmitting before the 3 minute warm-up period has elapsed can cause a violation of FCC regulations.

2.2 FCC REQUIREMENTS

"How to Correctly Operate Your Radiotelephone Set" is a booklet available from the Radio Technical Commission for Marine Service (RTCM), P.O. Box 19087, Washington D.C. 20036 and is highly recommended reading material.

## 2.3 FRONT PANEL CONTROLS AND INDICATORS

Figure 2.3 illustrates the front panel of the SEA 322 Controller. The function of the individual keys in the 21 key keypad are listed below. The LCD provides specialized annunciators for operation of the HF sideband transceiver.

PWR	Toggles main power on and off.
AUX	Activates special functions.
ENT	Executes information entered by numeric keys.
MODE	Selects modes of operation ie: USB, LSB, TELEX, or AME.
CHAN/FREQ	Selects LCD numeric display mode: Channel number or frequency.
UP/ARROW	Programmed frequencies: Increases receiver frequency by up to 200 Hz in 100 Hz steps.
DOWN/ARROW	Programmed frequencies: Decreases receiver frequency by up to 200 Hz in 100 Hz steps.

NOTE: In receive only applications the 200 Hz limit on the clarifier is removed.

KEYS 0-9 used for:

- A) Numerical recall of programmed frequencies by assigned channel number.
- B) Entering receive only frequencies.
- C) Forcing radiotelephone into PROGRAM mode.
- D) Numeric entry of frequencies when in PROGRAM mode.
- E) Adjusting squelch threshold.
- F) Adjusting panel illumination level.
- G) Programming BEEP status when in PROGRAM mode.



**CONTROLLER FRONT PANEL**

**FIGURE 2.3**

EMER Single stroke selects frequency in E0 ie: 2182.0 KHz. Single stroke after leading numeric entry 1-9 selects channels E1-E9.

UP/VOL Increases receiver volume level.

DOWN/VOL Decreases receiver volume level.

SQL Toggles squelch on or off.

#### 2.4 DISPLAY

The Controller makes use of a custom liquid crystal display which has a variety of special annunciator legends. These legends are listed below together with their functions.

NUMBERS Provides numeric frequency/channel display.

CHAN Indicates that numeric display is a CHANNEL indication.

FREQ Indicates that numeric display is a FREQUENCY indication.

UNLK Indicates that synthesizer is unlocked.

XMIT Indicates that transceiver is in TRANSMIT mode.

SQL Indicates that transceiver squelch system is activated.

USB Indicates that transceiver is in the UPPER sideband mode.

LSB Indicates that transceiver is in the LOWER sideband mode.

TLX Indicates that transceiver is in the TELEX (0.3F1) mode.

AME Indicates that AM equivalent carrier is reinserted.

TUNED Antenna coupler status flag. See pp. 2.6.11

BARGRAPH Indicates relative level of transmitter output and receiver audio.

PRGM Indicates that transceiver is in the PROGRAM mode.

#### 2.5 PROPAGATION

HF signals propagate far beyond the horizon. MF frequencies (2-3 MHz) are generally usable within 300 miles depending on the time of day, atmospheric conditions and man-made noise level.

The High Seas frequencies (4, 6, 8, 12, 16 and 22 MHz) allow communications over thousands of miles, again subject to the above mentioned limitations. Interference tends to be more of a problem than on VHF.

## 2.6 OPERATING YOUR SEA 322 HF/SSB RADIOTELEPHONE

### 2.6.1 DESCRIPTION OF MEMORY FUNCTIONS

The SEA 322 has TWO memory banks. First, the factory programmed frequency memory which contains 604 frequency PAIRS, stored and recalled by CHANNEL NUMBER. Second, the internal "scratchpad" memory which allows the operator to program and recall 99 frequency pairs. See pp. 3.4 for ITU channel listing. (Note: 9 of the 99 field programmable channels are "EMERGENCY" channels).

### 2.6.2 PUTTING THE SEA 322 IN THE OPERATING MODE

Depress the "PWR" key to activate the SEA 322 power control relay. When the liquid crystal display indicates "2182.0", the radiotelephone had properly initialized and is set up to operate on 2182.0 KHz. Wait 3 minutes for the synthesizer frequency to stabilize and the SEA 322 is ready to operate on 2182.0 KHz.

### 2.6.3 CONTROLLING FRONT PANEL ILLUMINATION

Enter any desired SINGLE digit number from 0 to 3, followed by the "ENT" command. The single digit command will be interpreted by the operating system as a level of front panel illumination intensity with 0 being OFF and 3 being maximum brilliance.

### 2.6.4 SELECTING A FREQUENCY FROM SCRATCHPAD MEMORY

Enter any desired TWO digit number, followed by the "ENT" command. The two digit command will be interpreted by the operating system as the number of the desired location in scratchpad memory. Note that the scratchpad memory must be programmed in the field.

### 2.6.5 SELECTING A CHANNEL BY NUMBER

Enter any desired THREE or FOUR digit channel number, followed by the "ENT" command. Example: "4, 0, 3, ENT". Verify that the radio has responded by examining the display which should now have the "CHAN" annunciator activated. The numeric display should read "CH 403". Pressing the CH/FREQ key will cause the numeric display to read 4363.6 KHz, the receiver frequency associated with ITU channel 403. Pressing the CH/FREQ key again will restore the channel readout. Refer to pp.

3.4 and/or your SEA 322 Operators Manual for channel vs. frequency data.

#### 2.6.6 SELECTING A TELEX CHANNEL BY NUMBER

Enter any desired THREE or FOUR digit channel number, followed by the "MODE" command. Example: "4, 0, 3, MODE". Verify that the radio has responded by examining the display which should now have the "TLX" annunciator activated. The numeric display should read "CH 403". Pressing the CH/FREQ key will cause the numeric display to read 4351.0 KHz. This is the receiver frequency associated with TELEX channel 403. Pressing the CH/FREQ key again will restore the channel readout. Refer to pp. 3.4 and/or your SEA 322 Operator's Manual for channel vs. frequency data.

#### 2.6.7 ENTERING A RECEIVE ONLY FREQUENCY

Enter any desired FIVE or SIX digit frequency between 10000 and 249999, followed by the "ENT" command. Example: "1, 0, 0, 0, 0, ENT". This will be interpreted by the operating system as a RECEIVE frequency of 10,000.0 KHz. Note that the "FREQ" annunciator will be turned on when the display is indicating a channel FREQUENCY.

#### 2.6.8 SELECTING AN EMERGENCY CHANNEL

Up to 9 emergency frequencies may be stored in the scratchpad memory of the SEA 322. Emergency channel 0 is already loaded with the international calling and distress frequency, 2182.0 KHz. When E0 is recalled, the operating mode will be A3J and the mode annunciator will read "USB". If A3H (AME) operation is desired it may be selected ON CHANNEL E0 ONLY by pressing the "MODE" key until the AME annunciator lights. Any of the emergency channels may be recalled from memory by entering ANY SINGLE DIGIT followed immediately by the "EMER" command. Note that with the exception of E0, the emergency channel memory locations must be programmed in the field.

#### 2.6.9 SELECTING LOWER SIDEBAND

When authorized, the lower sideband mode may be selected by pressing the "MODE" key. This key will allow the operator to switch between upper sideband and lower sideband operation. The sideband status will be indicated by the "USB" and "LSB" annunciators.

#### 2.6.10 ACTIVATING THE SQUELCH FUNCTION

The squelch function in the SEA 322 is activated by pressing the "SQL" key on the keypad. When the squelch system is activated,

the "SQL" annunciator on the liquid crystal display will be turned on. Pressing the "SQL" key a second time will de-activate the squelch function and the "SQL" annunciator will extinguish.

The SEA 322 squelch system makes use of a software analogue of the "voice operated" squelch used in previous SEA products. It is sensitive to the changing frequency components in the human voice and therefore requires no level control. A momentary tone will open the squelch but will not hold it open. A moving tone is required to hold the squelch open. When power is initially applied to the SEA 322, the squelch circuitry will be DE-ACTIVATED.

#### 2.6.11 ACTIVATING THE "TUNED" INDICATOR

The "TUNED" annunciator on the liquid crystal display is used to provide the antenna coupler "tuned status" annunciator blank. When an antenna coupler such as the SEA 1612 is used, the "TND" line from the coupler should be connected to the "TND" port on the accessory plug on the SEA 322 rear panel. The antenna coupler will signal that it has successfully tuned the antenna by pulling the "TND" line low. This will activate the "TUNED" indicator on the display. Once activated, the "TUNED" annunciator will remain on UNTIL A FREQUENCY CHANGE TAKES PLACE. At that time the indicator will extinguish, since a properly tuned antenna is no longer assured. Once extinguished, the "TND" line must again be pulled low to activate the indicator.

#### 2.7 OPERATING THE TRANSMITTER

The operation of the transmitter is straightforward. Pressing the microphone push-to-talk button will switch the transmitter circuits on. This will be indicated by the display changing to the transmitter frequency and the "XMIT" indicator will activate. Speak in a normal voice with your lips approximately one half inch from the microphone. Do NOT shout into the microphone as this may reduce the intelligibility of the transmission. The bargraph indicator should modulate with the voice, indicating normal power output. Note that acknowledgement of a message cannot be done by keying the microphone, since no signal is transmitted until the operator actually speaks.

##### 2.7.1 THE OVERTEMPERATURE ALARM

Under some conditions of extended duty cycle, the temperature of the power amplifier components may exceed safe limits, triggering the overtemperature alarm circuitry. This condition will cause:

1. Inhibition of the transmitter. When the transmitter PTT line is grounded, the display will indicate "Hot".

2. Pressing "AUX", "EMER" will enable the transmitter for a period of 3 minutes to allow for EMERGENCY transmissions. WARNING! Sustained operation of the transmitter under overtemperature conditions will cause damage to transmitter circuitry.
3. Normal operation will resume when the transmitter cools off.

#### 2.7.2 OPERATING THE SEA 322 AS AN INTERCOM

When the SEA 322 is fitted with multiple controllers, it is possible to operate the radiotelephone as an intercommunications system. To accomplish this function, proceed as follows:

1. Press "AUX", "0". This puts the radiotelephone into the "INTERCOM" mode. All key functions EXCEPT the VOLUME keys will be inhibited. Radiotelephone audio is suppressed. All Controllers will display "Int" in the numeric readout.
2. Keying any Controller microphone will allow communications from that station to all other Controllers.
3. If there is no intercom traffic for 3 minutes the system will revert to normal radiotelephone operation as previously configured.
4. While in the "INTERCOM" mode, pressing the "ENT" or "EMER" key will restore normal radiotelephone operation.

### 3. PROGRAMMING

#### 3.1 FREQUENCY AND MODE SELECTION

As discussed above, the SEA 322 contains TWO memory systems. The factory programmed frequencies are listed in pp. 3.4 and are stored in the operating system EEPROM. Normal access to these frequencies is through the channel number system described above. (See pp. 2.6.5) In addition to those frequencies contained in the factory programmed memory, the operator may program up to 99 frequency pairs into the non-volatile EEPROM memory referred to as "scratchpad memory". This memory is arranged as 99 "bins" or channel locations and each is designed to hold one channel. A channel consists of TWO frequencies, a TRANSMITTER frequency and a RECEIVER frequency.

The frequencies selected for entry into the scratchpad memory must be legally authorized for the desired operating service.

When the SEA 322 is to be used in services other than the Marine Service, it is possible to provide a special program for the permanent memory. Contact the Factory for information.

## 3.2 BANDWIDTH LIMITATIONS

The only limitations imposed by the SEA 322 is that the desired frequency be inside the operating range of the equipment. Totally unrelated duplex pairs might be employed, since the computer controls the filter bandswitching. In practice, the antenna system will have a great deal to do with dictating the maximum allowable frequency separation. If a wide bandwidth antenna system such as a Conical Monopole is used, it is conceivable that the transmitter could operate in the 22 MHz band while the receiver was operating on 2000.0 KHz. If the companion SEA 1612B automatic antenna coupler is used in conjunction with the normal short whip, the allowable 2 MHz split may be reduced to a few hundred KHz.

## 3.3 FIELD PROGRAMMING THE SEA 322 SCRATCHPAD MEMORY

### 3.3.1 ENTERING THE PROGRAM MODE

The SEA 322 is forced into the PROGRAM mode by entering the number 8888888 (seven # 8s). The operating system will immediately signal the operator that the SEA 322 has shifted to the PROGRAM mode by blinking the "PRGM" annunciator on the display. After a short delay, the operating system will signal the operator to proceed by blinking the "CHAN" annunciator and prompting "CH?" on the numeric display.

### 3.3.2 ENTERING SCRATCHPAD FREQUENCY AND MODE DATA

After the SEA 322 has shifted to the PROGRAM mode, the operator should select and enter the desired scratchpad channel number, such as channel 10. This is done by keying in the sequence "1, 0, ENT". If the selected scratchpad location is full, the operating system will respond with the prompt "FULL". If it is desired to "overwrite" the location with new data, simply press the numeral "1" key. If the operator does not desire to overwrite the location, pressing the "ENT" key will cause the operating system to again present the "CH?" prompt. This allows the operator to choose another scratchpad memory location.

Once the desired scratchpad location is selected, the operating system will blink the "PRGM", "FREQ" and "XMIT" annunciators. The operator should then enter the desired TRANSMITTER frequency down to and including the 100 Hz increment. EXAMPLE: "1, 2, 4, 2, 9, 2, ENT". This will enter the frequency of 12,429.2 KHz in the transmitter frequency memory.

At this time, the "XMIT" annunciator will extinguish but the "PRGM" and "FREQ" annunciators will continue to blink, signalling that the

operator must now enter the desired RECEIVER operating frequency. If the channel being programmed is a SIMPLEX channel it is only necessary to press the "ENT" key again. This will load the previously programmed TRANSMITTER frequency into the RECEIVER storage location. If the channel being programmed is a DUPLEX channel, it will be necessary to enter the desired RECEIVER frequency. Example: "1, 2, 3, 4, 5, 6, ENT". This will enter the frequency of 12,345.6 KHz in the receiver frequency memory.

At this time, the "FREQ" annunciator will extinguish and the operating system will prompt "A3A ?" for DUPLEX channels only. If the channel requires -16 dB carrier insertion, the operator enters the numeral "1". If normal A3J (no carrier) operation is required, the operator simply presses the "ENT" key. (If A3A operation is selected, the display will prompt "A3A" for 1 second before proceeding).

On those channels where A3A has not been selected, the operating system will now blink the "TLX" annunciator. If the channel being programmed is for TELEX operation the operator enters the numeral "1". If normal voice operation is required, the operator simply presses the "ENT" key. (If TELEX operation is selected, the display will prompt "tty" for 1 second before proceeding).

At this time, the scratchpad memory location has been fully programmed. The operating system will indicate this by prompting "CH 10" (held for one second) "StorEd" (held for one second). The operating system will then be ready to program the next location and will signal the operator by again prompting "CH ?" and blinking the "PRGM" and "CHAN" annunciators.

### 3.3.3 ADJUSTING THE SQUELCH THRESHOLD

The software SINAD squelch in the SEA 322 has an adjustable threshold which may be reset in the field to compensate for varying levels of noise interference. Normally this level is set at the factory for proper operation under typical field condition. Number 0 corresponds to a very LOW squelch threshold, while number 9 corresponds to a very HIGH squelch threshold. Should the operator desire to alter the squelch level, proceed as follows:

1. Enter PROGRAM mode. (See pp. 3.3.1).
2. In response to the "CH ?" prompt enter "SQL".
3. The operating system will respond "S 0-9 ?". After 2 seconds the PRESENT squelch setting will appear in the LEAST significant digit of the display. (Factory setting is 4).

4. Enter the desired squelch threshold as a SINGLE digit followed by the "ENT" key.
5. The operating system will respond with the prompt "StorEd".
6. Exit PROGRAM mode. (See pp. 3.3.7).

#### 3.3.4 PROGRAMMING THE "BEEP" FUNCTION

The audible "beep" which occurs when keys are pressed may be controlled by programming the function on or off. In order to select the desired beep mode, proceed as follows:

1. Enter PROGRAM mode. (See pp. 3.3.1).
2. In response to the "CH ?" prompt enter "AUX, 1, ENT".
3. The operating system will respond "BEEP ?". After 2 seconds the prompt will change to reflect the PRESENT status of the beep, either "ON" or "OFF".
4. To turn the beep ON, enter "1". To turn the beep OFF, enter "0". To leave the beep status unchanged enter "ENT".
5. The operating system will respond with the prompt "StorEd".
6. Exit PROGRAM mode. (See pp. 3.3.7).

#### 3.3.5 PROGRAMMING LOWER SIDEBAND

Enter PROGRAM mode (press 8888888). Display will prompt "CH?". Press "AUX", "9" and "ENT". Display will read "LSB". Display will read either "ON" or "OFF" to reflect present LSB status. To program lower sideband, press "1". To turn the LSB off, press "0". To leave lower sideband unchanged, press "ENT".

WARNING: LSB may only be used in services other than marine, i.e., amateur.

#### 3.3.6 PROGRAMMING CONTROLLER ADDRESS

In multiple controller installations, you must assign individual unit numbers to the controllers in the system. To assign unit numbers in multiple controller installations, proceed as follows:

1. Disconnect all Controllers EXCEPT the Controller being programmed.
2. Enter program mode. (Press 8888888).
3. In response to "CH?" prompt, enter "AUX, 0, ENT".
4. The operating system will respond "Unit?". After 2 seconds the "?" will be replaced by the current unit number assigned.
5. Enter the unit number desired (1-4), followed by the "ENT" command. If no change is required, simply enter "ENT". Do not program more than one head with the same number.
6. The Controller will respond with the prompt "StorEd".
7. Exit PROGRAM mode.
8. In multiple Controller installations, it may be necessary to adjust the audio line level. This is a function of the extra line loading presented by the added Controllers. This may be accomplished by clipping out the 620 ohm line loading resistor R1 in any or all of the controllers in the system. This resistor is located on the Controller Cable Interface Board (ASY-0322-04). Exact line level is not critical.

### 3.3.7 EXITING THE PROGRAM MODE

If, after a program entry sequence, no further entries are made for a period of 30 seconds, the operating system will exit the PROGRAM mode and come up on the LAST channel entered while in the PROGRAM mode. If NO entry has been made while in the PROGRAM mode, the system will revert to EMER 0. Further, it is possible to exit the PROGRAM mode immediately by pressing "EMER". Operation will abort to the last channel entered or, if no channel has been entered, to channel E0. PROGRAM mode will also be exited by cycling the main power switch OFF. When the system comes up it will be back in the normal operating mode.

### 3.4 SEA 322 FREQUENCY PROGRAM

CHANNEL NUMBER	SHIP TRANSMIT FREQ.	SHIP RECEIVE	USE
201	2003	SIMPLEX	Ship-to-Ship, Great Lakes
202	2003	2450	KMI, Point Reyes, CA KOE, Eureka, CA
203	2006	SIMPLEX	Alaska
204	2009	2442	KFX, Astoria, OR
205	2009	2446	WLO, Mobile, AL
206	2009	2506	WAH, St. Thomas
208	2030	SIMPLEX	Virginia, Is. Intership
209	2031.5	2490	WOM, Ft. Lauderdale, FL
211	2054	SIMPLEX	British Columbia WX
212	2065	SIMPLEX	Ship-to-Ship
213	2079	SIMPLEX	Ship-to-Ship
214	2082.5	SIMPLEX	Ship-to-Ship Only
215	2086	SIMPLEX	Ship-to-Ship, Mississippi River Limited Coast
216	2086	2585	KRV, Ponce Playa, WAH, St. Thomas, VI
217	2093	SIMPLEX	Ship-to-Ship Only-Commercial Fish
218	2096.5	SIMPLEX	Ship-to-Ship Ship to Limited Coast Station
219	2115	SIMPLEX	Alaska
220	2118	SIMPLEX	Alaska
221	2118	2514	WOM, Ft. Lauderdale, FL WLC, Rogers City, MI
223	2131	2309	WOU-23, Kodiak, AK
224	2134	2312	WGG-53, Cold Bay, AK
225	2135	2530	KBP, Kahuka, HI KOP, Galveston
226	2134	SIMPLEX	Eastern Canada Intership
227	2142	2538	KCC, Corpus Christi, TX
228	2142	SIMPLEX	CA Intership
230	2158	2550	WFA, Tampa, FL WBL, Buffalo, NY PJC, Curacao
231	2166	2550	VRT, Burmuda
232	2166	2558	WOO, Manahawkin, NJ
233	2166	2582	8PO, Barbados C6XZ, Marsh Harbor
00	2182	SIMPLEX	Distress Calling
234	2198	2590	VPN-2, Nassau Scheduled Weather
235	2198	2590	WOX, N.Y.

236	2203	SIMPLEX	Ship-to-Ship Gulf of Mexico
238	2206	2582	WBL, Buffalo, NY
			VCS, Halifax, Canada
239	2237	2397	WDV-26, Cordova, WGG-56, Ketchikan, AK
240	2240	2400	WGG-58, Juneau, WGG-55, Nome, AK
241	2290	2735	9YL, North Post, Trinidad
242	2366	2450	WOU, Boston
243	2382	2466	KOU, San Pedro
244	2382	2482	WOX New York, WAK New Orleans
245	2390	2566	WOM, Ft. Lauderdale, FL
247	2406	2442	WOM, Ft. Lauderdale, FL
248	2406	2506	KMI, Point Reyes, CA
			KOE, Eureka, CA
249	2419	SIMPLEX	Alaska
250	2422	SIMPLEX	Alaska
251	2427	SIMPLEX	Alaska
252	2430	2572	WLO, Mobile, AL
254	2430	SIMPLEX	Alaska
255	2447	SIMPLEX	Alaska
256	2450	SIMPLEX	Alaska
257	2458	2506	KGN, Delambre, LA
258	2479	SIMPLEX	Alaska
259	2482	SIMPLEX	Alaska
261	2506	SIMPLEX	Alaska
262	2509	SIMPLEX	Alaska
263	2182.0	2545.0	FFP, Ft. DeFrance, Windward, Is.
264	2527	SIMPLEX	
265	2535	SIMPLEX	Alaska
267	2538	SIMPLEX	Alaska
268	2563	SIMPLEX	Alaska
269	2566	SIMPLEX	Alaska
270	2582	SIMPLEX	Alaska
271	2590	SIMPLEX	Alaska
273	2616	SIMPLEX	Alaska
275	2638	SIMPLEX	Ship-to-Ship
276	2640	SIMPLEX	
277	2670	SIMPLEX	USCG Working
278	2704	SIMPLEX	Ocean Racing
279	2735	SIMPLEX	9YL, North Post, Trinidad
280	2738	SIMPLEX	Ship-to-Ship
			All Except Great Lakes and Gulf
281	2782	SIMPLEX	Ship-to-Ship River, WFN Jeffersonville, IN
			WGK, St. Louis, MO
			WJG, Memphis, TN
282	2830	SIMPLEX	Ship-to-Ship, Gulf Only
302	3198	SIMPLEX	Alaska Point-to-Point
303	3201	SIMPLEX	Alaska Point-to-Point
304	3258	SIMPLEX	Alaska
305	3261	SIMPLEX	Alaska

306	3411	SIMPLEX	Alaska Aero
401	4063	4357.4	KMI, Point Reyes, CA WAH, St. Thomas, VI
402	4066.1	4360.5	
403	4069.2	4363.6	WOM, Ft. Lauderdale, FL
404	4072	4366.7	
405	4075.4	4369.0	WLO, Mobile, AL WLC, Roger City, MI
406	4078.5	4372.9	
407	4081.6	4376.0	
408	4084.7	4379.1	
409	4087.8	4382.2	WBL, Buffalo, NY WMI, Lorain, OH
410	4090.9	4385.3	WOO, Manahawkin, NJ
411	4094.0	4388.4	WOO, Manahawkin, NJ
412	4097.1	4391.5	WOM, Ft. Lauderdale, FL
413	4100.2	4394.6	
414	4103.3	4397.7	WLO, Mobile, AL
415	4106.4	4400.8	
416	4109.5	4403.9	KMI, Point Reyes, CA, WOO, Manahawkin, NJ
417	4112.6	4407.0	KMI, Point Reyes, CA, WOM, Ft. Lauderdale, FL
418	4115.7	4410.1	WBL, Buffalo, NY WMI, Lorain, OH WLO, Mobile, AL
419	4118.8	4413.2	
420	4121.9	4416.3	
<del>421</del>	<del>4125.0</del>	<del>4419.4</del>	
422	4128.1	4422.5	WOO, Manahawkin, NJ
423	4131.2	4425.6	WOM, Ft. Lauderdale, FL
424	4134.3	4428.7	NMG, New Orleans, LA NMN, Portsmouth, VA, Weather
425	4137.4	4431.8	
<del>4A 451</del>	<del>4125</del>	<del>SIMPLEX</del>	4A LTD Coast/Intership
<del>4B 452</del>	<del>4143.6</del>	<del>SIMPLEX</del>	4B LTD Coast/Intership
<del>4C 453</del>	<del>4419.4</del>	<del>SIMPLEX</del>	4C LTD Coast/Intership
454	4366.7	SIMPLEX	Alaska
455	4369.8	SIMPLEX	Alaska
458	4397.7	SIMPLEX	Alaska
459	4403.9	SIMPLEX	Alaska
461	4422.5	SIMPLEX	Alaska
462	4425.6	SIMPLEX	Alaska
463	4428.6	SIMPLEX	
464	5472.0	SIMPLEX	Aero Search/Rescue
465	5490.0	SIMPLEX	
501	5164.5	SIMPLEX	Alaska Public Fixed
502	5167.5	SIMPLEX	Alaska Emergency/Calling
503	5680	SIMPLEX	Aero Search/Rescue
601	6200	6506.4	NMN, Portsmouth, VA NMG, New Orleans, LA NMA, Miami, FL

602	6203.1	6509.5	
603	6206.2	6512.6	
604	6209.3	6515.7	
605	6212.4	6518.8	
606	6215.5	6521.9	
650	6215.5	SIMPLEX	6 MHZ Calling Freq.
<del>6-A 651</del>	<del>6218.6</del>	<del>SIMPLEX</del>	6A LTD Coast/Intership
<del>6-B 652</del>	<del>6221.6</del>	<del>SIMPLEX</del>	6B LTD Coast/Intership
<del>6-C 653</del>	<del>6521.9</del>	<del>SIMPLEX</del>	6C LTD Coast/Intership
801	8195.0	8718.9	
802	8198.1	8722.0	WOM, Ft. Lauderdale, FL
803	8201.2	8725.1	
804	8204.3	8728.2	KMI, Point Reyes, CA
805	8207.4	8731.3	WOM, Ft. Lauderdale, FL
806	8210.5	8734.4	
807	8213.6	8737.5	
808	8316.7	8440.6	WOO, Manahawkin, NJ
809	8219.8	8743.7	KMI, Point Reyes, CA
810	8222.9	8746.8	WOM, Ft. Lauderdale, FL
811	8226.0	8749.9	WOO, Manahawkin, NJ
812	8229.1	8753.0	
813	8232.2	8756.1	
814	8235.3	8759.2	WOM, Ft. Lauderdale, FL
815	8238.4	8762.3	WOO, Manahawkin, NJ
816	8241.5	8765.4	
817	8244.6	8768.5	
818	8247.7	8771.6	
819	8250.8	8774.7	
820	8253.9	8777.8	
821	8257.0	8780.9	
822	8260.1	8784.0	
823	8263.2	8787.1	
824	8266.3	8790.2	WLO, Mobile, AL
825	8269.4	8793.3	WOM, Ft. Lauderdale, FL
826	8272.5	8796.4	WOO, Manahawkin, NJ, WBL, Buffalo NY
827	8275.6	8799.5	WMI, Lorain, OH, WLC, Rogers City, MI
828	8278.7	8802.6	
829	8281.8	8805.7	WLO, Mobile, AL
830	8284.9	8808.8	WLO, Mobile, AL
831	8288.0	8811.9	WLO, Mobile, AL
<del>8-A 851</del>	<del>8291.1</del>	<del>SIMPLEX</del>	WOM, Ft. Lauderdale, FL
<del>8-B 852</del>	<del>8294.2</del>	<del>SIMPLEX</del>	8A LTD Coast/Intership
853	8725.1	SIMPLEX	8B LTD Coast/Intership
854	8737.5	SIMPLEX	WFN Jeffersonville
1201	12330.0	13100.8	WGK St. Louis
1202	12333.1	13103.9	KMI, Point Reyes, CA
1203	12336.2	13107.0	KMI, Point Reyes, CA
			WOO, Manahawkin, NJ

000	2182.0	2182.0	Emergency
1204	12339.3	13110.1	
1205	12342.4	13113.2	
1206	12345.5	13116.3	WOM, Ft. Lauderdale, FL
1207	12348.6	13119.4	
1208	12351.7	13122.5	WOM, Ft. Lauderdale, FL
1209	12354.8	13125.6	WOM, Ft. Lauderdale, FL
1210	12357.9	13128.7	WOO, Manahawkin, NJ
1211	12361.0	13131.8	WOO, Manahawkin, NJ
1212	12364.1	13134.9	WLO, Mobile, AL
1213	12367.2	13138.0	
1214	12370.3	13141.1	
1215	12373.4	13144.2	WOM, Ft. Lauderdale, FL
1216	12376.5	13147.3	
1217	12379.6	13150.4	
1218	12382.7	13153.5	
1219	12385.8	13156.6	
1220	12388.9	13159.7	
1221	12392.0	13162.8	
1222	12395.1	13165.9	WOM, Ft. Lauderdale, FL
1223	12398.2	13169.0	
1224	12401.3	13172.1	
1225	12404.4	13175.2	
1226	12407.5	13178.3	WLO, Mobile, AL
1227	12410.6	13181.4	
1228	12413.7	13184.5	WOO, Manahawkin, NJ
1229	12416.8	13187.6	KMI, Point Reyes, CA
1230	12419.9	13190.7	
1231	12423.0	13193.8	
1232	12426.1	13196.9	
12A 1251	12429.2	SIMPLEX	12A LTD Coast/Intership
12B 1252	12432.3	SIMPLEX	12B LTD Coast/Intership
12C 1253	12435.4	SIMPLEX	12C LTD Coast/Intership
1601	16460.0	17232.9	WOM, Ft. Lauderdale, FL
1602	16463.1	17236.0	KMI, Point Reyes, CA
1603	16466.2	17239.1	KMI, Point Reyes, CA
1604	16469.3	17242.2	
1605	16472.4	17245.3	WOO, Manahawkin, NJ
1606	16475.5	17248.4	
1607	16478.6	17251.5	
1608	16481.7	17254.6	
1609	16484.8	17257.7	WOM, Ft. Lauderdale, FL
1610	16487.9	17260.8	WOM, Ft. Lauderdale, FL
1611	16491.0	17263.9	WOM, Ft. Lauderdale, FL
1612	16494.1	17267.0	
1613	16497.2	17270.1	
1614	16500.3	17270.1	
1615	16503.4	17276.3	

16 B  
16 C

1616	16506.5	17279.4	WOM, Ft. Lauderdale, FL
1617	16509.6	17282.5	
1618	16512.7	17285.6	
1619	16515.8	17288.7	
1620	16518.9	17291.8	WOO, Manahawkin, NJ
1621	16522.0	17294.9	
1622	16525.1	17298.0	
1623	16528.2	17301.1	
1624	16531.3	17304.2	KMI, Point Reyes, CA
1625	16534.4	17307.3	
1626	16537.5	17310.4	WOO, Manahawkin, NJ
1627	16540.6	17313.5	
1628	16543.7	17316.6	
1629	16546.8	17319.7	
1630	16549.9	17322.8	
1631	16553.0	17325.9	WOO, Manahawkin, NJ
1632	16556.1	17329.0	
1633	16559.2	17332.1	
1634	16562.3	17335.2	
1635	16565.4	17338.3	
1636	16568.5	17341.4	
1637	16571.6	17344.5	
1638	16574.7	17347.6	
1639	16577.8	17350.7	
1640	16580.9	17353.8	
1641	16584.0	17356.9	WLO, Mobile, AL
1651	16593.3	SIMPLEX	16A LTD Coast/Intership
1652	16590.2	SIMPLEX	16B LTD Coast/Intership
1653	16593.3	SIMPLEX	16C LTD Coast/Intership
2201	22000.0	22596.0	WOO, Manahawkin, NJ
2202	22003.1	22599.1	
2203	22006.2	22602.2	
2204	22009.3	22605.3	
2205	22012.4	22608.4	WOO, Manahawkin, NJ
2206	22015.5	22611.5	
2207	22018.6	22614.6	
2208	22021.7	22617.7	
2209	22024.8	22620.8	
2210	22027.9	22623.9	WOO, Manahawkin, NJ
2211	22031.0	22627.0	
2212	22034.1	22630.1	
2213	22037.2	22633.2	
2214	22040.3	22636.3	KMI, Point Reyes, CA
2215	22043.4	22639.4	WOM, Ft. Lauderdale, FL
2216	22046.5	22642.5	WOM, Ft. Lauderdale, FL
2217	22049.6	22645.6	
2218	22052.7	22648.7	
2219	22055.8	22651.18	

2220	22058.9	22654.9
2221	22062.0	22658.0
2222	22065.1	22661.1
2223	22068.2	22664.2
2224	22071.3	22667.3
2225	22074.4	22670.4
2226	22077.5	22673.5
2227	22080.6	22676.6
2228	22083.7	22679.7
2229	22086.8	22682.8
2230	22089.9	22685.9
2231	22093.0	22689.0
2232	22096.1	22692.1
2233	22099.2	22695.2
2234	22102.3	22698.3
2235	22105.4	22701.4
2236	22108.5	22704.5
2237	22111.6	22707.6
2238	22114.7	22710.7
2239	22117.8	22713.8
2240	22120.9	22716.9
<i>22 A</i>	2251	22124     SIMPLEX
<i>22 B</i>	<del>2252</del>	<del>22127.1     SIMPLEX</del>
<i>22 C</i>	<del>2253</del>	<del>22130.2     SIMPLEX</del>
<i>22 D</i>	<del>2254</del>	<del>22130.3     SIMPLEX</del>
<i>22 E</i>	<del>2255</del>	<del>22136.4     SIMPLEX</del>

WOM, Ft. Lauderdale, FL  
KMI, Point Reyes, CA

KMI , Point Reyes, CA

KMI, Point Reyes, CA  
WOO, Manahawkin, NJ  
WLO, Mobile, AL

22A LTD Coast/Intership  
22B LTD Coast/Intership  
22C LTD Coast/Intership  
22D LTD Coast/Intership  
22E LTD Coast/Intership



SEA 322 FREQUENCY PROGRAM  
ITU CHANNELS

16 MHz BAND			22 MHz BAND		
CHANNEL	SHIP TRANSMIT	SHIP RECEIVE	CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
1601	16469.0	17232.9	2201	22000.0	22596.0
1602	16463.1	17236.0	2202	22003.1	22599.1
1603	16466.2	17239.1	2203	22006.2	22602.2
1604	16469.3	17242.2	2204	22009.3	22608.3
1605	16472.4	17245.3	2205	22012.4	22608.4
1606	16475.5	17248.4	2206	22015.5	22611.5
1607	16478.6	17251.5	2207	22018.6	22614.6
1608	16481.7	17254.6	2208	22021.7	22617.7
1609	16484.8	17257.7	2209	22024.8	22620.8
1610	16487.9	17260.8	2210	22027.9	22623.9
1611	16491.0	<u>17263.9</u>	2211	22031.0	22627.0
1612	16494.1	17267.0	2212	22034.1	22630.1
1613	16497.2	17270.1	2213	22037.2	22633.2
1614	16500.3	17273.2	2214	22040.3	22636.3
1615	16503.4	17276.3	2215	22043.4	22639.4
1616	16506.5	17279.4	2216	22046.5	22642.5
1617	16509.6	17282.5	2217	22049.6	22645.6
1618	16512.7	17285.6	2218	22052.7	22648.7
1619	16515.8	17288.7	2219	22055.8	22651.8
1620	16518.9	17291.8	2220	22058.9	22654.9
1621	16522.0	17294.9	2221	22062.0	22658.0
1622	16525.1	17298.0	2222	22065.1	22661.1
1623	16528.2	17301.1	2223	22068.2	22664.2
1624	16531.3	17304.2	2224	22071.3	22667.3
1625	16534.4	17307.3	2225	22074.4	22670.4
1626	16537.5	17310.4	2226	22077.5	22673.5
1627	16540.6	17313.5	2227	22080.6	22676.6
1628	16543.7	17316.6	2228	22083.7	22679.7
1629	16546.8	17319.7	2229	22086.8	22682.8
1630	16549.9	17322.8	2230	22089.9	22686.9
1631	16553.0	17325.9	2231	22093.0	22689.0
1632	16556.1	17329.0	2232	22096.1	22692.1
1633	16559.2	17332.1	2233	22099.2	22695.2
1634	16562.3	17335.2	2234	22102.3	22698.3
1635	16565.4	17338.3	2235	22105.4	22701.4
1636	16568.5	17341.4	2236	22108.5	22704.5
1637	16571.6	17344.5	2237	22111.6	22707.6
1638	16574.7	17347.6	2238	22114.7	22710.7
1639	16577.8	17350.7	2239	22117.8	22713.8
1640	16580.9	17353.8	2240	22120.9	22716.9
1641	16584.0	17356.9			
			2251	22124.0	SIMPLEX
1651	16587.1	SIMPLEX	2252	22127.1	SIMPLEX
1652	16590.2	SIMPLEX	2253	22130.2	SIMPLEX
1653	16593.3	SIMPLEX	2254	22133.3	SIMPLEX
			2255	22136.4	SIMPLEX

SEA 322 FREQUENCY PROGRAM  
SITOR CHANNELS

4 MHz BAND

TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
401	4170.5	4350.0
402	4171.0	4350.5
403	4171.5	4351.0
404	4172.0	4351.5
405	4172.5	4352.0
406	4173.0	4352.5
407	4173.5	4353.0
408	4174.0	4353.5
409	4174.5	4354.0
410	4175.0	4354.5
411	4175.5	4355.0
412	4176.0	4355.5
413	4176.5	4356.0
414	4177.0	4356.5

8 MHz BAND

TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
801	8344.0	8705.0
802	8344.5	8705.5
803	8345.0	8706.0
804	8345.5	8706.5
805	8346.0	8707.0
806	8346.5	8707.5
807	8347.0	8708.0
808	8347.5	8708.5
809	8348.0	8709.0
810	8348.5	8709.5
811	8349.0	8710.0
812	8349.5	8710.5
813	8350.0	8711.0
814	8350.5	8711.5
815	8351.0	8712.0
816	8351.5	8712.5
817	8352.0	8713.0
818	8352.5	8713.5
819	8353.0	8714.0
820	8353.5	8714.5
821	8354.0	8715.0
822	8354.5	8715.5
823	8355.0	8716.0
824	8355.5	8716.5
825	8356.0	8717.0
826	8356.5	8717.5
827	8357.0	8718.0

6 MHz Band

TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
601	6256.5	6494.5
602	6257.0	6495.0
603	6257.5	6495.5
604	6258.0	6496.0
605	6258.5	6496.5
606	6259.0	6497.0
607	6259.5	6497.5
608	6260.0	6498.0
609	6260.5	6498.5
610	6261.0	6499.0
611	6261.5	6499.5
612	6262.0	6500.0
613	6262.5	6500.5
614	6263.0	6501.0
615	6263.5	6501.5
616	6264.0	6502.0
617	6264.5	6502.5
618	6265.0	6503.0
619	6265.5	6503.5
620	6266.0	6504.0
621	6266.5	6504.5
622	6267.0	6505.0
623	6267.5	6505.5

## SEA 322 FREQUENCY PROGRAM SITOR CHANNELS

12 MHz BAND			12 MHz BAND		
TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE	TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
1201	12491.5	13071.5	1250	12516.0	13096.0
1202	12492.0	13072.0	1251	12516.5	13096.5
1203	12492.5	13072.5	1252	12517.0	13097.0
1204	12493.0	13073.0	1253	12517.5	13097.5
1205	12493.5	13073.5	1254	12518.0	13098.0
1206	12494.0	13074.0	1255	12518.5	13098.5
1207	12494.5	13074.5	1256	12519.0	13099.0
1208	12495.0	13075.0	1257	12519.5	13099.5
1209	12495.5	13075.5			
1210	12496.0	13076.0			
1211	12496.5	13076.5			
1212	12497.0	13077.0			
1213	12497.5	13077.5			
1214	12498.0	13078.0			
1215	12498.5	13078.5			
1216	12499.0	13079.0			
1217	12499.5	13079.5			
1218	12500.0	13080.0			
1219	12500.5	13080.5			
1220	12501.0	13081.0			
1221	12501.5	13081.5			
1222	12502.0	13082.0			
1223	12502.5	13082.5			
1224	12503.0	13083.0			
1225	12503.5	13083.5			
1226	12504.0	13084.0			
1227	12504.5	13084.5			
1228	12505.0	13085.0			
1229	12505.5	13085.5			
1230	12506.0	13086.0			
1231	12506.5	13086.5			
1232	12507.0	13087.0			
1233	12507.5	13087.5			
1234	12508.0	13088.0			
1235	12508.5	13088.5			
1236	12509.0	13089.0			
1237	12509.5	13089.5			
1238	12510.0	13090.0			
1239	12510.5	13090.5			
1240	12511.0	13091.0			
1241	12511.5	13091.5			
1242	12512.0	13092.0			
1243	12512.5	13092.5			
1244	12513.0	13093.0			
1245	12513.5	13093.5			
1246	12514.0	13094.0			
1247	12514.5	13094.5			
1248	12515.0	13095.0			
1249	12515.5	13095.5			

16 MHz BAND		
TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
1601	16660.5	17197.5
1602	16661.0	17198.0
1603	16661.5	17198.5
1604	16662.0	17199.0
1605	16662.5	17199.5
1606	16663.0	17200.0
1607	16663.5	17200.5
1608	16664.0	17201.0
1609	16664.5	17201.5
1610	16665.0	17202.0
1611	16665.5	17202.5
1612	16666.0	17203.0
1613	16666.5	17203.5
1614	16667.0	17204.0
1615	16667.5	17204.5
1616	16668.0	17205.0
1617	16668.5	17205.5
1618	16669.0	17206.0
1619	16669.5	17206.5
1620	16670.0	17207.0
1621	16670.5	17207.5
1622	16671.0	17208.0
1623	16671.5	17208.5
1624	16672.0	17209.0
1625	16672.5	17209.5
1626	16673.0	17210.0
1627	16673.5	17210.5
1628	16674.0	17211.0
1629	16674.5	17211.5
1630	16675.0	17212.0
1631	16675.5	17212.5
1632	16676.0	17213.0
1633	16676.5	17213.5
1634	16677.0	17214.0

SEA 322 FREQUENCY PROGRAM  
SITOR CHANNELS

16 MHz BAND			22 MHz BAND					
TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE	TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE	TELEX CHANNEL	SHIP TRANSMIT	SHIP RECEIVE
1635	16677.5	17214.5	2201	22192.5	22561.5	2240	22212.0	22581.0
1636	16678.0	17215.0	2202	22193.0	22562.0	2241	22212.5	22581.5
1637	16678.5	17215.5	2203	22193.5	22562.5	2242	22213.0	22582.0
1638	16679.0	17216.0	2204	22194.0	22563.0	2243	22213.5	22582.5
1639	16679.5	17216.5	2205	22194.5	22563.5	2244	22214.0	22583.0
1640	16680.0	17217.0	2206	22195.0	22564.0	2245	22214.5	22583.5
1641	16680.5	17217.5	2207	22195.5	22564.5	2246	22215.0	22584.0
1642	16681.0	17218.0	2208	22196.0	22565.0	2247	22215.5	22584.5
1643	16681.5	17218.5	2209	22196.5	22565.5	2248	22216.0	22585.0
1644	16682.0	17219.0	2210	22197.0	22566.0	2249	22216.5	22585.5
1645	16682.5	17219.5	2211	22197.5	22566.5	2250	22217.0	22586.0
1646	16683.0	17220.0	2212	22198.0	22567.0	2251	22217.5	22586.5
1647	16683.5	17220.5	2213	22198.5	22567.5	2252	22218.0	22587.0
1648	16684.0	17221.0	2214	22199.0	22568.0	2253	22218.5	22587.5
1649	16684.5	17221.5	2215	22199.5	22568.5	2254	22219.0	22588.0
1650	16685.0	17222.0	2216	22200.0	22569.0	2255	22219.5	22588.5
1651	16685.5	17222.5	2217	22200.5	22569.5	2256	22220.0	22589.0
1652	16686.0	17223.0	2218	22201.0	22570.0	2257	22220.5	22589.5
1653	16686.5	17223.5	2219	22201.5	22570.5	2258	22221.0	22590.0
1654	16687.0	17224.0	2220	22202.0	22571.0	2259	22221.5	22590.5
1655	16687.5	17224.5	2221	22202.5	22571.5	2260	22222.0	22591.0
1656	16688.0	17225.0	2222	22203.0	22572.0	2261	22222.5	22591.5
1657	16688.5	17225.5	2223	22203.5	22572.5	2262	22223.0	22592.0
1658	16689.0	17226.0	2224	22204.0	22573.0	2263	22223.5	22592.5
1659	16689.5	17226.5	2225	22204.5	22573.5	2264	22224.0	22593.0
1660	16690.0	17227.0	2226	22205.0	22574.0	2265	22224.5	22593.5
1661	16690.5	17227.5	2227	22205.5	22574.5	2266	22225.0	22594.0
1662	16691.0	17228.0	2228	22206.0	22575.0	2267	22225.5	22594.5
1663	16691.5	17228.5	2229	22206.5	22575.5			
1664	16692.0	17229.0	2230	22207.0	22576.0			
1665	16692.5	17229.5	2231	22207.5	22576.5			
1666	16693.0	17230.0	2232	22208.0	22577.0			
1667	16693.5	17230.5	2233	22208.5	22577.5			
1668	16694.0	17231.0	2234	22209.0	22578.0			
1669	16694.5	17231.5	2235	22209.5	22578.5			
			2236	22210.0	22579.0			
			2237	22210.5	22579.5			
			2238	22211.0	22580.0			
			2239	22211.5	22580.5			
			2240	22212.0	22581.0			
			2241	11112.5	22581.5			

SEA-322 FREQUENCY PROGRAM  
SIMPLEX-SITOR CHANNELS

TELEX CHANNEL	SHIP TRANSIT/ RECEIVE	TELEX CHANNEL	SHIP TRANSIT/ RECEIVE
<u>4 MHz</u>		<u>6 MHz</u>	
401	4170.5	671	6268.0
402	4171.0	672	6268.5
403	4171.5	673	6269.0
471	4177.5	674	6269.5
472	4178.0		
473	4178.5		
474	4179.0		
475	4179.5		
<u>8 MHz</u>		<u>12 MHz</u>	
871	8357.5	1271	12520.0
872	8297.6	1272	12520.5
873	8298.1	1273	12521.0
874	8298.6	1274	12521.5
875	8299.1	1275	12522.0
876	8299.6	1276	12522.5
		1277	12523.0
		1278	12523.5
		1279	12524.0
		1280	12524.5
		1281	12525.0
		1282	12525.5
		1283	12526.0
		1284	12526.5
<u>16 MHz</u>		<u>22 MHz</u>	
1671	16695.0		
1672	16695.5		
1673	16696.0		
1674	16696.5		
1675	16697.0	2272	22226.0
1676	16697.5	2273	22226.5
1677	16698.0		
1678	16698.5		
1679	16699.0		
1680	16699.5		
1681	16700.0		
1682	16700.5		
1683	16701.0		
1684	16701.5		
1685	16702.0		
1686	16702.5		
1687	16703.0		
1688	16703.5		
1689	16704.0		
1690	16704.5		
1691	16705.0		
1692	16705.5		

### 3.5 CAUTION! FREQUENCY TOLERANCE

Under FCC Rules, the frequency tolerance for the Marine Service is  $\pm 15$  Hz. In order to achieve this accuracy a frequency counter with a long term accuracy of 1-3 Hertz should be used.

All work affecting the transmitter performance must be done by, or under the supervision of, a person holding at least a General Radio-telephone FCC license.

### 3.6 SETTING THE TRANSMITTER FREQUENCIES

#### 3.6.1 THE MASTER CLOCK OSCILLATOR

Select the highest desired transmitter frequency. (Such as 22101.5 KHz). With the transmitter output connected to an appropriate dummy load and a few watts of re-inserted carrier being generated, connect an appropriate counter to the RF dummy load and adjust trimmer capacitor C179 on the transceiver main board (ASY-0322-01) for the correct carrier frequency. C179 is located next to U22 and the foam crystal enclosure.

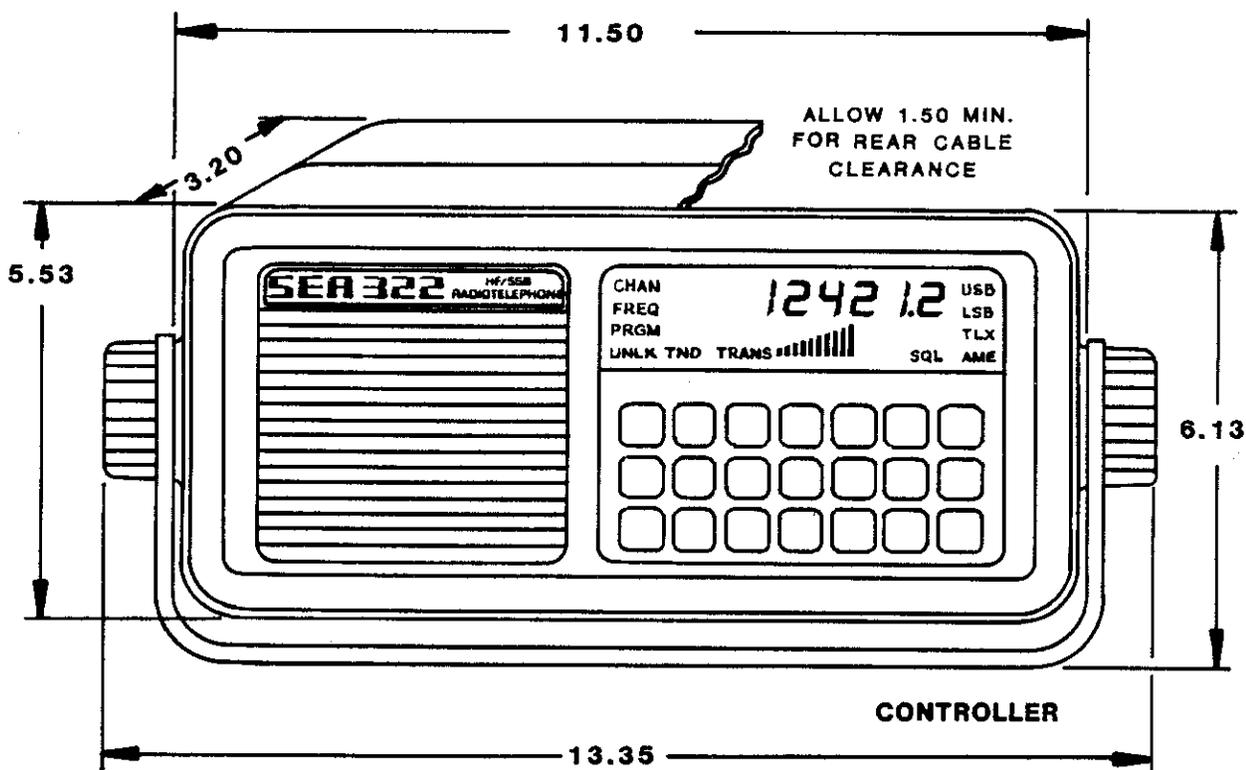
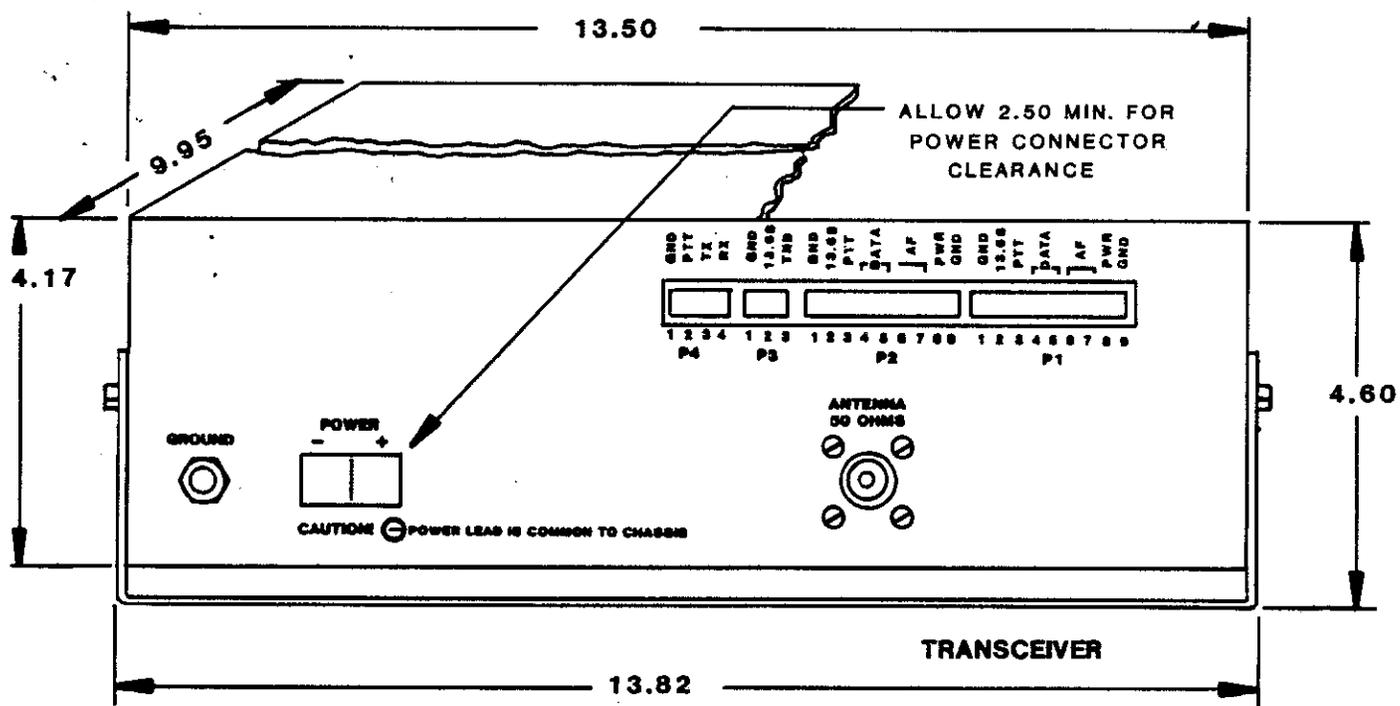
## 4. INSTALLATION

### 4.1 MOUNTING THE TRANSCEIVER

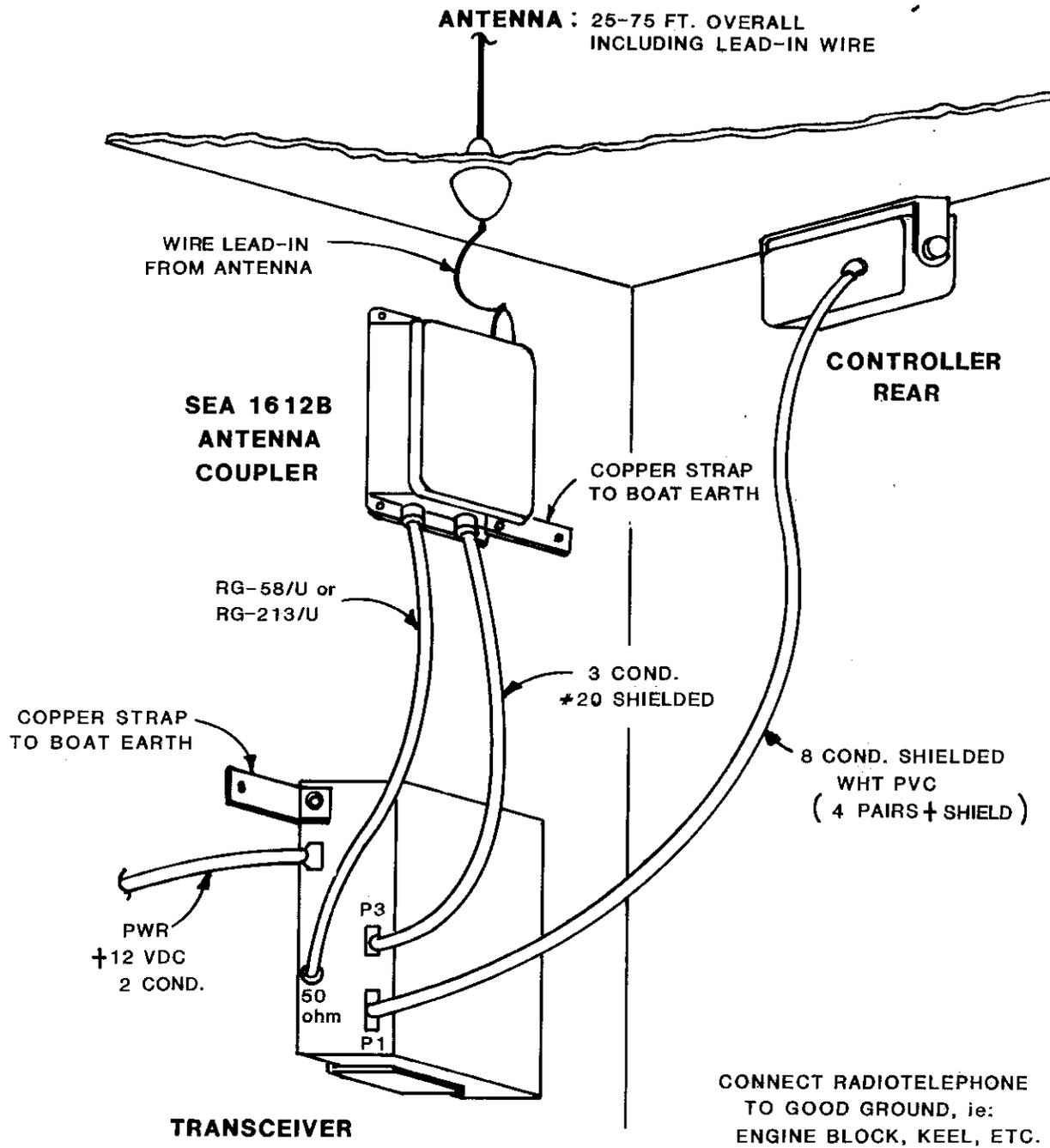
The SEA 322 transceiver unit is compact enough to allow great flexibility in location, even on smaller vessels. Several options for mounting are available. The mounting bracket fits underneath or on top of the transceiver for bulkhead, overhead or shelf locations. Figure 4.1 shows the outline dimensions of the SEA 322 transceiver and mounting bracket. The bracket can be used as a template to locate the mounting holes. When choosing a location for the transceiver, take care to avoid areas directly over a heater or lacking adequate ventilation. If the transceiver is mounted in a closet, insure that it is located in a dry environment where such items as raingear will not be hung above it or piled on it.

### 4.2 MOUNTING THE CONTROLLER

The controller may be mounted at the operator's station using either the standard gimbals mount or bulkhead mounting plates. Both are supplied with the controller. The gimbal bracket or bulkhead plates can be used as drilling and cutting templates to insure correct fit. Figure 4.1 shows the outline dimensions of the controller and bracket.



**OUTLINE DIMENSIONS WITH BRACKETS  
SEA 322**



## TYPICAL INSTALLATION

SEA 322

FIGURE 4.2

### 4.3 A TYPICAL INSTALLATION

Figure 4.2 shows a typical installation consisting of four parts: (1) The transceiver unit; (2) The controller unit; (3) System inter-connection cables; (4) The antenna system.

Any radio communications system operating in the MF-HF spectrum MUST have an adequate ground connection, otherwise the overall efficiency of the radio installation is degraded. In extreme cases, it may be impossible to properly load the radiotelephone into the antenna.

The 50 Ohm output impedance of the SEA 322 makes it necessary to employ an antenna system of the resonant or externally matched type. The use of the SEA 1612B antenna coupler in conjunction with a whip antenna allows an efficient installation which will cover both the MF and HF bands. The SEA 1612B was designed specifically for Marine applications and will easily interface with the transceiver.

On wooden or fiberglass boats, the use of a copper ground plate may be necessary. On sailboats, the keel may perform adequately as a ground system. In any case, the ground system MUST be joined to the antenna coupler with a heavy copper strap.

### 4.4 TRANSCEIVER UNIT REAR PANEL CONNECTION AND FUSES

#### 4.4.1 THE POWER CONNECTOR

A heavy duty power plug is used on the SEA 322 to assure minimum voltage drop in the primary power circuit. See Figure 4.3.1 for proper assembly of the power plug.

#### 4.4.2 THE RF CONNECTOR

One type UHF female connector is provided on the SEA 322 rear panel. The output impedance of this transceiver is 50 Ohms. The most common types of coaxial cables used are RG-58C/U and RG-213/U. The correct mating plug is the PL-259 or Amphenol 83-1SP.

#### 4.4.3 THE TRANSCEIVER/CONTROLLER INTERFACE PLUGS

Two nine contact screw terminal type plugs are provided on the SEA 322 transceiver rear panel, Figure 4.3.3, to provide interconnection with the system controller(s). These are P1 and P2. Either or both may be used to connect the system controller(s), since all contacts are directly in parallel. Up to a total of four controllers and 100 feet of control cable can be supported by the system.

#### 4.4.4 THE CONTROLLER INTERFACE CONNECTOR

The controller cable interface connector is located inside the plastic housing, immediately above the loudspeaker. To gain access to this connector, the 6 retaining screws must be removed, allowing the two halves of the controller enclosure to be separated. The connector is a 9 terminal screw type located on the printed circuit board immediately above the loudspeaker. See Figure 4.3.4. Cabling is connected pin to pin between the controller and the transceiver unit. That is, pin 1 on the controller connects to pin 1 on the transceiver, etc. Cable entry into the plastic housing is through the watertight stuffing gland on the rear of the housing.

##### 4.4.4.1 INTERFACE CABLE TERMINAL FUNCTIONS

Pins 1 and 9 - System common ground. Used for D.C. Power return and termination of shield braides.

Pin 2 - 13.6 Volts switched from transceiver to controller.

Pin 3 - PTT line for radiotelephone. Connecting this terminal to ground places the radiotelephone in the TRANSMIT mode.

Pins 4 and 5 - Balance data lines. Approximately RS485 format, differential logic. Use a twisted pair, preferably individually shielded.

Pins 6 and 7 - Balanced, bidirectional audio lines. Nominal audio level is approximately 1 volt peak to peak. Use a twisted pair, preferably individually shielded.

Pin 8 - PWR buss. This is the ON-OFF control line from the controller to the radiotelephone relay control circuitry. Momentarily grounding this line will "toggle" the power controller to its opposite state.

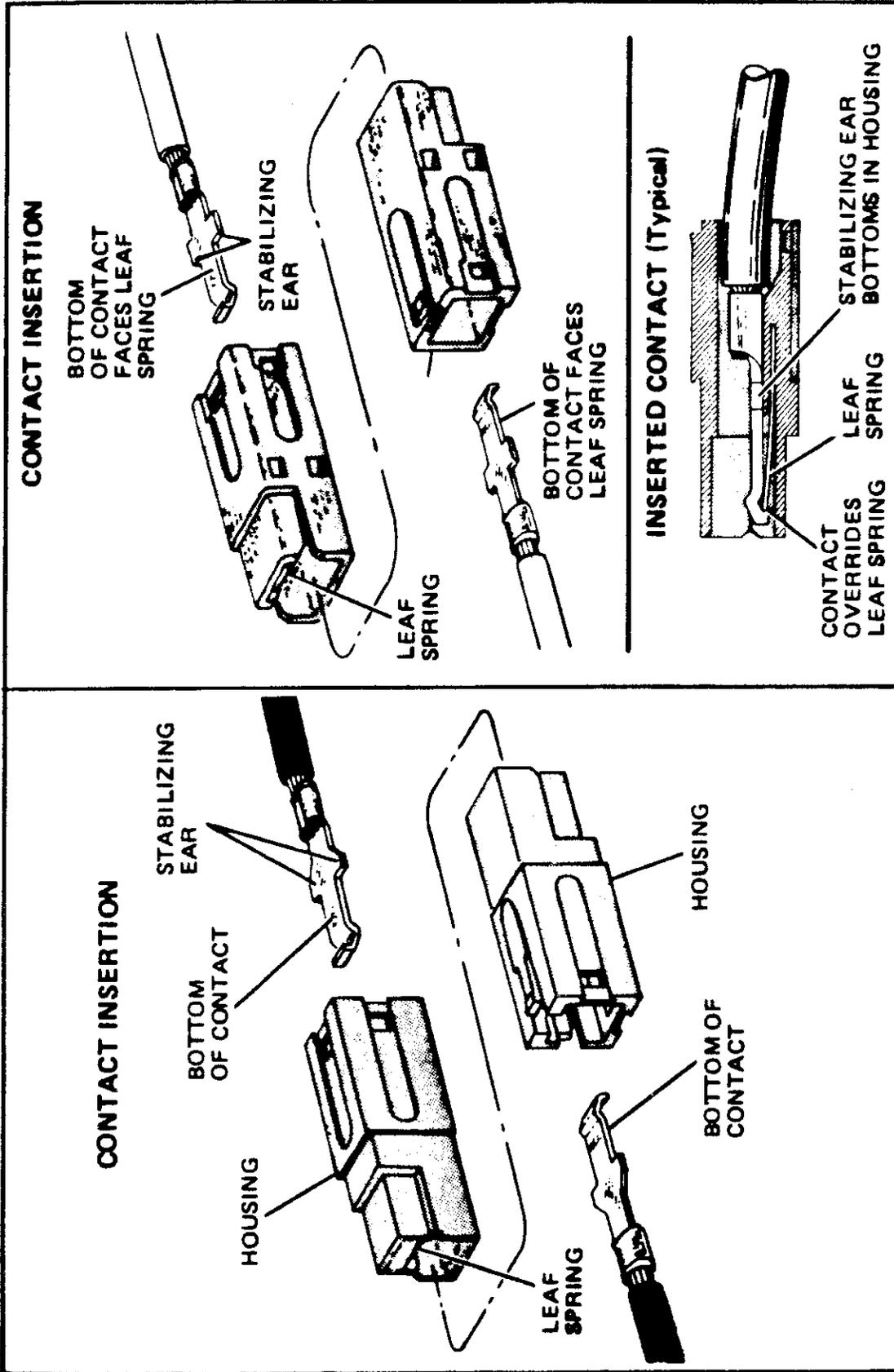
##### 4.4.4.2 ANTENNA COUPLER INTERFACE PLUG

A three contact screw terminal type plug, P3, is provided on the transceiver unit to allow interconnection with the SEA 1612B antenna coupler. See Figure 4.3.3 P3 provides the following connections:

Pin 1 - System ground return.

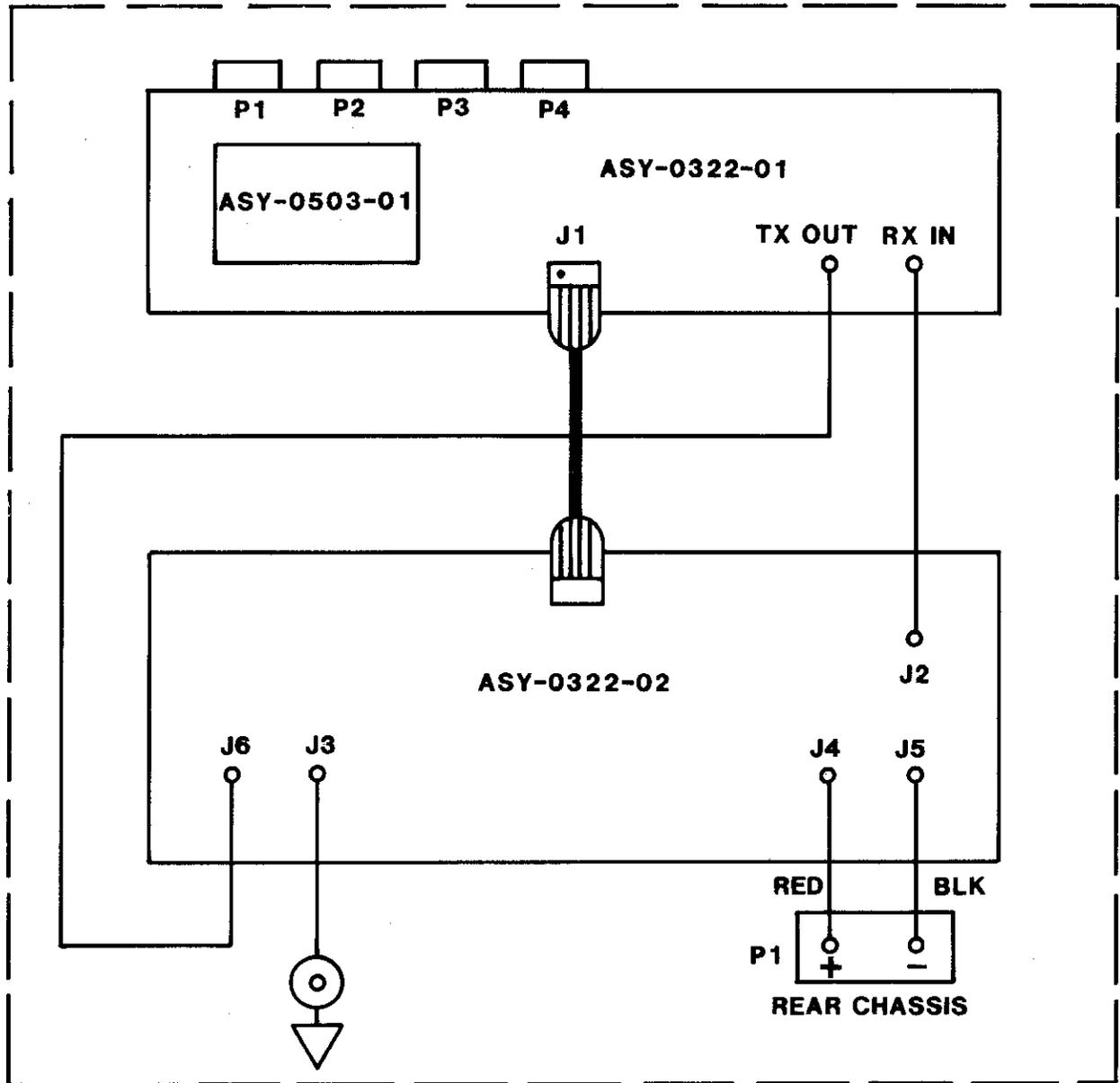
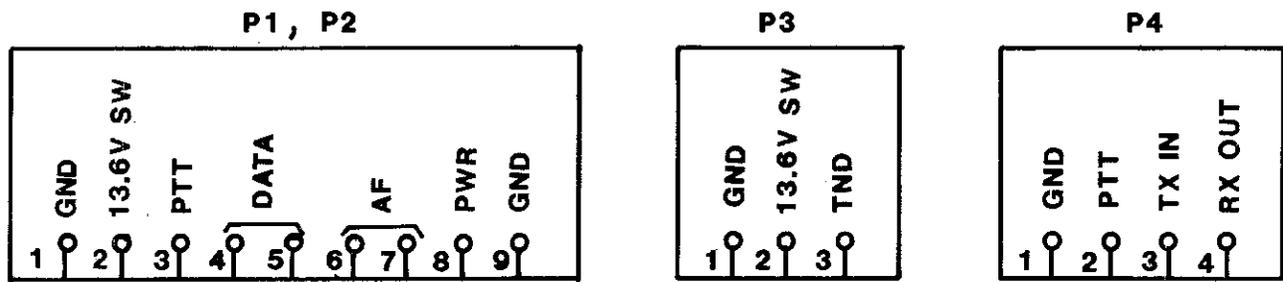
Pin 2 - 13.6 Volts switched. This voltage source is fused by the 5 amp fuse on the radiotelephone power amplifier board, F3. Maximum current not to exceed 1.5 amps.

Pin 3 - "TUNED" flag line from coupler to radiotelephone. This line goes low at the completion of a successful coupler tune cycle.

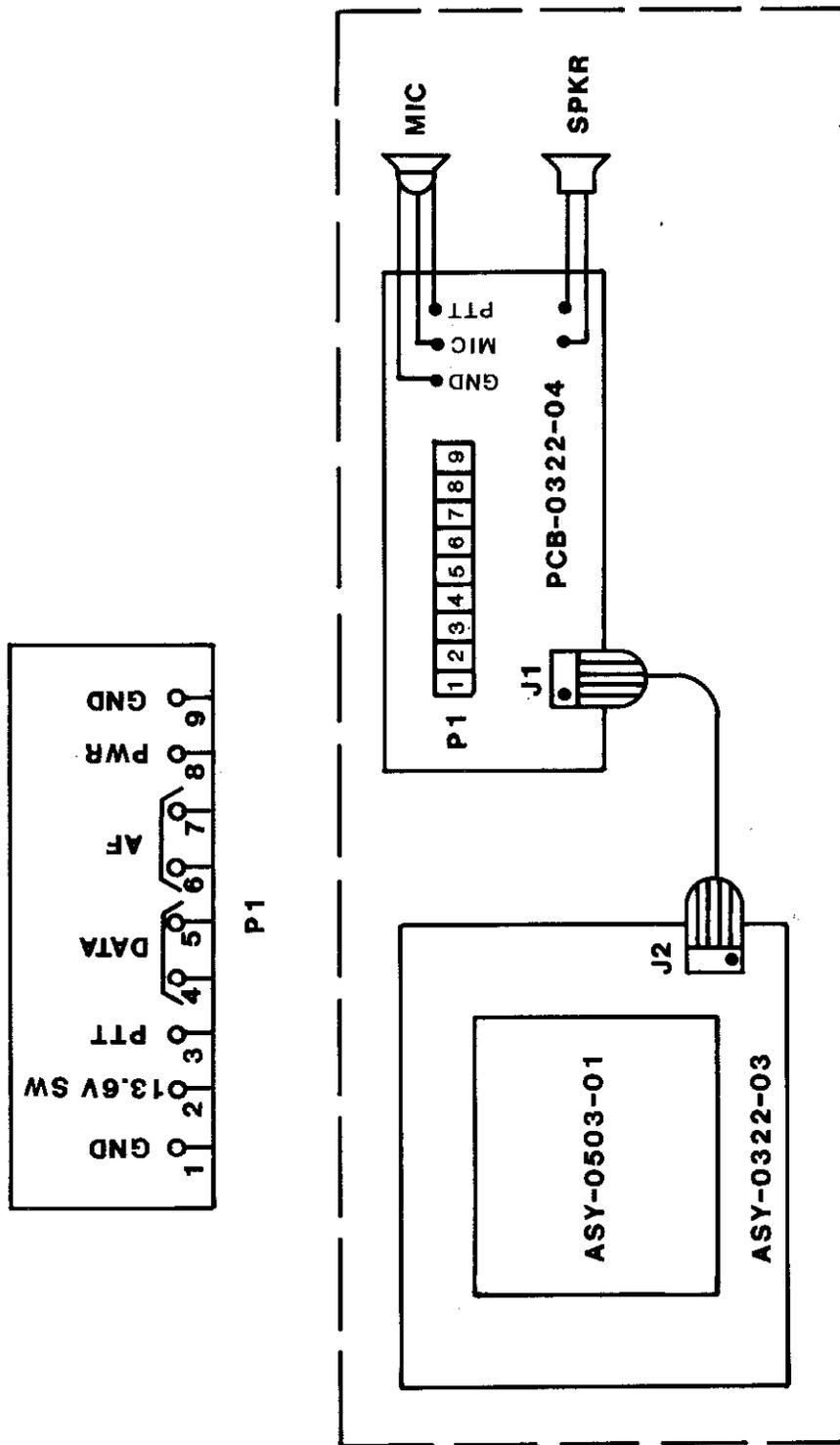


**POWER PLUG ASSEMBLY**

**FIGURE 4.3.1**



**TRANSCEIVER  
 WIRING DIAGRAM SEA 322**



**CONTROLLER  
WIRING DIAGRAM SEA 322**

**FIGURE 4.3.4**

#### 4.4.4.3 ACCESSORY INTERFACE PLUG

A four contact screw terminal type plug, P4, is provided on the transceiver unit to allow interconnection with such accessories as the SEA SITOR system. See Figure 4.3.3. P4 provides the following connections:

Pin 1 - System ground return.

Pin 2 - Radiotelephone PTT line. Grounding this terminal places the radiotelephone in the TRANSMIT mode.

Pin 3 - Low level transmitter audio input. Single ended. Allows interconnection of audio sources such as SITOR, auto-alarm, etc.

Pin 4 - Low level receiver audio output. Single ended at approximately 1 volt peak to peak. Allows interconnection of accessories such as SITOR, NECODE, etc.

#### 4.4.5 FUSING

Three fuses are provided in the SEA 322, all mounted internally on the PA/Filter Board (ASY-0322-02).

Fuses F1 and F2 are 15 AMP, 3AG fast blow fuses. Each fuse protects one pair of power output transistors, and each fuse is provided with a reverse polarity protection diode.

Fuse F3 is a 5 AMP, 3AG fast blow fuse. This fuse protects the low level circuitry in the SEA 322 and also provides a fused 13 Volt power buss for an external antenna coupler. This fuse is also provided with a reverse polarity protection diode.

#### 4.4.6 THE GROUND CONNECTION

A stainless steel bolt and nut are provided on the rear panel to allow a low resistance connection between the radiotelephone chassis and the engine block, keel or similar RF ground system.

### 5. THEORY OF OPERATION

#### 5.1 GENERAL

The SEA 322 is a double conversion HF SSB transceiver. Certain circuits perform the same function in receive and transmit (bilateral design). The first intermediate frequency (IF) is approximately 75 MHz and permits the use of low pass filters to provide excellent image, spurious and harmonic rejection. This type of broad band design results in a minimum of tuned circuits. The second IF of 10.7 MHz

allows for good secondary image rejection and the use of relatively inexpensive crystal filters for sideband selection.

The SEA 322 uses a unique multi loop PLL local oscillator system to allow complete frequency coverage without the addition of channel control crystals. Since the high stability reference oscillators are all phase locked to a high stability reference oscillator, the frequency stability is strictly a function of the 4020.00 KHz Master Clock.

Most operating functions of the SEA 322 are controlled through the controller keyboard. The keyboard is used, along with the custom LCD display, as a control terminal. This allows the operator to communicate with the small microprocessor based computer which actually controls the various transceiver functions.

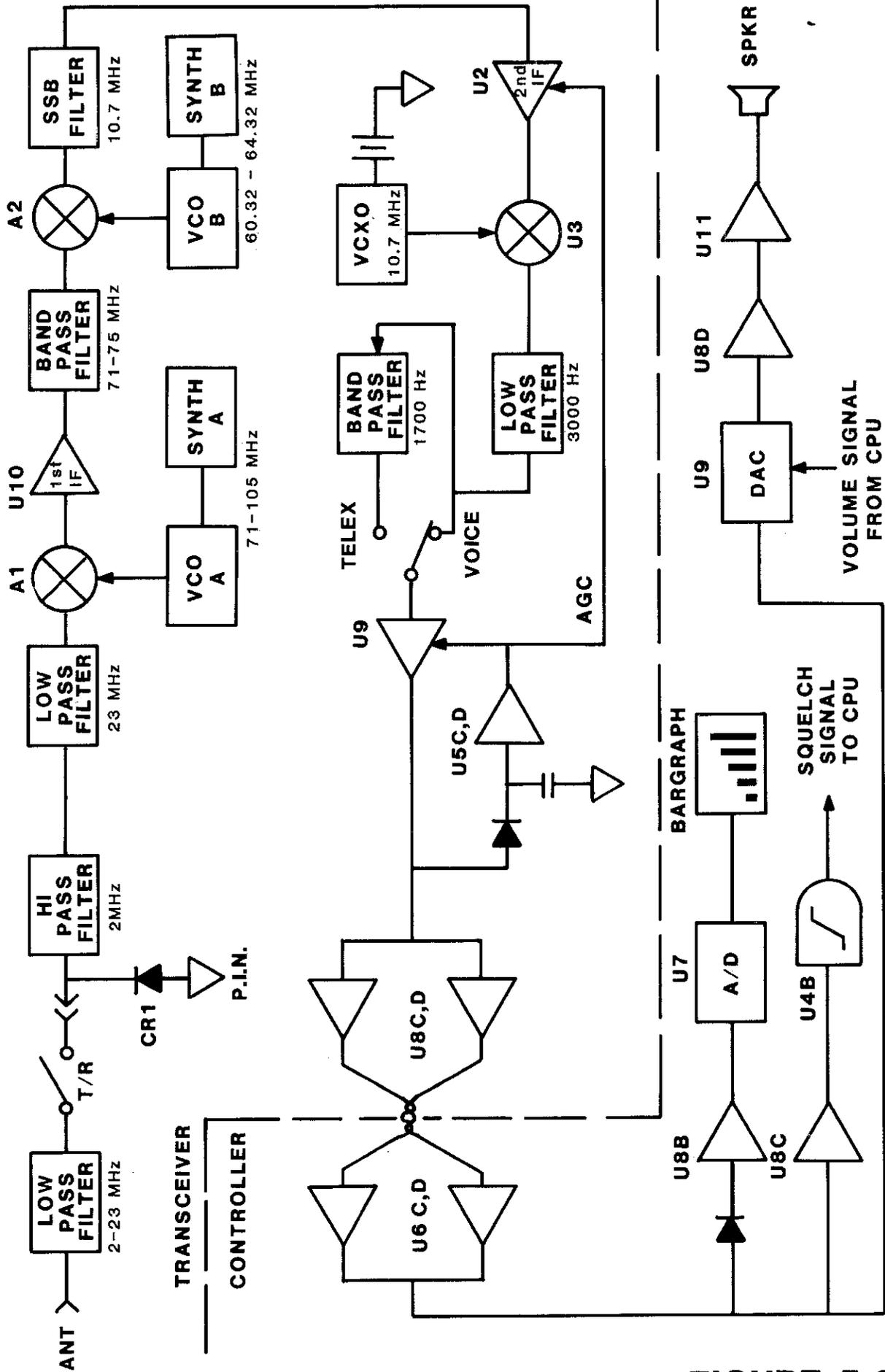
## 5.2 THE RECEIVER

### 5.2.1 BLOCK DIAGRAM

Figure 5.2.1 shows the block diagram of the receive mode. The received RF signal is routed from the rear panel antenna jack to J3 on the PA/Filter Board. On this PC Board, the signal is routed through a relay selected set of low pass filters and the antenna relay, K9 to J2. From J2 the signal goes to the RX input jack on the Main Board, RX IN. From RX IN the signal passes first through a P.I.N. Protector Circuit and then through a 2 MHz high pass filter. A second low pass filter with a cutoff frequency of 23 MHz completes the "front end" selectivity. No less than two cascaded filters are used, providing excellent image and first IF rejection.

After filtering, the signal is applied to mixer, A1, where it is mixed with a signal from the A VCO and up converted to the first IF frequency of approximately 75 MHz. The output from A1 is then passed through U10, a bilateral wideband amplifier and a bandpass filter consisting of T2, T3 and T7. The filter passband is approximately 70 to 75 MHz. The output from this bandpass filter is then applied to the input of the second mixer, A2.

The wideband first IF signal is combined with a signal from VCO B in mixer A2 to provide the second IF signal of 10.7 MHz. The second IF signal is then passed through FL1, a narrow band single sideband filter. Note that the 10.7 MHz filter normally selects the LOWER sideband. This is actually the UPPER sideband because of the frequency inversion which occurred at the first mixer. The filtered signal is then amplified in IF amplifier U2 and combined with the 10.7 MHz BFO frequency in balanced modulator U3. The output from U3 is a low level audio signal which is passed through active low pass filter U5B and



RECEIVER BLOCK DIAGRAM SEA 322

FIGURE 5.2.1

(when TELEX mode is selected) through bandpass filter U5A. The filtered audio signal is then applied through control switches to the gain controlled audio amplifier, U9. U9, U5C and U5D form a closed loop gain controlled amplifier which also generates the AGC voltage for IF amplifier, U2. The AGC is generated from the output of U5C by CR 13 and then buffered by U5D prior to application to the AGC control buss. The AGC is of the fast attack, slow release type tailored for SSB communications. The output from the gain controlled audio stage is switched through U7C to the balanced line driver U8C and U8D. The output from the line driver is then passed through the bilateral audio line to the controller. The combination of IF and audio stage AGC serves to hold the audio line level at approximately 1 volt peak to peak over most of the useful dynamic range of the receiver.

At the controller, the balanced audio signal is passed through the line receiver circuitry, consisting of U6C and U6D. The resultant single-ended audio signal is then routed to the volume control circuitry, the bar graph A to D converter and the squelch limiter.

The volume control circuitry consists of U9, a DAC832. This is a D to A converter which is used as a combination volume control and squelch gate. The attenuation level in U9 is a function of the status of the squelch routine running in the controller CPU and the volume level demanded by the operator through the volume keys on the controller keypad.

The bar graph circuitry consists of a peak detector formed by diodes CR5 and CR6. The DC output from the detector is buffered by U8B and applied to the input of U7, and A to D converter. The output from U7 is serially transmitted to the controller CPU which uses the data to adjust the level of the bar graph on the LCD display. The resultant VU meter is approximately logarithmic with a dynamic range of approximately 40 dB.

The squelch limiter consists of amplifier U8C which is coupled through R46 to NAND gate U4B. The output of U4B, which is heavily limited audio is then applied to the timer input of the controller CPU board.

The squelch and volume controlled audio from U9 is then passed through buffer amplifier U8D to the input of the 5 watt power amplifier, U11. U11 provides the loudspeaker signal.

### 5.3 RECEIVE RF CIRCUITRY AND FIRST MIXER

As previously discussed, an incoming signal is first passed through a system of cascaded low and high pass filters, a T/R relay and a P.I.N. diode device which is designed to protect the sensitive input

mixer from damage due to high RF overloads. On the RF board, switching diodes CR5 and CR6 are forward biased by the +10V Rx buss, thus passing the received signal to the double balanced mixer A1. The use of a hot carrier diode double balanced mixer assures minimal cross modulation and intermodulation distortion in the receiver front end. The 2 MHz high pass filter provides some protection from the very large signals generated by nearby standard broadcast transmitters.

#### 5.3.1 THE BILATERAL 75 MHz WIDEBAND IF AMPLIFIER

The output from A1 is a band of signals which include the desired signal. U10, a high gain, low noise MMIC, in conjunction with P.I.N. Diodes CR 18, 19, 20 and 21 form a low noise wideband amplifier which can operate bilaterally. In the receive mode, this amplifier provides a proper wideband termination for the IF port of A1 and sufficient gain to override the loss in the input filters, mixer A1 and the 70 to 75 MHz bandpass filter. The overload point for U10 is approximately equal to that of the double balanced mixers used in the SEA 322, so the dynamic range of the receiver is preserved.

#### 5.3.2 SECOND MIXER AND 10.7 MHz SSB FILTER

Once the 75 MHz IF signal is amplified in U10, it is applied to the second double balanced mixer, A2, along with the VCO B signal at about 62.5 MHz. the DIFFERENCE frequency output, at 10.7 MHz is then passed through FL1, a narrow bandwidth lower sideband filter. The LOWER sideband at this point is equivalent to a signal frequency UPPER sideband signal, since the first conversion INVERTS the information band, while the SECOND conversion to 10.7 MHz does not.

#### 5.3.3 10.7 MHz IF AMPLIFIER AND PRODUCT DETECTOR

The twice converted, amplified and filtered signal from the 10.7 MHz filter (FL1) is then passed through the second IF amplifier. This is a tuned amplifier which uses the MC1350P. This device has high gain and an excellent, temperature stable AGC function which can provide approximately 50 dB of automatic gain control. The amplified IF signal is transformer coupled to U3. This is an integrated circuit double balanced mixer which combines the IF signal with 10.7 MHz BFO signal and provides a detected audio signal from Pin 6.

#### 5.3.4 AUDIO PREAMPLIFIER/FILTER

U5B is connected as a moderate gain active low pass filter with a cutoff frequency of approximately 3000 Hz and a slope of 12 dB/octave. Some additional rolloff is provided in the product detector by C53. The effect of this filter is to remove the high frequency "hiss" present at the output of the product detector and to enhance the speech

signal to noise ratio. The output from U5B is connected to the "voice" switch, U6A and the input of the "TELEX" audio bandpass filter, U5A. This is an active bandpass filter, centered at 1700 Hz, the midpoint between TELEX mark and space frequencies in a normal SSB receiver. The primary purpose of this filter is to prevent the AGC system from operating on adjacent channel TELEX signals when TELEX operation is desired. The output from the TELEX bandpass filter is connected to the "NOT voice" switch U6B. In normal voice operation, the output from U5B is connected to the following stages, while in TELEX operation, the output from U5A is selected. The gain of the TELEX filter is adjusted to provide approximately the same gain/bandwidth level as the normal voice filter in order to minimize AGC variations between modes.

### 5.3.5 AUDIO AGC AMPLIFIER

Integrated circuit U9 in conjunction with U5C, CR 13 and U5D provide an audio AGC stage with approximately 40 dB dynamic range while simultaneously generating an AGC voltage which controls the 10.7 MHz IF amplifier. Since the IF amplifier and the gain controlled audio stage make use of the same amplifier chip, the MC1350P, there is no problem with AGC buss compatibility. In practice, the audio input signal from U9 is supplied to both the AGC generator circuitry and the audio line driver circuit. The AGC generator consists of buffer amplifier U5C which provides a voltage gain of 5 for the audio signal while also setting the DC threshold level for the following peak detector diode, CR13. CR13 is a hot carrier diode which generates a fast attack, slow release AGC signal which is then buffered by follower U5D. AGC attack time is adjusted with R84, while the hold time constant is adjusted by R85. The buffered AGC signal from U5D is connected through R80 to the AGC input of the audio AGC stage, U9, and through R86 to the AGC input of the IF amplifier, U2. Adjusting these resistors allows the AGC characteristic of the overall receiver to be adjusted for maximum dynamic range. Transistor Q9 serves as a switch to prevent the AGC buss voltage from feeding through U2 when the transceiver is in the TRANSMIT mode.

### 5.3.6 THE RECEIVER AUDIO LINE DRIVER

The gain leveled audio output from U9 is applied through RX switch U7C, to the receiver audio line driver circuitry. This circuit, consisting of U8C and U8D, converts the high impedance, single-ended receiver audio to a balanced, low impedance signal. Simultaneously, the circuit has sufficient gain to allow the leveled audio signal to be adjusted to the desired interface level of 1 volt peak to peak. In practice, U8C serves as an amplifier and one phase of the line driver circuit. U8C gain is adjusted by R95 to provide the 1 volt peak to peak output required. U8D is connected as a unity gain inverter which

provides the opposite phase of the line. U8 is a type LM348 quad operational amplifier. This insures that the amplifiers can provide undistorted drive to the low line impedance. TX switch U7D shorts the stage gain control resistor, R95, when the transceiver is in the TRANSMIT mode, reducing the gain of the audio line driver to far below unity and preventing crosstalk from the receiver circuitry from disturbing the transmitter voice output.

### 5.3.7 THE AUDIO T/R GATES

Since both transmitter and receiver systems in the SEA 322 utilize a common audio intercommunications channel, the audio circuitry is quite unique. Both transceiver and controller units make use of similar audio line driver/receiver circuitry. In the transceiver, however, some additional circuitry is required to properly isolate the transmitter and receiver audio channels. This is accomplished by the audio T/R gating system.

As previously mentioned, the receiver audio is filtered through either the audio low pass filter or the audio low pass filter AND the TELEX bandpass filter, depending on the transceiver operating mode required. Filter selection is through U6A and U6B, the "voice" gate and "NOT voice" gate respectively. These gates are part of a quad analog gate chip, the 4066, and are actuated by control busses.

The remaining two gates in U6, U6C and U6D form part of the audio T/R gating system, along with another quad analog gate chip, U7 and MOSFET Q5.

In the controller, MOSFET Q4 is turned ON in the RECEIVE mode to prevent any possibility of feedback from the microphone audio line.

#### 5.3.7.1 RECEIVE MODE AUDIO GATING

In the receive mode, gates U6C, U7B, U7C and MOSFET Q5 are in the "ON" state, while U6D, U7A and U7D are "OFF". Thus, the receiver audio is connected to the gain controlled audio amplifier through U6C, while the transmitter line receiver is disconnected by U6D. The output from the gain controlled audio amplifier is connected to the audio line driver through U7C while being disconnected from the transmitter modulator channel by U7A and Q5. U7B serves to reduce the gain of the transmitter audio channel to a very low value, thus eliminating receiver feedback from the common audio channel.

#### 5.3.7.2 TRANSMIT MODE AUDIO GATING

In the transmit mode, gate states are reversed. Now receiver audio is blocked by U6C and U7C, while transmitter audio is passed by U6D, U7A

and Q5. The gain of the transmitter line receiver is restored to normal by U7B, while the receiver line transmitter gain is reduced to nearly zero by U7D.

Q5 provides extra receiver audio isolation by grounding the transmitter audio line to the balanced modulator (product detector) in the receive mode.

#### 5.3.8 VOLUME AND SQUELCH CONTROL CIRCUITRY

The volume control and squelch gate circuitry is located in the controller and makes use of U9, a monolithic digital to analog converter chip (DAC). The audio signal from the line receiver is fed into the DAC output pin and the volume controlled audio signal is taken from the Vref pin. The attenuation level in the chip is controlled by the controller CPU which "talks" to the DAC on the bytewise data pins, D0 through D7. 256 Discrete audio levels are available.

#### 5.3.9 THE AUDIO POWER AMPLIFIER

The output signal from the volume/squelch control DAC is passed through buffer U8D to the non-inverting input of power audio amplifier IC, U11. This chip boosts the audio signal to at least 4 watts into the 3.2 ohm loudspeaker. A separate speaker ground line is carried out to J2 to minimize ground loop problems.

### 5.4 THE TRANSMITTER

#### 5.4.1 BLOCK DIAGRAM

Figure 5.4.1 shows the block diagram of the SEA 322 in the transmit mode. In the controller, the microphone input first passes through U8A, a combination amplifier, low pass filter which provides bandwidth limited gain for the approximately 50 mV peak to peak output signal from the microphone. The output from U8A is then sent to the transmitter line driver circuitry, U6A and U6B. The transmitter line driver circuitry converts the single-ended signal from U8A to balanced line configuration and adjusts the amplitude to approximately 1 volt peak to peak. The line signal is then routed through a twisted pair to the transceiver unit. Note also that the line signal from the microphone also passes through the controller line receiver to the controller audio circuitry as well. Thus, the bargraph circuitry functions in the transmit mode, providing a VU type display of the relative microphone output level.

At the transceiver, the transmitter line receiver, U8A and U8B, converts the balanced microphone audio signal back to a single-ended signal which is applied through U6D to the gain controlled audio

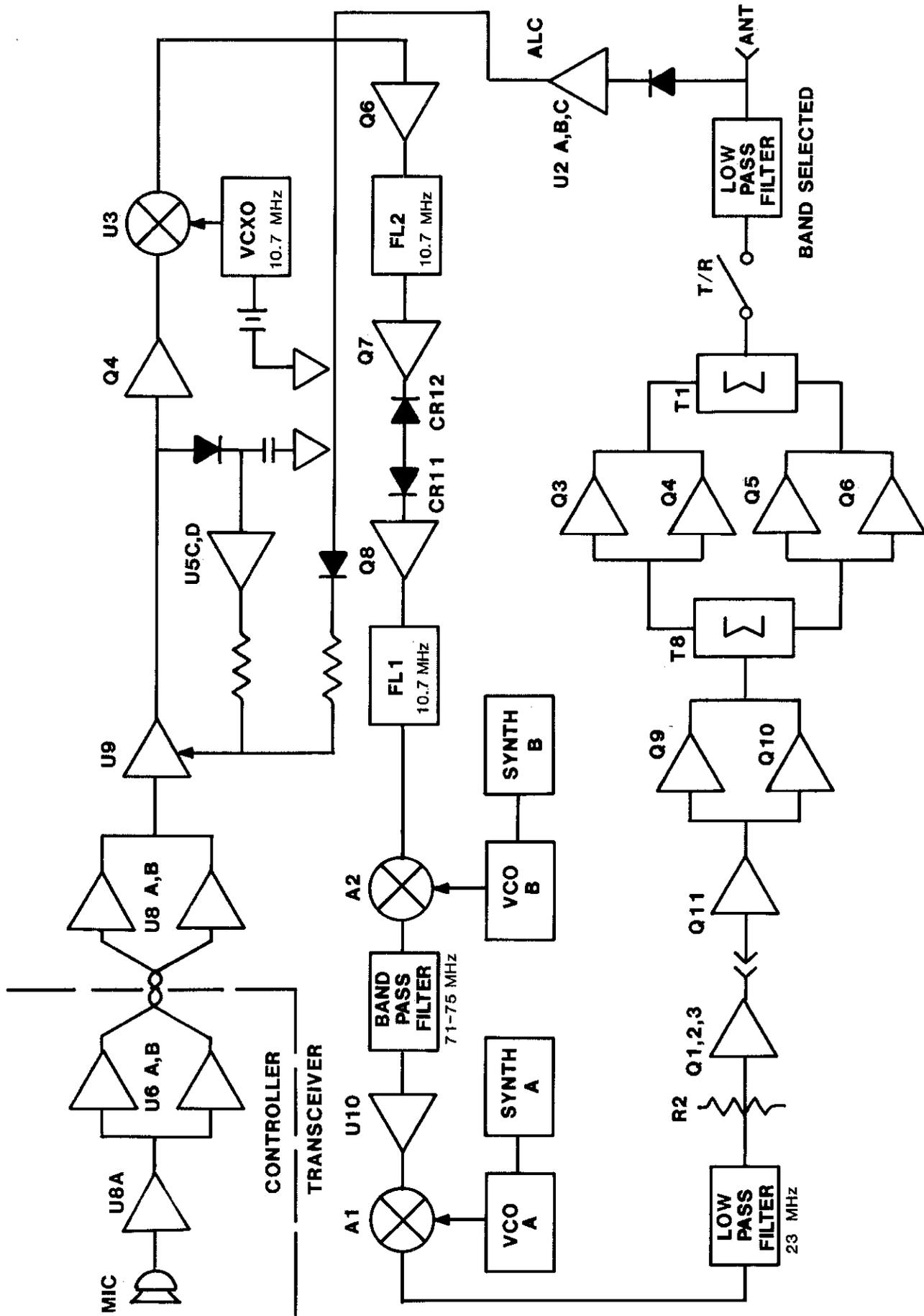


FIGURE 5.4.1

amplifier circuitry, U9, U5C and U5D. The use of a gain leveled audio system allows a high average modulation level to be maintained without danger of overmodulation.

The leveled audio output is then passed through U7A, Q4 and the secondary winding of the receiver IF output transformer to the balanced modulator, U3. The output from U3 is a double sideband, suppressed

carrier signal which is then passed through amplifier Q6 to FL2. The output from FL2 is a LOWER sideband, suppressed carrier signal which is then amplified by Q7, clipped by CR11 and CR12, buffered by Q8 and then refiltered by FL1.

The output from FL1 is combined with a signal from VCO B in mixer A2 and the upconverted output is then filtered by the 75 MHz bandpass filter, amplified by the bilateral wideband first IF amplifier, U10, and then downconverted in A1 by a signal from VCO A. The downconverted SSB signal is inverted, becoming the desired USB signal in the HF spectrum where it is then passed through the low pass filter to buffer amplifiers Q1, Q2 and Q3. The output level at Tx OUT is approximately 1 mwatt.

The Tx OUT signal is then applied to the input to the PA/Filter board, ASY-0322-02, where it is amplified to a power level of 150 watts PEP, passed through an appropriate low pass filter and output from the radiotelephone on the UHF connector.

A sample of the output signal is selected by an attenuator and rectified by CR2. The output from CR2 is an envelope representation of the SSB signal which is applied through U2A to a fast attack, slow release time constant circuit consisting of R34, R35 and C5. R34 controls the attack time constant of the ALC voltage, while R35 determines the release time constant. The ALC voltage generated across C5 is then buffered by U2B and applied to one input of buffer amplifier U2C. An adjustable offset voltage from R38 is combined with the ALC voltage in U2C and the resultant output is connected to the ALC line to eventually be used to control the gain of the audio AGC amplifier, U9 on the Main Board. The ALC voltage is applied to the AGC port on U9 through diode CR15. Normally, the ALC control voltage is lower than the normal AGC feedback voltage and CR15 is cut off. Under severe overdrive conditions, the ALC voltage will exceed the AGC voltage and reduce the gain of U9, thus limiting the transmitter output.

#### 5.4.2 MICROPHONE PREAMPLIFIER

The 600 ohm dynamic microphone output is terminated by R48, filtered by R50 and C28 and then buffered by voltage follower, U8A. The buffered audio is then applied to the transmitter line driver which

consists of U6A and U6B. The line driver amplifies the buffered signal from the microphone by about 45. The output from the line driver is a balanced, low impedance signal of approximately 1 volt peak to peak. When the radiotelephone is in the RECEIVE mode, the CPU turns Q4 on, which prevents any possibility of feedback from the microphone.

#### 5.4.3 THE TRANSMITTER LINE RECEIVER

The filtered, amplified output from the line driver is then passed over the interconnecting cable to the transceiver unit line receiver. This stage consists of U8A and U8B. Here, the balanced microphone signal is converted back to a single-ended audio signal, mixed with audio from the TELEX input buffer (if any) and attenuated to a suitable level for application to the audio AGC amplifier. U7B is normally OFF in the TRANSMIT mode, which allows unity gain in U8A. In RECEIVE mode, this switch is ON, which reduces the gain of U8A to a very low level. This prevents receiver audio feedback through the line receiver.

#### 5.4.4 AUDIO AGC AMPLIFIER

The transmitter audio signal is passed through the audio agc amplifier before application to the balanced modulator. This circuit is described in pp. 5.3.5. The circuit operates exactly the same in the TRANSMIT and RECEIVE modes, the only difference being the source and destination of the leveled audio signal and the additional gain control line from the ALC circuitry. In the TRANSMIT mode, the audio from the AGC amplifier is switched through U7A to the audio buffer, Q4. Q4 is configured as an emitter follower which served to drive the low impedance input of the balanced modulator stage.

#### 5.4.5 TRANSMITTER BALANCED MODULATOR

Double balanced mixer, U3, is used as the transmitter balanced modulator. The processed microphone audio is applied to non inverting modulator input of U3, while the carrier signal at 10.7 MHz is applied to the L.O. Port. R35 serves as the carrier balance potentiometer and a double sideband suppressed carrier signal is taken from the non inverted output pin of the balanced modulator. This signal is then applied to the buffer-filter circuitry.

#### 5.4.6 IF BUFFER-FILTER

Q6, FL2 and Q7 form the buffer-filter circuitry. Q6 is a transistor amplifier with gain of approximately 25. The collector signal is passed through FL2, a four pole crystal filter which eliminates the upper sideband. Q7 is a low gain buffer stage which compensates for the loss in FL2. Note that the collector resistor of Q6 and the input bias resistors of Q7 are selected to provide a good impedance match for FL2.

#### 5.4.7 THE RF CLIPPER

The output from Q7 is applied to a fixed level RF clipper consisting of diodes CR11 and CR12. The output from the clipper is a SSB signal with approximately 6 dB of RF clipping. The bias resistors for Q8 are selected to keep the input impedance high enough to prevent undue loading of the clipper. The use of highly leveled audio for the balanced modulator, together with careful adjustment of the various stage gains, allows for a very consistent clipping level of approximately 6 dB. This degree of RF clipping of a single sideband filter serves to greatly increase the average peak to RMS ratio of the voice signal without adding significantly to the in band intermodulation distortion level. Out of band intermodulation products are removed by the second single sideband filter, FL1.

#### 5.4.8 CARRIER REINSERTION AMPLIFIER

Carrier is reinserted when desired through amplifier U1. This integrated circuit is a voltage controlled attenuator, used here to control the level of reinserted carrier. Normally in the A3J mode, the control voltage port of U1 is held at +8 volts, which cuts off any output signal. When carrier is desired, the control computer switches in a level control potentiometer which allows the output signal from U1 to be adjusted to the desired level. Two control potentiometers are provided: The A3A (-16dB) level pot, R26 and the A3H (-6dB) level pot, R27. The reinserted carrier signal is routed around FL1 and applied to mixer A2.

#### 5.4.9 10.7 MHz IF AMPLIFIER AND SSB FILTER

From the clipper, the 10.7 MHz single sideband suppressed carrier signal is applied to the input of buffer amplifier, Q8. This stage prevents undue loading of the RF clipper and provides an impedance matched signal for the main SSB filter, FL1. FL1 is used bilaterally and is a 6 pole filter. Adequate selectivity is provided to insure that the resultant single sideband signal is clean and without spurious products.

#### 5.4.10 THE UP CONVERTER, 75 MHz IF AMP. AND FILTER

The up converter mixer is a double balanced diode ring type mixer with inputs from the 62.5 MHz VCO B and the 10.7 MHz IF amplifier. The mixer output is amplified by the bilateral 75 MHz IF amplifier. This amplifier is discussed in pp. 5.3.1. The SUM of the two frequencies is selected by the 75 MHz IF filter. Selecting the sum frequency results in a LOWER sideband 75 MHz SSB signal. The 75 MHz bandpass filter is matched to the low impedance amplifier and mixer stages by link wind-

ings on the filter inductors. The filter output is applied to the input of the down converter or signal mixer.

#### 5.4.11 SIGNAL MIXER AND LOW PASS FILTER

A1 is another double balanced ring diode mixer. The output from this stage is the down converted 75 MHz SSB signal. This signal has been changed to the desired OPERATING frequency by mixing with a signal from VCO A and the use of the DIFFERENCE frequency here results in a frequency inversion. Thus the output signal is an UPPER sideband SSB signal as required. The mixer output is passed through a seven section elliptical function low pass filter which provides some 50 dB of rejection for the image and IF frequencies above 23 MHz.

#### 5.4.12 TRANSMITTER SIGNAL PREAMPLIFIER

The signal output from the low pass filter is switched through CR7 to the input of the transmitter preamplifier. This is a two stage wide band amplifier, with the first stage configured as a two transistor direct coupled pair. The first transistor, Q1, is connected as a common emitter stage which provides power gain and impedance matching for the output signal. DC feedback from the emitter of Q2 to the base of Q1 stabilizes the circuit operating point over a wide temperature range, while the use of VHF transistors provides a very wide frequency response.

Q3 is driven from the output of emitter follower Q2 and is configured as a transformer coupled grounded emitter amplifier. DC feedback is provided by emitter resistor R12. The output from this stage is nominally +0 dBm. From TX OUT, the SSB signal goes to the PA/Filter board for further amplification.

#### 5.4.13 TRANSMITTER PREDRIVER

The transmitter low level signal is applied through a 3 dB pad and a wide-band transformer to the base of Q11. Q11 is a 2N3866 connected in the common emitter configuration and is transformer coupled to the push-pull driver stage. Bias for Q11 is provided by the base resistor network with R41 used to adjust the idling (no signal) current in the device to 60 mA. (0.30 Volts across R43). R43 is used, along with the press on heat sink to provide thermal stability.

#### 5.4.14 TRANSMITTER DRIVER

Transistors Q9 and Q10 are small plastic RF power devices, connected as a push-pull common emitter amplifier. Transformer T11 provides push-pull base drive from the collector of Q11, while transformers T9 and T10 provide collector to load impedance matching and DC power

decoupling, respectively. Gain/bandwidth compensation is provided by the collector/base feedback networks and the various peaking capacitors and terminating resistors. Temperature tracking bias is provided for Q9 and Q10 by bonding a silicon transistor, Q16, to the PC mounted heat sink for Q10. Idling current (no signal) for the driver devices is approximately 130 mA and is adjusted with potentiometer R57. Q15 is an emitter follower which supplies the high current, low impedance bias source for Q9 and Q10.

As part of the gain/bandwidth compensation circuitry for the total power amplifier, the output from the transmitter driver is connected to the output power amplifier through a 3 dB pad consisting of R30, R31 and R32.

#### 5.4.15 TRANSMITTER POWER AMPLIFIER

The power amplifier in the SEA 322 is made up of two 75 Watt power amplifier modules, a power splitter and a power combiner. Each amplifier module is a push-pull common emitter design, each is independently fused and each has its own temperature stabilized bias source. Each amplifier, like the push-pull driver, has the collector voltage present at all times. The amplifiers are activated by turning on the various bias supplies when in the transmit mode. The power amplifier bias is provided from the +10 Volt Tx buss. This voltage is applied to silicon transistors Q12 and Q13. These transistors are heat sensors and are bonded to the heat transfer plate which serves as a power amplifier heat sink. The bias generators consist of the two sensor transistors and their buffers Q7 and Q8. The operation of each pair is identical. Bias pair Q12 and Q7 are configured as an amplifier-buffer with the output to the amplifier bias port taken from the emitter follower, Q7. Current through amplifier Q12 is a function of the setting of potentiometer R60 and the heat sink temperature. Each amplifier is normally adjusted to 150 mA idling current (no signal). R60 adjusts the idling current for Q3 and Q4, while R63 adjusts the idling current for Q5 and Q6.

At the input to the power amplifier, T8 is provided as a wide band hybrid which splits the driver power output into two equal parts. Each of these signals is then independently amplified by a two transistor push-pull power amplifier module. The amplifier outputs are then recombined in hybrid T1. Resistors are provided to terminate each hybrid in the event of failure of one of the power amplifier modules.

Configuring the power amplifier in this fashion has the advantage of providing for better system redundancy, better heat distribution for the output devices and additionally provides a much wider range of useable output power devices.

#### 5.4.16 OUTPUT LOW PASS FILTER(s)

Four low pass filters are provided to cover the frequency range from 2-23 MHz. Note that the highest frequency filter, which covers the 16-23 MHz spectrum, is a 5 pole elliptical function design, while the lower frequency filters are 7 pole elliptical function types. This is possible because of the natural drop in spurious outputs from the power amplifier at higher frequencies. Filter selection is through small power relays which are operated by the control computer through serial relay driver, U1.

#### 5.4.17 ALC CIRCUIT

The ALC circuit provides a DC level which is proportional to the RF output at the antenna connector on the rear panel. This DC level is used to control the gain of the audio AGC amplifier U9 on the main board, preventing transmitter overload and resultant nonlinearity.

The voltage across R69 is derived from the actual RF output voltage through a voltage divider and diode detector CR2. The output from the RF envelope detector is applied through follower U2A and ALC diode CR7 to the fast attack, slow release time constant circuitry, consisting of R34, R35 and C5. The attack time constant is a function of R34 and C5, while the release time is controlled by R35 and C5. The ALC voltage is buffered by voltage follower U2B and combined in non-inverting amplifier U2C with a voltage from the ALC control potentiometer, R38. The output from U2C is an amplified, level shifted voltage which follows the RF envelope faithfully. This voltage is routed to the interboard cable and then applied through steering diodes to the gain control port of U9.

Thus, it can be seen that the main board gain control potentiometer, R2, sets the average gain "floor" for the transmitter and the ALC potentiometer adjusts the attack threshold for the ALC feedback voltage. Under normal drive conditions, the instantaneous ALC feedback voltage will not exceed the idling DC level on the ALC buss. Under high drive conditions, when the output attempts to exceed 150 Watts, the ALC feedback will override the DC level and reduce transmitter gain to prevent distortion.

#### 5.4.18 THE TEMPERATURE ALARM GENERATOR

In order to prevent damage to the power amplifier circuitry, an overtemperature alarm generator is provided. This circuit consists of thermistor RT1 and U2D. In operation, RT1 senses the temperature of the heat transfer plate and a DC voltage which is proportional to temperature is generated at the junction of RT1 and R5. U2D operates

as a comparator and until an overtemperature condition exists, the reference signal on the non-inverting input is LOWER than the output from RT1. Thus, the "TEMP" signal is LOW. At approximately 70 degrees Centigrade, the voltage from RT1 will fall below the reference voltage, causing U2D output to go HIGH, initiating an overtemperature alarm signal. This signal is connected to the transceiver CPU through the interboard cable.

## 5.5 THE PHASE LOCKED LOCAL OSCILLATOR SYSTEM

### 5.5.1 BLOCK DIAGRAM

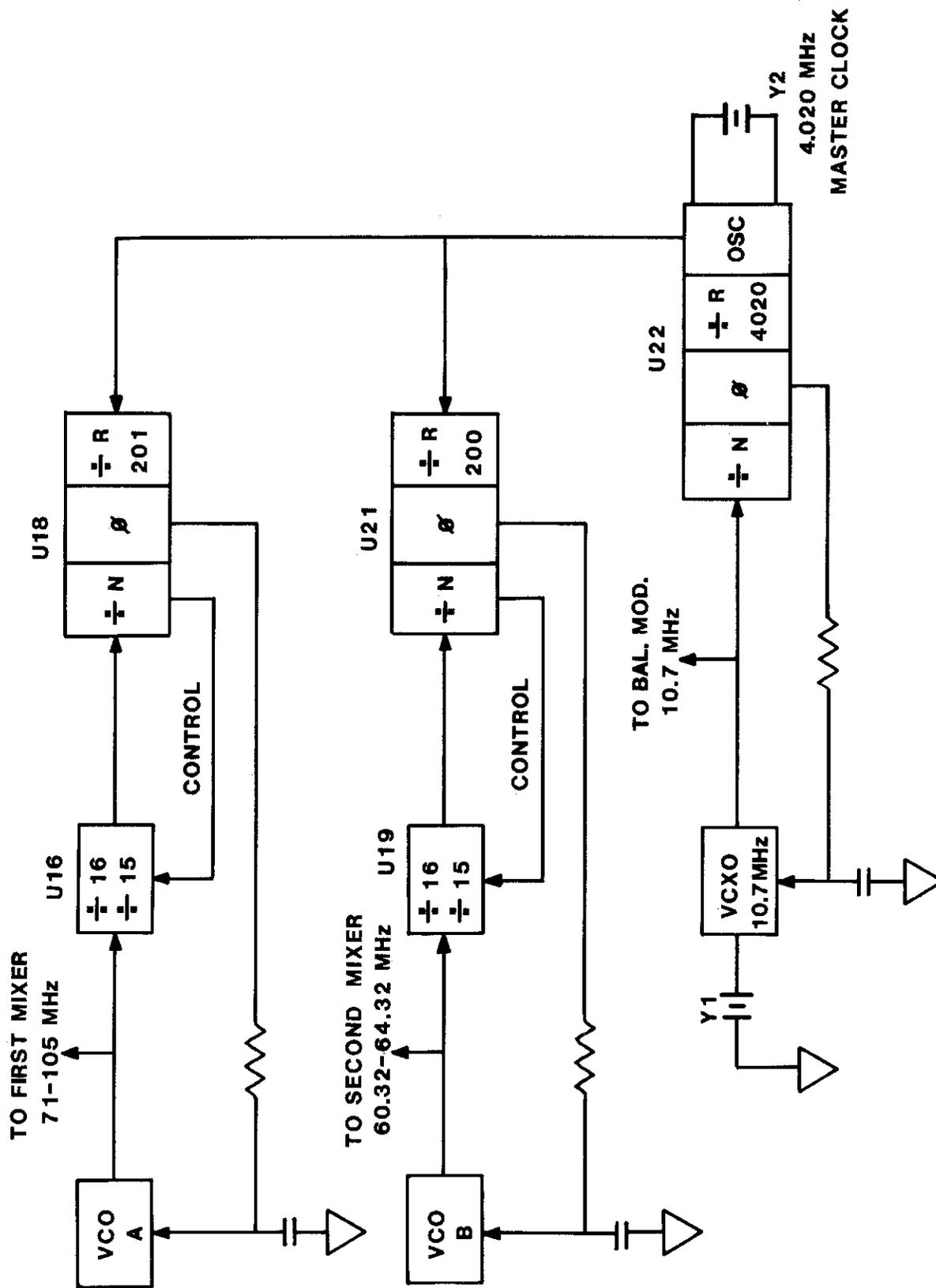
Figure 5.5.1 shows the block diagram of the phase locked local oscillator system of the SEA 322.

A two loop system is used in the SEA 322 to provide a high speed, high resolution local oscillator system. The technique used is somewhat sophisticated and makes use of a system best described as a "slip loop synthesizer".

The frequency selection is accomplished by two frequency synthesizers which control two VCOs: VCO A and VCO B. (VCO A actually consists of two bandswitched VCOs to provide adequate tuning range.) VCO A is the first local oscillator and drives the first mixer, A1. The output of A1 is the first IF frequency which, depending on the operating frequency chosen will be somewhere in the range of 71,020.1 KHz to 75,020.0 KHz. VCO A operates on the HIGH side of the first IF which means that it tunes a range of approximately 71,040.0 KHz to 105,102.0 KHz as the operating frequency of the radiotelephone varies from 0 to 30 MHz. VCO A is controlled by a phase locked loop using a 20.0 KHz reference. This means that the VCO A coarse tunes the radiotelephone in 20 KHz steps. Point to remember: THE OPERATING FREQUENCY OF THE SEA 322 INCREASES AS VCO A INCREASES IN FREQUENCY.

VCO B is the second local oscillator which drives the second mixer, A2. The second mixer takes the 71-75 MHz first IF and converts it to the 10.7 MHz second IF frequency. Depending on the operating frequency of the radiotelephone, VCO B will operate between 60,420.1 KHz and 64,332.0 KHz. Point to remember: THE OPERATING FREQUENCY OF THE SEA 322 DECREASES AS VCO B INCREASES IN FREQUENCY. VCO B is controlled by a phase locked loop using a 20.1 KHz reference. This means that VCO B tunes the radiotelephone in 20.1 KHz steps.

The purpose of VCO B is to provide the fine tuning of the SEA 322 operating frequency in 100 Hz steps. Both A and B loops operate at relatively high frequencies to provide for fast loop settling times. All other considerations equal, a 20 KHz loop will settle 200 times more rapidly than a loop operating at 100 Hz. Fast loop settling times are very useful for DUPLEX and SITOP operating modes.



PLL BLOCK DIAGRAM SEA 322

FIGURE 5.5.1

In the SEA 322, 100 Hz resolution is achieved by changing BOTH VCO A and VCO B, using a technique called "slip loop" operation. The key is this: By DECREASING VCO B one step, we INCREASE the frequency of operation by 20.1 KHz. By DECREASING VCO A one step, we DECREASE the frequency of operation by 20 KHz. The net effect is that the operating frequency INCREASES by 100 Hz. By repeating this process from 0 to 199 times we can increase the operating frequency from 0 to 19.9 KHz. The math is handled by the on board CPU. An example of Modulo N calculations is given below:

The following describes the method for determining the frequencies actually loaded into the synthesizer(s) for a given operating frequency:

1. The operating frequency is divided into two parts; a main portion divisible by 20.0 KHz (M), and a remainder of 0 to 19.9 KHz (R). R is expressed as a value from 0 to 199.  
Example: For 16587.1 KHz, M = 16580 and R = 71

Determine the VCO A frequency required:

2. Add a 75020 KHz offset to M.  $M + 75020 = N$   
Example:  $16580 + 75020 = 91600 = N$
3. Divide N by 20.  $N/20 = P$   
Example:  $91600/20 = 4580 = P$
4. Subtract R from P.  $P - R = T$   
Example:  $4580 - 71 = 4509 = T$   
This (T) is the modulo N number for the VCO A loop
5. The actual frequency is  $T \times 20.0$  KHz.  
Example:  $4509 \times 20.0 = 90,180.0$  KHz for 16587.1 KHz

Determine the VCO B frequency.

6. Subtract the remainder R (0 to 199) from 3200.  
( $3200 \times 20.1$  KHz = 64,320.0 KHz)  
 $3200 - R = V$   
Example:  $3200 - 71 = 3129 = V$   
This is the modulo N number for the VCO B loop.
7. The actual VCO B frequency is  $V \times 20.1$  KHz.  
Example:  $3129 \times 20.1$  KHz = 62,892.9 KHz for 16587.1 KHz

In the above example 16,587.1 KHz operating frequency subtracted from 90,180.2 first VCO gives a first IF of 73,592.9 KHz. 73,592.9 KHz first IF - 62,892.9 KHz second VCO yields a second IF of 10,700.0 KHz.

Over the frequency range of 19.9 KHz to 30 MHz, the modulus N for VCO A varies from 3552 to 5251. These moduli correspond to VCO A frequencies of 71,040.0 to 105,020.0 KHz. This frequency range is split into two bands, LO and HI which are covered by separate oscillators. The correct oscillator is selected by the control CPU when the moduli are calculated.

VCO B runs over the range of moduli from 3200 - 199 to 3200. Since the reference frequency of the PLL which controls the loop is 20.1 KHz, VCO B tunes the frequency range of 60,320.1 KHz to 64,320 KHz.

#### 5.5.2 THE REFERENCE CLOCK OSCILLATOR

The master clock oscillator operates at a frequency of 4020.0 KHz. This frequency allows the use of a compact, high stability crystal which is enclosed in a temperature stabilized holder. The combination of a high stability crystal, capacitors of the proper temperature coefficient and crystal temperature stabilization provides excellent frequency stability over the environmental temperature range of the equipment. Warm up time for the clock oscillator is less than 3 minutes.

The oscillator used is the oscillator portion of synthesizer chip U22. This circuit has been especially designed for use as a stable high frequency crystal oscillator and also provides the VCXO loop reference divider in the form of the built in divide-by-R counter. This counter is set to 4020 and provides the phase detector of U22 with a stable reference of 1.0 KHz. The REF out pin provides a buffered oscillator signal for synthesizer chips U18 and U21.

#### 5.5.3 LOOP A AND LOOP B REFERENCE DIVIDERS

The 20 KHz VCO A and 20.1 KHz VCO B loop reference signals are derived from the buffered 4020.0 KHz signal from U22. Both U18 and U21 use the MC145158 synthesizer chip which contains a fully programmable divide-by-R counter. U18 controls VCO A which requires a 20 KHz reference. Therefore the divide-by-R counter in U18 is set to 201. VCO B is controlled by U21 and requires a 20.1 KHz reference. Therefore the divide-by-R counter in U21 is set to 200.

#### 5.5.4 THE HIGH FREQUENCY DIVIDE-BY-N COUNTERS

Both VCO A and VCO B are controlled by similar phase locked loops. The high speed divide-by-N function is performed through use of the built in divide-by-N counter in synthesizer chips U18 and U21 in conjunction with the dual modulus prescaler chips, U16 and U19.

In practice, the high frequency signal from the VCO is applied to the prescaler which normally operates in the divide-by-16 mode until

a control signal from the divide-by-A counter in the synthesizer chip forces it into the divide-by-15 mode. The number of cycles in each prescaler mode, along with the internal divide-by-N counter, determines the actual divide-by-N modulus. The required modulus is calculated by the control computer for each given frequency and then the proper A and N counter register numbers are loaded into the synthesizer chips by the control computer.

#### 5.5.5 HIGH FREQUENCY PHASE DETECTOR/LOOP FILTERS

Integrated circuits U18 and U21 also contain the high frequency phase detector, whose output is proportional to the phase difference between the clock derived reference frequency and a similar input derived from the dual modulus/divide-by-N counter described in pp. 5.5.4. The error voltages are filtered through second order R/C filters and applied to the varactor tuning elements in the VCO circuits.

#### 5.5.6 THE VCO SYSTEM AND ASSOCIATED BUFFERS

As discussed above, the SEA 322 synthesizer consists of two VCO systems which drive the first and second mixers to convert an HF signal to the 10.7 MHz IF frequency. Each VCO is individually buffered by an emitter follower. Then the HI and LO oscillators which make up VCO A are combined and the common output is applied to a buffer amplifier which consists of Q22, Q23 and Q24. This VHF wideband amplifier both isolates VCO A from mixer A1 and raises the power level of the VCO to approximately +10 dBm. VCO B is similarly buffered by Q27, Q28 and Q29. Each VCO output is terminated in a 3 dB, 50 ohm pad prior to application to the mixers. This adjusts the mixer drive level to the required +7 dBm while simultaneously providing both mixer and buffer amplifier with a constant, frequency independent 50 ohm termination.

#### 5.5.7 THE VCXO AND ASSOCIATED BUFFERS

The VCXO (voltage controlled crystal oscillator) serves as the carrier oscillator for the SEA 322 and operates at approximately 10.7 MHz. Since this oscillator is phase locked to the master clock oscillator in 1000 Hz increments, it is possible to invert the generated sideband by moving the carrier oscillator to the opposite side of the 10.7 MHz crystal filters. In practice, normal upper sideband operation requires that the carrier operate at 10700.0 KHz, while lower sideband operation requires 10697.0 KHz.

The VCXO operates as a Colpitts type with a FET as the oscillator device. A ceramic resonator is used in place of the usual crystal. This resonator is in series with an inductor. Coupling varactor CR36

and CR37 to the series inductor allows the oscillator to be voltage tuned over the required frequency range. Q31 amplifies the VCX0 signal to the level required by the balanced modulator, U3. Capacitors C139 and C140, together with inductor L13 form a low pass filter to keep oscillator harmonics to a minimum.

## 6. MODE AND FREQUENCY CONTROL

### 6.1 GENERAL

In the SEA 322, the frequency of operation is determined by loading a serial bit stream containing a binary number in the two synthesizer chip registers in the frequency synthesizer circuitry.

These binary numbers are calculated through an internal algorithm by the control computer. When the computer loads a desired frequency into the control computer, the computer then calculates all the required binary data streams and inputs the information into the various control registers.

Such data as filter band, VCO A band (high or low), VCO A loop divide-by-N, VCO B loop divide-by-N and carrier and filter control bits are all calculated by the computer, once the desired channel is entered by the operator.

#### 6.1.1 TRANSMITTER MODE SELECTION

The primary mode of operation of the SEA 322 is in the A3J (SSB with fully suppressed carrier) mode.

Three auxiliary modes are provided:

A3A: SSB with pilot carrier re-inserted 16 dB below PEP.

A3H: SSB with pilot carrier re-inserted 6 dB below PEP (AM equivalent).

0.3F1: Narrow bandwidth teleprinting, carrier suppressed.

A3J is the basic SSB operating mode and is used for ship-to-ship, base station-to-ship and point-to-point communications.

A3A is used primarily for 2 MHz public correspondence channel. This allows the shore station to lock on to the pilot carrier with an autotune receiver and gives "telephone quality" voice reproduction.

A3H is a secondary mode, designed to allow a degree of compatibility between old style AM equipment and SSB systems. In this mode, the

carrier is suppressed only 3 to 6 dB below PEP. Such systems are inherently wasteful of the power capability of any SSB transmitter. As required by law, the "E0" channel is provided with optional A3H carrier. (SEE Page 3).

In the SEA 322, the normal mode of operation is ALWAYS A3J. On public correspondence channels, the operator may, if desired, insert a -16 dB carrier, by entering the desired A3A channel into "scratchpad" memory and inserting the A3A bit. (SEE pp. 3.3.2 for scratchpad programming information).

A3H mode operation on 2182.0 KHz (the international distress and calling frequency) is available by recalling emergency channel E#0.

Two carrier insertion potentiometers are provided on the main board. R26 and R27 control the reinsertion level in the A3A and A3H mode, respectively.

The 0.3F1 mode is available when desired by initiating the TELEX mode through the keypad. This is a narrow band teleprinting mode which requires external equipment such as the SEA SHIPCOM unit.

#### 6.1.2 RECEIVE MODE SELECTION

Since the SEA 322 as normally supplied always operates as a normal upper sideband only SSB receiver, little mention need be made of alternate modes of operation. Where allowed, the receiver is capable of lower sideband operation.

AM reception is by the "exhalted carrier" or "zero beat" method. That is, the incoming signal is simply tuned in until the carrier wave is zero beat with the internal BFO. This technique has proven completely adequate for those applications where voice fidelity is desired. For reception of music, the internal IF and AF filters sharply limit the level of fidelity which may be achieved.

When the 0.3F1 (TELEX) mode is selected, the narrow bandwidth audio filter is inserted to improve the receiver S/N ratio. Frequency offsets are selected automatically.

### 7. THE POWER SUPPLY CIRCUIT

#### 7.1 GENERAL

The basic supply voltage for the SEA 322 is a negative ground 13.6 Volt DC source. Line voltage regulation of  $\pm 15\%$  or better is required, with a current capacity of at least 25 - 30 Amperes.

From this raw source are derived the necessary regulated operating voltages for the SEA 322 circuitry.

#### 7.1.1 BLOCK DIAGRAM

Figure 7.1.1 shows a simplified schematic diagram of the power supply circuitry.

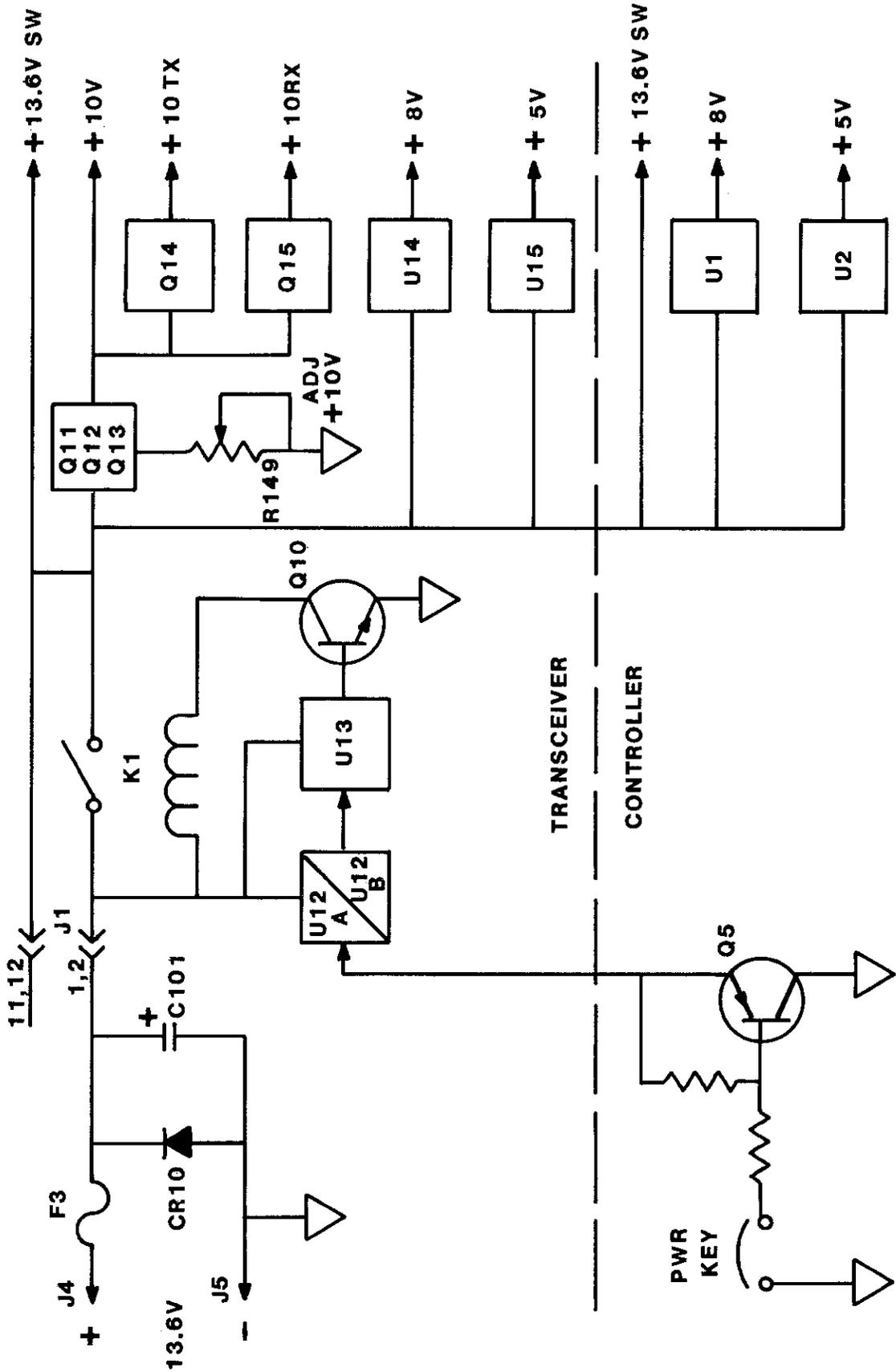
Once the basic 13.6 Volt power is provided, it is connected to the set through the heavy duty power plug on the transceiver rear panel. Three internally mounted fuses are provided to protect the set in the event of malfunction. Each fuse has a reverse voltage protection diode which will blow the fuse in the event of reversed line polarity.

The ON/OFF relay, K1 is controlled through Q10 by U13A. U13A is connected as a "toggle" flip-flop. The state of U13A changes each time a clock pulse is delivered from the Schmitt trigger consisting of U12A and U12B. Normally, U12A is ON, holding the clock line to U13A low and turning U12B OFF. When the "PWR" line on P1 or P2 is grounded (as when the "PWR" key on the controller is pressed), U12A is turned OFF, generating a clock pulse for U13A and turning U12B ON. The output from U12B is regenerative, creating hysteresis and preventing keyswitch bounce from causing erratic operation of K1. The RESET input pin of U13A is connected to the raw 13.6 volt buss through an R/C network which serves to prevent transient operation during 13.6 volt buss initialization.

Several regulators, located throughout the radiotelephone, distribute the required voltages. All the +10 volt busses are derived from the 10 volt regulator on the main board in the transceiver unit.

The +10 volt Rx and +10 volt Tx busses are generated through computer control of inverted transistor switches, Q15 and Q14, while the +13.6 volt Tx buss is generated on the PA/Filter board through computer control of switching transistor Q2.

The +8 and +5 volt logic buss voltages are generated from the switched + 13.6 volt buss through the use of standard three terminal regulators, U14 and U15. Throughout the radiotelephone, local regulation is used to provide good overall voltage regulation isolation. For example, U17 and U20 on the main board serve as local +5 volt regulators for the synthesizer prescaler chips. Similarly, each control computer board has on-board regulation. This type of distributed regulation allows excellent isolation from power buss noise, line drop etc.



**SIMPLIFIED DIAGRAM OF  
POWER SUPPLY CIRCUITRY SEA 322**

**FIGURE 7.1.1**

### 7.1.2 +10 VOLT REGULATOR AND THE TX/RX SWITCHES

The + 10 Volt regulator in the SEA 322 makes use of PNP power transistor as a series pass device. This transistor, Q11, is connected as an inverted power stage with its base drive derived from a negative feedback amplifier consisting of Q12 and Q13.

In operation, the base of emitter follower Q13 is provided with a sample of the +10 Volt regulator output through resistor network R148, R149. This sample is supplied to the emitter of feedback amplifier Q12.

The base of Q12 is provided with a stable reference voltage from zener diode CR25. This device has a nearly "flat" temperature vs voltage characteristic and is further stabilized by obtaining its voltage drive from the +10 Volt buss.

Since the base voltage of Q12 is stabilized by CR25, the collector current in Q12 and thus the base current of the series pass transistor Q11 is inversely proportional to the voltage at the base of Q13. That is, a RISE in the voltage at the base of Q13 causes a REDUCTION in base drive to Q11. This in turn causes the output voltage to be reduced. Similarly, a DROP in the voltage at the base of Q12 will result in an INCREASE in base drive to Q11 which causes the output voltage to be increased.

R141 is shunted across Q11 to provide "start up" voltage for the regulator system. Potentiometer R149 is the +10 Volt adjustment and allows the regulator to "trimmed" to exactly +10 Volts by setting the base voltage on Q13. Resistor R143 is provided to limit the base drive to Q11. This provides a degree of short circuit immunity for the regulator, since the base drive for Q11 tends to "starve off" at about 1 Amp of output current.

The use of the inverted PNP transistor, Q11, as the series pass device has the advantage that the regulator will remain operational under low line voltage conditions. The low line limits are primarily a function of the E-C saturation voltage in Q11, which is normally less than 0.5 Volts. Thus, the regulator will provide excellent 10 Volt buss stability, even when the input line voltage has dropped to approximately 10.5 Volts.

Transistors Q15 and Q14 generate the non-overlapping +10 RX and +10 TX busses, respectively. These devices are operated as inverted transistor switches and are controlled by the main control computer through the serial relay driver device, U1. U1 is located on the PA/Filter printed circuit board. The use of transistor switches to generate the TX and RX buss voltages eliminates any problems with relay contacts or T-R buss timing.

### 7.1.3 +8 VOLT AND +5 VOLT REGULATORS

In the SEA 322, the synthesizer circuitry operates from a regulated +8 Volt buss, while the control computer operates from a regulated +5 Volt buss. These voltages are provided by standard three terminal voltage regulator integrated circuits, U14 and U15. U14 is a 7808 and provides the +8 Volt buss, while U15 is a 7805 and provides the +5 Volt buss.

### 7.1.4 +13.6 VOLTS TX BUSS

The transmitter predriver circuitry and the bias systems for the transmitter driver are supplied with a relatively high current +13.6 Volt buss through PNP switch, Q2. This transistor is located on the PA/Filter board and is connected as an inverted switch. Base drive is supplied from the relay control driver, U1. The same driver port which is used to provide base drive to Q2 is also used to switch the antenna circuit T/R relay, K1. Diode steering through CR4 and CR11 prevents interaction between the relay and transistor circuits.

## 8. THE SEA 503 CPU MODULE

### 8.1 GENERAL

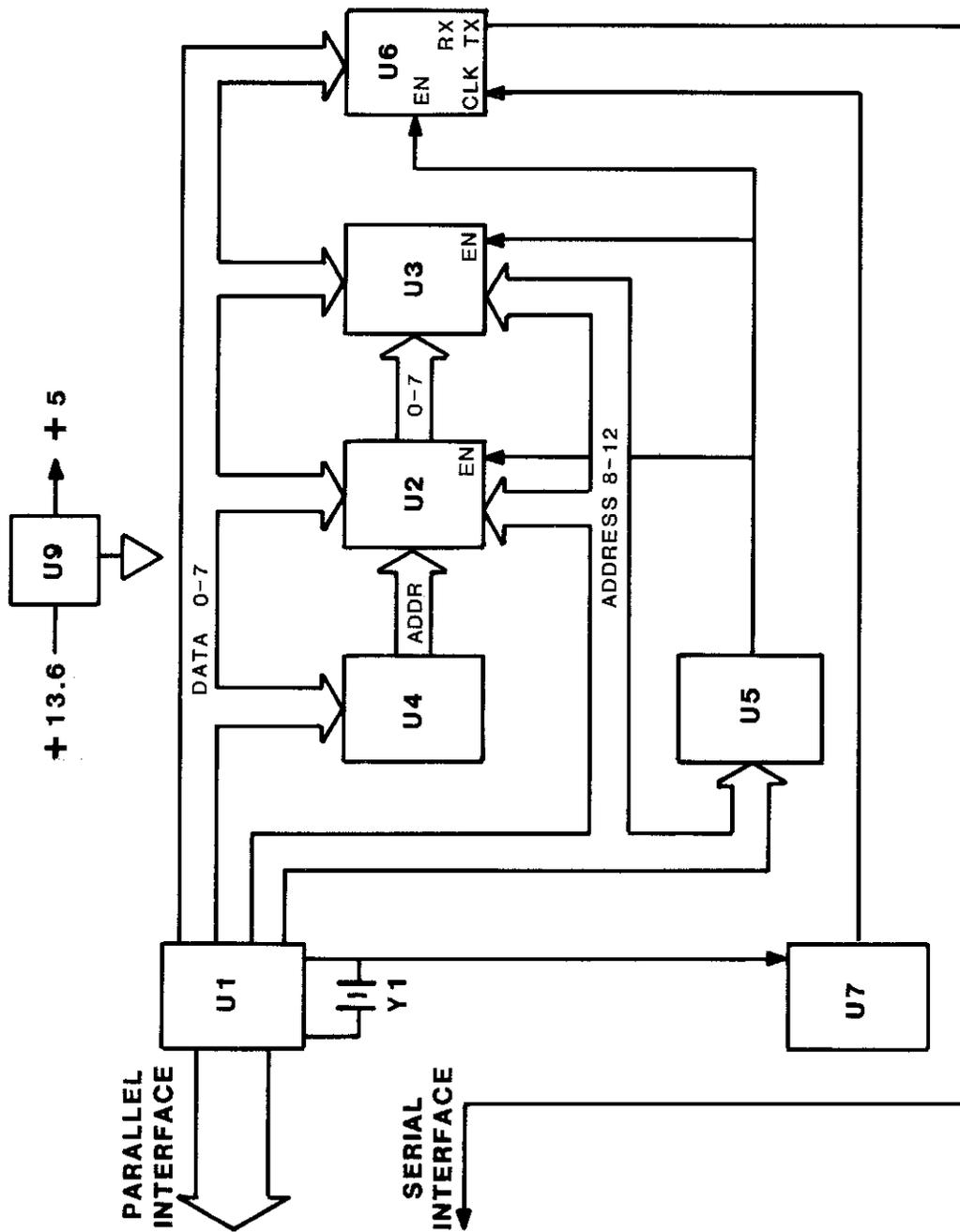
The SEA 322 radiotelephone makes extensive use of microprocessor technology. Each controller and the transceiver contain a complete microprocessor based control computer, complete with custom software in EPROM which configures the computer specifically for the desired task. For this reason, SEA has designed a small stand alone CPU module, the SEA 503 controller/computer.

#### 8.1.1 BLOCK DIAGRAM

Figure 8.1.1 shows a block diagram of the SEA 503 controller/computer circuitry.

The SEA 503 uses the Motorola MC146805E2P microprocessor, U1. This is a CMOS 8 bit machine with 16 bi-directional ports, timer, on board clock oscillator, RAM and a powerful controller oriented instruction set. Also included on the CPU board are provisions for EPROM, EEPROM, a serial data transceiver and a baud rate generator. Although configured for 2764 EPROM (U2), paging allows the use of PROMs up to 27256 density. An EEPROM socket (U3) is provided which supports EEPROMs up to the 2864. If the specific application requires, one or both of the ROM sockets may be populated with RAM.

The baud rate generator, U7, is driven from the CPU clock, a standard 4.9152 MHz crystal. Strapping allows the selection of baud rates from 75 baud to 19.2k baud.



**CONTROLLER/COMPUTER BLOCK DIAGRAM**

On board voltage regulation is provided by U9, so that unregulated line voltages may be used to power the CPU board. CR4, CR5 and U8B form a undervoltage reset/memory "write protect" circuit which operates at approximately +9 volts. IN the SEA 322, the +13.6 volt switched buss is used to power all the CPU boards in the system.

A serial interface is provided by U6, a ACIA chip. The serial baud rate is adjusted by selecting the proper clock jumper between the ACIA and the baud rate divider, U7.

U4 is an octal latch which serves to deMUX the address buss, while U5 and U8A, U8C and U8D are decoders which assign the memory map of the CPU chip, U1.

J1, the interface connector, is arranged along a wide edge of the PC board. This 30 pin interface provides access to all essential CPU pins, the necessary power input, the serial communications buss and, when the jumper is installed, a signal from the CPU clock. Pin 5 provides a spare pin for future expansion.

## 9. THE CONTROLLER UNIT

### 9.1 GENERAL

Much of the controller circuitry has already been discussed in the RECEIVER and TRANSMITTER theory sections. Some of the controller system is, however, not directly in the signal path and will be considered here.

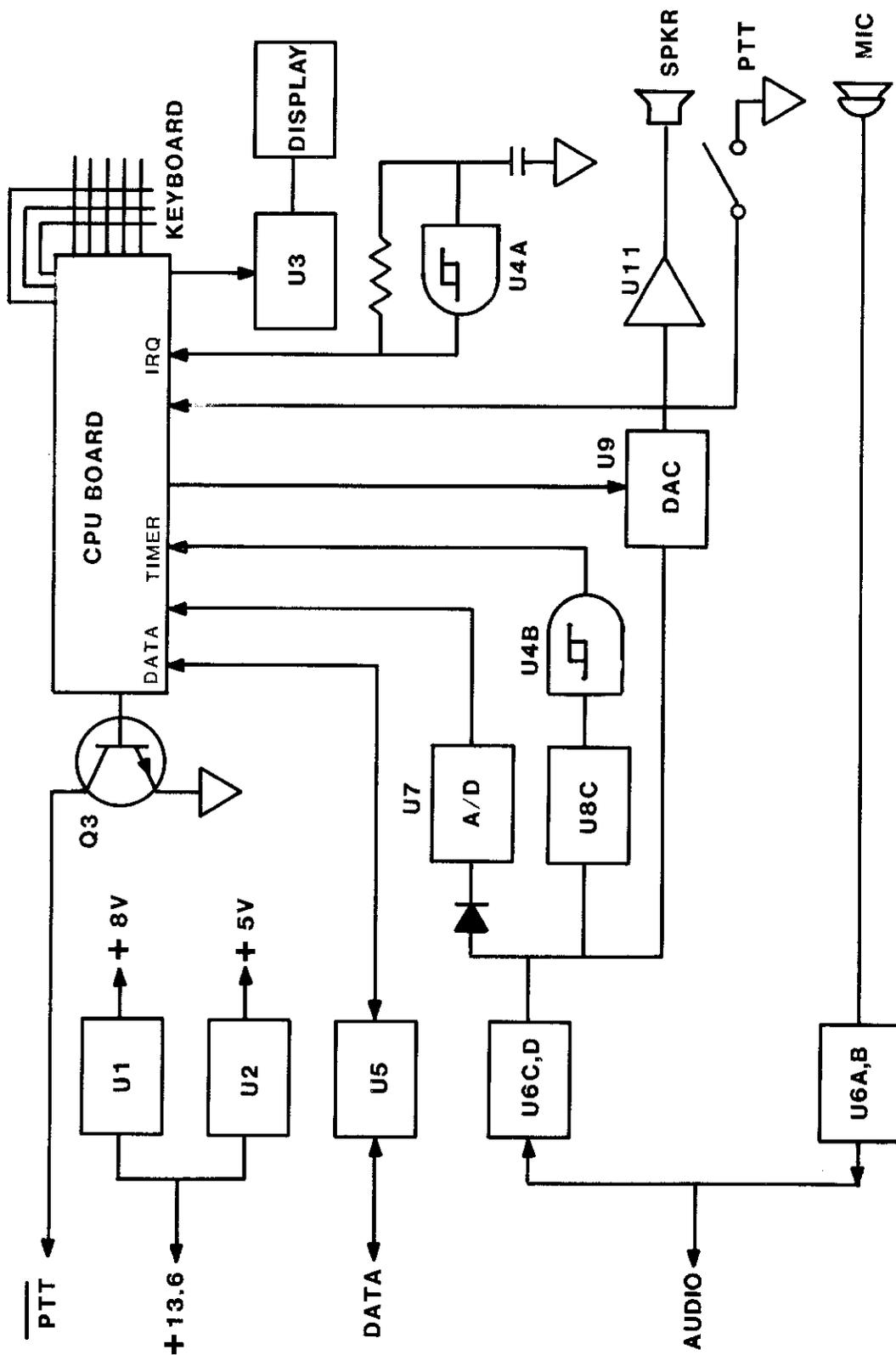
#### 9.1.1 BLOCK DIAGRAM

Figure 9.1.1 shows a block diagram of the SEA 322 controller unit.

The controller is essentially a "dumb terminal" configured specifically as the front panel of a Marine SSB transceiver. Transceiver functions are controlled by the keypad, transceiver parameters are indicated by the liquid crystal display, microphone audio is processed by the controller and sent to the transceiver, and receiver audio is received from the transceiver, processed by the controller and routed to the loudspeaker.

The controller circuitry is contained on the terminal interface PC assembly, ASY-0322-03. This printed circuit board contains the display, keyboard interface, terminal circuitry and the controller CPU board.

Connection to the interface board from the control cable is through J2, a 16 pin DIP connector and the interface board is contained within



**CONTROLLER UNIT BLOCK DIAGRAM SEA 322**

**FIGURE 9.1.1.**

a shielded aluminum box which is in turn housed inside a drip proof plastic outer enclosure.

The audio path for the controller unit has been adequately described in the RECEIVER theory of operation (see pp. 5.2) and will not be repeated here. The serial data stream which connects the controller(s) and the transceiver unit is passed through U5 in the controller and U11 in the transceiver. This is a bi-directional data transceiver which uses a bi-phase data format similar to RS485. On each end of the data path, the data transceivers are connected to the system CPU boards through the Sout and Sin pins provided.

The primary power source for the controller is the +13 volt switched buss from the transceiver unit. When necessary, internal regulators provide stabilized buss voltages. U1 provides +8 volts while U2 provides +5 volts for the logic elements.

The LC display is supported by U3. This part is a serially controlled LCD driver chip which is capable of driving up to 64 annunciators on the LCD. The desired LCD pattern is loaded into U3 from the controller CPU board. Illumination for the keypad and display is provided by LEDs CR2, CR3, CR10 and CR11. Current for these devices is provided by Q1 and Q2. The transistors are controlled by the CPU through the deMUX chip, U10, thus allowing operator control over the illumination level.

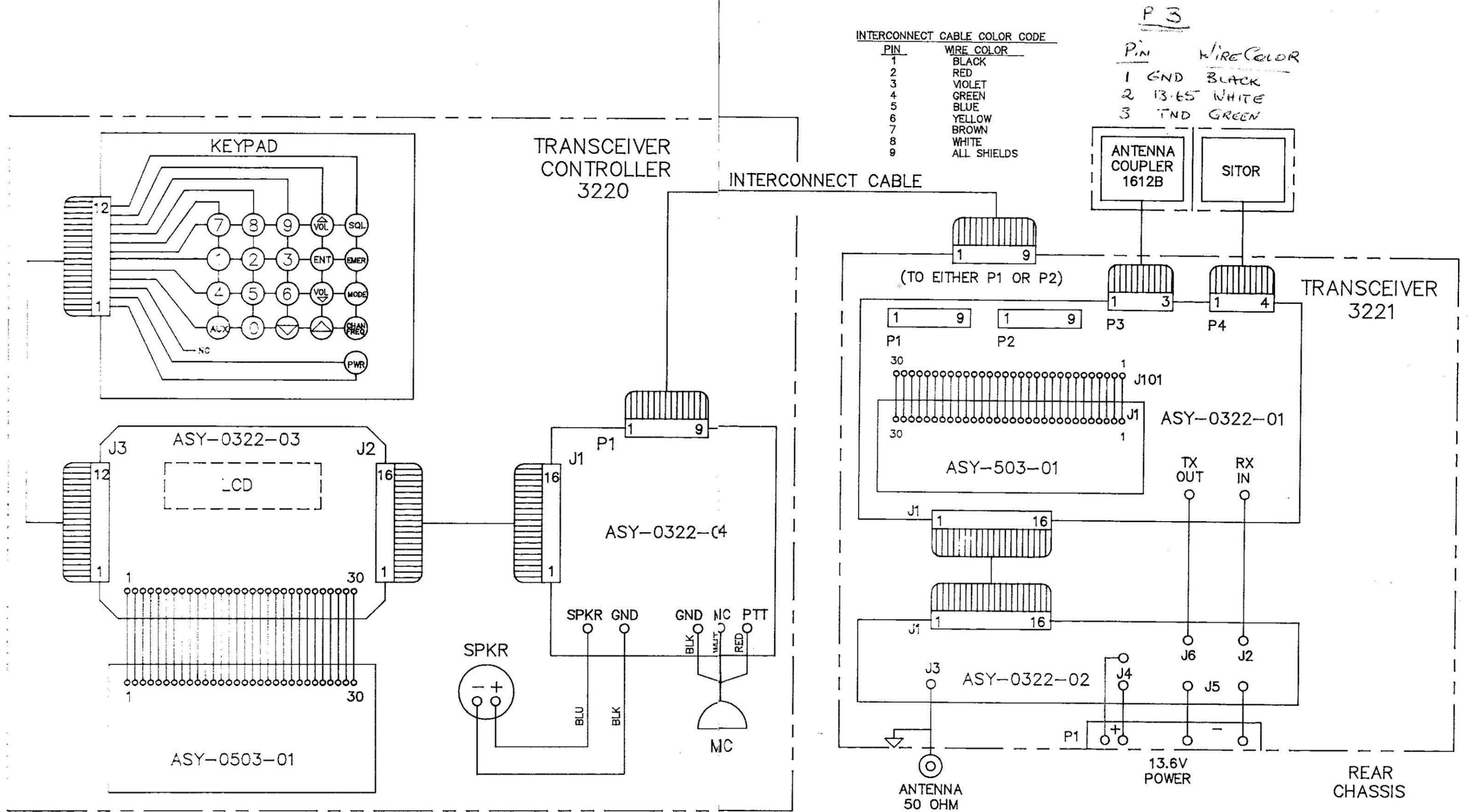
The SQUELCH function in the SEA 322 is a software model of the SEA voice operated "constant SINAD" squelch system. Each controller has its own squelch system which functions by examining the audio stream to determine the presence of a voice signal. If a voice is present, the volume control DAC, U9, is set to the level selected by the operator. If no voice is present, the CPU board adjusts U9 for full audio attenuation. U8C, CR7 and U4B are used to provide the CPU board TIMER input with hard limited audio, while U4A forms an interrupt oscillator which calls the CPU squelch routine regularly.

The PTT signal from the controller to the transceiver is provided by the controller CPU through transistor Q3. The controller CPU receives a filtered, debounced PTT signal from the microphone through U4C.

The 21 key keypad is actually 20 key keypad in a crossbar matrix and one extra key. The extra key is the "PWR" key and is used to cycle the input power control relay in the transceiver. This is accomplished through inverted transistor switch, Q5. When the "PWR" key is pressed, Q5 is biased ON through R64. This in turn pulls the PWR line low, toggling relay K1. The remaining keypad functions are directly read by the CPU. The CPU firmware interprets the keystrokes and communicates

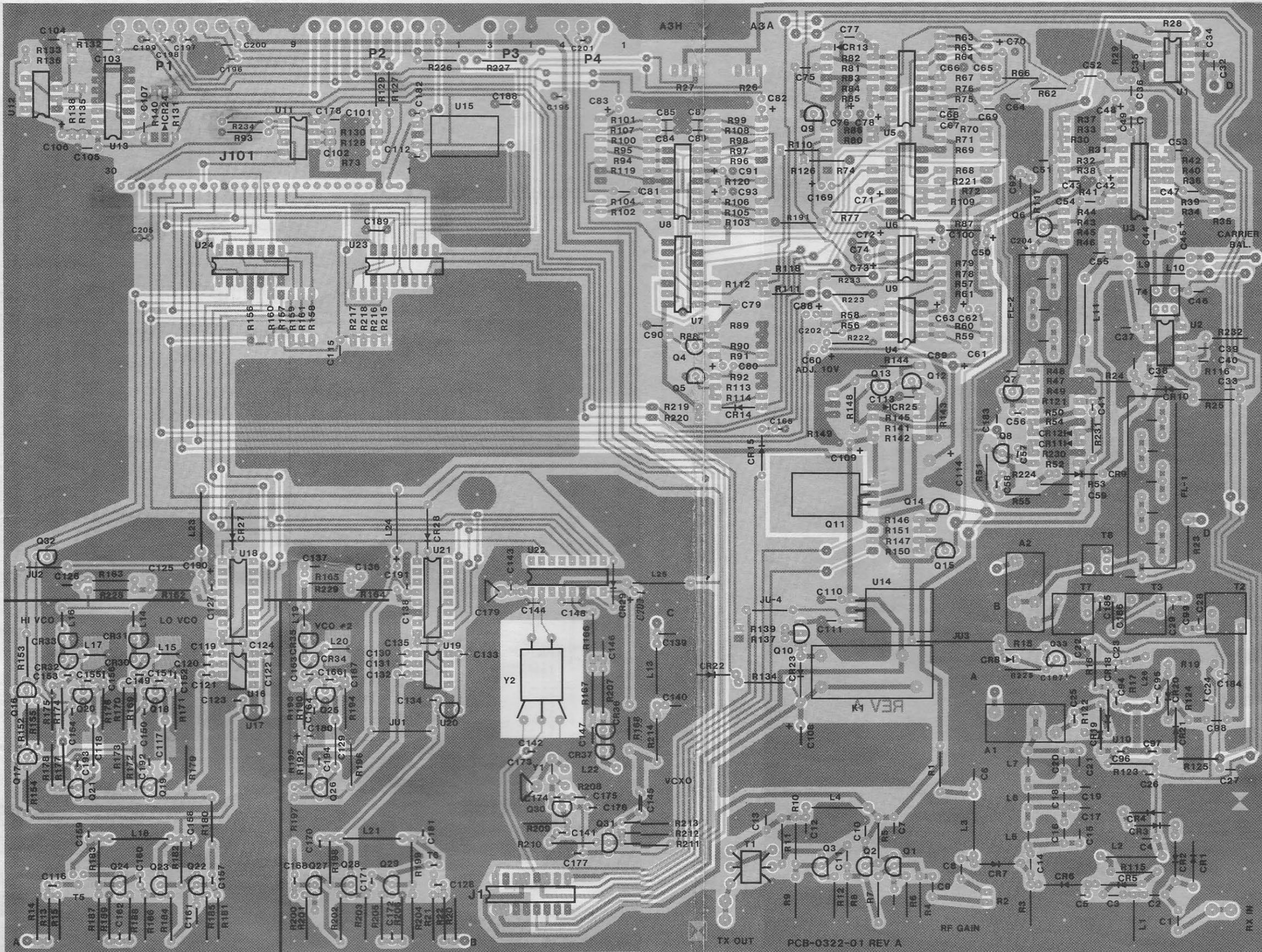
via the serial interface with the CPU in the transceiver. The communications format is error checked and handshaking is used to assure that errors are eliminated. Simultaneously, the controller CPU handles the LCD, squelch, illumination level, volume level and monitors for a PTT signal. Interunit communications is kept to a minimum and the "intelligence" level of the controller is minimized by shifting most of the firmware burden to the transceiver. This approach allows many controller options to be realized, such as simultaneous control of the transceiver unit from several locations, an intercom function between controllers, direct control of the transceiver system with a computer equipped with an appropriate hardware interface and software, etc.

Communications between the controller(s) and the R/T unit is bidirectional and fully interactive. This means that when more than one controller is used, the status of the R/T unit is reflected at all operating stations. For example, if one controller is used to change the operating frequency of the radiotelephone, ALL controllers in the system will have the display information updated. Controller-R/T data is sent in packets and is error checked. Collision protection is provided for all data sources.



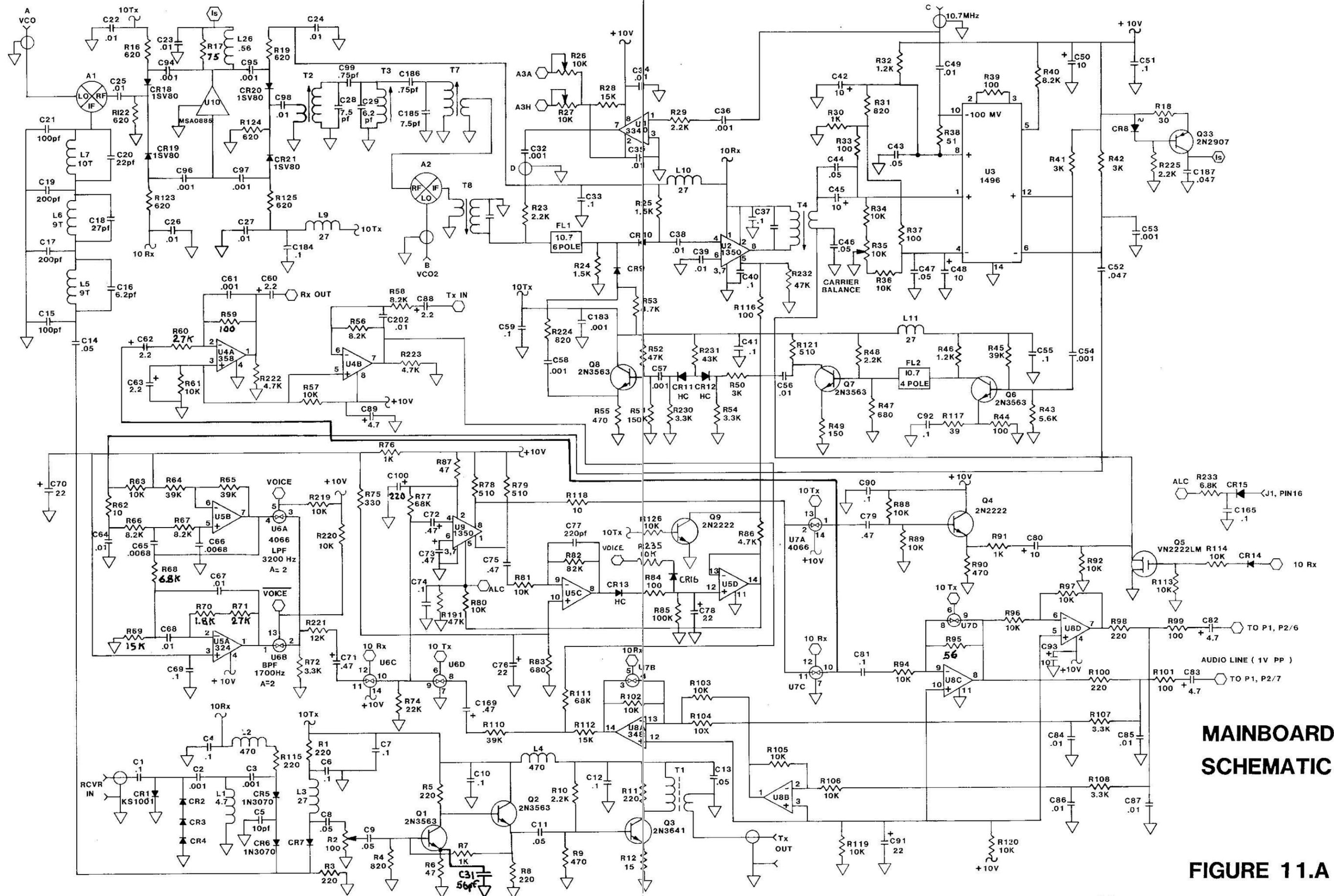
**322 INTERCONNECT WIRING DIAGRAM**

**FIGURE 10.0**



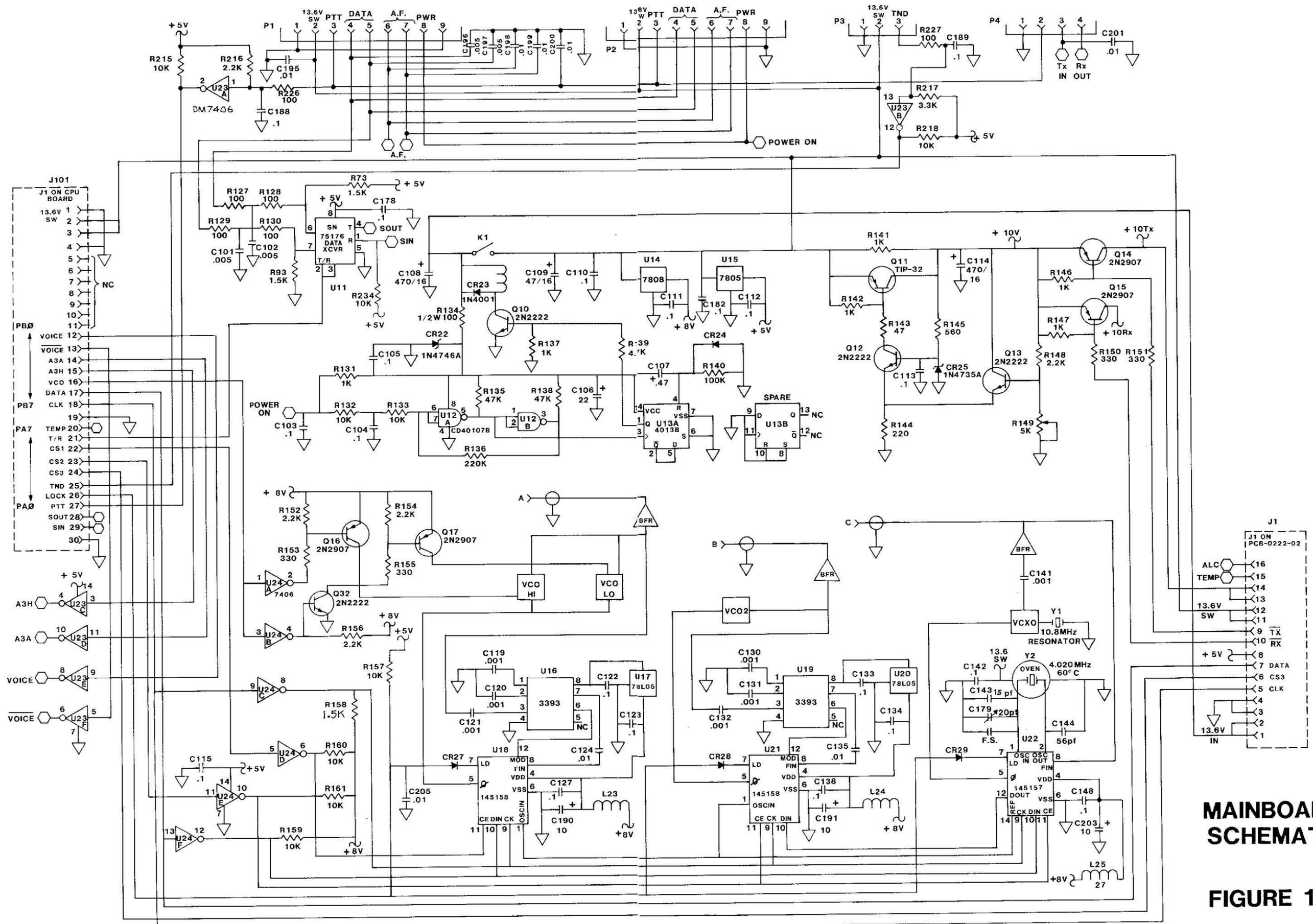
**MAINBOARD**

**FIGURE 11.0**



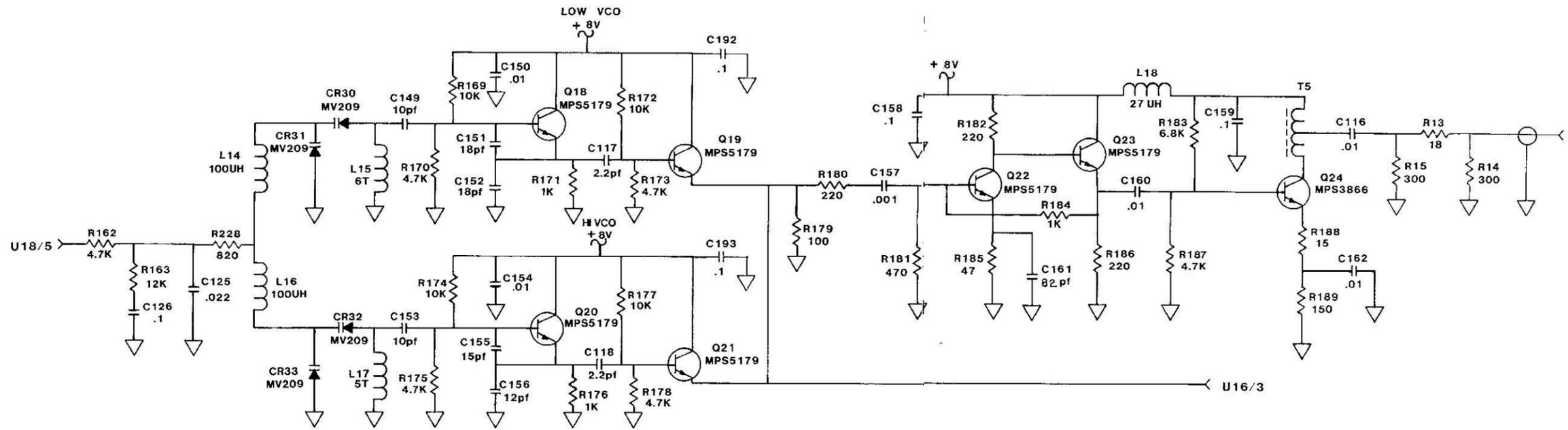
**MAINBOARD  
SCHEMATIC**

**FIGURE 11.A**

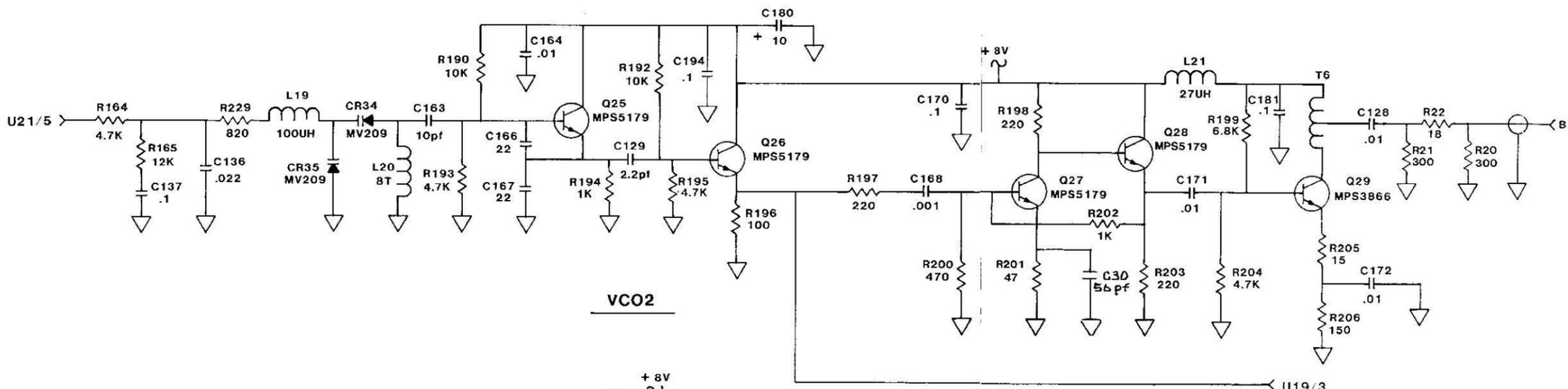


**MAINBOARD  
SCHEMATIC**

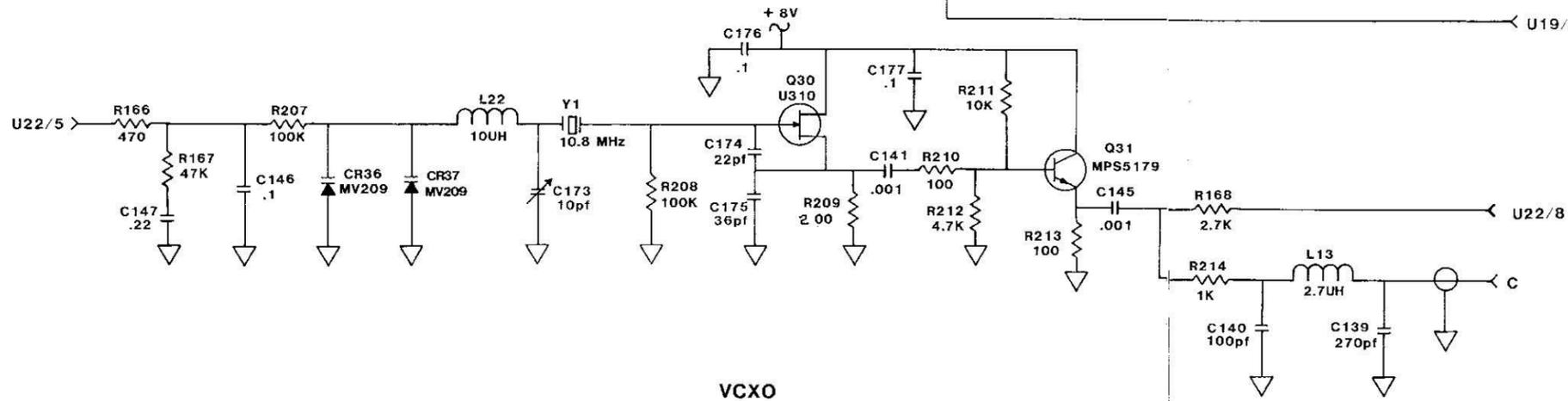
**FIGURE 11.B**



VCO 1



VCO2



VCXO

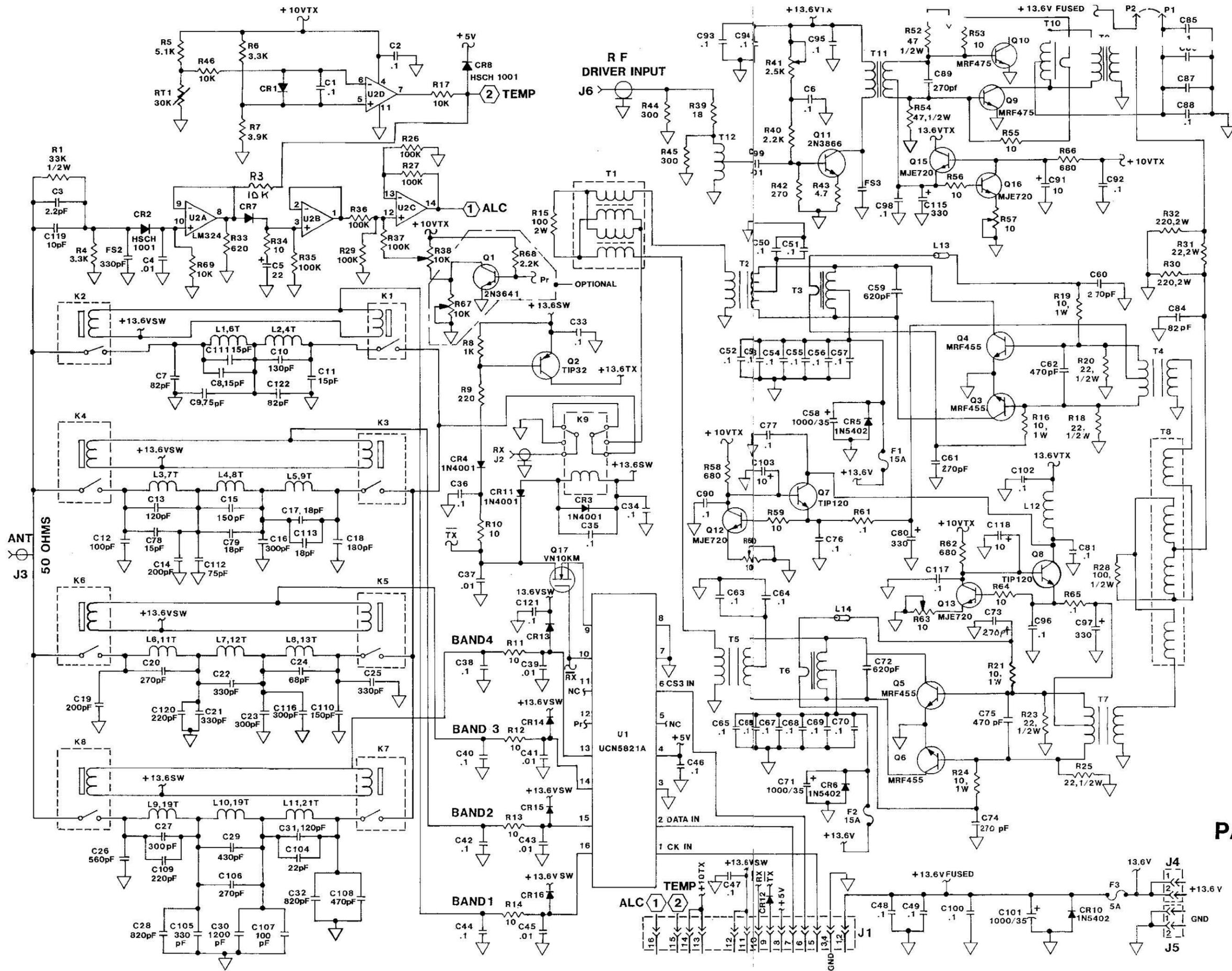
LAST DESIGNATOR USED								
A2	F2	C205	CR37	L26	R235	Q33	T8	U24

DESIGNATORS NOT USED		
C31	CR17	R109
C204		

UNLESS OTHERWISE NOTED:  
CAPACITORS IN MICROFARADS  
RESISTORS IN OHMS  
DIODES ARE 1N4148

# MAINBOARD SCHEMATIC





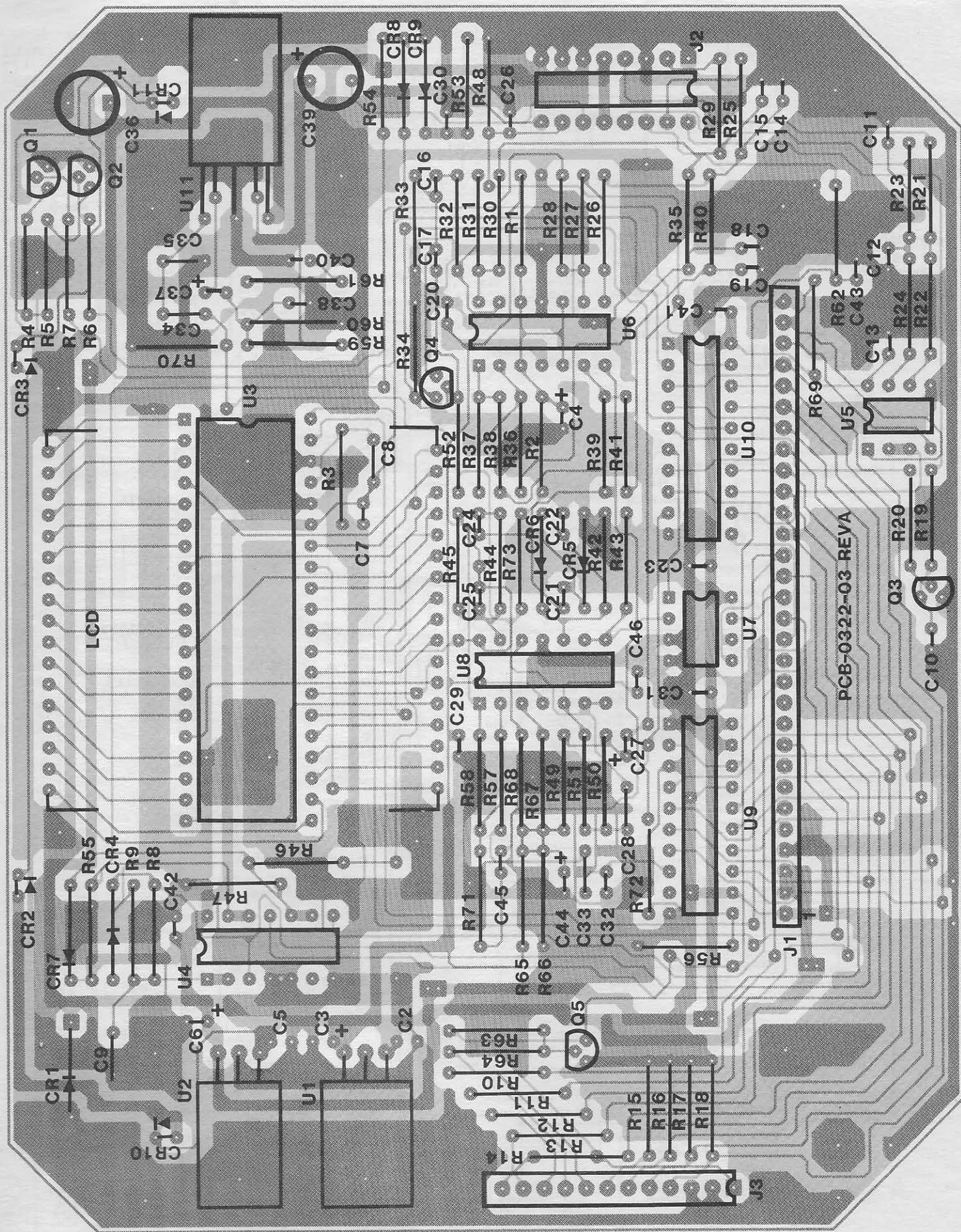
- NOTES** UNLESS OTHERWISE SPECIFIED
- 1 RESISTORS ARE IN OHMS, 1/4W, 5%
  - 2 CAPACITORS ARE IN MFD/WVDC
  - 3 DIODES ARE 1N4148

LAST DESIGNATOR USED							
C122	CR16	K9	L14	Q17	R69	T12	JU8

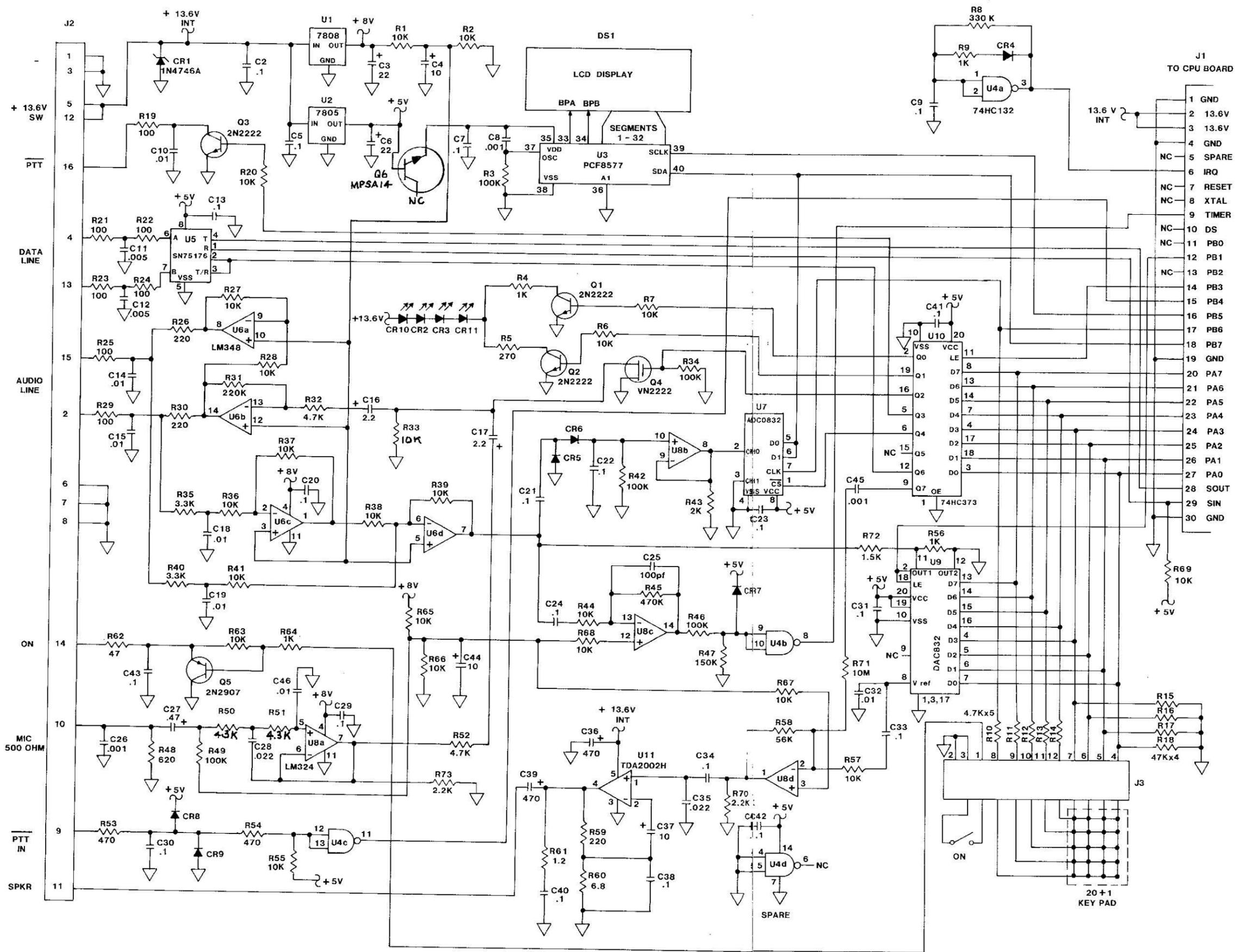
DESIGNATORS NOT USED							
C82	CR9	FS1	R22	Q14			
C83		FS4	R47				
C114			R48				
			R49				
			R50				
			R51				
			R67				
			R68				
			R2				

**PA/FILTER SCHEMATIC**

**FIGURE 12.A**



TERMINAL INTERFACE BOARD FIGURE 13.0

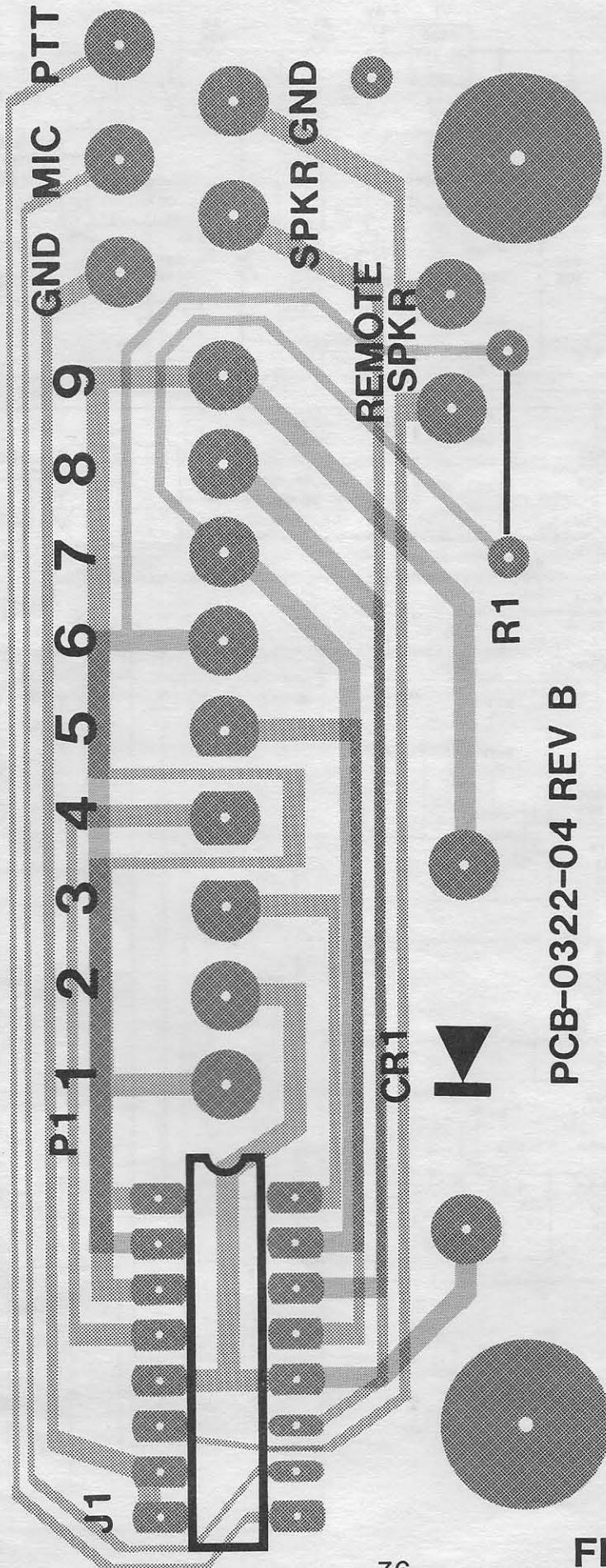


LAST DESIGNATOR USED				
C46	CR11	Q6	R73	U11

DESIGNATORS NOT USED : C1

- NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, 1/4 WATT, 5%
  2. CAPACITORS ARE IN MICROFARADS
  3. DIODES ARE 1N4148

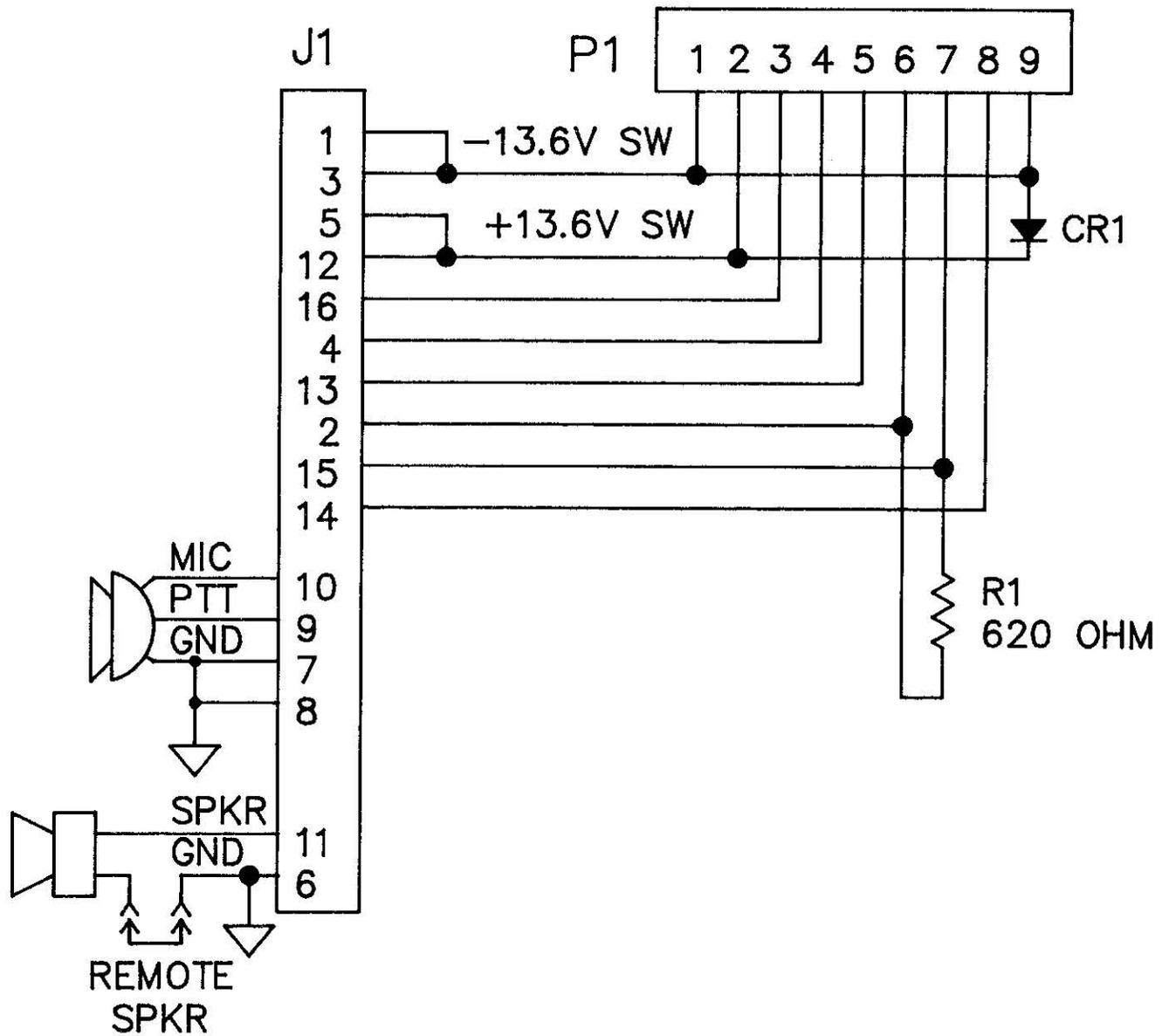
## TERMINAL INTERFACE SCHEMATIC



PCB-0322-04 REV B

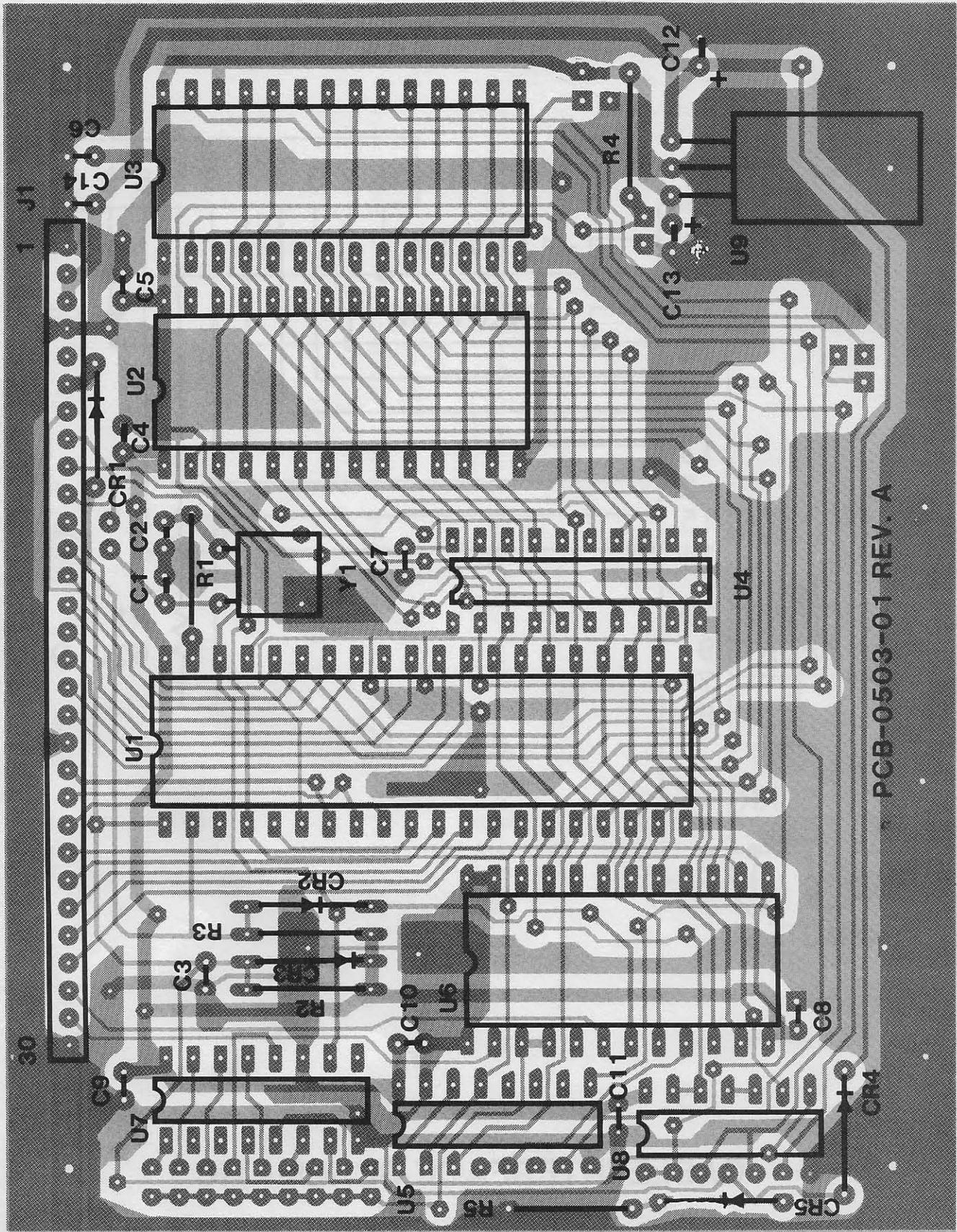
CABLE INTERFACE BOARD

FIGURE 14.0



**CABLE INTERFACE SCHEMATIC**

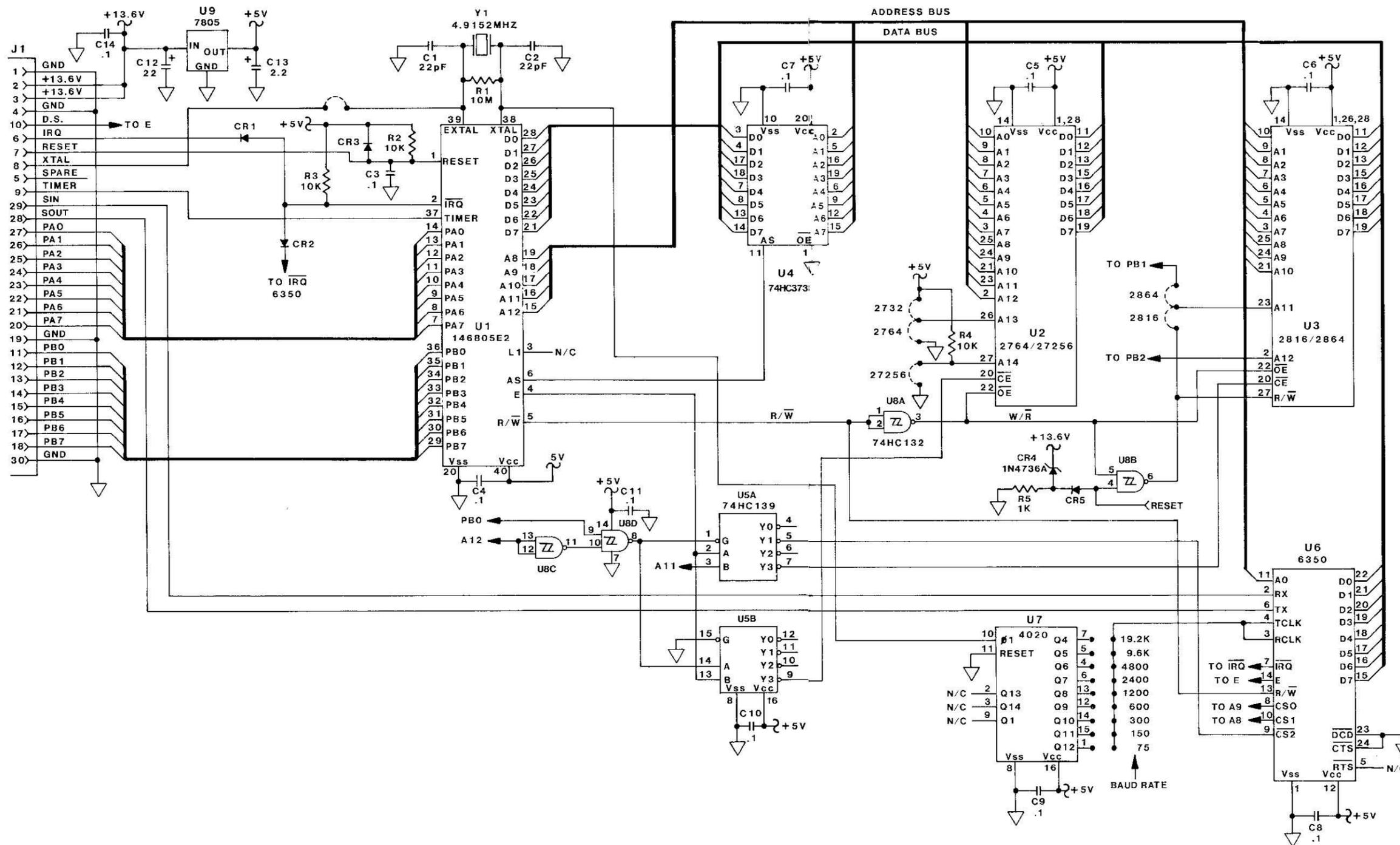
**FIGURE 14.A**



PCB-0503-01 REV. A

CPU BOARD

FIGURE 15.0



LAST DESIGNATOR USED				
C14	CR5	R5	U9	Y1

DESIGNATORS NOT USED

NOTES:

- UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS 1/4W 5%.
  2. CAPACITORS ARE IN MICROFARADS.
  3. DIODES ARE IN4148.

CPU SCHEMATIC

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REFERENCE DESIGNATORS FOR 3220-25 TRANSCEIVER CONTROLLER

EFFECTIVE 10-10-87

REF DES	PART NUM	DESCRIPTION
1	MIC-0002-010	MICROPHONE ASSY
10	FAB-0322-11	MOUNTING PLATE HALF
2	MIC-0003-001	MIC HANGER BRACKET HEAVY
3	CAB-0322-025	CABLE ASSY, 25 FT. LONG
4	FAB-0322-12	ENCLOSURE KNOB
5	HAR-0043-001	WASHER, FLAT .050/1.05/.25
6	FAB-0322-16	KNOB GASKET -NEOPRENE
8	HAR-0043-004	NY WASHER, .143x.370x.031
9	SPE-0001-007	3.5 4 OHM, 5W MYLAR SPEAKER
U3	SEM-0170-012	X2816AD-45 (RED)
	ASY-0322-03-U	INTERFACE BOARD WITH COMPUTER BD
U2	ROM-3220-US2	CONTROL HEAD PROM (PROGRAMMED)
2	HAR-0071-003	6-32x.5 HEX SPACER
6	HAR-0071-004	6-32x1.75 HEX SPACER
1	FAB-0322-13	MOUNTING BRACKET
1	ASY-0322-10	ENCLOSURE-FACE HALF WITH KEYPAD
	CON-0021-003	NYLON STUFFING GLAND

REFERENCE DESIGNATORS FOR 3221 TRANSCEIVER

REF DES	PART NUM	DESCRIPTION
1	ASY-0322-01-U	MAIN BOARD WITH COMPUTER
1	ASY-0322-02-U	P.A. - FILTER BOARD
1	FAB-0322-05	MOUNTING BRACKET
1	FAB-0322-21	CPU SHIELD
2	CON-0028-001	9 PIN CONNECTOR CABLE END
1	CON-0028-006	4 PIN CONNECTOR CABLE END
1	CON-0028-007	3 PIN CONNECTOR CABLE END
U2	ROM-3221-US2	TRANSCEIVER PROM (PROGRAMMED)
U3	ROM-3221-US3	TRANSCEIVER FREQUENCY PROM (PROGRAMMED)

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
A1	MIX-0002-001	DBL BAL MIXER
A2	MIX-0002-001	DBL BAL MIXER
C1	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C10	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C100	CAP-0037-014	220 UF 10V RAD ELECTROLYTIC
C101	CAP-0013-004	CAPACITOR, MONO .0047UF
C102	CAP-0013-004	CAPACITOR, MONO .0047UF
C103	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C104	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C105	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C106	CAP-0030-009	CAPACITOR TANT 22uf 25V
C107	CAP-0030-005	CAPACITOR TANT .47uf 35V
C108	CAP-0037-010	CAP. ELECT 470UF RAD
C109	CAP-0037-004	CAP. ELECT 47UF RAD
C11	CAP-0006-004	CAP, MULTILAYER CER DIP .047
C110	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C111	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C112	CAP-0013-001	CAPACITOR MONO .1uf
C113	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C114	CAP-0037-010	CAP. ELECT 470UF RAD
C115	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C116	CAP-0013-003	CAPACITOR MONO .01uf 100V
C117	CAP-0002-014	CAP 2.2PF TUB-CERAMIC 10%
C118	CAP-0002-014	CAP 2.2PF TUB-CERAMIC 10%
C119	CAP-0013-005	CAPACITOR MONO .001 uf
C12	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C120	CAP-0013-005	CAPACITOR MONO .001 uf
C121	CAP-0013-005	CAPACITOR MONO .001 uf
C122	CAP-0013-001	CAPACITOR MONO .1uf
C123	CAP-0013-001	CAPACITOR MONO .1uf
C124	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C125	CAP-0027-223	CAPACITOR FILM CK05 .022
C126	CAP-0027-104	CAPACITOR FILM CK05 .1
C127	CAP-0013-001	CAPACITOR MONO .1uf
C128	CAP-0013-003	CAPACITOR MONO .01uf 100V
C129	CAP-0002-014	CAP 2.2PF TUB-CERAMIC 10%
C13	CAP-0006-004	CAP, MULTILAYER CER DIP .047
C130	CAP-0013-005	CAPACITOR MONO .001 uf
C131	CAP-0013-005	CAPACITOR MONO .001 uf
C132	CAP-0013-005	CAPACITOR MONO .001 uf
C133	CAP-0013-001	CAPACITOR MONO .1uf
C134	CAP-0013-001	CAPACITOR MONO .1uf
C135	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C136	CAP-0027-223	CAPACITOR FILM CK05 .022
C137	CAP-0027-104	CAPACITOR FILM CK05 .1
C138	CAP-0013-001	CAPACITOR MONO .1uf
C139	CAP-0001-021	CAPACITOR MICA 270pf
C14	CAP-0006-004	CAP, MULTILAYER CER DIP .047
C140	CAP-0001-015	CAPACITOR MICA 100pf
C141	CAP-0013-005	CAPACITOR MONO .001 uf

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
C142	CAP-0013-001	CAPACITOR MONO .1uf
C143	CAP-0001-002	CAPACITOR MICA 15pf
C144	CAP-0001-010	CAPACITOR MICA 56pf
C145	CAP-0006-003	CAP, MULTILAYER CER DIP .001
C146	CAP-0027-104	CAPACITOR FILM CK05 .1
C147	CAP-0027-224	CAPACITOR FILM CK05 .22
C148	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C149	CAP-0001-001	CAPACITOR MICA 10pf
C15	CAP-0001-015	CAPACITOR MICA 100pf
C150	CAP-0013-003	CAPACITOR MONO .01uf 100V
C151	CAP-0001-031	CAPACITOR MICA 18pf
C152	CAP-0001-031	CAPACITOR MICA 18pf
C153	CAP-0001-001	CAPACITOR MICA 10pf
C154	CAP-0013-003	CAPACITOR MONO .01uf 100V
C155	CAP-0001-002	CAPACITOR MICA 15pf
C156	CAP-0001-039	CAPACITOR, MICA 12pf
C157	CAP-0013-005	CAPACITOR MONO .001 uf
C158	CAP-0013-001	CAPACITOR MONO .1uf
C159	CAP-0013-001	CAPACITOR MONO .1uf
C16	CAP-0001-040	CAPACITOR MICA 6.2 pf
C160	CAP-0013-003	CAPACITOR MONO .01uf 100V
C161	CAP-0001-014	CAPACITOR MICA 82pf
C162	CAP-0013-003	CAPACITOR MONO .01uf 100V
C163	CAP-0001-001	CAPACITOR MICA 10pf
C164	CAP-0013-003	CAPACITOR MONO .01uf 100V
C165	CAP-0013-001	CAPACITOR MONO .1uf
C166	CAP-0001-003	CAPACITOR MICA 22pf
C167	CAP-0001-003	CAPACITOR MICA 22pf
C168	CAP-0013-005	CAPACITOR MONO .001 uf
C169	CAP-0030-005	CAPACITOR TANT .47uf 35V
C17	CAP-0001-028	CAPACITOR MICA 200pf
C170	CAP-0013-001	CAPACITOR MONO .1uf
C171	CAP-0013-003	CAPACITOR MONO .01uf 100V
C172	CAP-0013-003	CAPACITOR MONO .01uf 100V
C173	CAP-0025-002	CAPACITOR TRIMMER 2-10pf
C174	CAP-0001-003	CAPACITOR MICA 22pf
C175	CAP-0001-007	CAPACITOR MICA 36pf
C176	CAP-0013-001	CAPACITOR MONO .1uf
C177	CAP-0013-001	CAPACITOR MONO .1uf
C178	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C179	CAP-0025-001	CAPACITOR TRIMMER 2-20PF
C18	CAP-0001-004	CAPACITOR MICA 27pf
C180	CAP-0031-005	CAPACITOR TANT 10uf 16V
C181	CAP-0013-001	CAPACITOR MONO .1uf
C182	CAP-0013-001	CAPACITOR MONO .1uf
C183	CAP-0006-003	CAP, MULTILAYER CER DIP .001
C184	CAP-0013-001	CAPACITOR MONO .1uf
C185	CAP-0001-042	CAPACITOR MICA 7.5pf
C186	CAP-0002-750	.75PF 10% QC CAPACITOR
C187	CAP-0013-006	CAP. MONO .047UF

REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
C188	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C189	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C19	CAP-0001-028	CAPACITOR MICA 200pf
C190	CAP-0031-005	CAPACITOR TANT 10uf 16V
C191	CAP-0031-005	CAPACITOR TANT 10uf 16V
C192	CAP-0013-001	CAPACITOR MOND . 1uf
C193	CAP-0013-001	CAPACITOR MOND . 1uf
C194	CAP-0013-001	CAPACITOR MOND . 1uf
C195	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C196	CAP-0013-004	CAPACITOR, MOND . 0047UF
C197	CAP-0013-004	CAPACITOR, MOND . 0047UF
C198	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C199	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C2	CAP-0006-003	CAP, MULTILAYER CER DIP . 001
C20	CAP-0001-003	CAPACITOR MICA 22pf
C200	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C201	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C202	CAP-0012-005	CAP, MYLAR . 01uf/50V
C203	CAP-0031-005	CAPACITOR TANT 10uf 16V
C205	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C21	CAP-0001-015	CAPACITOR MICA 100pf
C22	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C23	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C24	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C25	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C26	CAP-0013-003	CAPACITOR MOND . 01uf 100V
C27	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C28	CAP-0001-042	CAPACITOR MICA 7.5pf
C29	CAP-0001-040	CAPACITOR MICA 6.2 pf
C3	CAP-0006-003	CAP, MULTILAYER CER DIP . 001
C30	CAP-0001-010	CAPACITOR MICA 56pf
C31	CAP-0001-010	CAPACITOR MICA 56pf
C32	CAP-0006-003	CAP, MULTILAYER CER DIP . 001
C33	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C34	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C35	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C36	CAP-0006-003	CAP, MULTILAYER CER DIP . 001
C37	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C38	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C39	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C4	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C40	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C41	CAP-0013-001	CAPACITOR MOND . 1uf
C42	CAP-0031-005	CAPACITOR TANT 10uf 16V
C43	CAP-0006-004	CAP, MULTILAYER CER DIP . 047
C44	CAP-0006-004	CAP, MULTILAYER CER DIP . 047
C45	CAP-0037-006	CAP. ELECT 10UF RAD
C46	CAP-0006-004	CAP, MULTILAYER CER DIP . 047
C47	CAP-0006-004	CAP, MULTILAYER CER DIP . 047
C48	CAP-0031-005	CAPACITOR TANT 10uf 16V

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
C49	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C5	CAP-0001-001	CAPACITOR MICA 10pf
C50	CAP-0037-006	CAP. ELECT 10UF RAD
C51	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C52	CAP-0027-473	CAPACITOR FILM CK05 .047
C53	CAP-0006-003	CAP, MULTILAYER CER DIP .001
C54	CAP-0006-003	CAP, MULTILAYER CER DIP .001
C55	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C56	CAP-0013-003	CAPACITOR MONO .01uf 100V
C57	CAP-0013-005	CAPACITOR MONO .001 uf
C58	CAP-0013-005	CAPACITOR MONO .001 uf
C59	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C6	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C60	CAP-0037-002	CAP. ELECT 2.2uf RAD
C61	CAP-0006-003	CAP, MULTILAYER CER DIP .001
C62	CAP-0031-001	CAP TANT 2.2uf 16-25V
C63	CAP-0037-002	CAP. ELECT 2.2uf RAD
C64	CAP-0027-103	CAPACITOR FILM CK05 .01
C65	CAP-0027-682	CAPACITOR FILM CK05 .0068
C66	CAP-0027-682	CAPACITOR FILM CK05 .0068
C67	CAP-0027-103	CAPACITOR FILM CK05 .01
C68	CAP-0027-103	CAPACITOR FILM CK05 .01
C69	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C7	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C70	CAP-0037-005	CAP. ELECT 22UF RAD
C71	CAP-0030-005	CAPACITOR TANT .47uf 35V
C72	CAP-0030-005	CAPACITOR TANT .47uf 35V
C73	CAP-0030-005	CAPACITOR TANT .47uf 35V
C74	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C75	CAP-0027-474	CAPACITOR FILM CK05 .47
C76	CAP-0031-007	CAPACITOR TANT 22uf 16V
C77	CAP-0001-020	CAPACITOR MICA 220pf
C78	CAP-0031-007	CAPACITOR TANT 22uf 16V
C79	CAP-0027-474	CAPACITOR FILM CK05 .47
C8	CAP-0006-004	CAP, MULTILAYER CER DIP .047
C80	CAP-0031-005	CAPACITOR TANT 10uf 16V
C81	CAP-0027-104	CAPACITOR FILM CK05 .1
C82	CAP-0031-003	CAPACITOR TANT 4.7uf 16V
C83	CAP-0031-003	CAPACITOR TANT 4.7uf 16V
C84	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C85	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C86	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C87	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C88	CAP-0037-002	CAP. ELECT 2.2uf RAD
C89	CAP-0031-003	CAPACITOR TANT 4.7uf 16V
C9	CAP-0006-004	CAP, MULTILAYER CER DIP .047
C90	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C91	CAP-0031-007	CAPACITOR TANT 22uf 16V
C92	CAP-0006-001	CAP, MULTILAYER CER DIP .1
C93	CAP-0031-005	CAPACITOR TANT 10uf 16V

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

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REF DES	PART NUM	DESCRIPTION
C94	CAP-0013-005	CAPACITOR MONO .001 uf
C95	CAP-0013-005	CAPACITOR MONO .001 uf
C96	CAP-0013-005	CAPACITOR MONO .001 uf
C97	CAP-0013-005	CAPACITOR MONO .001 uf
C98	CAP-0006-002	CAP, MULTILAYER CER DIP .01
C99	CAP-0002-750	.75PF 10% GC CAPACITOR
CR1	SEM-0096-002	KS1001
CR10	SEM-0076-001	DIODE, 1N4148
CR11	SEM-0170-027	SMALL SIGNAL SCHOTTKY DIODE
CR12	SEM-0170-027	SMALL SIGNAL SCHOTTKY DIODE
CR13	SEM-0170-027	SMALL SIGNAL SCHOTTKY DIODE
CR14	SEM-0076-001	DIODE, 1N4148
CR15	SEM-0076-001	DIODE, 1N4148
CR16	SEM-0076-001	DIODE, 1N4148
CR18	SEM-0096-004	1SV80
CR19	SEM-0096-004	1SV80
CR2	SEM-0076-001	DIODE, 1N4148
CR20	SEM-0096-004	1SV80
CR21	SEM-0096-004	1SV80
CR22	SEM-0083-005	18V ZENER 1N4746A
CR23	SEM-0078-002	1N4001
CR24	SEM-0076-001	DIODE, 1N4148
CR25	SEM-0083-004	1N4735A ZENER 1 W REG
CR27	SEM-0076-001	DIODE, 1N4148
CR28	SEM-0076-001	DIODE, 1N4148
CR29	SEM-0076-001	DIODE, 1N4148
CR3	SEM-0076-001	DIODE, 1N4148
CR30	SEM-0080-004	MV209
CR31	SEM-0080-004	MV209
CR32	SEM-0080-004	MV209
CR33	SEM-0080-004	MV209
CR34	SEM-0080-004	MV209
CR35	SEM-0080-004	MV209
CR36	SEM-0080-004	MV209
CR37	SEM-0080-004	MV209
CR4	SEM-0076-001	DIODE, 1N4148
CR5	SEM-0091-001	DIODES 1N3070
CR6	SEM-0091-001	DIODES 1N3070
CR7	SEM-0076-001	DIODE, 1N4148
CR8	SEM-0084-001	LED, RED
CR9	SEM-0076-001	DIODE, 1N4148
FL1	FIL-0012-001	6 POLE LADDER , 500 OHM
FL2	FIL-0012-002	4 POLE LADDER 500 OHM
FS	CAP-0073-003	33PF 10% 50 WVDC RADIAL CAP
JISOC	SOC-0002-016	IC SOCKET, 16 PIN DIP
JU1	JUM-0002-060	JUMPER
JU2	JUM-0002-045	JUMPER
JU3	JUM-0002-085	JUMPER
JU4	JUM-0002-045	JUMPER
JU5	JUM-0002-320	JUMPER

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

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REF DES	PART NUM	DESCRIPTION
K1	REL-0007-001	RELAY, SPST 12VDC
L1	IND-0021-011	INDUCTOR, 4.7uh
L10	IND-0021-020	INDUCTOR, 27uh CRAMER
L11	IND-0021-020	INDUCTOR, 27uh CRAMER
L13	IND-0021-022	2.7UH INDUCTOR
L14	IND-0010-101	100UH RADIAL SHIELD CHOKE
L15	ASY-0004-06	IND, TOR 6T18-226on11-1 T304
L16	IND-0010-101	100UH RADIAL SHIELD CHOKE
L17	ASY-0004-05	IND, TOR 5T18-226on11-1 T304
L18	IND-0021-020	INDUCTOR, 27uh CRAMER
L19	IND-0010-101	100UH RADIAL SHIELD CHOKE
L2	IND-0020-014	INDUCTOR, 470uh CRAMER
L20	ASY-0004-08	IND, TOR 8T18-226on11-1 T304
L21	IND-0021-020	INDUCTOR, 27uh CRAMER
L22	IND-0001-110	INDUCTOR, 10uh WEE
L23	IND-0021-020	INDUCTOR, 27uh CRAMER
L24	IND-0021-020	INDUCTOR, 27uh CRAMER
L25	IND-0021-020	INDUCTOR, 27uh CRAMER
L26	IND-0001-568	INDUCTOR, .56uh WEE
L3	IND-0021-020	INDUCTOR, 27uh CRAMER
L4	IND-0020-014	INDUCTOR, 470uh CRAMER
L5	ASY-0004-09	INDUCTOR, TOROID
L6	ASY-0004-09	INDUCTOR, TOROID
L7	ASY-0004-10	IND, TOR 10T18-226on11-1
L9	IND-0021-020	INDUCTOR, 27uh CRAMER
P1	CON-0028-002	HEADER MALE 9 TERM.
P2	CON-0028-002	HEADER MALE 9 TERM.
P3	CON-0028-008	HEADER, 3 TERM MALE, GREEN
P4	CON-0028-006	PLUG IN 4 TERM FEMALE, GREEN
Q1	SEM-0003-001	2N3563
Q10	SEM-0021-002	PN2222A
Q11	SEM-0032-002	TIP 32 SILICON POW TRANS
Q12	SEM-0021-002	PN2222A
Q13	SEM-0021-002	PN2222A
Q14	SEM-0004-002	2N2907
Q15	SEM-0004-002	2N2907
Q16	SEM-0004-002	2N2907
Q17	SEM-0004-002	2N2907
Q18	SEM-0003-002	MPS5179
Q19	SEM-0003-002	MPS5179
Q2	SEM-0003-001	2N3563
Q20	SEM-0003-002	MPS5179
Q21	SEM-0003-002	MPS5179
Q22	SEM-0003-002	MPS5179
Q23	SEM-0003-002	MPS5179
Q24	SEM-0063-002	PLASTIC NPN 2N3866
Q25	SEM-0003-002	MPS5179
Q26	SEM-0003-002	MPS5179
Q27	SEM-0003-002	MPS5179
Q28	SEM-0003-002	MPS5179

REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

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REF DES	PART NUM	DESCRIPTION
Q29	SEM-0063-002	PLASTIC NPN 2N3866
Q3	SEM-0007-001	2N3641
Q30	SEM-0017-004	J310
Q31	SEM-0003-002	MPS5179
Q32	SEM-0021-002	PN2222A
Q33	SEM-0004-002	2N2907
Q4	SEM-0021-002	PN2222A
Q5	SEM-0021-004	VN2222LM 60V FET
Q6	SEM-0003-001	2N3563
Q7	SEM-0003-001	2N3563
Q8	SEM-0003-001	2N3563
Q9	SEM-0021-002	PN2222A
R1	RES-0001-221	RESISTOR 220 1/4W
R10	RES-0001-222	RESISTOR 2.2K 1/4W
R100	RES-0001-221	RESISTOR 220 1/4W
R101	RES-0001-101	RESISTOR 100 1/4W
R102	RES-0001-103	RESISTOR 10K 1/4W
R103	RES-0001-103	RESISTOR 10K 1/4W
R104	RES-0001-103	RESISTOR 10K 1/4W
R105	RES-0001-103	RESISTOR 10K 1/4W
R106	RES-0001-103	RESISTOR 10K 1/4W
R107	RES-0001-332	RESISTOR 3.3K 1/4W
R108	RES-0001-332	RESISTOR 3.3K 1/4W
R11	RES-0001-221	RESISTOR 220 1/4W
R110	RES-0001-393	RESISTOR 39K 1/4W
R111	RES-0001-683	RESISTOR 68K 1/4W
R112	RES-0001-153	RESISTOR 15K 1/4W
R113	RES-0001-103	RESISTOR 10K 1/4W
R114	RES-0001-103	RESISTOR 10K 1/4W
R115	RES-0001-221	RESISTOR 220 1/4W
R116	RES-0001-101	RESISTOR 100 1/4W
R117	RES-0001-390	39 OHM 1/4 WATT 5%
R118	RES-0001-100	RESISTOR 10 1/4W
R119	RES-0001-103	RESISTOR 10K 1/4W
R12	RES-0001-150	RESISTOR 15 1/4W
R120	RES-0001-103	RESISTOR 10K 1/4W
R121	RES-0001-511	RESISTOR 510 1/4W
R122	RES-0001-621	RESISTOR 620 1/4W
R123	RES-0001-621	RESISTOR 620 1/4W
R124	RES-0001-621	RESISTOR 620 1/4W
R125	RES-0001-621	RESISTOR 620 1/4W
R126	RES-0001-103	RESISTOR 10K 1/4W
R127	RES-0001-101	RESISTOR 100 1/4W
R128	RES-0001-101	RESISTOR 100 1/4W
R129	RES-0001-101	RESISTOR 100 1/4W
R13	RES-0001-180	RESISTOR 18 1/4W
R130	RES-0001-101	RESISTOR 100 1/4W
R131	RES-0001-102	RESISTOR 1K 1/4W
R132	RES-0001-103	RESISTOR 10K 1/4W
R133	RES-0001-103	RESISTOR 10K 1/4W

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

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REF DES	PART NUM	DESCRIPTION
R134	RES-0002-101	RESISTOR, 100 1/2W
R135	RES-0001-473	RESISTOR 47K 1/4W
R136	RES-0001-224	RESISTOR 220K 1/4W
R137	RES-0001-102	RESISTOR 1K 1/4W
R138	RES-0001-473	RESISTOR 47K 1/4W
R139	RES-0001-472	RESISTOR 4.7K 1/4W
R14	RES-0001-301	RESISTOR 300 1/4W
R140	RES-0001-104	RESISTOR 100K 1/4W
R141	RES-0001-102	RESISTOR 1K 1/4W
R142	RES-0001-102	RESISTOR 1K 1/4W
R143	RES-0001-470	RESISTOR 47 1/4W
R144	RES-0001-221	RESISTOR 220 1/4W
R145	RES-0001-561	RESISTOR 560 1/4W
R146	RES-0001-102	RESISTOR 1K 1/4W
R147	RES-0001-102	RESISTOR 1K 1/4W
R148	RES-0001-222	RESISTOR 2.2K 1/4W
R149	RES-0034-502	TRIMMER, 5K
R15	RES-0001-301	RESISTOR 300 1/4W
R150	RES-0001-331	RESISTOR 330 1/4W
R151	RES-0001-331	RESISTOR 330 1/4W
R152	RES-0001-222	RESISTOR 2.2K 1/4W
R153	RES-0001-331	RESISTOR 330 1/4W
R154	RES-0001-222	RESISTOR 2.2K 1/4W
R155	RES-0001-331	RESISTOR 330 1/4W
R156	RES-0001-222	RESISTOR 2.2K 1/4W
R157	RES-0001-103	RESISTOR 10K 1/4W
R158	RES-0001-152	RESISTOR 1.5K 1/4W
R159	RES-0001-103	RESISTOR 10K 1/4W
R16	RES-0001-621	RESISTOR 620 1/4W
R160	RES-0001-103	RESISTOR 10K 1/4W
R161	RES-0001-103	RESISTOR 10K 1/4W
R162	RES-0001-472	RESISTOR 4.7K 1/4W
R163	RES-0001-123	RESISTOR 12K 1/4W
R164	RES-0001-472	RESISTOR 4.7K 1/4W
R165	RES-0001-123	RESISTOR 12K 1/4W
R166	RES-0001-471	RESISTOR 470 1/4W
R167	RES-0001-473	RESISTOR 47K 1/4W
R168	RES-0001-272	RESISTOR 2.7K 1/4W
R169	RES-0001-103	RESISTOR 10K 1/4W
R17	RES-0001-750	RESISTOR, 75 1/4W
R170	RES-0001-472	RESISTOR 4.7K 1/4W
R171	RES-0001-102	RESISTOR 1K 1/4W
R172	RES-0001-103	RESISTOR 10K 1/4W
R173	RES-0001-472	RESISTOR 4.7K 1/4W
R174	RES-0001-103	RESISTOR 10K 1/4W
R175	RES-0001-472	RESISTOR 4.7K 1/4W
R176	RES-0001-102	RESISTOR 1K 1/4W
R177	RES-0001-103	RESISTOR 10K 1/4W
R178	RES-0001-472	RESISTOR 4.7K 1/4W
R179	RES-0001-101	RESISTOR 100 1/4W

REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

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REF DES	PART NUM	DESCRIPTION
R18	RES-0001-300	30 OHM 1/4 WATT 5 %
R180	RES-0001-221	RESISTOR 220 1/4W
R181	RES-0001-471	RESISTOR 470 1/4W
R182	RES-0001-221	RESISTOR 220 1/4W
R183	RES-0001-682	RESISTOR 6.8K 1/4W
R184	RES-0001-102	RESISTOR 1K 1/4W
R185	RES-0001-470	RESISTOR 47 1/4W
R186	RES-0001-221	RESISTOR 220 1/4W
R187	RES-0001-472	RESISTOR 4.7K 1/4W
R188	RES-0001-150	RESISTOR 15 1/4W
R189	RES-0001-151	RESISTOR 150 1/4W
R19	RES-0001-621	RESISTOR 620 1/4W
R190	RES-0001-103	RESISTOR 10K 1/4W
R191	RES-0001-473	RESISTOR 47K 1/4W
R192	RES-0001-103	RESISTOR 10K 1/4W
R193	RES-0001-472	RESISTOR 4.7K 1/4W
R194	RES-0001-102	RESISTOR 1K 1/4W
R195	RES-0001-472	RESISTOR 4.7K 1/4W
R196	RES-0001-101	RESISTOR 100 1/4W
R197	RES-0001-221	RESISTOR 220 1/4W
R198	RES-0001-221	RESISTOR 220 1/4W
R199	RES-0001-682	RESISTOR 6.8K 1/4W
R2	RES-0027-101	TRIMMER, 100 91AR100
R20	RES-0001-301	RESISTOR 300 1/4W
R200	RES-0001-471	RESISTOR 470 1/4W
R201	RES-0001-470	RESISTOR 47 1/4W
R202	RES-0001-102	RESISTOR 1K 1/4W
R203	RES-0001-221	RESISTOR 220 1/4W
R204	RES-0001-472	RESISTOR 4.7K 1/4W
R205	RES-0001-150	RESISTOR 15 1/4W
R206	RES-0001-151	RESISTOR 150 1/4W
R207	RES-0001-104	RESISTOR 100K 1/4W
R208	RES-0001-104	RESISTOR 100K 1/4W
R209	RES-0001-201	RESISTOR 200 1/4W
R21	RES-0001-301	RESISTOR 300 1/4W
R210	RES-0001-101	RESISTOR 100 1/4W
R211	RES-0001-103	RESISTOR 10K 1/4W
R212	RES-0001-472	RESISTOR 4.7K 1/4W
R213	RES-0001-101	RESISTOR 100 1/4W
R214	RES-0001-102	RESISTOR 1K 1/4W
R215	RES-0001-103	RESISTOR 10K 1/4W
R216	RES-0001-222	RESISTOR 2.2K 1/4W
R217	RES-0001-332	RESISTOR 3.3K 1/4W
R218	RES-0001-103	RESISTOR 10K 1/4W
R219	RES-0001-103	RESISTOR 10K 1/4W
R22	RES-0001-180	RESISTOR 18 1/4W
R220	RES-0001-103	RESISTOR 10K 1/4W
R221	RES-0001-123	RESISTOR 12K 1/4W
R222	RES-0001-472	RESISTOR 4.7K 1/4W
R223	RES-0001-472	RESISTOR 4.7K 1/4W

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

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REF DES	PART NUM	DESCRIPTION
R224	RES-0001-821	RESISTOR 820 1/4W
R225	RES-0001-222	RESISTOR 2.2K 1/4W
R226	RES-0001-101	RESISTOR 100 1/4W
R227	RES-0001-101	RESISTOR 100 1/4W
R228	RES-0001-821	RESISTOR 820 1/4W
R229	RES-0001-821	RESISTOR 820 1/4W
R23	RES-0001-222	RESISTOR 2.2K 1/4W
R230	RES-0001-332	RESISTOR 3.3K 1/4W
R231	RES-0001-433	RESISTOR, 43K 1/4W 5%
R232	RES-0001-473	RESISTOR 47K 1/4W
R233	RES-0001-682	RESISTOR 6.8K 1/4W
R234	RES-0001-103	RESISTOR 10K 1/4W
R235	RES-0001-103	RESISTOR 10K 1/4W
R24	RES-0001-152	RESISTOR 1.5K 1/4W
R25	RES-0001-152	RESISTOR 1.5K 1/4W
R26	RES-0027-103	TRIMMER, 10K
R27	RES-0027-103	TRIMMER, 10K
R28	RES-0001-153	RESISTOR 15K 1/4W
R29	RES-0001-222	RESISTOR 2.2K 1/4W
R3	RES-0001-221	RESISTOR 220 1/4W
R30	RES-0001-102	RESISTOR 1K 1/4W
R31	RES-0001-821	RESISTOR 820 1/4W
R32	RES-0001-122	RESISTOR 1.2K 1/4W
R33	RES-0001-101	RESISTOR 100 1/4W
R34	RES-0001-103	RESISTOR 10K 1/4W
R35	RES-0027-103	TRIMMER, 10K
R36	RES-0001-103	RESISTOR 10K 1/4W
R37	RES-0001-101	RESISTOR 100 1/4W
R38	RES-0001-510	510HM, 1/4W CARBON FILM
R39	RES-0001-101	RESISTOR 100 1/4W
R4	RES-0001-821	RESISTOR 820 1/4W
R40	RES-0001-822	RESISTOR 8.2K 1/4W
R41	RES-0001-302	3K, 1/4WATT 5% CARBON FILM
R42	RES-0001-302	3K, 1/4WATT 5% CARBON FILM
R43	RES-0001-562	RESISTOR 5.6K 1/4W
R44	RES-0001-101	RESISTOR 100 1/4W
R45	RES-0001-393	RESISTOR 39K 1/4W
R46	RES-0001-122	RESISTOR 1.2K 1/4W
R47	RES-0001-681	RESISTOR 680 1/4W
R48	RES-0001-222	RESISTOR 2.2K 1/4W
R49	RES-0001-151	RESISTOR 150 1/4W
R5	RES-0001-221	RESISTOR 220 1/4W
R50	RES-0001-302	3K, 1/4WATT 5% CARBON FILM
R51	RES-0001-154	RESISTOR 150K 1/4W
R52	RES-0001-473	RESISTOR 47K 1/4W
R53	RES-0001-472	RESISTOR 4.7K 1/4W
R54	RES-0001-332	RESISTOR 3.3K 1/4W
R55	RES-0001-471	RESISTOR 470 1/4W
R56	RES-0001-822	RESISTOR 8.2K 1/4W
R57	RES-0001-103	RESISTOR 10K 1/4W

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
R58	RES-0001-822	RESISTOR 8.2K 1/4W
R59	RES-0001-104	RESISTOR 100K 1/4W
R6	RES-0001-470	RESISTOR 47 1/4W
R60	RES-0001-273	RESISTOR 27K 1/4W
R61	RES-0001-103	RESISTOR 10K 1/4W
R62	RES-0001-100	RESISTOR 10 1/4W
R63	RES-0001-103	RESISTOR 10K 1/4W
R64	RES-0001-393	RESISTOR 39K 1/4W
R65	RES-0001-393	RESISTOR 39K 1/4W
R66	RES-0001-822	RESISTOR 8.2K 1/4W
R67	RES-0001-822	RESISTOR 8.2K 1/4W
R68	RES-0001-682	RESISTOR 6.8K 1/4W
R69	RES-0001-153	RESISTOR 15K 1/4W
R7	RES-0001-102	RESISTOR 1K 1/4W
R70	RES-0001-182	RESISTOR 1.8K 1/4W
R71	RES-0001-273	RESISTOR 27K 1/4W
R72	RES-0001-332	RESISTOR 3.3K 1/4W
R73	RES-0001-152	RESISTOR 1.5K 1/4W
R74	RES-0001-223	RESISTOR 22K 1/4W
R75	RES-0001-331	RESISTOR 330 1/4W
R76	RES-0001-102	RESISTOR 1K 1/4W
R77	RES-0001-683	RESISTOR 68K 1/4W
R78	RES-0001-511	RESISTOR 510 1/4W
R79	RES-0001-511	RESISTOR 510 1/4W
R8	RES-0001-221	RESISTOR 220 1/4W
R80	RES-0001-103	RESISTOR 10K 1/4W
R81	RES-0001-103	RESISTOR 10K 1/4W
R82	RES-0001-823	RESISTOR 82K 1/4W
R83	RES-0001-681	RESISTOR 680 1/4W
R84	RES-0001-101	RESISTOR 100 1/4W
R85	RES-0001-104	RESISTOR 100K 1/4W
R86	RES-0001-472	RESISTOR 4.7K 1/4W
R87	RES-0001-470	RESISTOR 47 1/4W
R88	RES-0001-103	RESISTOR 10K 1/4W
R89	RES-0001-103	RESISTOR 10K 1/4W
R9	RES-0001-471	RESISTOR 470 1/4W
R90	RES-0001-471	RESISTOR 470 1/4W
R91	RES-0001-102	RESISTOR 1K 1/4W
R92	RES-0001-103	RESISTOR 10K 1/4W
R93	RES-0001-152	RESISTOR 1.5K 1/4W
R94	RES-0001-103	RESISTOR 10K 1/4W
R95	RES-0001-563	RESISTOR 56K 1/4W
R96	RES-0001-103	RESISTOR 10K 1/4W
R97	RES-0001-103	RESISTOR 10K 1/4W
R98	RES-0001-221	RESISTOR 220 1/4W
R99	RES-0001-101	RESISTOR 100 1/4W
T1	ASY-0222-TT5	INDUCTOR, T TRIFI ON #43
T2	TRA-0011-001	TRANS VIOLET
T3	TRA-0011-001	TRANS VIOLET
T4	TRA-0005-001	TRANSFORMER, BLK

## REFERENCE DESIGNATORS FOR ASY-0322-01 MAIN BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
T5	ASY-0010-08	TRANSFORMER
T6	ASY-0010-08	TRANSFORMER
T7	TRA-0011-001	TRANS VIOLET
T8	TRA-0005-001	TRANSFORMER, BLK
U1	SEM-0102-001	MC3340P
U10	SEM-0165-004	MSA-0885 MMIC
U11	SEM-0174-001	DATA XCEIVER SN75176
U12	SEM-0140-107	DUAL NAND CD40107B
U13	SEM-0140-013	4013 (RED)
U14	SEM-0109-004	7808
U15	SEM-0109-001	UA7805CKC 5V REGULATOR
U16	SEM-0162-002	MC3393 (RED)
U17	SEM-0170-015	LM78L05AWC
U18	SEM-0176-001	SYNTHESIZER MC145158
U19	SEM-0162-002	MC3393 (RED)
U2	SEM-0101-001	MC1350P
U20	SEM-0170-015	LM78L05AWC
U21	SEM-0176-001	SYNTHESIZER MC145158
U22	SEM-0175-001	SYNTHESIZER MC145157
U23	SEM-0170-007	DM7406
U24	SEM-0170-007	DM7406
U3	SEM-0103-002	MC1496P BAL MODULATOR
U4	SEM-0154-003	LM358 DUAL OP AMP
U5	SEM-0154-001	LM324 QUAD OPAMP
U6	SEM-0140-066	4066 (RED)
U7	SEM-0140-066	4066 (RED)
U8	SEM-0154-010	LM348 OP AMP
U9	SEM-0101-001	MC1350P
Y1	CRY-0018-001	10. BMHZ CERAMIC RESONATOR
Y2	CRY-0017-002	4020.00KHz 60C CRYSTAL

REFERENCE DESIGNATORS FOR ASY-0322-02 P. A. / FILTER

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
C1	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C10	CAP-0003-023	CAPACITOR DM19 130pf
C100	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C101	CAP-0037-009	CAP. ELECT 1000UF RAD
C102	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C103	CAP-0031-005	CAPACITOR TANT 10uf 16V
C105	CAP-0003-003	CAPACITOR DM19 330pf
C106	CAP-0003-019	CAPACITOR DM19 270pf
C108	CAP-0003-004	CAPACITOR DM19 470pf
C11	CAP-0007-003	CAPACITOR DM15 15pf
C110	CAP-0003-013	CAPACITOR DM19 150pf
C111	CAP-0007-003	CAPACITOR DM15 15pf
C112	CAP-0003-026	CAPICITOR DM19 75pf
C113	CAP-0003-034	CAPICITOR DM19 18pf
C115	CAP-0037-012	CAP. ELECT 330UF RAD
C116	CAP-0003-028	CAPACITOR DM19 300pf
C117	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C118	CAP-0031-005	CAPACITOR TANT 10uf 16V
C121	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C122	CAP-0003-033	CAPICITOR DM19 82pf
C13	CAP-0003-029	CAPACITOR DM19 120pf
C14	CAP-0003-021	CAPACITOR DM19 200pf
C15	CAP-0003-013	CAPACITOR DM19 150pf
C16	CAP-0003-028	CAPACITOR DM19 300pf
C17	CAP-0003-034	CAPICITOR DM19 18pf
C18	CAP-0003-032	CAPACITOR DM19 180pf
C19	CAP-0003-021	CAPACITOR DM19 200pf
C2	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C20	CAP-0003-019	CAPACITOR DM19 270pf
C21	CAP-0003-003	CAPACITOR DM19 330pf
C22	CAP-0003-003	CAPACITOR DM19 330pf
C23	CAP-0003-028	CAPACITOR DM19 300pf
C24	CAP-0003-030	CAPICITOR DM19 68pf
C25	CAP-0003-003	CAPACITOR DM19 330pf
C27	CAP-0003-028	CAPACITOR DM19 300pf
C30	CAP-0003-007	CAPACITOR DM19 1200pf
C31	CAP-0003-029	CAPACITOR DM19 120pf
C33	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C34	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C35	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C36	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C37	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C38	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C39	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C4	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C40	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C41	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C42	CAP-0006-001	CAP, MULTILAYER CER DIP . 1
C43	CAP-0006-002	CAP, MULTILAYER CER DIP . 01
C44	CAP-0006-001	CAP, MULTILAYER CER DIP . 1

## REFERENCE DESIGNATORS FOR ASY-0322-02 P. A. / FILTER

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
L1	ASY-0003-06M	IND, TOR 6T18-18on8-1 T80-2
L10	ASY-0003-17	IND, TOR 17T18-18on8-1 T80-2
L11	ASY-0003-21M	IND, TOR 21T18-18on8-1 T80-2
L12	FER-0004-001	TOROID, TYPE 73 BEAD
L13	FER-0002-001	TOROID, TYPE 43
L14	FER-0002-001	TOROID, TYPE 43
L2	ASY-0003-04M	IND, TOR 4T18-18on8-1 T80-2
L3	ASY-0003-07M	IND, TOR 7T18-18on8-1 T80-2
L4	ASY-0003-08M	IND, TOR 8T18-18on8-1 T80-2
L5	ASY-0003-09M	IND, TOR 9T18-18on8-1 T80-2
L6	ASY-0003-11M	IND, TOR 11T18-18on8-1 T80-2
L7	ASY-0003-12M	IND, TOR 12T18-18on8-1 T80-2
L8	ASY-0003-13M	IND, TOR 13T18-18on8-1 T80-2
L9	ASY-0003-17	IND, TOR 17T18-18on8-1 T80-2
P1	TER-0004-002	BOARD STAKE, TAPE & REEL
P2	TER-0004-002	BOARD STAKE, TAPE & REEL
Q10	SEM-0068-001	RF POWER TRANS (SD1214-4)
Q11	SEM-0063-001	2N3866
Q12	SEM-0070-001	MJE720 POWER TRANS
Q13	SEM-0070-001	MJE720 POWER TRANS
Q15	SEM-0070-001	MJE720 POWER TRANS
Q16	SEM-0070-001	MJE720 POWER TRANS
Q17	SEM-0170-023	POWER MOS FET
Q2	SEM-0032-002	TIP 32 SILICON POW TRANS
Q3	SEM-0057-005	455 NPN SILICON RF POWER T
Q4	SEM-0057-005	455 NPN SILICON RF POWER T
Q5	SEM-0057-005	455 NPN SILICON RF POWER T
Q6	SEM-0057-005	455 NPN SILICON RF POWER T
Q7	SEM-0026-001	TRANSISTOR TIP120W/HDW
Q8	SEM-0026-001	TRANSISTOR TIP120W/HDW
Q9	SEM-0068-001	RF POWER TRANS (SD1214-4)
R1	RES-0002-333	RESISTOR, 1/2W 33K
R10	RES-0001-100	RESISTOR 10 1/4W
R11	RES-0001-100	RESISTOR 10 1/4W
R12	RES-0001-100	RESISTOR 10 1/4W
R13	RES-0001-100	RESISTOR 10 1/4W
R14	RES-0001-100	RESISTOR 10 1/4W
R15	RES-0005-101	RESISTOR, 100 2W
R16	RES-0006-100	RESISTOR, 10 1W
R17	RES-0001-103	RESISTOR 10K 1/4W
R18	RES-0002-220	RESISTOR, 22 1/2W
R19	RES-0006-100	RESISTOR, 10 1W
R20	RES-0002-220	RESISTOR, 22 1/2W
R21	RES-0006-100	RESISTOR, 10 1W
R23	RES-0002-220	RESISTOR, 22 1/2W
R24	RES-0006-100	RESISTOR, 10 1W
R25	RES-0002-220	RESISTOR, 22 1/2W
R26	RES-0001-104	RESISTOR 100K 1/4W
R27	RES-0001-104	RESISTOR 100K 1/4W
R28	RES-0002-101	RESISTOR, 100 1/2W

## REFERENCE DESIGNATORS FOR ASY-0322-02 P. A. / FILTER

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
R29	RES-0001-104	RESISTOR 100K 1/4W
R3	RES-0001-103	RESISTOR 10K 1/4W
R30	RES-0005-221	RESISTOR, 220 2W
R31	RES-0005-220	RESISTOR, 22 2W
R32	RES-0005-221	RESISTOR, 220 2W
R33	RES-0001-621	RESISTOR 620 1/4W
R34	RES-0001-100	RESISTOR 10 1/4W
R35	RES-0001-104	RESISTOR 100K 1/4W
R36	RES-0001-104	RESISTOR 100K 1/4W
R37	RES-0001-104	RESISTOR 100K 1/4W
R38	RES-0027-103	TRIMMER, 10K
R39	RES-0001-180	RESISTOR 18 1/4W
R4	RES-0001-332	RESISTOR 3.3K 1/4W
R40	RES-0001-222	RESISTOR 2.2K 1/4W
R41	RES-0025-252	TRIMMER, 2.5K
R42	RES-0001-271	RESISTOR 270 1/4W
R43	RES-0001-047	RESISTOR 4.7 1/4W
R44	RES-0001-301	RESISTOR 300 1/4W
R45	RES-0001-301	RESISTOR 300 1/4W
R46	RES-0001-103	RESISTOR 10K 1/4W
R5	RES-0001-512	RESISTOR 5.1K 1/4W
R52	RES-0002-470	RESISTOR, 47 1/2W
R53	RES-0001-100	RESISTOR 10 1/4W
R54	RES-0002-470	RESISTOR, 47 1/2W
R55	RES-0001-100	RESISTOR 10 1/4W
R56	RES-0001-100	RESISTOR 10 1/4W
R57	RES-0027-100	10 OHM TRIM POT
R58	RES-0001-681	RESISTOR 680 1/4W
R59	RES-0001-100	RESISTOR 10 1/4W
R6	RES-0001-332	RESISTOR 3.3K 1/4W
R60	RES-0027-100	10 OHM TRIM POT
R61	RES-0037-001	RESISTOR 1W WIRE W. .1 OHm
R62	RES-0001-681	RESISTOR 680 1/4W
R63	RES-0027-100	10 OHM TRIM POT
R64	RES-0001-100	RESISTOR 10 1/4W
R65	RES-0037-001	RESISTOR 1W WIRE W. .1 OHm
R66	RES-0001-681	RESISTOR 680 1/4W
R69	RES-0001-103	RESISTOR 10K 1/4W
R7	RES-0001-302	3K, 1/4WATT 5% CARBON FILM
R8	RES-0001-102	RESISTOR 1K 1/4W
R9	RES-0001-221	RESISTOR 220 1/4W
RT1	RES-0030-303	R-T CURVE MATCH THERMISTER
T1	TUB-0003-125	TUB, RD 1/4x.012x1.25 BRASS
T10	ASY-0223-L2M	INDUCTOR
T11	FER-0005-001	TOROID, BEAD 0801
T12	ASY-0010-08M	7 TURN TRANSFORMER
T2	TUB-0003-125	TUB, RD 1/4x.012x1.25 BRASS
T3	ASY-0222-T2	INDUCTOR, TOROID
T4	FER-0002-001	TOROID, TYPE 43
T5	TUB-0003-125	TUB, RD 1/4x.012x1.25 BRASS

## REFERENCE DESIGNATORS FOR ASY-0322-02 P.A. / FILTER

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
T6	ASY-0222-T2	INDUCTOR, TOROID
T7	FER-0002-001	TOROID, TYPE 43
T8	ASY-0222-T3	INDUCTOR, TOROID
T9	ASY-0223-L2M	INDUCTOR
U1	SEM-0151-002	8 BIT LATCH DRIVER
U1SOC	SOC-0002-016	IC SOCKET, 16 PIN DIP
U2	SEM-0154-001	LM324 QUAD OPAMP

REFERENCE DESIGNATORS FOR ASY-0322-03 TERMINAL INTERFACE PCB

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
C10	CAP-0013-003	CAPACITOR MONO .01uf 100V
C11	CAP-0013-004	CAPACITOR, MONO .0047UF
C12	CAP-0013-004	CAPACITOR, MONO .0047UF
C14	CAP-0013-003	CAPACITOR MONO .01uf 100V
C15	CAP-0013-003	CAPACITOR MONO .01uf 100V
C16	CAP-0031-001	CAP TANT 2.2uf 16-25V
C17	CAP-0031-001	CAP TANT 2.2uf 16-25V
C18	CAP-0013-003	CAPACITOR MONO .01uf 100V
C19	CAP-0013-003	CAPACITOR MONO .01uf 100V
C25	CAP-0001-015	CAPACITOR MICA 100pf
C26	CAP-0013-005	CAPACITOR MONO .001 uf
C27	CAP-0030-005	CAPACITOR TANT .47uf 35V
C28	CAP-0027-223	CAPACITOR FILM CK05 .022
C3	CAP-0031-007	CAPACITOR TANT 22uf 16V
C32	CAP-0013-003	CAPACITOR MONO .01uf 100V
C33	CAP-0027-104	CAPACITOR FILM CK05 .1
C34	CAP-0027-104	CAPACITOR FILM CK05 .1
C35	CAP-0027-223	CAPACITOR FILM CK05 .022
C36	CAP-0037-010	CAP. ELECT 470UF RAD
C37	CAP-0031-005	CAPACITOR TANT 10uf 16V
C39	CAP-0037-010	CAP. ELECT 470UF RAD
C4	CAP-0031-005	CAPACITOR TANT 10uf 16V
C44	CAP-0031-005	CAPACITOR TANT 10uf 16V
C45	CAP-0013-005	CAPACITOR MONO .001 uf
C46	CAP-0013-003	CAPACITOR MONO .01uf 100V
C6	CAP-0031-007	CAPACITOR TANT 22uf 16V
CB	CAP-0027-102	CAPACITOR FILM CK05 .001
C9	CAP-0027-104	CAPACITOR FILM CK05 .1
CR1	SEM-0083-005	18V ZENER 1N4746A
CR10	SEM-0085-001	LED, GREEN
CR11	SEM-0085-001	LED, GREEN
CR2	SEM-0085-001	LED, GREEN
CR3	SEM-0085-001	LED, GREEN
CR4	SEM-0076-001	DIODE, 1N4148
CR5	SEM-0076-001	DIODE, 1N4148
CR6	SEM-0076-001	DIODE, 1N4148
CR7	SEM-0076-001	DIODE, 1N4148
CR8	SEM-0076-001	DIODE, 1N4148
CR9	SEM-0076-001	DIODE, 1N4148
DS1	DIS-0003-001	LCD DISPLAY
J1	CON-0030-030	30 PIN FLEX STRIP JUMPER
J2SOC	SOC-0002-016	IC SOCKET, 16 PIN DIP
J3	CON-0240-120	12 PIN SINGLE ROW HEADER
Q1	SEM-0021-002	PN2222A
Q2	SEM-0021-002	PN2222A
Q3	SEM-0021-002	PN2222A
Q4	SEM-0021-004	VN2222LM 60V FET
Q5	SEM-0004-002	2N2907
Q6	SEM-0010-001	MPS-A14
R1	RES-0001-103	RESISTOR 10K 1/4W

## REFERENCE DESIGNATORS FOR ASY-0322-03 TERMINAL INTERFACE PCB

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
R10	RES-0001-472	RESISTOR 4.7K 1/4W
R11	RES-0001-472	RESISTOR 4.7K 1/4W
R12	RES-0001-472	RESISTOR 4.7K 1/4W
R13	RES-0001-472	RESISTOR 4.7K 1/4W
R14	RES-0001-472	RESISTOR 4.7K 1/4W
R15	RES-0001-473	RESISTOR 47K 1/4W
R16	RES-0001-473	RESISTOR 47K 1/4W
R17	RES-0001-473	RESISTOR 47K 1/4W
R18	RES-0001-473	RESISTOR 47K 1/4W
R19	RES-0001-101	RESISTOR 100 1/4W
R2	RES-0001-103	RESISTOR 10K 1/4W
R20	RES-0001-103	RESISTOR 10K 1/4W
R21	RES-0001-101	RESISTOR 100 1/4W
R22	RES-0001-101	RESISTOR 100 1/4W
R23	RES-0001-101	RESISTOR 100 1/4W
R24	RES-0001-101	RESISTOR 100 1/4W
R25	RES-0001-101	RESISTOR 100 1/4W
R26	RES-0001-221	RESISTOR 220 1/4W
R27	RES-0001-103	RESISTOR 10K 1/4W
R28	RES-0001-103	RESISTOR 10K 1/4W
R29	RES-0001-101	RESISTOR 100 1/4W
R3	RES-0001-104	RESISTOR 100K 1/4W
R30	RES-0001-221	RESISTOR 220 1/4W
R31	RES-0001-224	RESISTOR 220K 1/4W
R32	RES-0001-472	RESISTOR 4.7K 1/4W
R33	RES-0001-103	RESISTOR 10K 1/4W
R34	RES-0001-104	RESISTOR 100K 1/4W
R35	RES-0001-332	RESISTOR 3.3K 1/4W
R36	RES-0001-103	RESISTOR 10K 1/4W
R37	RES-0001-103	RESISTOR 10K 1/4W
R38	RES-0001-103	RESISTOR 10K 1/4W
R39	RES-0001-103	RESISTOR 10K 1/4W
R4	RES-0001-102	RESISTOR 1K 1/4W
R40	RES-0001-332	RESISTOR 3.3K 1/4W
R41	RES-0001-103	RESISTOR 10K 1/4W
R42	RES-0001-104	RESISTOR 100K 1/4W
R43	RES-0001-202	RESISTOR 2K 1/4W
R44	RES-0001-103	RESISTOR 10K 1/4W
R45	RES-0001-474	RESISTOR 470K 1/4W
R46	RES-0001-104	RESISTOR 100K 1/4W
R47	RES-0001-154	RESISTOR 150K 1/4W
R48	RES-0001-621	RESISTOR 620 1/4W
R49	RES-0001-104	RESISTOR 100K 1/4W
R5	RES-0001-271	RESISTOR 270 1/4W
R50	RES-0001-432	RESISTOR 4.3K 1/4W
R51	RES-0001-432	RESISTOR 4.3K 1/4W
R52	RES-0001-472	RESISTOR 4.7K 1/4W
R53	RES-0001-471	RESISTOR 470 1/4W
R54	RES-0001-471	RESISTOR 470 1/4W
R55	RES-0001-103	RESISTOR 10K 1/4W

REFERENCE DESIGNATORS FOR ASY-0322-03 TERMINAL INTERFACE PCB

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
R56	RES-0001-102	RESISTOR 1K 1/4W
R57	RES-0001-103	RESISTOR 10K 1/4W
R58	RES-0001-563	RESISTOR 56K 1/4W
R59	RES-0001-221	RESISTOR 220 1/4W
R6	RES-0001-103	RESISTOR 10K 1/4W
R60	RES-0001-068	RESISTOR, 6.8 1/4W
R61	RES-0001-012	RESISTOR 1.2 1/4W
R62	RES-0001-470	RESISTOR 47 1/4W
R63	RES-0001-103	RESISTOR 10K 1/4W
R64	RES-0001-102	RESISTOR 1K 1/4W
R65	RES-0001-103	RESISTOR 10K 1/4W
R66	RES-0001-103	RESISTOR 10K 1/4W
R67	RES-0001-103	RESISTOR 10K 1/4W
R68	RES-0001-103	RESISTOR 10K 1/4W
R69	RES-0001-103	RESISTOR 10K 1/4W
R7	RES-0001-103	RESISTOR 10K 1/4W
R70	RES-0001-222	RESISTOR 2.2K 1/4W
R71	RES-0001-106	RESISTOR 10MEG 1/4W
R72	RES-0001-152	RESISTOR 1.5K 1/4W
R73	RES-0001-222	RESISTOR 2.2K 1/4W
R8	RES-0001-334	RESISTOR 330K 1/4W
R9	RES-0001-102	RESISTOR 1K 1/4W
U1	SEM-0109-004	7808
U10	SEM-0143-373	74HC373 OCTAL D LATCH
U11	SEM-0153-003	TDA2002H
U2	SEM-0109-001	UA7805CKC 5V REGULATOR
U3	SEM-0182-001	PCF8577 MULTIPLEXED LCD DRIV
U4	SEM-0143-132	74HC132 (RED)
U5	SEM-0174-001	DATA XCEIVER SN75176
U6	SEM-0154-010	LM348 OP AMP
U7	SEM-0158-002	ADC0832 A/D CONVERTER
U8	SEM-0154-001	LM324 QUAD OPAMP
U9	SEM-0158-003	DAC0832 D/A CONVERTER

REFERENCE DESIGNATORS FOR ASY-0322-04 CABLE INTERFACE BOARD

EFFECTIVE 03-15-88

REF	PART NUM	DESCRIPTION
CR1	SEM-0089-001	1N5402
R1	RES-0001-621	620 $\Omega$ $\frac{1}{4}$ w
J1	SOC-0002-016	IC socket, 16 pin dip
P1	TER-0026-003	9 position terminal

REFERENCE DESIGNATORS FOR ASY-0503-01 CPU BOARD

EFFECTIVE 03-15-88

REF DES	PART NUM	DESCRIPTION
C1	CAP-0001-003	CAPACITOR MICA 22pf
C10	CAP-0013-001	CAPACITOR MONO .1uf
C11	CAP-0013-001	CAPACITOR MONO .1uf
C12	CAP-0031-007	CAPACITOR TANT 22uf 16V
C13	CAP-0031-001	CAP TANT 2.2uf 16-25V
C14	CAP-0013-001	CAPACITOR MONO .1uf
C2	CAP-0001-003	CAPACITOR MICA 22pf
C3	CAP-0013-001	CAPACITOR MONO .1uf
C4	CAP-0013-001	CAPACITOR MONO .1uf
C5	CAP-0013-001	CAPACITOR MONO .1uf
C6	CAP-0013-001	CAPACITOR MONO .1uf
C7	CAP-0013-001	CAPACITOR MONO .1uf
C8	CAP-0013-001	CAPACITOR MONO .1uf
C9	CAP-0013-001	CAPACITOR MONO .1uf
CR1	SEM-0076-001	DIODE, 1N4148
CR2	SEM-0076-001	DIODE, 1N4148
CR3	SEM-0076-001	DIODE, 1N4148
CR4	SEM-0170-026	IN4736A
CR5	SEM-0076-001	DIODE, 1N4148
R1	RES-0001-106	RESISTOR 10MEG 1/4W
R2	RES-0001-103	RESISTOR 10K 1/4W
R3	RES-0001-103	RESISTOR 10K 1/4W
R4	RES-0001-103	RESISTOR 10K 1/4W
R5	RES-0001-102	RESISTOR 1K 1/4W
U1	SEM-0161-001	MC146805E2 (RED)
U1SOC	SOC-0004-040	IC SOCKET, 40 PIN DIP
U4	SEM-0143-373	74HC373 OCTAL D LATCH
U5	SEM-0143-139	74HC139 (RED)
U6	SEM-0157-002	6350 S. I. A. (RED)
U6SOC	SOC-0004-024	IC SOCKET, 24 PIN DIP
U7	SEM-0170-008	4020 (RED)
U8	SEM-0143-132	74HC132 (RED)
U9	SEM-0109-001	UA7805CKC 5V REGULATOR
Y1	CRY-0009-003	4.9152MHZ CRYSTAL