FIRST DRAFT 10-7-99
V1.01 4-10-00
V1.02 10-20-00
V1.03 12-1-00
V1.04 2-2-01
V1.05 5-31-01

SEA INC OF DELAWARE

PRELIMINARY MAINTENANCE MANUAL

MF/HF SSB GMDSS RADIOTELEPHONE/DSC CONTROLLER

MODEL SEA 245

SEA, Inc.

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****IMPORTANT****

NOTICE TO INSTALLERS

NOTE: The safe compass distance for this equipment (As defined in Paragraph 29 of IEC Publication 92-101, Third Edition):

SEA 245 SINGLE SIDEBAND TRANSCEIVER = 2.0 meters

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1 GENERAL INFORMATION

1.1 DESCRIPTION

The SEA 245 is a compact, all solid-state, 150-Watt PEP, MF/HF SSB Radiotelephone Transceiver/DSC Controller. The SEA 245 is Type Certified for use in Sea Area A2 GMDSS stations and it suitable for use in any general purpose MF/HF radiotelephone application.

The SEA 245 covers the 1.605 to 29.999 MHz frequency range with channel restrictions which are determined only by the rules regarding the appropriate radio service. As normally programmed, the SEA 245 frequency memory contains ALL normally assigned ITU VOICE and TELEX channels and has space available for any additional channels which might be desired.

The SEA 245 is fully synthesized with 10 Hz resolution and the channel frequencies are controlled by a precision crystal housed in a temperature-stabilized enclosure. The transceiver is designed to operate from a 24-Volt power system. Grounding the chassis of the SEA 245 will NOT ground either supply voltage rail. The SEA 245 is normally configured as a conventional locally controlled radiotelephone with a backlit 19 key keypad and large backlit LCD graphics display. The output impedance is 50 ohms and the radiotelephone is certified for operation directly into suitable 50 ohm antenna systems in the 2000 kHz to 27.5 MHz frequency range.

When operation in the 1605 to 2000 KHz frequency range is required (FCC pp 80.905 and pp 80.909 "Maritime Services; General Exemption for Small Passenger Vessels Operated on Domestic Voyages" as amended June 19, 1991), it is MANDATORY that the SEA 245 be operated with either the companion SEA 1635 antenna tuner or the standard SEA 1612C or SEA 1631 antenna tuners.

The usual MARINE applications will employ an antenna tuner to properly match the antenna to the 50 ohm impedance required by the radiotelephone. For these applications, the SEA 245 is designed to operate interactively with either the SEA 1635, SEA 1612C or SEA 1631 antenna tuners. See installation diagrams for details on system interconnections.

The SEA 245 may also be operated from a single remote location using SEA 2450 Remote Controllers and the upgraded SEABUSS(c) interconnection provided.

The SEA 245 is also provided with an independent RS232 port which provides for easy interconnection with a computer.

1.2 EQUIPMENT FURNISHED

1.2.1 SEA 245 MF/HF Single Sideband Transceiver

1.2.2 Transceiver Mounting Bracket

1.2.3 Microphone and Microphone Clip

1.2.4 Power Connector

1.2.5 SEABUSS Connector, 9 pin PHOENIX type, female

1.2.6 Accessory Connector, 14 pin PHOENIX type, female

1.2.7 SEA 245 Operator's Manual

1.3 TRANSCEIVER UNIT SPECIFICATIONS

1.4 MECHANICAL INFORMATION

1.4.1 DIMENSIONS:

(HEIGHT-WIDTH-DEPTH)
In: 3.9 x 10.5 x 10.5
mm: 99 x 265 x 265

1.4.2 WEIGHT:

Lbs: 10
Kgs: 4.5

1.5 ELECTRICAL SPECIFICATIONS:

Type Acceptance	FCC Parts 80, 87, 90
FCC IDENTIFIER	BZ6SEA245
Frequency Range	(Tx) 1.605 - 29.999 MHz (Rx) 0.490 - 29.999 MHz
Circuitry	Double Conversion, 45 MHz 1st IF, 40 kHz (nominal) DSP
Operating Controls	19 Key Keypad, Volume Control
Channel Capacity	976 Marine ITU Channels in permanent storage, 200 scratchpad channels

Operating Temperature	-30 degrees to +60 degrees C
Frequency Stability	± 10 Hz
Operating Modes	J3E, R3E, H3E (2182 kHz), A1A (CW), F2B (TELEX)
Primary Voltage	24 V DC –10, +25% (21.6 to 30 V DC)
Current Drain:	
Receive (Standby)	1 Amp
Receive (Full Audio)	1.5 Amps
Transmit (Average Voice)	6 Amps
Transmit (Two Tone)	8 Amps
Transmit (TELEX)	12 Amps
RF Impedance	50 Ohms

1.5.1 TRANSMITTER

Power Output	R3E, J3E 150 Watts PEP
	F2B 100 Watts
	LOW = 50 - 75 Watts
	VLOW = 25 - 40 Watts
Intermodulation (J3E)	-34 dB below PEP (3rd)
Spurious Emissions	-65 dB below PEP
Carrier Suppression	-46 dB below PEP
Unwanted Sideband (@1000Hz)	-41 dB below PEP
Audio Response (J3E)	400 - 2500 Hz (@ -6 dB)
Hum and Noise	-46 dB below PEP
Tx Attack Time	≥ 15 ms

1.5.2 RECEIVER

Sensitivity, J3E ≥ 2.0 MHz	≤ 1 µV for 12 dB SINAD
Bandwidth, J3E	400 - 2500 Hz (@ -6 dB)
Selectivity, J3E at -1 kHz	≤ -55 dB
AGC, J3E	Fast attack, slow release, ≤ 10 dB audio level change from 10 µV to 100 mV input
Intermodulation	≤ -80 dB

Spurious Responses	≤ -60 dB
Audio Output	4 W with ≤ 10% distortion into external 4 ohm load.
Internal Loudspeaker	2.5" round, 4 ohm, 2 Watt
Spurious Radiation	Complies with FCC, EIA

SEA 245 FRONT VIEW (see separate attachment)

FIGURE 2.1 SEA 245 FRONT VIEW

2 OPERATION

2.1 WARM UP CAUTION

Do not attempt to transmit until the radiotelephone is warmed up for at least 1 minute. Transmitting before the 1-minute warm-up period has elapsed can cause violation of FCC regulations.

2.2 FRONT PANEL CONTROLS

Figure 1 illustrates the front panel of the SEA 245. The function of the individual controls and indicators are listed below.

2.2.1 ROTARY CONTROL

One rotary control is provided. This is the ON/OFF VOLUME control. Rotating the control clockwise from the extreme counter-clockwise position will switch the power ON. Further clockwise rotation adjusts the receiver loudspeaker volume to the desired level. Note that this control does NOT adjust the SEABUSS audio level.

2.2.2 KEYPAD

All of the various operating functions of a MF/HF radiotelephone and a Class A Digital Selective Calling Controller are realized through the 19 key keypad on the SEA 245 front panel, together with an interactive system of menus on the front panel LCD. For more specific details regarding the operating system, refer to the SEA 245 Operators Manual (OPR-245).

2.2.3 LCD DISPLAY

The LCD display used in the SEA 245 is an LED backlit graphics display module. This technology provides a fully reprogrammable display that facilitates the many different display requirements for a combination Radiotelephone/DSC Controller.

2.3 PROPAGATION

MF/HF radio 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 levels.

The High Seas frequencies (4, 6, 8, 12, 18, 22 and 25 MHz) allow communications over thousands of miles, again subject to the above mentioned limitations,

Interference tends to be more of a problem on the MF/HF bands than on VHF channels.

To promote a more in-depth understanding of the vicissitudes of MF/HF communications, SEA's "Mariners Guide to Single Sideband" (MAN-0001-001) is highly recommended reading.

2.4 BANDWIDTH LIMITATIONS

The only limitation imposed by the SEA 245 is that the desired frequency be inside the operating range of the equipment. In practice the antenna system will have a great deal to do with dictating the maximum allowable frequency separation. If (as is usually the case) a companion antenna tuner such as the SEA 1635 or SEA 1612C in used in conjunction with the usual short whip antenna, the allowable 2 MHz split may be reduced to a few hundred kHz.

3 MODE AND FREQUENCY CONTROL

3.1 GENERAL

In the SEA 245, the frequency of operation is determined through a combination of coarse and fine tuning mechanisms. The coarse tuning system consists of the PLL circuitry associated with the first Local Oscillator VCO. The effective loop frequency of the PLL is 4 kHz and the first LO is preset to the nearest incremental frequency needed to convert the desired operating frequency to 45 MHz. The required divide-by-N number for a given operating frequency is calculated by the control microprocessor and then loaded into the main loop PLL chip through the microprocessor SPI bus. The fine tuning system is incorporated into the DSP algorithm, which operates as the receiver “back end” and the transmitter "front end". The PLL that controls the second conversion oscillator is also loaded through the microprocessor SPI bus.

Such data as filter band, VCO band, synthesizer loads, carrier status and DSP algorithm are calculated and stored in appropriate registers by the controller computer, once the desired channel is entered by the operator.

3.1.1 TRANSMITTER MODE SELECTION

The primary mode of operation of the SEA 245 is in the J3E (SSB with fully suppressed carrier) mode.

Two auxiliary VOICE modes are also provided:

R3E: SSB with pilot carrier re-inserted 16 dB below PEP.

H3E: SSB with pilot carrier re-inserted 6 dB below PEP.

J3E is the basic SSB operating mode and is used for virtually all VOICE communications. H3E (AME) is used to provide a degree of compatibility between old style AM and SSB systems. Present practice limits this mode to 2182.0 kHz ONLY. R3E is primarily used to provide a pilot carrier on public correspondence channels. Present practice ignores this mode.

J2B: TELEX operation with both internally and externally generated (AFSK) tones. Uses J3E mode with narrower bandpass filter. Note that the internal DSC system uses the same standard 1700 Hz subcarrier frequency as is used in the SEA 3000 SEATOR equipment.

3.1.2 RECEIVE MODE SELECTION

The SEA 245 supports J3E, R3E and H3E modes as a standard SSB (J3E) receiver. The passband filter and AGC characteristics are tailored for SSB VOICE operation.

In the TELEX (J2B) receive mode, the passband filter is shifted to narrowband (500

Hz) and the BFO offset is set to the International Standard of 1700 Hz. AGC is fast attack, fast release.

In the CW (A1A) receive mode, the receiver passband filter is shifted to narrowband (500 Hz) and the BFO offset is set to 1000 Hz. AGC is fast attack, fast release.

In the AM (A3E) receive mode, the receiver passband is shifted to maximum bandwidth (4 kHz) and the received signal carrier is offset 1 kHz from the passband center. The DSP based envelope detector provides "true" AM demodulation with an effective bandwidth of 3000 Hz for audio recovery. This mode is useful primarily in the reception of time signals from WWV, shortwave broadcast signal etc. AGC is fast attack, fast release.

3.2 SEA 245 FREQUENCY LISTING

3.2.1 2 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
201	2003.0	2003.0	Ship-to-Ship, Great Lakes
202	2450.0	2003.0	KMI Point Reyes, CA
203	2006.0	2006.0	Alaska
205	2446.0	2009.0	WLO, Mobile, AL
206	2506.0	2009.0	WAH, St. Thomas
208	2030.0	2030.0	Virgin Islands, Intership
209	2490.0	2031.5	WOM, Ft. Lauderdale, FL
211	2054.0	2054.0	British Columbia WX
212	2065.0	2065.0	Ship-to-Ship
213	2079.0	2079.0	Ship-to-Ship
214	2082.5	2082.5	Ship-to-Ship Only
215	2086.0	2086.0	Ship-to-Ship, Miss. River Limited Coast
216	2585.0	2086.0	KRV, Pence Playa, WAH, St. Thomas, VI
217	2093.0	2093.0	Ship-to-Ship Only Commercial Fish
218	2096.5	2096.5	Ship-to-Ship,

			Ship to Limited Coast Station
219	2115.0	2115.0	Alaska
220	2118.0	2118.0	Alaska
221	2514.0	2118.0	WOM, Ft. Lauderdale, FL
			WLC, Rogers City, MI
223	2309.0	2131.0	WOU-23, Kodiak, AK
224	2312.0	2134.0	WGG-53, Cold Bay, AK
225	2530.0	2134.0	KBP, Kahuka, HI,
			KOP, Galveston
226	2134.0	2134.0	Eastern Canada Intership
227	2538.0	2142.0	KCC, Corpus Christi, TX
228	2142.0	2142.0	CA Intership
229	2146.0	2146.0	
230	2550.0	2158.0	PJC, Curacao
231	2550.0	2166.0	VRT, Bermuda
232	2558.0	2186.0	WOO, Manahawkin, NJ
233	2582.0	2166.0	8PO, Barbados,
			C6XZ, Marsh Harbor
234	2558.0	2198.0	VPN-2, Nassau Weather
236	2203.0	2203.0	Ship-to-Ship, Gulf of Mexico
238	2582.0	2206.0	WBL, Buffalo, NY
			VCS, Halifax, Canada
239	2397.0	2237.0	WDV-26, Cordova
			WGG-56, Ketchikan, AK
240	2400.0	2240.0	WGG-58, Juneau, AK
			WGG-55, Nome, AK
241	2735.0	2290.0	9YL, North Post, Trinidad
242	2450.0	2366.0	
245	2566.0	2390.0	WOM, Ft Lauderdale, FL
246	2400.0	2400.0	
247	2442.0	2406.0	WOM, Ft Lauderdale, FL

248	2506.0	2406.0	KMI, Point Reyes, CA
249	2419.0	2419.0	Alaska
250	2422.0	2422.0	Alaska
251	2427.0	2427,0	Alaska
252	2572.0	2430.0	WLO, Mobile, AL
254	2430.0	2430.0	Alaska
255	2447.0	2447.0	Alaska
256	2450.0	2450.0	Alaska
257	2506.0	2458.0	KGN, Delcambre, LA
258	2479.0	2479.0	Alaska
259	2482.0	2482.0	Alaska
261	2506.0	2506.0	Alaska
262	2509.0	2509.0	Alaska
263	2512.0	2512.0	FFP, Ft. Defrance,
			Windward Is.
264	2545.0	2545.0	
265	2527.0	2527.0	Alaska
266	2535.0	2535.0	
267	2538.0	2538.0	Alaska
268	2563.0	2583.0	Alaska
269	2566.0	2566.0	Alaska
270	2582.0	2582.0	Alaska
271	2590.0	2590.0	Alaska
273	2616.0	2616.0	Alaska
275	2638.0	2638.0	Ship-to-Ship
276	2640.0	2640.0	
277	2670.0	2870.0	USCG Working
278	2704.0	2704.0	Ocean Racing
279	2735.0	2735.0	9YL, North Post, Trinidad
280	2738.0	2738.0	Ship-to-Ship
			Except Great Lakes and Gulf

281	2782.0	2782.0	Ship-to-Ship River
			WFN, Jeffersonville, IN
			WGK, St. Louis, MO
			WJG, Memphis, TN
282	2830.0	2830.0	Ship-to-Ship, Gulf Only
283	2237.0	2237.0	
284	2530.0	2815.0	
285	2040.0	2040.0	
286	2318.0	2318.0	
287	2366.0	2366.0	
288	2469.0	2708.0	
289	2060.0	2798.0	
290	2458.0	2340.0	
291	2085.0	2045.0	NORWEGIAN
292	2048.0	2048.0	NORWEGIAN
293	2051.0	2051.0	NORWEGIAN
294	2057.0	2057.0	NORWEGIAN
302	3198.0	3198.0	Alaska Point-to-Point
303	3201.0	3201.0	Alaska Point-to-Point
304	3258.0	3258.0	Alaska
305	3261.0	3261.0	Alaska
306	3449.0	3449.0	Alaska Aero

3.2.2 4 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
401	4357.0	4065.0	KMI, Point Reyes, CA
			WAH, St. Thomas, VI
402	4360.0	4068.0	

403	4363.0	4071.0	WOM, Ft. Lauderdale, FL
404	4366.0	4074.0	KGN, Delcambre, LA
405	4369.0	4077.0	WLO, Mobile, AL
			WLC, Roger City, MI
406	4372.0	4080.0	
407	4375.0	4083.0	
408	4378.0	4086.0	
409	4381.0	4089.0	
410	4384.0	4092.0	WOO, Manahawkin, NJ
411	4387.0	4095.0	WOO, Manahawkin, NJ
412	4390.0	4098.0	WOM, Ft. Lauderdale, FL
413	4393.0	4101.0	
414	4396.0	4104.0	WLO, Mobile, AL
415	4399.0	4107.0	
416	4402.0	4110.0	KMI, Point Reyes, CA
			WOO, Manahawkin, NJ
417	4405.0	4113.0	KMI, Point Reyes, CA
			WOM, Ft. Lauderdale, FL
418	4408.0	4116.0	
419	4411.0	4119.0	WLO, Mobile, AL
420	4414.0	4122.0	
421	4417.0	4125.0	
422	4420.0	4128.0	WOO, Manahawkin, NJ
423	4423.0	4131.0	WOM, Ft. Lauderdale, FL
424	4426.0	4134.0	NMG, New Orleans, LA
			NMN, Portsmouth, VA, WX
425	4429.0	4137.0	
426	4432.0	4140.0	
427	4435.0	4143.0	
428	4351.0	4060.0	WLO, Mobile, AL

450	**4125.0**	**4125.0**	**DISTRESS**
451	4146.0	4146.0	4A LTD Coast/Intership
452	4149.0	4149.0	4B LTD Coast/Intership
453	4417.0	4417.0	4C LTD Coast/Intership
454	4366.0	4366.0	Alaska
455	4369.0	4369.0	Alaska
456	4396.0	4396.0	Alaska
457	4402.0	4402.0	Alaska
458	4420.0	4420.0	Alaska
459	4423.0	4423.0	Alaska
460	4065.0	4065.0	Mississippi River
461	4089.0	4089.0	Mississippi River
462	4116.0	4116.0	Mississippi River
463	4408.0	4408.0	Mississippi River
501	5164.5	5164.5	Alaska Public Fixed
502	5167.5	5167.5	Alaska Emergency/Calling
503	5680.0	5680.0	Aero Search/Rescue
504	5472.0	5472.0	Aero Search/Rescue
505	5490.0	5490.0	Aero

3.2.3 6 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
601	6501.0	6200.0	NMN, Portsmouth, VA NMG, New Orleans, LA MNA, Miami, FL
602	6504.0	6203.0	
603	6507.0	6206.0	
604	6510.0	6209.0	

605	6513.0	6212.0	
606	6516.0	6215.0	
607	6519.0	6218.0	WLO, Mobile, AL
608	6522.0	6221.0	
650	**6215.0**	**6215.0**	**DISTRESS**
651	6224.0	6224.0	6A LTD Coast/Intership
652	6227.0	6227.0	6B LTD Coast/Intership
653	6230.0	6230.0	6C LTD Coast/Intership
654	6516.0	6616.0	6D LTD Coast DAYTIME ONLY
655	6209.0	6209.0	Mississippi River
656	6212.0	6212.0	Mississippi River
657	6510.0	6510.0	Mississippi River
658	6513.0	6513.0	Mississippi River

3.2.4 8 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
801	8719.0	8195.0	
802	8722.0	8198.0	WOM, Ft. Lauderdale, FL
803	8725.0	8201.0	
804	8728.0	8204.0	KMI, Point Reyes, CA
805	8731.0	8207.0	WOM, Ft. Lauderdale, FL
806	8734.0	8210.0	
807	8737.0	8213.0	
808	8740.0	8216.0	WOO, Manahawkin, NJ
809	8743.0	8219.0	KMI, Point Reyes, CA
810	8746.0	8222.0	WOM, Ft. Lauderdale, FL
811	8749.0	8225.0	WOO, Manahawkin, NJ

812	8752.0	8228.0	
813	8755.0	8231.0	
814	8758.0	8234.0	WOM, Ft. Lauderdale, FL
815	8761.0	8237.0	WOO, Manahawkin, NJ
816	8764.0	8240.0	
817	8767.0	8243.0	
818	8770.0	8246.0	
819	8773.0	8249.0	
820	8776.0	8252.0	
821	8779.0	8255.0	
822	8782.0	8258.0	KMI, Point Reyes, CA
823	8785.0	8261.0	
824	8788.0	8264.0	WLO, Mobile, AL
825	8791.0	8267.0	WOM, Ft. Lauderdale, FL
826	8794.0	8270.0	WOO, Manahawkin, NJ WLC, Rogers City, MI
827	8797.0	8273.0	
828	8800.0	8276.0	
829	8803.0	8279.0	
830	8806.0	8282.0	WLO, Mobile, AL
831	8809.0	8285.0	WOM, Ft. Lauderdale, FL
832	8812.0	8288.0	
833	8291.0	8291.0	
836	8713.0	8113.0	WLO, Mobile, AL
837	8716.0	8128.0	KGN, Delcambre, LA
850	**8291.0**	**8291.0**	**DISTRESS**
851	8294.0	8294.0	8A LTD Coast/Intership
852	8297.0	8297.0	8B LTD Coast/Intership
853	8201.0	8201.0	WFN, Jeffersonville, Mississippi. River

854	8213.0	8213.0	WGK, St. Louis, Miss. River
855	8725.0	8725.0	Mississippi River
856	8737.0	8737.0	Mississippi River

3.2.5 12 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
1201	13077.0	12230.0	KMI, Point Reyes, CA
1202	13080.0	12233.0	KMI, Point Reyes, CA
1203	13083.0	12236.0	KMI, Point Reyes, CA
1204	13086.0	12239.0	
1205	13089.0	12242.0	
1206	13092.0	12245.0	WOM, Ft. Lauderdale, FL
1207	13095.0	12248.0	
1208	13098.0	12251.0	WOM, Ft. Lauderdale, FL
1209	13101.0	12254.0	WOM, Ft. Lauderdale, FL
1210	13104.0	12257.0	WOO, Manahawkin, NJ
1211	13107.0	12260.0	WOO, Manahawkin, NJ
1212	13110.0	12263.0	WLO, Mobile, AL
1213	13113.0	12266.0	
1214	13116.0	12269.0	USCG, Miami/Portsmouth
1215	13119.0	12272.0	WOM, Ft. Lauderdale, FL
1216	13122.0	12275.0	
1217	13125.0	12278.0	
1218	13128.0	12281.0	
1219	13131.0	12284.0	
1220	13134.0	12287.0	
1221	13137.0	12290.0	
1222	13140.0	12293.0	
1223	13143.0	12296.0	WOM, Ft. Lauderdale, FL

1224	13146.0	12299.0	
1225	13149.0	12302.0	
1226	13152.0	12305.0	
1227	13155.0	12308.0	
1228	13158.0	12311.0	WOO, Manahawkin, NJ
1229	13161.0	12314.0	KMI, Point Reyes, CA
1230	13164.0	12317.0	WOM, Ft. Lauderdale, FL
1231	13167.0	12320.0	
1232	13170.0	12323.0	
1233	13173.0	12326.0	WLO, Mobile, AL
1234	13176.0	12329.0	
1235	13179.0	12332.0	WLO, Mobile, AL
1236	13182.0	12335.0	
1234	13176.0	12329.0	
1235	13179.0	12332.0	WLO, Mobile, AL
1236	13182.0	12335.0	KGN, Delcambre, LA
1237	13185.0	12338.0	
1238	13188.0	12341.0	
1239	13191.0	12344.0	
1240	13194.0	12347.0	
1241	13197.0	12350.0	
1250	**12290.0**	**12290.0**	**DISTRESS**
1251	12353.0	12353.0	12A LTD Coast/Intership
1252	12356.0	12356.0	12B LTD Coast/Intership
1253	12359.0	12359.0	12C LTD Coast/Intership
1254	12362.0	12362.0	PUB. COAST & Miss. River
1255	12365.0	12365.0	PUB. COAST & Miss. River

3.2.6 16 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
1601	17242.0	16360.0	WOM, Ft. Lauderdale, FL
1602	17245.0	16363.0	KMI, Point Reyes, CA
1603	17248.0	16366.0	KMI, Point Reyes, CA
1604	17251.0	16369.0	
1605	17254.0	16372.0	WOO, Manahawkin, NJ
1606	17257.0	16375.0	
1607	17260.0	16378.0	
1608	17263.0	16381.0	
1609	17266.0	16384.0	WOM, Ft. Lauderdale, FL
1610	17269.0	16387.0	WOM, Ft. Lauderdale, FL
1611	17272.0	16390.0	WOM, Ft. Lauderdale, FL
1612	17275.0	16393.0	
1613	17278.0	16396.0	
1614	17281.0	16399.0	
1615	17284.0	16402.0	
1616	17287.0	16405.0	WOM, Ft. Lauderdale, FL
1617	17290.0	16408.0	
1618	17293.0	16411.0	
1619	17296.0	16414.0	
1620	17299.0	16417.0	WOO, Manahawkin, NJ
1621	17302.0	16420.0	
1622	17305.0	16423.0	
1623	17308.0	16426.0	
1624	17311.0	16429.0	KMI, Point Reyes, CA
1625	17314.0	16432.0	USCG, Miami, Portsmouth
1626	17317.0	16435.0	WOO, Manahawkin, NJ
1627	17320.0	16438.0	
1628	17323.0	16441.0	

1629	17326.0	16444.0	
1630	17329.0	16447.0	
1631	17332.0	16450.0	WOO, Manahawkin NJ
1632	17335.0	16453.0	
1633	17338.0	16456.0	
1634	17341.0	16459.0	
1635	17344.0	16462.0	
1636	17347.0	16465.0	
1637	17350.0	16468.0	
1638	17353.0	16471.0	
1639	17356.0	16474.0	
1640	17359.0	16477.0	
1641	17362.0	16480.0	WLO, Mobile, AL
1642	17365.0	16483.0	
1643	17368.0	16486.0	WLO, Mobile, AL
1644	17371.0	16489.0	
1645	17374.0	16492.0	KGN, Delcambre, LA
1646	17377.0	16495.0	
1647	17380.0	16498.0	WLO, Mobile, AL
1648	17383.0	16501.0	
1649	17386.0	16504.0	
1650	**16420.0**	**16420.0**	**DISTRESS**
1651	16528.0	16528.0	16A LTD Coast/Intership
1652	16531.0	16531.0	16B LTD Coast/Intership
1653	16534.0	16534.0	16C LTD Coast/Intership
1654	16537.0	16537.0	
1655	16540.0	16540.0	
1656	16543.0	16543.0	PUB. COAST & Miss. River
1657	16546.0	16546.0	PUB. COAST & Miss. River

3.2.7 18 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
1801	19755.0	18780.0	
1802	19758.0	18783.0	
1803	19761.0	18786.0	
1804	19764.0	18789.0	
1805	19767.0	18792.0	
1806	19770.0	18795.0	
1807	19773.0	18798.0	WLO, Mobile, AL
1808	19776.0	18801.0	
1809	19779.0	18804.0	
1810	19782.0	18807.0	
1811	19785.0	18810.0	
1812	19788.0	18813.0	
1813	19791.0	18816.0	
1814	19794.0	18819.0	
1815	19797.0	18822.0	
1851	18840.0	18840.0	18A LTD Coast/Intership
1852	18843.0	18843.0	18B LTD Coast/Intership
1853	18825.0	18825.0	
1854	18828.0	18828.0	
1855	18831.0	18831.0	
1856	18834.0	18834.0	
1857	18837.0	18837.0	

3.2.8 22 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE

2201	22896.0	22000.0	WOO, Manahawkin, NJ
2202	22699.0	22003.0	
2203	22702.0	22006.0	
2204	22705.0	22009.0	
2205	22708.0	22012.0	WOO, Manahawkin, NJ
2206	22711.0	22015.0	
2207	22714.0	22018.0	
2208	22717.0	22021.0	
2209	22720.0	22024.0	
2210	22723.0	22027.0	WOO, Manahawkin, NJ
2211	22726.0	22030.0	
2212	22729.0	22033.0	
2213	22732.0	22036.0	
2214	22735.0	22039.0	KMI, Point Reyes, CA
2215	22738.0	22042.0	WOM, Ft. Lauderdale, FL
2216	22741.0	22045.0	WOM, Ft. Lauderdale, FL
2217	22744.0	22048.0	
2218	22747.0	22051.0	
2219	22750.0	22054.0	
2220	22753.0	22057.0	
2221	22756.0	22060.0	
2222	22759.0	22063.0	WOM, Ft. Lauderdale, FL
2223	22762.0	22066.0	KMI, Point Reyes, CA
2224	22765.0	22069.0	
2225	22768.0	22072.0	
2226	22771.0	22075.0	
2227	22774.0	22078.0	
2228	22777.0	22081.0	KMI, Point Reyes, CA
2229	22780.0	22084.0	
2230	22783.0	22087.0	
2231	22786.0	22090.0	

2232	22789.0	22093.0	
2233	22792.0	22096.0	
2234	22795.0	22099.0	
2235	22798.0	22102.0	
2236	22801.0	22105.0	KMI, Point Reyes, CA WOO, Manahawkin, NJ
2237	22804.0	22108.0	WLO, Mobile, AL
2238	22807.0	22111.0	
2239	22810.0	22114.0	
2240	22813.0	22117.0	
2241	22816.0	22120.0	
2242	22819.0	22123.0	WLO, Mobile, AL
2243	22822.0	22126.0	
2244	22825.0	22129.0	
2245	22828.0	22132.0	
2246	22831.0	22135.0	WLO, Mobile, AL
2247	22834.0	22138.0	
2248	22837.0	22141.0	
2249	22840.0	22144.0	
2250	22843.0	22147.0	
2251	22159.0	22159.0	22A LTD Coast/Intership
2252	22162.0	22162.0	22B LTD Coast/Intership
2253	22165.0	22165.0	22C LTD Coast/Intership
2254	22168.0	22168.0	22D LTD Coast/Intership
2255	22171.0	22171.0	22E LTD Coast/Intership
2256	22174.0	22174.0	Public Coast
2257	22177.0	22177.0	Public Coast

3.2.9 25 MHZ VOICE BAND

VOICE CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
2501	26145.0	25070.0	
2502	26148.0	25073.0	
2503	26151.0	25076.0	WLO, Mobile, AL
2504	26154.0	25079.0	
2505	26157.0	25082.0	
2506	26160.0	25085.0	
2507	26163.0	25088.0	
2508	26166.0	25091.0	
2509	26169.0	25094.0	
2510	26172.0	25097.0	
2551	25115.0	25115.0	25A LTD Coast/Intership
2552	25118.0	25118.0	25B LTD Coast/Intership
2553	25100.0	25100.0	
2554	25103.0	25103.0	
2555	25106.0	25106.0	
2556	25109.0	25109.0	
2557	25112.0	25112.0	

3.2.10 DSC FREQUENCIES

DSC CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
	2174.5	**2174.5**	**NBDP EMER CALLING**
201	**2187.5**	**2187.5**	**DSC EMER CALLING**
202	2177.0	2189.5	INTL DSC CALLING
203	2177.0	2177.0	INTERSHIP DSC CALLING
401	**4207.5**	**4207.5**	**DSC EMER CALLING**
402	4219.5	4208.0	INTL DSC CALLING

403	4220.0	4208.5	ATLANTIC DSC CALLING
404	4220.5	4209.0	PACIFIC DSC CALLING
601	**6312.0**	**6312.0**	**DSC EMER CALLING**
602	6331.0	6312.5	INTL DSC CALLING
603	6331.5	6313.0	ATLANTIC DSC CALLING
604	6332.0	6313.5	PACIFIC DSC CALLING
801	**8414.5**	**8414.5**	**DSC EMER CALLING**
802	8436.5	8415.0	INTL DSC CALLING
803	8437.0	8415.5	ATLANTIC DSC CALLING
804	8437.5	8416.0	PACIFIC DSC CALLING
1201	**12577.0**	**12577.0**	**DSC EMER CALLING**
1202	12657.0	12577.5	INTL DSC CALLING
1203	12657.5	12578.0	ATLANTIC DSC CALLING
1204	12658.0	12578.5	PACIFIC DSC CALLING
1601	**16804.5**	**16804.5**	**DSC EMER CALLING**
1602	16903.0	16805.0	INTL DSC CALLING
1603	16903.5	16805.5	ATLANTIC DSC CALLING
1604	16904.0	16806.0	PACIFIC DSC CALLING
1802	19703.5	18898.5	INTL DSC CALLING
1803	19704.0	18899.0	ATLANTIC DSC CALLING
1804	19704.5	18899.5	PACIFIC DSC CALLING
2202	22444.0	22374.5	INTL DSC CALLING
2203	22444.5	22375.0	ATLANTIC DSC CALLING
2204	22445.0	22375.5	PACIFIC DSC CALLING
2502	26121.0	25208.5	INTL DSC CALLING
2503	26121.5	25209.0	ATLANTIC DSC CALLING
2504	26122.0	25209.5	PACIFIC DSC CALLING

3.2.11 4 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
401	4210.5	4172.5	WNU
402	4211.0	4173.0	ZLA
403	4211.5	4173.5	KFS
404	4212.0	4174.0	
405	4212.5	4174.5	WLO
406	4213.0	4175.0	WLO, VIP
407	4213.5	4175.5	KBS
408	4214.0	4176.0	KLB, WPD
409	4214.5	4176.6	KLC
410	4215.0	4177.0	WLO
411	**4177.5**	**4177.5**	**NBDP EMER CALLING**
412	4215.5	4178.0	KBS
413	4216.0	4178.5	KPH
414	4216.5	4179.0	WCC
415	4217.0	4179.5	WLO
416	4217.5	4180.0	VCT
417	4218.0	4180.5	WLO
418	4218.5	4181.0	
419	4219.0	4181.5	
471	4202.5	4202.5	
472	4203.0	4203.0	
473	4203.5	4203.5	
474	4204.0	4204.0	
475	4204.5	4204.5	
476	4205.0	4205.0	
477	4205.5	4205.5	
478	4206.0	4206.0	
479	4206.5	4206.5	

480	4207.0	4207.0	

3.2.12 6 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
601	6314.5	6263.0	KFS
602	6315.0	6263.5	WNU
603	6315.5	6264.0	KFS
604	6316.0	6264.5	
605	6316.5	6265.0	
606	6317.0	62655	WLO
607	6317.5	6266.0	
608	6318.0	6266.5	KLB
609	6318.5	6267.0	KLC
610	6319.0	6267.5	WLO
611	**6268.0**	**6268.0**	**NBDP EMER CALLING**
612	6319.5	6268.5	
613	6320.0	6269.0	KPH
614	6320.5	6269.5	
615	6521.0	6270.0	WLO
616	6321.5	6270.5	
617	6322.0	6271.0	KLC
618	6322.5	6271.5	
619	6323.0	6272.0	WLO
620	6323.5	6272.5	
621	6324.0	6273.0	WCC
622	6324.5	62736	KPH, KLC
623	6325.0	6274.0	
624	6325.5	6274.5	
625	6326.0	6275.0	
626	6326.5	6275.5	

627	6327.0	6281.0
628	6327.5	6281.5
629	6328.0	6282.0
630	6328.5	6282.5
631	6329.0	6283.0
632	6329.5	6283.5
633	6330.0	6284.0
634	6330.5	6284.5
671	6300.5	6300.5
672	6301.0	6301.0
673	6301.5	6301.5
674	6302.0	6302.0
675	6302.5	6302.5
676	6303.0	6303.0
677	6303.5	6303.5
678	6304.0	6304.0
679	6304.5	6304.5
680	6305.0	6305.0
681	6305.5	6305.5
682	6306.0	6306.0
683	6306.5	6306.5
684	6307.0	6307.0
685	6307.5	6307.5
686	6308.0	6308.0
687	6308.5	6308.5
688	6309.0	6309.0
689	6309.5	6309.5
690	6310.0	6310.0
691	6310.5	6310.5
692	6311.0	6311.0
693	6311.5	6311.5

3.2.13 8 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
801	**8376.5**	**8376.5**	**NBDP EMER CALLING**
802	8417.0	8377.0	WNU
803	8417.5	8377.5	KFS
804	8418.0	8378.0	
805	8418.5	8378.5	WLO
806	8419.0	8379.0	WLO
807	8419.5	8379.5	
808	8420.0	8380.0	
809	8420.5	8380.5	KLC
810	8421.0	8381.0	WLO
811	8421.5	8381.5	WLO
812	8422.0	8382.0	
813	8422.5	8382.5	KPH
814	8423.0	8383.0	
815	8423.5	8383.5	WLO
816	8424.0	8384.0	WCC
817	8424.5	8384.5	KLC
818	8425.0	8385.0	KLB
819	8425.5	8385.5	
820	8426.0	8386.0	
821	8426.5	8386.5	WCC
822	8427.0	8387.0	KLC
823	8427.5	8387.5	
824	8428.0	8388.0	
825	8428.5	8388.5	
826	8429.0	8389.0	WLO
827	8429.5	8389.5	

828	8430.0	8390.0
829	8430.5	8390.5
830	8431.0	8391.0
831	8431.5	8391.5
832	8432.0	8392.0
833	8432.5	8392.5
834	8433.0	8393.0
835	8433.5	8393.5
836	8434.0	8394.0
837	8434.5	8394.5
838	8435.0	8395.0
839	8435.5	8395.5
840	8436.0	8396.0
871	8396.5	8396.5
872	8397.0	8397.0
873	8397.5	8397.5
874	8398.0	8398.0
875	8398.5	8398.5
876	8399.0	8399.0
877	8399.5	8399.5
878	8400.0	8400.0
879	8400.5	8400.5
880	8401.0	8401.0
881	8401.5	8401.5
882	8402.0	8402.0
883	8402.5	8402.5
884	8403.0	8403.0
885	8403.5	8403.5
886	8404.0	8404.0
887	8404.5	8404.5
888	8405.0	8405.0

889	8405.5	8405.5	
890	8406.0	8406.0	
891	8406.5	8406.5	
892	8407.0	8407.0	
893	8407.5	8407.5	
894	8408.0	8408.0	
895	8408.5	8408.5	
896	8409.0	8409.0	
897	8409.5	8409.5	
898	8410.0	8410.0	
899	8410.5	8410.5	
900	8411.0	8411.0	
901	8411.5	8411.5	
902	8412.0	8412.0	
903	8412.5	8412.5	
904	8413.0	8413.0	
905	8413.5	8413.5	
906	8414.0	8414.0	

3.2.14 12 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
1201	12579.5	12477.0	
1202	12580.0	12477.5	ZLA
1203	12580.5	12478.0	KFS
1204	12581.0	12478.5	
1205	12581.5	12479.0	WLO
1206	12582.0	12479.5	VIP
1207	12582.5	12480.0	
1208	12583.0	12480.5	
1209	12583.5	12481.0	KLC

1210	12584.0	12481.5	VIP
1211	12584.5	12482.0	WLO
1212	12585.0	12482.5	
1213	12585.5	12483.0	KPH
1214	12586.0	12483.5	
1215	12586.5	12484.0	WLO
1216	12587.0	12484.5	
1217	12587.5	12485.0	KLC
1218	12588.0	12485.5	
1219	12588.5	12486.0	WNU
1220	12589.0	12486.5	
1221	12589.5	12487.0	WCC
1222	12590.0	12487.5	KLC
1223	12590.5	12488.0	KLB
1224	12591.0	12488.5	
1225	12591.5	12489.0	WLO
1226	12592.0	12489.5	
1227	12592.5	12490.0	
1228	12593.0	12490.5	
1229	12593.5	12491.0	WLO
1230	12594.0	12491.5	
1231	12594.5	12492.0	
1232	12595.0	12492.5	
1233	12595.5	12493.0	
1234	12596.0	12493.5	WLO
1235	12596.5	12494.0	
1236	12597.0	12494.5	
1237	12597.5	12495.0	
1238	12598.0	12495.5	WCC
1239	12598.5	12496.0	
1240	12599.0	12496.5	WLO

1241	12599.5	12497.0	
1242	12600.0	12497.5	KPH
1243	12600.5	12498.0	
1244	12601.0	12498.5	
1245	12601.5	12499.0	
1246	12602.0	12499.5	
1247	12602.5	12500.0	
1248	12603.0	12500.5	KLC
1249	12603.5	12501.0	
1250	12604.0	12501.5	WLO
1251	12604.5	12502.0	WLO
1252	12605.0	12502.5	
1253	12605.5	12503.0	
1254	12606.0	12503.5	WLO
1255	12606.5	12504.0	
1256	12807.0	12504.5	
1257	12607.5	12505.0	WNU
1258	12608.0	12505.5	
1259	12608.5	12506.0	
1260	12609.0	12506.5	
1261	12609.5	12507.0	
1262	12610.0	12507.5	
1263	12610.5	12508.0	VCT
1264	12611.0	12508.5	
1265	12611.5	12509.0	KEJ
1266	12612.0	12509.5	
1267	12612.5	12510.0	
1268	12613.0	12510.5	
1269	12613.5	12511.0	
1270	12614.0	12511.5	
1271	12614.5	12512.0	

1272	12615.0	12512.5	
1273	12615.5	12513.0	
1274	12616.0	12513.5	
1275	12616.5	12514.0	
1276	12617.0	12514.5	
1277	12617.5	12515.0	
1278	12618.0	12515.5	
1279	12618.5	12516.0	
1280	12619.0	12516.5	
1281	12619.5	12517.0	
1282	12620.0	12517.5	
1283	12620.5	12518.0	
1284	12621.0	12518.5	
1285	12621.5	12519.0	
1286	12622.0	12519.5	
1287	**12520.0**	**12520.0**	**NBDP EMER CALLING**
1288	12622.5	12520.5	
1289	12623.0	12521.0	
1290	12623.5	12521.5	
1291	12624.0	12522.0	SAB
1292	12624.5	12522.5	
1293	12625.0	12523.0	
1294	12625.5	12523.5	
1295	12626.0	12524.0	
1296	12626.5	12524.5	
1297	12627.0	12525.0	
1298	12627.5	12525.5	
1299	12628.0	12526.0	
1300	12628.5	12526.5	
1301	12629.0	12527.0	
1302	12629.5	12527.5	

1303	12630.0	12528.0
1304	12630.5	12528.5
1305	12631.0	12529.0
1306	12631.5	12529.5
1307	12632.0	12530.0
1308	12632.5	12530.5
1309	12633.0	12531.0
1310	12633.5	12531.5
1311	12634.0	12532.0
1312	12634.5	12532.5
1313	12635.0	12533.0
1314	12635.5	12533.5
1315	12636.0	12534.0
1316	12636.5	12534.5
1317	12637.0	12535.0
1318	12637.5	12535.5
1319	12638.0	12536.0
1320	12638.5	12536.5
1321	12639.0	12537.0
1322	12639.5	12537.5
1323	12640.0	12538.0
1324	12640.5	12538.5
1325	12641.0	12539.0
1326	12641.5	12539.5
1327	12642.0	12540.0
1328	12642.5	12540.5
1329	12643.0	12541.0
1330	12643.5	12541.5
1331	12644.0	12542.0
1332	12644.5	12542.5
1333	12645.0	12543.0

1334	12645.5	12543.5	
1335	12646.0	12544.0	
1336	12646.5	12544.5	
1337	12647.0	12545.0	
1338	12647.5	12545.5	
1339	12648.0	12546.0	
1340	12648.5	12546.5	
1341	12649.0	12547.0	
1342	12649.5	12547.5	
1343	12650.0	12548.0	
1344	12650.5	12548.5	
1345	12651.0	12549.0	
1346	12651.5	12549.5	
1347	12652.0	12555.0	
1348	12652.5	12555.5	
1349	12653.0	12556.0	
1350	12653.5	12556.5	
1351	12654.0	12557.0	
1352	12654.5	12557.5	
1353	12655.0	12558.0	
1354	12655.5	12558.5	
1355	12656.0	12559.0	
1356	12656.5	12559.5	
1371	12560.0	12560.0	
1372	12560.5	12560.5	
1373	12561.0	12561.0	
1374	12561.5	12561.5	
1375	12562.0	12562.0	
1376	12562.5	12562.5	
1377	12563.0	12563.0	
1378	12563.5	12563.5	

1379	12564.0	12564.0	
1380	12564.5	12564.5	
1381	12565.0	12565.0	
1382	12565.5	12565.5	
1383	12566.0	12566.0	
1384	12566.5	12566.5	
1385	12567.0	12567.0	
1386	12567.5	12567.5	
1387	12568.0	12568.0	
1388	12568.5	12568.5	
1389	12569.0	12569.0	
1390	12569.5	12569.5	
1391	12570.0	12570.0	
1392	12570.5	12570.5	
1393	12571.0	12571.0	
1394	12571.5	12571.5	
1395	12572.0	12572.0	
1396	12572.5	12572.5	
1397	12573.0	12573.0	
1398	12573.5	12573.5	
1399	12574.0	12574.0	
1400	12574.5	12574.5	
1401	12575.0	12575.0	
1402	12575.5	12575.5	
1403	12576.0	12576.0	
1404	12576.5	12576.5	

3.2.15 16 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
1601	16807.0	16683.5	

1602	16807.5	16684.0	ZLA
1603	16808.0	16684.5	KFS
1604	16808.5	16685.0	KLB
1605	16809.0	16685.5	WLO
1606	16809.5	16686.0	VIP
1607	16810.0	16686.5	
1608	16810.5	16687.0	
1609	16811.0	16687.5	KLC
1610	16811.5	16688.0	VIP
1611	16812.0	16688.5	WLO
1612	16812.5	16689.0	
1613	16813.0	16689.5	KPH
1614	16813.5	16690.0	
1615	18814.0	16690.5	WLO
1616	16814.5	16691.0	
1617	16815.0	16691.5	KLC
1618	16815.5	16692.0	
1619	16816.0	16692.5	WNU
1620	16816.5	16693.0	
1621	16817.0	16693.5	
1622	16817.5	16694.0	KPH, KLC
1623	16818.0	16694.5	
1624	**16695.0**	**16695.0**	**NBDP EMER CALLING**
1625	16818.5	16695.5	WLO
1626	16819.0	16696.0	
1627	16819.5	16696.5	
1628	16820.0	16697.0	
1629	16820.5	16697.5	WLO
1630	16821.0	16698.0	
1631	16821.5	16698.5	
1632	16822.0	16699.0	

1633	16822.5	16699.5	
1634	16823.0	16700.0	
1635	16823.5	16700.5	
1636	16824.0	16701.0	
1637	16824.5	16701.5	
1638	16825.0	16702.0	WCC
1639	16825.5	16702.5	
1640	16826.0	16703.0	WLO
1641	16826.5	16703.5	
1642	16827.0	16704.0	
1643	16827.5	16704.5	
1644	16828.0	16705.0	WLO
1645	16828.5	16705.5	
1646	16829.0	16706.0	
1647	16829.5	16706.5	KFS
1648	16830.0	16707.0	KLC
1649	16830.5	16707.5	
1650	16831.0	16708.0	WLO
1651	16831.5	16708.5	
1652	16832.0	16709.0	WNU
1653	16832.5	16709.5	
1654	16833.0	16710.0	WLO
1655	16833.5	16710.5	
1656	16834.0	16711.0	
1657	16834.5	16711.5	WNU
1658	16835.0	16712.0	
1659	16835.5	16712.5	
1660	16836.0	16713.0	
1661	16836.5	16713.5	
1662	16837.0	16714.0	
1663	16837.5	16714.5	

1664	16838.0	16715.0	
1665	16838.5	16715.5	
1666	16839.0	16716.0	
1667	16839.5	16716.5	
1668	16840.0	16717.0	
1669	16840.5	16717.5	
1670	16841.0	16718.0	
1671	16841.5	16718.5	
1672	16842.0	16719.0	
1673	16842.5	16719.5	KEJ
1674	16843.0	16720.0	
1675	16843.5	16720.5	
1676	16844.0	16721.0	VCT
1677	16844.5	16721.5	
1678	16845.0	16722.0	
1679	16845.5	16722.5	
1680	16846.0	16723.0	
1681	16846.5	16723.5	
1682	16847.0	16724.0	
1683	16847.5	16724.5	
1684	16848.0	16725.0	
1685	16848.5	16725.5	
1686	16849.0	16726.0	
1687	16849.5	16726.5	
1688	16850.0	16727.0	
1689	16850.5	16727.5	
1690	16851.0	16728.0	
1691	16851.5	16728.5	SAB
1692	16852.0	16729.0	
1693	16852.5	16729.5	
1694	16853.0	16730.0	

1695	16853.5	16730.5
1696	16854.0	16731.0
1697	16854.5	16731.5
1698	16855.0	16732.0
1699	16855.5	16732.5
1700	16856.0	16733.0
1701	16856.5	16733.5
1702	16857.0	16739.0
1703	16857.5	16739.5
1704	16858.0	16740.0
1705	16858.5	16740.5
1706	16859.0	16741.0
1707	16859.5	16741.5
1708	16860.0	16742.0
1709	16860.5	16742.5
1710	16861.0	16743.0
1711	16861.5	16743.5
1712	16862.0	16744.0
1713	16862.5	16744.5
1714	16863.0	16745.0
1715	16863.5	16745.5
1716	16864.0	16746.0
1717	16864.5	16746.5
1718	16865.0	16747.0
1719	16865.5	16747.5
1720	16866.0	16748.0
1721	16866.5	16748.5
1722	16867.0	16749.0
1723	16867.5	16749.5
1724	16868.0	16750.0
1725	18868.5	16750.5

1726	16869.0	16751.0
1727	16869.5	16751.5
1728	16870.0	16752.0
1729	16870.5	16752.5
1730	16871.0	16753.0
1731	16871.5	16753.5
1732	16872.0	16754.0
1733	16872.5	16754.5
1734	16873.0	16755.0
1735	16873.5	16755.5
1736	16874.0	16756.0
1737	16874.5	16756.5
1738	16875.0	16757.0
1739	18875.5	16757.5
1740	16876.0	16758.0
1741	16876.5	16758.5
1742	16877.0	16759.0
1743	16877.5	16759.5
1744	16878.0	16760.0
1745	16878.5	16760.5
1746	16879.0	16761.0
1747	16879.5	16761.5
1748	16880.0	16762.0
1749	16880.5	16762.5
1750	16881.0	16763.0
1751	16881.5	16763.5
1752	16882.0	16764.0
1753	16882.5	16764.5
1754	16883.0	16765.0
1755	16883.5	16765.5
1756	16884.0	16766.0

1757	16884.5	16766.5
1758	16885.0	16767.0
1759	16885.5	16767.5
1760	16886.0	16768.0
1761	16886.5	16768.5
1762	16887.0	16769.0
1763	16887.5	16769.5
1764	16886.0	16770.0
1765	16888.5	16770.5
1766	16889.0	16771.0
1767	16889.5	16771.5
1768	16890.0	16772.0
1769	16890.5	16772.5
1770	16891.0	16773.0
1771	16891.5	16773.5
1772	16892.0	16774.0
1773	16892.5	16774.5
1774	16893.0	16775.0
1775	16893.5	16775.5
1776	16894.0	16776.0
1777	16894.5	16776.5
1778	16895.0	16777.0
1779	16895.5	16777.5
1780	16896.0	16778.0
1781	16896.5	16778.5
1782	16897.0	16779.0
1783	16897.5	16779.5
1784	16898.0	16780.0
1785	16898.5	16780.5
1786	16899.0	16781.0
1787	16899.5	16781.5

1788	16900.0	16782.0	
1789	16900.5	16782.5	
1790	16901.0	16783.0	
1791	16901.5	16783.5	
1792	16902.0	16784.0	
1793	16902.5	16784.5	
1794	16796.5	16796.5	
1795	16797.0	16797.0	
1796	16797.5	16797.5	
1797	16798.0	16798.0	
1798	16798.5	16798.5	
1799	16799.0	16799.0	
1800	16799.5	16799.5	

3.2.16 18 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
1801	19681.0	18870.5	
1802	19681.5	18871.0	
1803	19682.0	18871.5	
1804	19682.5	18872.0	
1805	19683.0	18872.5	
1806	19683.5	18873.0	
1807	19684.0	18873.5	
1808	19684.5	18874.0	
1809	19685.0	18874.5	
1810	19685.5	18875.0	
1811	19686.0	18875.5	
1812	19686.5	18876.0	
1813	19687.0	18876.5	
1814	19687.5	18877.0	

1815	19688.0	18877.5
1816	19688.5	18878.0
1817	19689.0	18878.5
1818	19689.5	18879.0
1819	19690.0	18879.5
1820	19690.5	18880.0
1821	19691.0	18880.5
1822	19691.5	18881.0
1823	19692.0	18881.5
1824	19692.5	18882.0
1825	19693.0	18882.5
1826	19693.5	18883.0
1827	19694.0	18883.5
1828	19694.5	18884.0
1829	19695.0	18884.5
1830	19695.5	18885.0
1831	19696.0	18885.5
1832	19696.5	18886.0
1833	19697.0	18886.5
1834	19697.5	18887.0
1835	19698.0	18887.5
1836	19698.5	18888.0
1837	19699.0	18888.5
1838	19699.5	18889.0
1839	19700.0	18889.5
1840	19700.5	18890.0
1841	19701.0	18890.5
1842	19701.5	18891.0
1843	19702.0	18891.5
1844	19702.5	18892.0
1845	19703.0	18892.5

1871	18893.0	18893.0	
1872	18893.5	18893.5	
1873	18894.0	18894.0	
1874	18894.5	18894.5	
1875	18895.0	18895.0	
1876	18895.5	18895.5	
1877	18896.0	18896.0	
1878	18896.5	18896.5	
1879	18897.0	18897.0	
1880	18897.5	18897.5	
1881	18898.0	18898.0	

3.2.17 22 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
2201	22376.5	22284.5	
2202	22377.0	22285.0	WNU
2203	22377.5	22285.5	KFS
2204	22378.0	22286.0	
2205	22378.5	22286.5	
2206	22379.0	22287.0	
2207	22379.5	22287.5	
2208	22380.0	22288.0	
2209	22380.5	22288.5	KLC
2210	22381.0	22289.0	WLO
2211	22381.5	22289.5	
2212	22382.0	22290.0	
2213	22382.5	22290.5	KPH
2214	22383.0	22291.0	
2215	22383.5	22291.5	WLO
2216	22384.0	22292.0	

2217	22384.5	22292.5	KLC
2218	22385.0	22293.0	
2219	22385.5	22293.5	WNU
2220	22386.0	22294.0	
2221	22386.5	22294.5	WCC
2222	22387.0	22295.0	KLC
2223	22387.5	22295.5	
2224	22388.0	22296.0	
2225	22388.5	22296.5	
2226	22389.0	22297.0	
2227	22389.5	22297.5	
2228	22390.0	22298.0	
2229	22390.5	22298.5	
2230	22391.0	22299.0	
2231	22391.5	22299.5	
2232	22392.0	22300.0	
2233	22392.5	22300.5	
2234	22393.0	22301.0	
2235	22393.5	22301.5	
2236	22394.0	22302.0	
2237	22394.5	22302.5	
2238	22395.0	22303.0	KPH
2239	22395.5	22303.5	
2240	22396.0	22304.0	KLB
2241	22396.5	22304.5	
2242	22397.0	22305.0	
2243	22397.5	22305.5	
2244	22398.0	22306.0	
2245	22398.5	22306.5	
2246	22399.0	22307.0	
2247	22399.5	22307.5	

2248	22400.0	22308.0	KLC
2249	22400.5	22308.5	
2250	22401.0	22309.0	
2251	22401.5	22309.5	
2252	22402.0	22310.0	WNU
2253	22402.5	22310.5	
2254	22403.0	22311.0	WLO
2255	22403.5	22311.5	
2256	22404.0	22312.0	WLO
2257	22404.5	22312.5	WNU
2258	22405.0	22313.0	
2259	22405.5	22313.5	
2260	22406.0	22314.0	WLO
2261	22406.5	22314.5	
2262	22407.0	22315.0	WLO
2263	22407.5	22315.5	
2264	22408.0	22316.0	
2265	22408.5	22316.5	
2266	22409.0	22317.0	
2267	22409.5	22317.5	
2268	22410.0	22318.0	
2269	22410.5	22318.5	
2270	22411.0	22319.0	
2271	22411.5	22319.5	
2272	22412.0	22320.0	
2273	22412.5	22320.5	
2274	22413.0	22321.0	
2275	22413.5	22321.5	
2276	22414.0	22322.0	
2277	22414.5	22322.5	
2278	22415.0	22323.0	

2279	22415.5	22323.5
2280	22416.0	22324.0
2281	22416.5	22324.5
2282	22417.0	22325.0
2283	22417.5	22325.5
2284	22418.0	22326.0
2285	22418.5	22326.5
2286	22419.0	22327.0
2287	22419.5	22327.5
2288	22420.0	22328.0
2289	22420.5	22328.5
2290	22421.0	22329.0
2291	22421.5	22329.5
2292	22422.0	22330.0
2293	22422.5	22330.5
2294	22423.0	22331.0
2295	22423.5	22331.5
2296	22424.0	22332.0
2297	22424.5	22332.5
2298	22425.0	22333.0
2299	22425.5	22333.5
2300	22426.0	22334.0
2301	22426.5	22334.5
2302	22427.0	22335.0
2303	22427.5	22335.5
2304	22428.0	22336.0
2305	22428.5	22336.5
2306	22429.0	22337.0
2307	22429.5	22337.5
2308	22430.0	22338.0
2309	22430.5	22338.5

2310	22431.0	22339.0	
2311	22431.5	22339.5	
2312	22432.0	22340.0	
2313	22432.5	22340.5	
2314	22433.0	22341.0	
2315	22433.5	22341.5	
2316	22434.0	22342.0	
2317	22434.5	22342.5	
2318	22435.0	22343.0	
2319	22435.5	22343.5	
2320	22436.0	22344.0	
2321	22436.5	22344.5	
2322	22437.0	22345.0	
2323	22437.5	22345.5	
2324	22438.0	22346.0	
2325	22438.5	22346.5	
2326	22439.0	22347.0	
2327	22439.5	22347.5	
2328	22440.0	22348.0	
2329	22440.5	22348.5	
2330	22441.0	22349.0	
2331	22441.5	22349.5	
2332	22442.0	22350.0	
2333	22442.5	22350.5	
2334	22443.0	22351.0	
2335	22443.5	22351.5	
2371	22352.0	22352.0	
2372	22352.5	22352.5	
2373	22353.0	22353.0	
2374	22353.5	22353.5	
2375	22354.0	22354.0	

2376	22354.5	22354.5
2377	22355.0	22355.0
2378	22355.5	22355.5
2379	22356.0	22356.0
2380	22356.5	22356.5
2381	22357.0	22357.0
2382	22357.5	22357.5
2383	22358.0	22358.0
2384	22358.5	22358.5
2385	22359.0	22359.0
2386	22359.5	22359.5
2387	22360.0	22360.0
2388	22360.5	22360.5
2389	22361.0	22361.0
2390	22361.5	22361.5
2391	22362.0	22362.0
2392	22362.5	22362.5
2393	22363.0	22363.0
2394	22363.5	22363.5
2395	22364.0	22364.0
2396	22364.5	22364.5
2397	22365.0	22365.0
2398	22365.5	22365.5
2399	22366.0	22366.0
2400	22366.5	22366.5
2401	22367.0	22367.0
2402	22367.5	22367.5
2403	22368.0	22368.0
2404	22368.5	22368.5
2405	22369.0	22369.0
2406	22369.5	22369.5

2407	22370.0	22370.0	
2408	22370.5	22370.5	
2409	22371.0	22371.0	
2410	22371.5	22371.5	
2411	22372.0	22372.0	
2412	22372.5	22372.5	
2413	22373.0	22373.0	
2414	22373.5	22373.5	

3.2.18 25 MHZ TELEX BAND

TELEX CHANNEL	SHIP RECEIVE	SHIP TRANSMIT	USE
2501	26101.0	25173.0	WLO
2502	26101.5	25173.5	
2503	26102.0	25174.0	
2504	26102.5	25174.5	
2505	26103.0	25175.0	
2506	26103.5	25175.5	
2507	26104.0	25176.0	
2508	26104.5	25176.5	
2509	26105.0	25177.0	
2510	26105.5	25177.5	
2511	26106.0	25178.0	
2512	26106.5	25178.5	
2513	26107.0	25179.0	
2514	26107.5	25179.5	
2515	26108.0	25180.0	
2516	26108.5	25180.5	
2517	26109.0	25181.0	
2518	26109.5	25181.5	
2519	26110.0	25182.0	

2520	26110.5	25182.5
2521	26111.0	25183.0
2522	26111.5	25183.5
2523	26112.0	25184.0
2524	26112.5	25184.5
2525	26113.0	25185.0
2528	26113.5	25185.5
2527	26114.0	25186.0
2528	26114.5	25186.5
2529	26115.0	25187.0
2530	26115.5	25187.5
2531	26116.0	25188.0
2532	26116.5	25188.5
2533	26117.0	25189.0
2534	26117.5	25189.5
2535	26118.0	25190.0
2536	26118.5	25190.5
2537	26119.0	25191.0
2538	26119.5	25191.5
2539	26120.0	25192.0
2540	26120.5	25192.5
2415	22374.0	22374.0
2571	25193.0	25193.0
2572	25193.5	25193.5
2573	25194.0	25194.0
2574	25194.5	25194.5
2575	25195.0	25195.0
2576	25195.5	25195.5
2577	25196.0	25196.0
2578	25196.5	25196.5
2579	25197.0	25197.0

2580	25197.5	25197.5
2581	25198.0	25198.0
2582	25198.5	25198.5
2583	25199.0	25199.0
2584	25199.5	25199.5
2585	25200.0	25200.0
2586	25200.5	25200.5
2587	25201.0	25201.0
2588	25201.5	25201.5
2589	25202.0	25202.0
2590	25202.5	25202.5
2591	25203.0	25203.0
2592	25203.5	25203.5
2593	25204.0	25204.0
2594	25204.5	25204.5
2595	25205.0	25205.0
2596	25205.5	25205.5
2597	25206.0	25206.0
2598	25206.5	25206.5
2599	25207.0	25207.0
2600	25207.5	25207.5
2601	25208.0	25208.0

3.3 CAUTION! FREQUENCY TOLERANCE

Under FCC Rules, the frequency tolerance for the Marine Service is ± 10 Hz. In order to achieve this accuracy a frequency counter with long term accuracy of ± 1 Hz 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 Radiotelephone FCC license.

3.4 SETTING THE TRANSMITTER FREQUENCIES

3.4.1 THE MASTER CLOCK OSCILLATOR

1. Select the highest desired transmitter frequency (Such as 25083.0 kHz). With the transmitter output connected to an appropriate dummy load and a few watts of re-inserted carrier being generated, connect a high accuracy frequency counter (See Paragraph 3.3) to the RF dummy load and adjust trimmer capacitor C56 on the transceiver Main Board (ASY-0245-01) for the correct carrier frequency. The trimmer capacitor is located next to the Master Clock crystal oven on the Main Board Assembly.

3.4.2 ENABLING CARRIER REINSERTION

Using DIRECT FREQUENCY ENTRY mode (See PP 2.5.28 above), enter the desired test frequency. E.g.: 25083.0 kHz. Select R3E from the MODE menu.

4 INSTALLATION

4.1 MOUNTING THE TRANSCEIVER

The SEA 245 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 either over or under the transceiver for overhead or shelf locations. Figure 4.1 shows the outline dimensions of the SEA 245 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.

Take special care not to block airflow over the cabinet, since this can cause overheating and resultant damage to the transceiver.

4.2 A TYPICAL INSTALLATION

Figure 4.2 shows a typical installation consisting of five parts: 1. The SEA 245 Transceiver/DSC unit; 2. The SEA 1635 antenna coupler; 3. The SEA 2450 Remote Controller unit; 4. The system interconnection cables; 5. 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 245 makes necessary to employ an antenna system of the resonant or externally matched type. The use of the SEA 1635 antenna coupler in conjunction with a whip antenna allows an efficient installation which will cover both the MF and HF bands. The SEA 1635 was designed specifically for Marine applications, is easily interconnected with the transceiver and compatible with most shipboard antenna installations. Note that the SEA 245 is also compatible with the SEA 1612C and SEA 1631 antenna couplers. These couplers are capable of superior performance with shorter antenna systems or higher duty cycle applications.

On wooden or fiberglass boats, the use of a copper ground plane 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.

4.3 THE TRANSCEIVER UNIT REAR PANEL CONNECTION AND FUSES

4.3.1 THE POWER CONNECTOR

A heavy duty power plug is used on the SEA 245 to assure minimum voltage drop in the primary power circuit. See Figure 4.3 for proper assembly of the power plug.

4.3.2 THE RF CONNECTOR

One type UHF female connector is provided on the SEA 245 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.

4.3.3 THE PARALLEL INTERFACE PLUG

A fourteen contact screw terminal type plug is provided on the SEA 245 rear panel. This plug (P2) provides access to both receiver and transmitter audio circuitry and transmitter PTT line, allowing installation of an extension microphone. Also provided is the switched, fused primary power (+12VSW) line, an "all tuned" flag line for the companion antenna coupler (TND) and a "demand tune" (DMD TUNE) line which allows the operator to cause the antenna coupler to retune if desired.

TERMINAL FUNCTION

GND - (Pin 1) Provides access to the negative side (ground) of the +12 volt supply. Common to the chassis. This terminal is usually used for the coaxial shield for the 2187.5 kHz antenna feedline.

2187.5 ANT - (Pin 2) Antenna input for the 2187.5 KHz monitor receiver. Compatible with either resonant antennas or the SEA 7003 Active Antenna System. CAUTION! If the internal jumper is configured to provide +12 volts to the SEA 7002G Active Antenna, this pin will be at +12 volts with reference to chassis ground.

TXAF - (Pin 3) Input for an alternative transmitter audio source such as a MODEM. Configured for unbalanced 600 ohm lines. Nominal input level for full modulation, 1 volt peak-to-peak.

LLAF - (Pin 4) Low level receiver output (unsquelched). Configured for unbalanced 600 ohm lines, nominal output level 1 volt peak-to-peak.

DMD TUNE - (Pin 5) This terminal provides the connection to operate the "DEMAND TUNE" in the SEA 1635 and SEA 1612C Antenna Tuners.

TND - (Pin 6) This terminal facilitates the connection of an "ALL TUNED" indicator line from the companion antenna tuner. Grounding this line will cause the "TND" annunciator on the display to light.

12 VSW - (Pin 7) 12 volts, switched through the normal PWR switch function. Normally used to power an external antenna tuner such as the SEA 1635 or SEA 1612C. DO NOT EXCEED 3 AMPS. The fuse for this circuit is the 5 amp fuse

located on the PA/Filter board, ASY-0245-02.

GND - (Pin 8) Provides access to the negative side (ground) of the +12 volt supply. Common to the chassis. This terminal is usually used as the ground return for system antenna tuners.

SPKR - (Pin 9) Internal speaker input. A jumper to the AF terminal is required to operate the internal speaker.

AF - (Pin 10) Output of the audio power amplifier, AC coupled. Speaker impedance required is 3.2 ohms or greater.

HANDSET - (Pin 11) This output terminal provides a 600 ohm source of receiver audio for a handset receiver.

MIC - (Pin 12) Remote microphone input terminal. Compatible with 600 ohm dynamic microphones.

PTT - (Pin 13) Remote microphone push-to-talk terminal. Grounding this pin places the radiotelephone in the TRANSMIT mode.

GND - (Pin 14) Provides access to the negative side (ground) of the +12 volt supply. Common to the chassis. This terminal is normally used to connect the shield braid for a remote microphone or handset.

NOTE: DO NOT USE THESE TERMINALS FOR HIGH-CURRENT APPLICATIONS!

4.3.4 THE SEABUSS INTERFACE CONNECTOR

One nine contact screw terminal type plug (P1) is provided on the SEA 245 transceiver rear panel. (SEE Figure 4.4 and the System Interconnection Diagram, Figure 4.5) The SEABUSS connector provides for interconnection between the (optional) SEA 2450 Remote Controller and the SEA 245 Transceiver/DSC. Standard SEABUSS interconnect cable is used and up to 150 feet (50 meters) of cable is permitted between the SEA 245 and the Remote Controller(s).

SEABUSS CABLE TERMINAL FUNCTIONS

Pins 1 and 9 - System common ground. Used for -12VDC power return and termination of shield braids.

Pin 2 - 12VSW terminal. Switched +12 volts from transceiver to remote controller.

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

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

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

NOTE: THE USE OF SEA CABLE PN# CAB-2350-XXX IS RECOMMENDED FOR THE INTERCONNECTION BETWEEN THE SEA 245 TRANSCEIVER AND THE SEA 2450 REMOTE CONTROLLER.

SEA CABLE PN# CAB-1635-XXX IS RECOMMENDED FOR USE BETWEEN THE SEA 245 TRANSCEIVER AND THE SEA 1635 ANTENNA TUNER. THIS CABLE PROVIDES INTERCONNECTIONS FOR THE RF POWER, DC POWER, GROUND, DEMAND TUNE AND TUNED FLAG LINES IN A SINGLE CABLE. MAXIMUM RECOMMENDED CABLE LENGTH IS 150 FEET (45 METERS).

4.3.5 THE RS232 DB-9 INTERFACE CONNECTOR

One female DB-9 connector (P2) is provided on the SEA 245 transceiver rear panel. (Figure 4.1 and the System Interconnect Diagram, Figure 4.4) This provides a general purpose RS232 type serial interface connection to the SEA 245 operating system.

RS232 CABLE TERMINAL FUNCTIONS

Pin 1 - No Connection.

Pin 2 - RXD Serial data RECEIVER pin for RS232 port.

Pin 3 - TXD Serial data TRANSMITTER pin for RS232 port.

Pin 4 - No Connection.

Pin 5 - RS232 port ground pin.

Pin 6 - DSR pin.

Pin 7 - NOT/RTS pin.

Pin 8 - NOT/CTS pin.

Pin 9 - No Connection.

4.4 FUSING

Three fuses are provided in the SEA 245, all mounted internally on the PA/Filter board (ASY-0245-02). Fuse F1 is a 15 amp, automotive (autoblade) fuses (SEA PN # FUS-0013-015). This fuse protects the +24 volt rail to the power output transistors and is provided with a reverse polarity protection diode.

Fuse F2 is a 5 amp, automotive (autoblade) fuse (SEA PN# FRS-0013-005). This fuse protects the +24 volt rail to the DC/DC power converter.

Fuse F3 is a 5 amp, automotive (autoblade) fuse (SEA PN # FUS-0013-005). This fuse protects the +12 volt output from the DC/DC power converter. This regulated +12 volt rail is chassis ground referenced (Negative rail connected to chassis ground) and powers the low level circuitry in the SEA 245 as well as external accessories such as an external antenna tuner or the SEA 2450 Remote Controller.

4.5 THE GROUND CONNECTION

A stainless steel 10-32 bolt and nut are provided on the rear panel to facilitate a low resistance connection between the radiotelephone chassis and the RF ground system.

5 THEORY OF OPERATION

5.1 GENERAL

The SEA 245 is a double conversion MF/HF SSB transceiver of up conversion design. The first intermediate frequency (IF) is 45 MHz and uses a relatively narrowband (8 kHz) crystal topping filter in conjunction with front end low and high pass filters to provide excellent image, spurious and harmonic rejection. This type of broadband design results in a minimum of tuned circuits. The second intermediate frequency of approximately 40 kHz permits the use of DSP oversampling techniques to provide secondary selectivity.

Receiver baseband recovery uses IF based DSP circuitry. The filtered, downconverted 40 kHz IF signal is fed into the ADC and DSP circuitry provides programmable receiver filtering and demodulation.

Transmitter baseband generation is likewise DSP based and uses the DSP/CODEC circuitry and an I/Q modulator, together with an appropriate DSP algorithm to generate the desired baseband signal at 45 MHz.

The frequency control circuitry in the SEA 245 uses a combination of two PLL-based frequency synthesizers and the system DSP engine to provide the various frequency conversions.

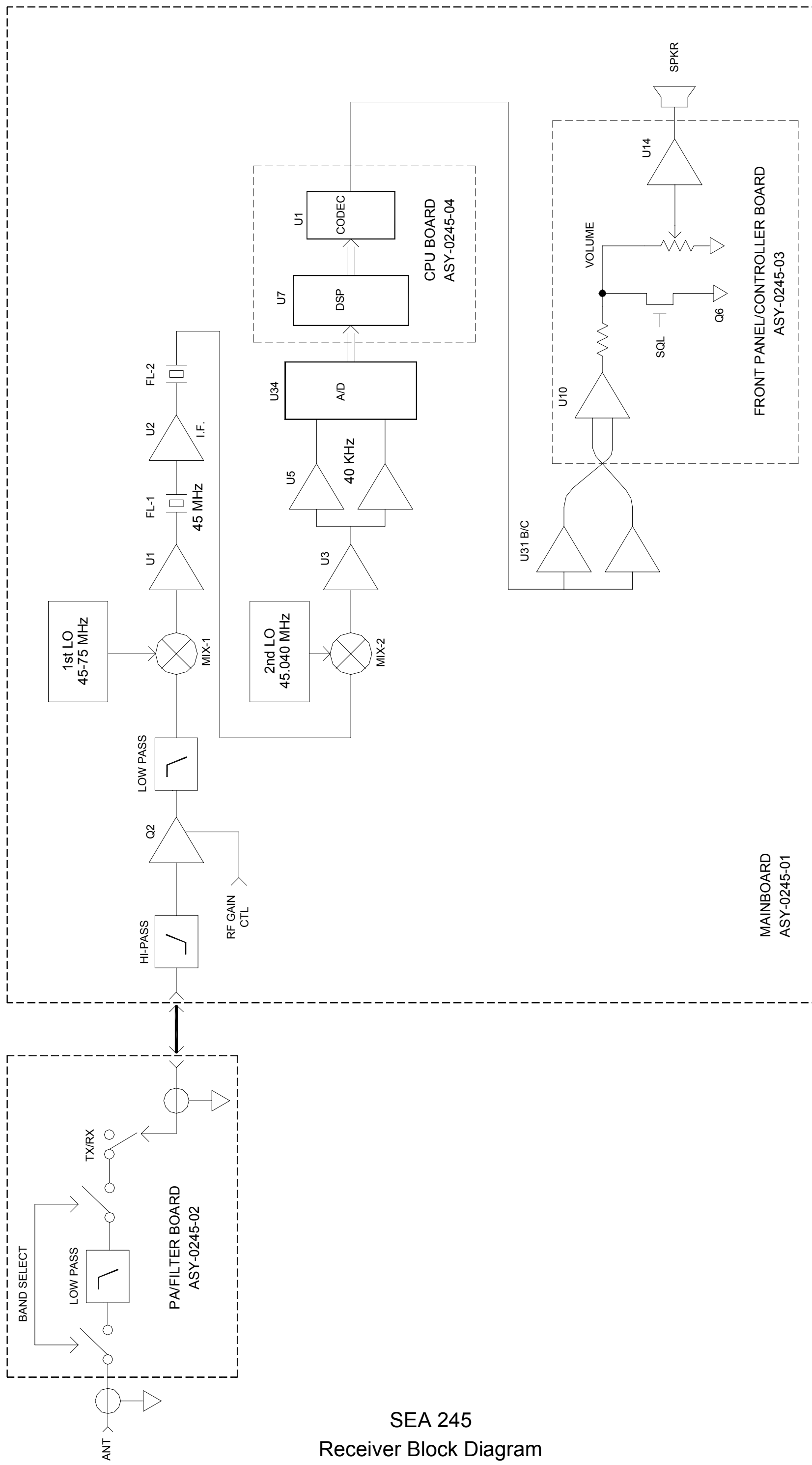
The first conversion oscillator is the 90-150 MHz VCO, which uses a PLL-based loop with a reference of 8 kHz. This oscillator is then divided by two to 45-75 MHz. The resulting coarse-tuned local oscillator has a resolution of 4 kHz, very fast settling time and a low noise floor.

The second conversion VCO operates at 45.040 MHz. In the transmit mode, the VCO operates at 45.016 MHz for the transmitter I/Q modulator circuitry. The loop reference frequency is 8 kHz.

All frequency determining circuitry is locked to the master clock oscillator, a 12.288 MHz OCXO.

The SEA 245 operating system resides in the Front Panel/Controller Assembly. The operator communicates with the operating system firmware through the 18 key keypad. The Front Panel/Controller Assembly is actually a SEAbuss(c) Controller designed to communicate with the Mainboard Controller through the standard SEABUSS interface. The SEA 245 SEABUSS is designed to support a single SEA 2450 Remote Controller in addition to the Front Panel.

5.2 THE RECEIVER



SEA 245
Receiver Block Diagram
Figure 5.2.1

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 a low pass filter selected by a relay bank on the PA/Filter Assembly (ASY-0245-02). The output of the filter is routed from J4 on the PA/Filter Assembly through a coaxial cable to the receiver input circuitry on the Mainboard Assembly (ASY-0245-01). The signal is further bandpass filtered to reject interfering signals and input to the RF preamplifier/attenuator, Q2. In the "on" state, the amplifier provides some 3-4 dB of low-noise preamplifier gain. In the "off" state, the stage becomes an attenuator that provides approximately 10 dB of signal attenuation. The use of this switched gain stage improves the weak signal sensitivity of the receiver and provides a front-end attenuator that is used to insure that large signals do not swamp the ADC in the DSP engine. The preamplifier/attenuator stage output is routed to the first mixer and the signal is upconverted to the first IF at 45 MHz.

The 45 MHz IF signal passes through a low noise MMIC gain stage to a 4-pole crystal "topping" filter with approximately 8 kHz bandwidth, a second MMIC amplifier stage and a second two-pole crystal filter into the second mixer. In the second mixer the signal is combined with the second Local Oscillator frequency of 45040 kHz. The mixer output signal is buffered by low-noise amplifier U3, converted to a push-pull signal by U5 and then applied to the input of the A/D converter U34. U34 digitizes the signal and passes it to the DSP engine, which provides all baseband filtering, fine-tuning, demodulation and AGC functions. The audio signal is converted to balanced format for transmission over the SEABUSS audio lines to the Front Panel/Controller board (ASY-0245-03). The Controller provides squelch processing, volume control and a speaker amplifier.

5.2.2 RECEIVE RF CIRCUITRY AND FIRST MIXER

As previously discussed, an incoming signal is first passed through some shared circuitry on the PA/Filter Board (ASY-0245-02). This consists of a bandswitched array of low pass filters, a T/R relay and a PIN diode signal limiter which prevents damage to receiver input circuitry in the presence of extremely large signals. The received signal is then sent through a coaxial cable to the receiver input on the Mainboard Assembly (ASY-0245-01). On the Mainboard, a high-pass filter consisting of C1, L1 and C7 further filters the signal.

Diode CR1 is forward biased in the receive mode from the +12VRX rail and reversed biased in the transmit mode from the +12VTX rail through CR2. This T/R switching circuitry provides extra isolation between the low-level transmitter signal and any signal leakage through the PA/Filter Board T/R switches. From CR1, the received signal passes through a low-pass filter (C5, L2 and C6) to the preamplifier/attenuator stage. This stage is a low noise, low gain (+4 dB) broadband common-gate JFET amplifier. A gain step is provided by switching the preamplifier supply voltage on and off through Q6. When Q6 is OFF, the stage becomes an attenuator with a loss of approximately 10 dB. The output of the preamplifier is then applied to double-balanced mixer MIX1. The use of a hot carrier diode mixer assures minimal cross modulation and intermodulation distortion in the receiver front end.

5.2.3 THE 45 MHz IF

The output from mixer MIX1 contains the desired signal upconverted to 45 MHz. This signal is amplified by a low noise, high dynamic range MMIC amplifier that establishes a good low noise 50-ohm termination for the mixer. Output of the first IF amplifier is filtered by FIL1, a four-pole monolithic crystal filter of approximately 8 kHz bandwidth. This is the "topping" filter, which serves to remove the unwanted secondary image, RF, and LO leakage as well as other unwanted upconverted HF signals that fall outside the filter bandwidth. Following the topping filter is a second MMIC amplifier stage and a second 2-pole filter. The total gain between the receiver input and the 45 MHz output is approximately 12 dB. The maximum allowable input signal with preamplifier on is approximately -3 dBm. Switching in the attenuator raises this level to approximately +10 dBm.

5.2.4 THE SECOND MIXER/POST AMPLIFIER

The second mixer converts the 45 MHz IF signal down to the second IF frequency of approximately 40 kHz. This mixer is a +13 dBm type, necessary to handle the somewhat higher signal levels present at this point. Following the mixer, the signal is passed through a low noise operational amplifier with a stage gain of 10 to a phase splitter circuit with stage gain of unity. The phase splitter output drives the differentially configured A/D input.

5.2.5 THE A/D CONVERTER

In IF/DSP receivers, system performance is highly dependent upon the characteristics of the A/D converter that moves the signal from the analog to the digital realm. In the SEA 245, A/D Converter U34 is a 24-bit, 96 kHz stereo ADC with a dynamic range of 110 dB and greater than 100 dB signal-to-noise ratio. The inputs to the ADC are full differential and the chip includes a reference filter and a digital decimation filter, which minimizes requirements for anti-aliasing filtering.

The 40 kHz second IF signal from the main receiver and the 14.583 kHz second IF signal from the 2187.5 kHz monitor receiver are each connected to one of the stereo inputs of the ADC. The resulting digitized signals are then passed on to the system DSP that is located on the CPU Board (ASY-0245-04).

5.2.6 THE CODEC

The CODEC is part of the CPU Board Assembly (ASY-0245-04) and uses AC'97 REV 1.03 architecture in a 18-bit sigma/delta configuration. The CODEC contains both an A/D and a D/A converter. The A/D converter is used to convert transmitter baseband signals into a digital bit stream suitable for processing in the DSP.

The D/A converter works in both receive and transmit modes. While receiving, digitally processed receiver signals from the DSP engine are converted back into the analog realm for processing through the amplifier/loudspeaker system. When transmitting, digitally processed (and generated) baseband signals from the DSP engine become the analog input signals to I/Q modulator chip U6 on the Mainboard Assembly.

5.2.7 THE DIGITAL SIGNAL PROCESSOR

The main DSP engine in the SEA 245 consists of U7 on the CPU Board Assembly. This is a TMS320VC5402, a specialized type of microprocessor which includes such features as a 40-bit ALU, data bus with Bus-Holder feature, extended addressing mode for 1Mx16-bit maximum external program space and many other specialized features intended to facilitate the specialized math functions necessary for DSP.

In the SEA 245, the DSP circuitry and firmware perform most of the signal processing functions necessary to convert a radio signal into an audio signal and vice-versa. These functions include frequency conversion, filtering, demodulation and gain control in the receive mode and baseband signal processing, filtering and generation in the transmit mode.

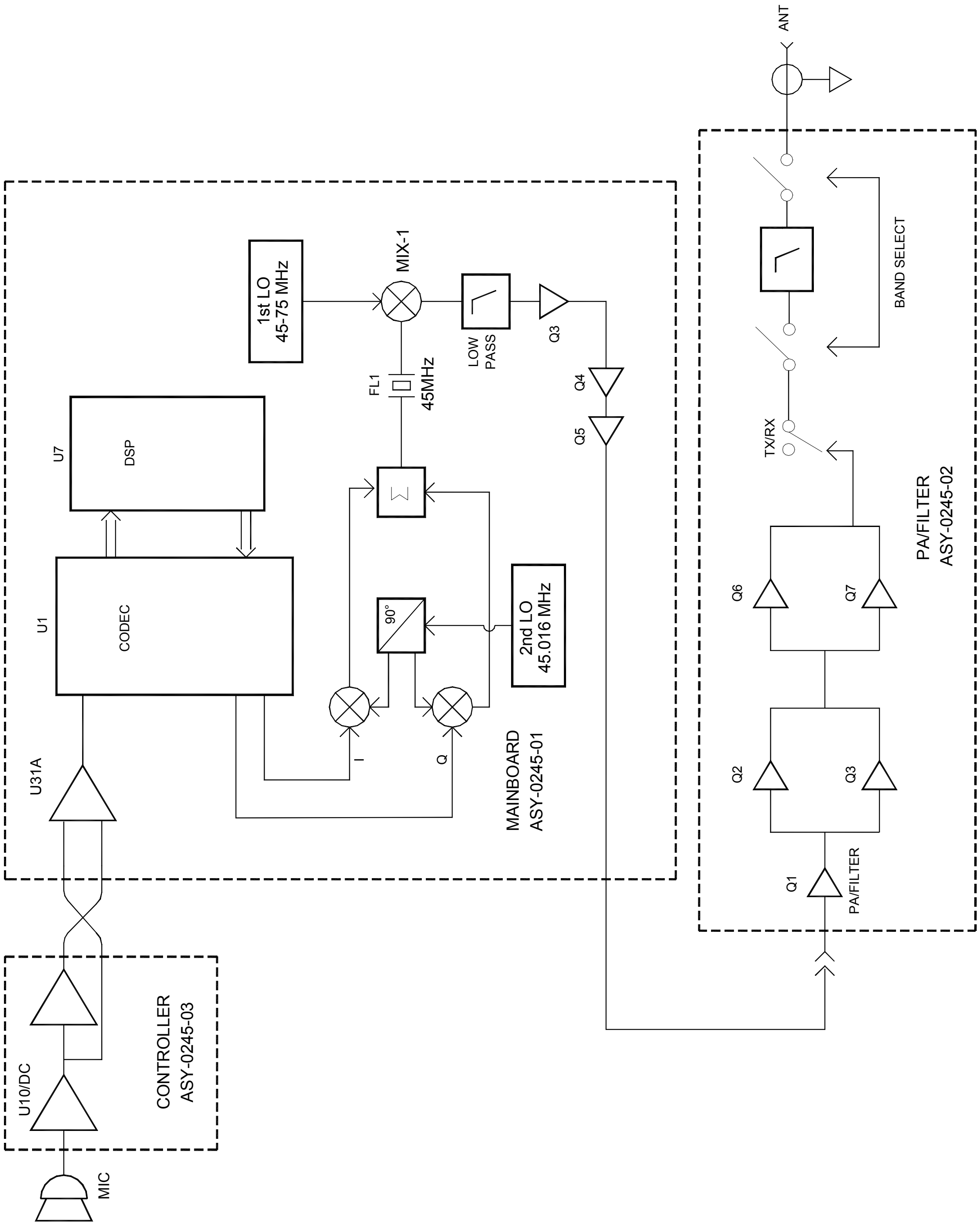
Since the DSP engine is actually a highly specialized type of microprocessor many, indeed most, of the characteristics of the receiver and transmitter functions are controlled by firmware algorithms embedded in the CPU Board memory. It is thus possible to use the same system <u>digital</u> hardware to generate (and demodulate) voice signals, TELEX signals, Digital Selective Calling signals or essentially <u>any</u> signal format up to the bandwidth limitations of the system <u>analog</u> hardware. Receiver AGC characteristics, transmitter bandwidth shaping and ALC functions are all determined in firmware.

5.2.8 THE RECEIVER AGC SYSTEM

There is only one variable gain element in the receiver AGC system, JFET preamplifier Q2. The amplifier passes signals whether or not it is enabled but, when disabled, there is approximately 10 dB of attenuation with respect to the enabled state. The actual AGC parameters are determined by the DSP algorithm and are tailored to suit the mode selected. When receiving SSB signals, the AGC has the usual fast attack-slow release characteristics suitable for SSB. The DSP software monitors signal level and disables the preamplifier when necessary to protect the A/D input from overload.

5.2.9 THE RECEIVER AUDIO CIRCUITY

The received signal is processed through the DSP engine and converted to an audio baseband signal in the system CODEC. This signal then exits the CPU Board as the SPKR.AF signal on pin 19 of J3 on the Mainboard and then passes through audio gate U30C to the audio SEABUSS driver stage consisting of U31B and U31C.



SEA 245

Transmitter Block Diagram

Figure 5.3.1

The audio signal then leaves the Mainboard Assembly (ASY-0245-01) as a 600 ohm balanced 0 dBm level and is received by the SEABUSS audio receiver in the Front Panel/Controller Assembly consisting of balanced line amplifier U10A.

After passing through U10A, the signal is then sent to the VOLUME control and the squelch limiter U8A and U8B. The signal from the VOLUME control wiper then goes to AF Power Amplifier U14 where it is amplified to a 4-Watt level and is then sent to the loudspeaker.

The limited audio signal from U8A is sent to an input of the Controller microprocessor (U1) where it is used to generate the SQL signal. An algorithm in U1 senses the presence (or absence) of a voice signal in the limited audio signal and, when the Squelch function is activated, generates a SQL OUT signal. The SQL OUT signal is used to turn on the squelch gate transistor Q6 to silence the loudspeaker.

5.3 THE TRANSMITTER

5.3.1 BLOCK DIAGRAM

Figure 5.3.1 shows the block diagram of the SEA 245 in the transmit mode. Microphone audio is amplified and converted to a balanced format for transmission from the Front Panel/Controller Assembly to the Mainboard Assembly (ASY-0245-01) via the SEAbuss audio lines. On the -01 board it is converted back to unbalanced format and then digitally sampled by CODEC U1 on the CPU board (ASY-0245-04). The CODEC transfers the data serially to the DSP, U7. The DSP generates a SSB signal at the (nominal) subcarrier frequency of 16 kHz. The CODEC converts the digital sample stream back to analog format. The resulting I and Q SSB signals are fed back to the Mainboard and into the inputs of quadrature modulator U6. The modulator mixes the I and Q signals with in-phase and quadrature 45.016 MHz local oscillator signals. This results in a single sideband signal at the 45 MHz intermediate frequency. This IF signal is passed through the bilateral 45 MHz crystal filter into the IF port of mixer MIX1. This mixer downconverts the IF signal into the MF/HF RF band. The RF signal is low-pass filtered and amplified before being passed on to the PA/Filter Assembly (ASY-0245-02) via a coaxial cable. Transmitter preamplifier Q1 boosts the signal level sufficiently to drive the push-pull driver stage consisting of Q2 and Q3. The driver output is then routed to the push-pull power amplifiers, Q6 and Q7. The output of the amplifier is then routed through the T/R relay to a low pass filter that is relay selected for the desired band of operation. The filtered output is fed to the antenna jack on the SEA 245 rear panel.

5.3.2 THE MICROPHONE AUDIO CIRCUITRY

The 600 ohm dynamic microphone output is terminated by 620 ohm resistor R8 and then passes through R94 and C13X to the input of the amplifier/phase splitter stage consisting of operational amplifiers U10C and U10D. MOSFET Q5 is connected between the junction of R94 and C13X and ground and serves to mute the microphone circuitry in the receive mode. The balanced audio output from U10C and U10D passes through analog gates U13A and U13D to the SEAbuss audio line. The SEABUSS audio interconnection between the Front Panel/Controller Assembly (ASY-0245-03) and the Mainboard Assembly (ASY-0245-01) is through the 8-pin ribbon cable between P2 on the Controller board and J4 on the Mainboard. These 8-pin DIP interconnections constitute an internal SEABUSS interface between the two assemblies.

5.3.3 THE AUDIO LINE RECEIVER/TRANSMITTERS

SEABUSS audio is bidirectional and passes through audio line receiver/transmitters at both ends of the path.

The receiver/transmitter circuitry consists of a balanced input line receiver and a balanced output line driver or transmitter. The line driver is connected to the SEAbuss(c) line through analog gates. These gates disconnect the line driver from the SEABUSS when the receiver/transmitter is in the receive mode. In the receive mode, balanced audio is presented to the input of an operational amplifier connected as a differential amplifier. Balanced operation permits a high degree of common mode rejection, insuring good noise rejection. The output of the line receiver is unbalanced audio which is then passed on to the internal radiotelephone circuitry.

When the receiver/transmitter circuitry is in the transmit mode, the analog gates are turned on, connecting the balanced output of the two amplifier line driver to the SEABUSS.

SEABUSS audio level is nominally 2 volts peak-to-peak balanced (0 dBm).

5.3.4 THE CODEC AND DIGITAL SIGNAL PROCESSOR

CODEC, U1, digitizes audio from the microphone circuitry at a rate of 96 kilosamples each second. The samples are transferred to the DSP U7 for processing. The DSP performs audio processing to maintain a relatively uniform audio level and to reduce the peak-to-average ratio of the audio. This facilitates more efficient use of the RF power amplifier. The audio is also bandpass filtered to remove unwanted components, particularly above 2900 Hz. The audio is then converted to a single sideband signal at the (nominal 16 kHz) subcarrier frequency. This SSB signal is then passed through the CODEC and converted to I and Q analog signals.

5.3.5 THE QUADRATURE MODULATOR

The I and Q signals from the CODEC are sent to quadrature modulator U6 on the Mainboard. This modulator consists of a PLL based LO phase shifter, two mixers and a combiner. A 45.016 MHz local oscillator (LO) signal from the synthesizer is AC coupled into the modulator. The internal PLL circuit regenerates the 45.016

MHz LO and produces two 45.016 MHz LO signals with a 90 degree phase differential. These are used as the two local oscillators for the mixers. One is mixed with the I component and the other is mixed with the Q component. The two mixer outputs are summed to complete the single sideband mixer. In the summer the desired sideband adds constructively while the undesired sideband cancels out, producing a single sideband signal with a center frequency of 45 MHz. A DC bias network with three trimpots (R77, R78, and R85) allows adjustment of opposite (image) sideband and carrier suppression.

5.3.6 45 MHz IF AND SIGNAL MIXER

The 45 MHz signal from the quadrature modulator passes through switching diode/attenuator CR6 to topping filter FIL1A/FIL1B. When in the transmit mode, CR6 is biased on by the +12VTX rail through resistors R48 and R66. Bias current is approximately 10 mA, resulting in a low loss switch. Monolithic filter FIL1A/FIL1B is matched to the low impedances of the quadrature modulator and mixer by the two "L" networks, L10/C39 and L9/C38. The filter output is passed through CR5 to a attenuator consisting of R34, R35 and R36 and then through CR4 to the IF port of MIX1

5.3.7 THE LOW PASS FILTER AND TRANSMITTER PREAMPLIER

The downconverted transmitter signal from MIX1 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 30 MHz. The filtered MF/HF signal is then passed through diode switch CR3 to the input of the transmitter preamplifier. L6, A 27 µH choke, serves as a simple high pass filter to restrict signal into the preamplifier to the MF/HF spectrum. The transmitter preamplifier is a two-stage wide band amplifier. The first stage consists of transistors Q3 and Q4 in a negative feedback voltage amplifier. The output of this stage is taken from the low impedance emitter of Q4 and further amplified by Q5. Q5 is a transformer coupled power amplifier which is used to boost the power output level of the SSB signal to the approximately 4 mW (+6 dBm) required by the PA/Filter Assembly (ASY-0245-02). The signal exits the Main Board via coaxial cable and enters the PA/Filter board on J1.

5.3.8 THE TRANSMITTER PREDRIVER

The low level transmitter signal is routed from J1 through a 3 dB pad and a wideband transformer (T1) to the base of Q1. Q1 is a 2N3866 connected in the common emitter configuration and is transformer coupled to the push-pull driver stage. Bias for Q1 is provided by the base resistor network with R6 used to adjust the idling (no signal) current in the device to 60 mA (0.275 volts across R7/R8). The emitter resistor (R7/R8) is used together with press-on heat sink to provide thermal stability for Q1.

5.3.9 THE TRANSMITTER DRIVER

Transistors Q2 and Q3 are small plastic RF power devices connected as a push-pull common emitter amplifier. Transformer T2 provides push-pull base drive from the predriver, while transformers T3 and T4 provide DC power isolation and collector to load impedance matching, 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 Q2 and Q3 by the circuitry associated with Q4 and Q5. Q4 is a small silicon power transistor connected as a voltage amplifier and buffered by power emitter follower Q5. The current in Q4 is proportional to temperature. This causes the collector voltage to drop as heat sink temperature rises. The collector voltage is the source of base drive for the bias buffer emitter follower Q5. Bias current for Q2 and Q3 is adjusted to 140 mA by the potentiometer, R14, in the emitter circuit of Q4. Collector voltage for Q4 is derived from the +10VTX bus, while collector voltage for Q5 is derived from the +12VTX rail.

5.3.10 THE TRANSMITTER POWER AMPLIFIER

The power amplifier in the SEA 245 is a push-pull common emitter design with a temperature stabilized bias source. The amplifier runs from the +24 volt input and has the collector voltage present at all times. The amplifier is activated by turning on the various bias supplies when in the transmit mode.

Since the +24 volt power source is isolated from the chassis, the power amplifier bias generator must be powered from the +24 volt rail. The bias generator circuitry consists of Q8, Q9 and regulator U4. +24 volt power for U4 and Q8 is switched by the +12VTX rail through Q12 by optical isolator U5. When the +12VTX rail is high U5 turns on Q12, energizing the bias generator circuitry. Q8 serves as a power emitter follower to buffer the voltage generated by the temperature-tracking amplifier, Q9. Q9 is a small power transistor that is thermally linked to the power amplifier heat sink. To insure stability in the presence of varying line voltages, the collector voltage for Q9 is obtained from 9 volt regulator U4. R28 permits adjustment of the idling (no signal) current in Q6 and Q7 to 150 mA.

5.3.11 THE OUTPUT LOW PASS FILTERS

Five low pass filters are provided to cover the frequency range from 1.6 - 30 MHz. Note that the highest frequency filter, which covers the-26 - 30 MHz spectrum, is a 3-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 Mainboard controller computer through a serially loaded relay driver consisting of shift register U2 and buffer-driver U3.

5.3.12 THE ALC CIRCUITRY

The transmitter ALC circuitry is DSP based. The control signals for the ALC system are derived from the dual directional coupler consisting of transformers T13 and T14 and termination resistors R44, R47 and R48. The forward power signal is detected by CR3 and scaled by resistors R49 and R50 before being buffered by U1B. The reflected power signal is detected by CR4 and buffered by U1A. The buffered analog voltages corresponding to forward and reflected power levels are then routed through the Mainboard to A/D converter inputs on the CPU board microprocessor, U5.

5.4 THE MASTER CLOCK OSCILLATOR AND SYNTHESIZER SYSTEM

5.4.1 BLOCK DIAGRAM

Figure 5.4.1 shows the block diagram of the local oscillator system of the SEA 245.

The block diagram illustrates a total of two synthesizers. The first local oscillator operates from 45 to 75 MHz and uses three bandswitched VCOs. These are controlled by synthesizer chip, U21, which contains a dual modulus divide-by-N counter, a variable modulus reference counter and a phase detector. The basic reference rate for the phase detector is 8 kHz, which sets the "coarse" step size for the first local oscillator to 4 kHz. (The VCO signal tunes from 90 to 150 MHz and is divided by two before being applied to the first mixer.)

The second local oscillator synthesizer operates at 45.040 MHz with a reference rate of 8 kHz.

5.4.2 THE MASTER CLOCK OSCILLATOR

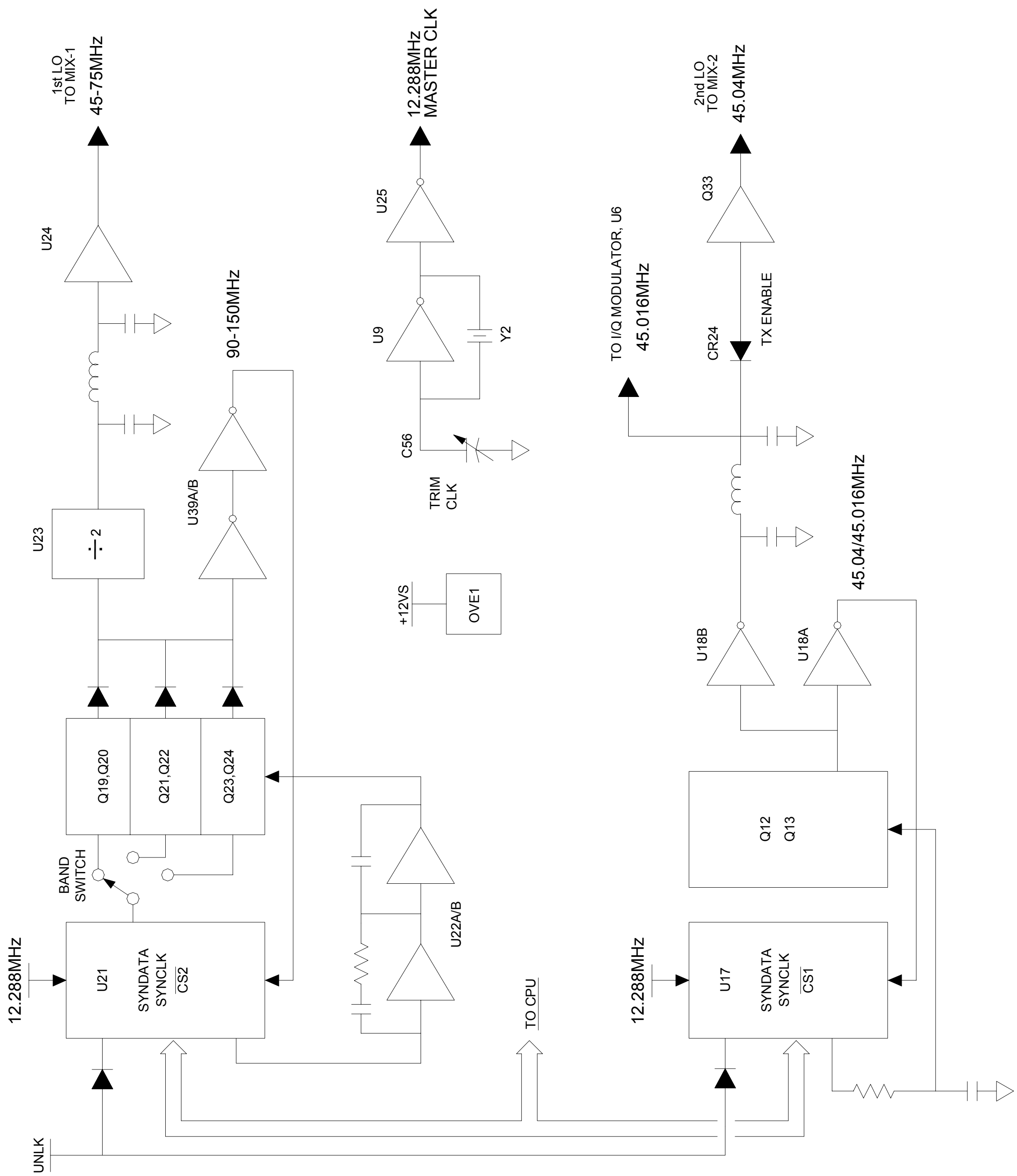
Primary frequency control is maintained through a master temperature-stable crystal oscillator (TCXO) operating at 12.288 MHz. Clock stability is achieved through a combination of temperature control and temperature compensation. The Master Clock Oscillator crystal Y2 is mounted in a proportional oven to insure stability. Unbuffered HCMOS U9 and U25 gates are used for both oscillator and buffer amplifier functions. Trimmer capacitor C56 is used to set the clock frequency.

5.4.3 THE FIRST LOCAL OSCILLATOR SYNTHESIZER

The first LO synthesizer consists of three switched VCOs, a buffer amplifier and a phase locked loop circuit. The synthesizer generates local oscillator frequencies from 45.4 - 75.0 MHz corresponding to operating frequencies of 0.4 - 30.0 MHz. The oscillators themselves operate at twice the desired output frequency, however. Operation of a typical VCO is described below. Q23 is configured as a Colpitts oscillator with inductor L35 and varactor diode CR15 serving as the frequency determining elements. Q24 buffers the VCO to prevent load pulling. These components make up the highest frequency VCO, which tunes from approximately

130 to 150 MHz.

Switch transistors Q16, Q17 and Q18 provide power to the selected VCO. The base of Q18 is pulled low through R146 supplying 10 volts to the HIGHBAND VCO, Q23-Q24. When the MIDBAND VCO is selected, Q13 will be turned on by a high on pin 16 of U21. This will pull the base of Q17 low, energizing Q21 and Q22. At the same time the base of Q18 is pulled high through diode CR10 switching OFF the HIGHBAND VCO. Similarly, selection of the LOWBAND VCO is accomplished by a high on pin 15 of U21, which turns on Q14/Q16, supplying power to Q19/Q20 and



SEA 245
Synthesizer Block Diagram
Figure 5.4.1

holding OFF the HIGHBAND VCO through diode CR10. Steering diodes CR17 and CR18 are used to provide isolation between the two OFF VCOs and the active output.

The output from the selected VCO is passed through prescaler, U23 where the signal is divided by two. The prescaler output is buffered by MMIC, U24, before being sent to the first mixer. The VCO output is also passed through dual buffer amplifiers U39A and U39B. The output signal from U39B provides the VCO signal to the synthesizer chip U21. Using separate amplifiers in this fashion improves the isolation between the receiver mixer circuitry and the input to the synthesizer chip.

Serially loaded PLL chip U21 provides a reference counter, divide-by-N counter, a phase/frequency detector and the VCO control register. The PLL reference frequency is derived from the 12.288 MHz Master Clock. Loop filtering and level shifting of the PLL phase detector output is accomplished by active filters U22A/B.

5.4.4 THE SECOND LOCAL OSCILLATOR SYNTHESIZER

The second local oscillator synthesizer consists of PLL chip U17, 45.040 MHz Colpitts oscillator FET Q12, and buffer amplifier Q13, U18A, U18B and Q33. Buffer amplifier U18A provides a sample of the 45.040 MHz VCO signal for the synthesizer chip while U18B provides 45.040 MHz drive for the second mixer.

5.5 THE 2187.5 kHz MONITOR RECEIVER

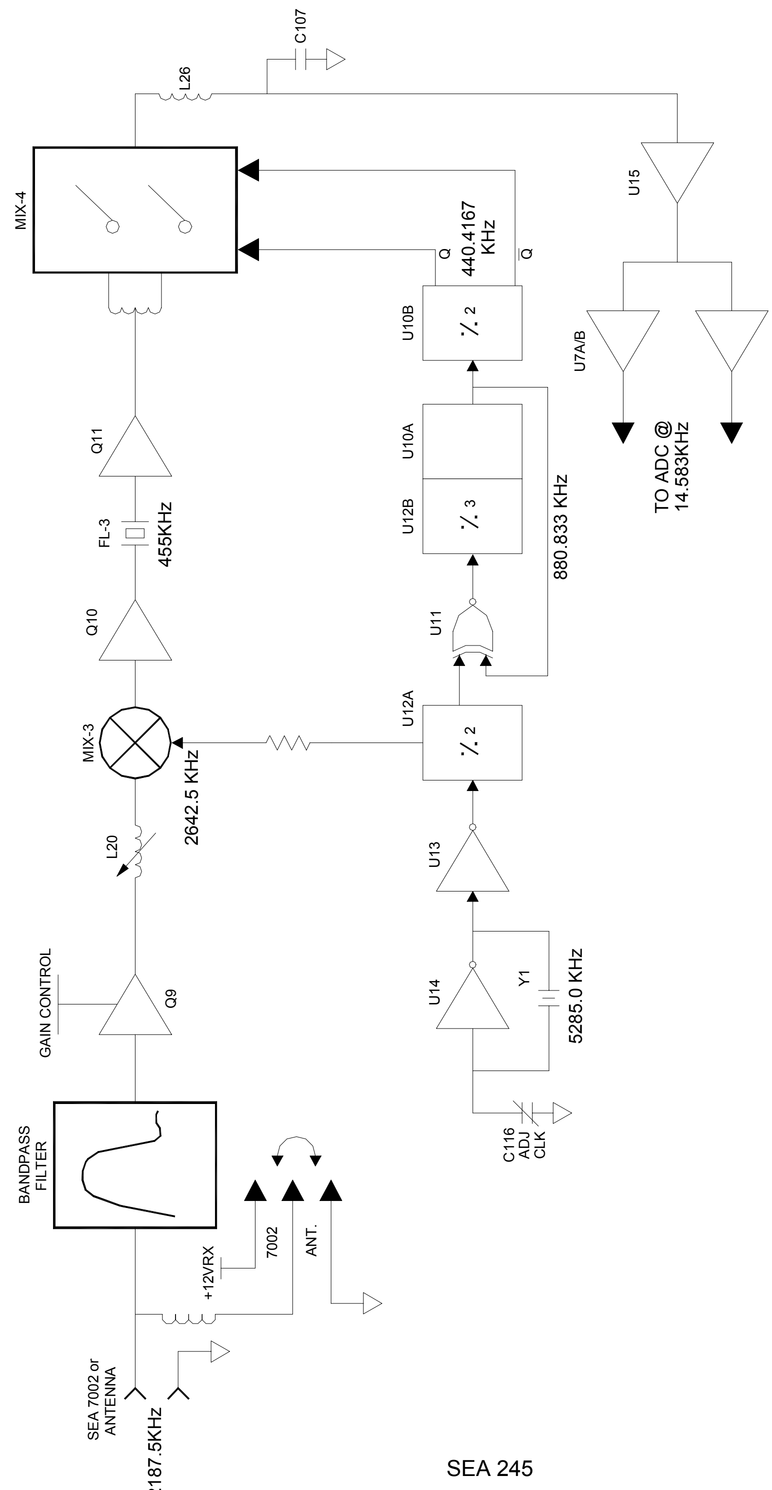
5.5.1 BLOCK DIAGRAM

Figure 5.5.1 shows the block diagram of the 2187.5 kHz monitor receiver, required for GMDSS applications is Sea Area 2. The receiver is a single channel, dual conversion design which uses a single crystal to provide both conversion signals. The first IF frequency is 455 kHz, the second IF frequency is nominally 14.583 kHz. As in the SEA 245 Main Receiver, the DSP engine provides all channel selectivity, signal demodulation, and AGC.

5.5.2 RECEIVER RF CIRCUITRY AND FIRST MIXER

Antenna input to the 2187.5 monitor receiver is on pins 13 (signal) and 14 (ground) of the rear panel Accessory Connector. The impedance is 50 ohms and provisions have been made to support the SEA 7002 Active Antenna, should this be desired.

The RF signal first passes through a high pass filter and a low pass filter to Q9, the preamplifier. The preamplifier is a grounded-gate JFET with tuned drain circuit. The nominal gain of this stage is about 8 dB with the drain voltage on. As in the main receiver, switching the drain voltage off under control of the AGC software in the DSP provides a gain step. The combination of the front end 5-section low pass filter and the low pass response of the preamplifier drain circuitry combine to provide the receiver with better than 75 dB rejection of the 3097.5 kHz primary image.



SEA 245

2187.5 KHz MONITOR BLOCK DIAGRAM

Figure 5.5.1

The first mixer is a conventional +7 dBm double balanced type, which provides excellent dynamic range in this application.

5.5.3 THE 455 kHz IF AMPLIFIER

The first 455 kHz IF amplifier is Q10, a grounded-gate JFET which provides some gain and serves as a wideband 50 ohm termination for the mixer. The output from the amplifier is passed through FL3, a 6-pole ceramic bandpass filter with a nominal bandwidth of 4 kHz. Output from the filter is then passed through emitter follower Q11 to the second mixer.

5.5.4 THE SECOND MIXER/POST AMPLIFIER

The second mixer is a double balanced commutation mixer, which uses a quad HCMOS analog gate (U16) as the switching element. Push-pull signal drive is provided to the two switch arms through a wideband transformer. (Note that two gate elements are used in each switch arm.) Push-pull local oscillator drive is applied to the switch actuator pins from the output of the local oscillator divider chain. Both output arms of the switch are summed together, resulting in a double-balanced switching mixer with excellent dynamic range and good local oscillator balance.

Output from the mixer is passed through a low pass filter consisting of L26 and C107 to a low noise operational amplifier stage with gain of 10 and a phase splitter, which, as in the Main Receiver, drives the A/D input.

5.5.5 THE LOCAL OSCILLATOR CIRCUITRY

Both conversion oscillator frequencies are derived from the same crystal controlled source in the following fashion. Crystal oscillator U14 operates at 5285.0 kHz. This oscillator is temperature compensated and maintains a frequency stability of less than ±4 ppm over the voltage and temperature range of the equipment. Trimmer capacitor C116 is used to set the oscillator frequency to exactly 5285.0 kHz at TP10. Output from the oscillator is buffered by gate U13 and then divided to 2642.5 kHz by U12A. This signal is sent to both the first mixer and the second local oscillator divider chain. The difference frequency between the first local oscillator and the 2187.5 kHz signal frequency is 455 kHz.

U11, U12B and U10A form a symmetrical divide-by-three counter. The resulting 880.3333 kHz signal is then further divided by two in U10B. The Q and notQ outputs of U10B are at 440.4167 kHz and, when mixed in MIX-4 with the 455 kHz IF signal, results in the 14.5833 kHz last IF frequency which is amplified by U3 and U5A/B and then sent through the A/D converter to the DSP for further filtering and demodulation.

5.6 THE POWER SUPPLY CIRCUIT

5.6.1 GENERAL

The basic supply voltage for the SEA 245 is a floating ground 24 Volt DC source. Line voltage regulation of ±15% or better is required, with a current capacity of at least 15-20 amperes. From this raw source are derived the necessary regulated operating voltages for the SEA 245 circuitry.

5.6.2 BLOCK DIAGRAM

Figure 5.6.1 shows a simplified schematic diagram of the power supply circuitry.

Once the basic 24 Volt DC power is provided, it is connected to the set through the heavy-duty power plug on the transceiver rear panel. A variety of internally mounted fuses are provided to protect the set in the event of malfunction. The primary line fuses are equipped with a polarity protection diode that will blow the line fuses in the event of reversed line polarity.

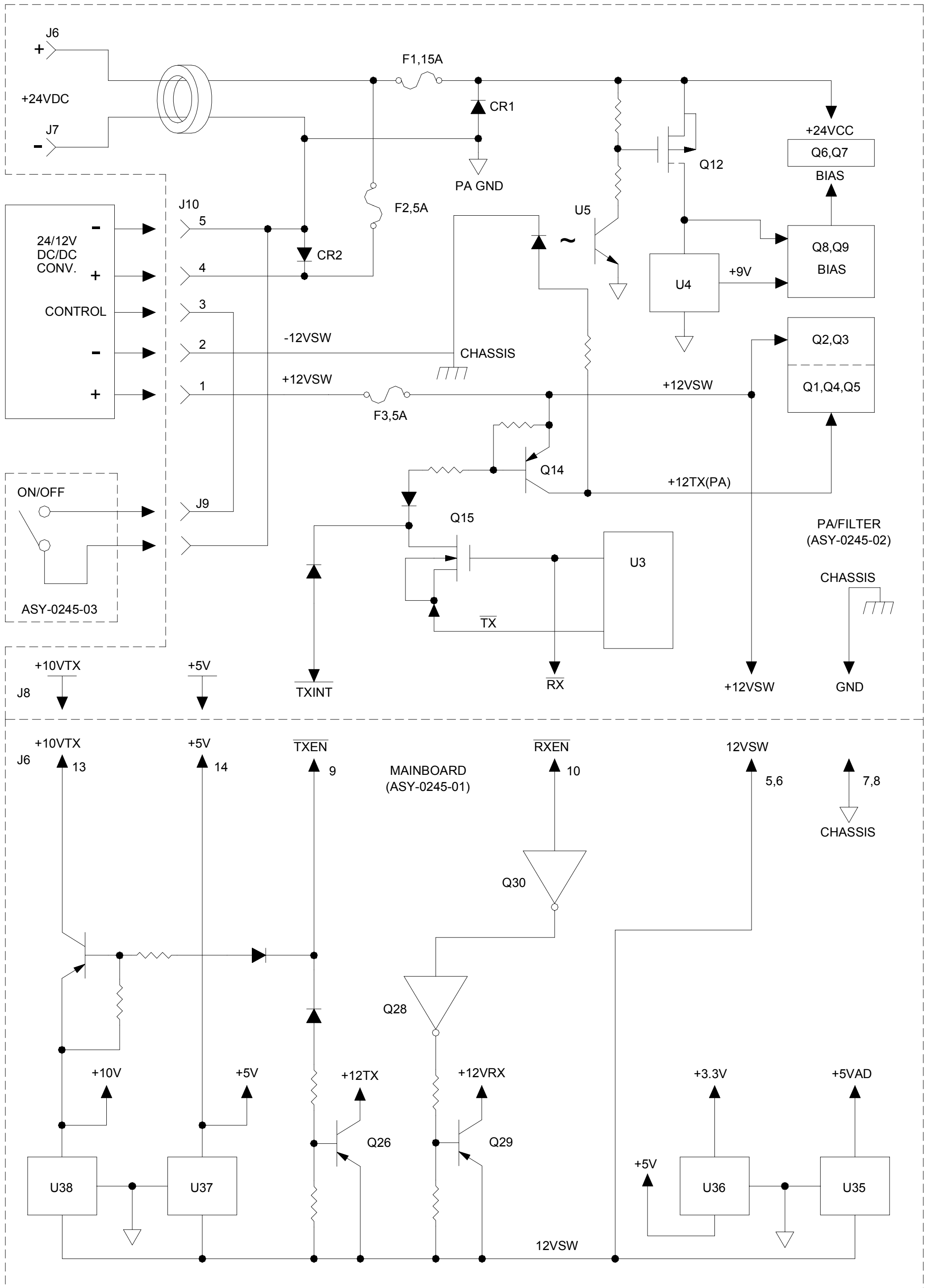
As illustrated in Figure 5.6.1, the 24 Volt DC power from the rear panel mounted connector passes through a ferrite line filter to the PA/Filter Board (ASY-0245-02) where the power is distributed to the internal circuitry through fuses F1 and F2.

15 ampere fuse F1 serves to protect the circuitry associated with the output stage of the power amplifier. 5 ampere fuse F2 protects the primary circuitry for the isolated 24/12 volt DC/DC converter which provides the regulated, chassis referenced, +12 volt rail. The +12 volt rail powers the low level circuitry in the SEA 245. Each fuse is individually protected from reverse polarity by power diodes CR1 and CR2 and each power rail is individually filtered by 470 µF capacitors C29 and C47. Note that these rails are NOT switched. Power is present on the power amplifier module and the DC/DC converter input AT ALL TIMES.

5 ampere fuse F3 protects the regulated +12 volt primary power distribution system in the SEA 245. Capacitors C75, C76 and C78 serve as line filters. The fused, filtered +12 volt regulated rail is designated the +12VSW line and is distributed to the SEA 245 circuitry through pins 5 and 6 of J8 on the PA/Filter Assembly. (Ground and negative rail use pins 7 and 8).

5.6.3 THE MAIN POWER CONTROL CIRCUITRY

The main power switch in the SEA 245 is the ON/OFF switch located on the front panel VOLUME control. Wires from the switch connect to J9 on the PA board (ASY-0245-02). When the front panel switch is closed by rotating the VOLUME control to the right from the stop, a connection is made between J10 pins 1 and 3. This turns the 24/12 volt DC/DC converter ON and powers up the +12VSW rail in the SEA 245.



SEA 245

Power Distribution Block Diagram

Figure 5.6.1

5.6.4 +10 VOLT REGULATOR AND THE +10VTX SWITCH

The internal +10V rails are derived from the +12VSW bus through regulator U38. The +10VTX rail is generated by inverted switch Q27. Grounding the notTXEN line will turn on Q27, enabling the +10VTX rail. The notTXEN line comes from the PA/Filter Assembly through pin 9 of J6.

5.6.5 +12 VOLT RAIL AND THE +12VTX/+12VRX SWITCHES

Transistors Q26 on the mainboard generate the mainboard +12VTX rail. The +12VTX rail is energized when the notTXEN line from pin 9 of J6 goes low, switching Q26 on.

The +12VRX rail is energized when the notRXEN line from pin 10 of J6 goes low. This turns Q30 off which turns Q28 on, switching Q29 on.

The use of transistor switches to generate the TX and RX rails eliminates any problems with relay contacts or T/R timing.

5.6.6 +5 VOLT REGULATORS

The +5 volt rail for the Mainboard Assembly and the PA/Filter Assembly is derived from the +12VSW rail through regulator U37.

In the Front Panel/Controller Assembly (ASY-0245-03) a separate 5 volt regulator, U16, provides the regulated rail for the controller circuitry. Note that the controller +12VSW rail comes through the standard SEABUSS interconnection.

5.6.7 +3.3 VOLT REGULATOR

U36 on the Mainboard Assembly provides the +3.3V rail which is used in the CPU/DSP Board (ASY-0245-04) to power the main control computer hardware.

5.6.8 +12VTX RAIL

The transmitter predriver circuitry and the bias systems for the transmitter driver are supplied with a relatively high current +12VTX rail through Q14. Q14 is a PNP power transistor, operated as an inverted switch. Base drive for Q14 is provided by the INTERLOCKED notTX line. This line is obtained through the "safety clamp' transistor, Q15, from the notTX and notRX ports generated by the controller computer through the shift register U2 and the buffer chip, U3. When the notTX port from pin 16 of U3 is LOW and the notRX port from pin 5 of U2 is HIGH, the INTERLOCKED notTX line is LOW. This will cause Q14 to be ON, energizing the +12VTX rail.

Note that the INTERLOCKED notTX line is also used to control Q26 and Q27, the +12VTX and +10VTX switch transistors respectively, on the Mainboard Assembly. The use of the INTERLOCKED NOT TX line in this fashion prevents the simultaneous application of +12VTX and +12VRX to the low level transceiver circuitry.

5.6.9 THE +24VTX RAIL AND PA BIAS SYSTEM

Bias for the PA output transistors is generated from the +24VTX rail. Since the entire +24 volt power source is isolated from the chassis, an optical isolator, U5 on the PA/Filter Assembly (ASY-0245-02) is used to switch on a P-channel FET (Q12) when the +12VTX rail is energized. This +24VTX line is then used to power bias regulator transistor Q8 and the +9V PA bias supply regulator U4. The output from U4 powers bias tracking amplifier transistor Q9. Q9 is a small power device which is bonded to the same heat sink as the RF power transistors to provide thermal feedback.

5.7 THE MAINBOARD CONTROLLER AND DSP PROCESSORS

5.7.1 GENERAL

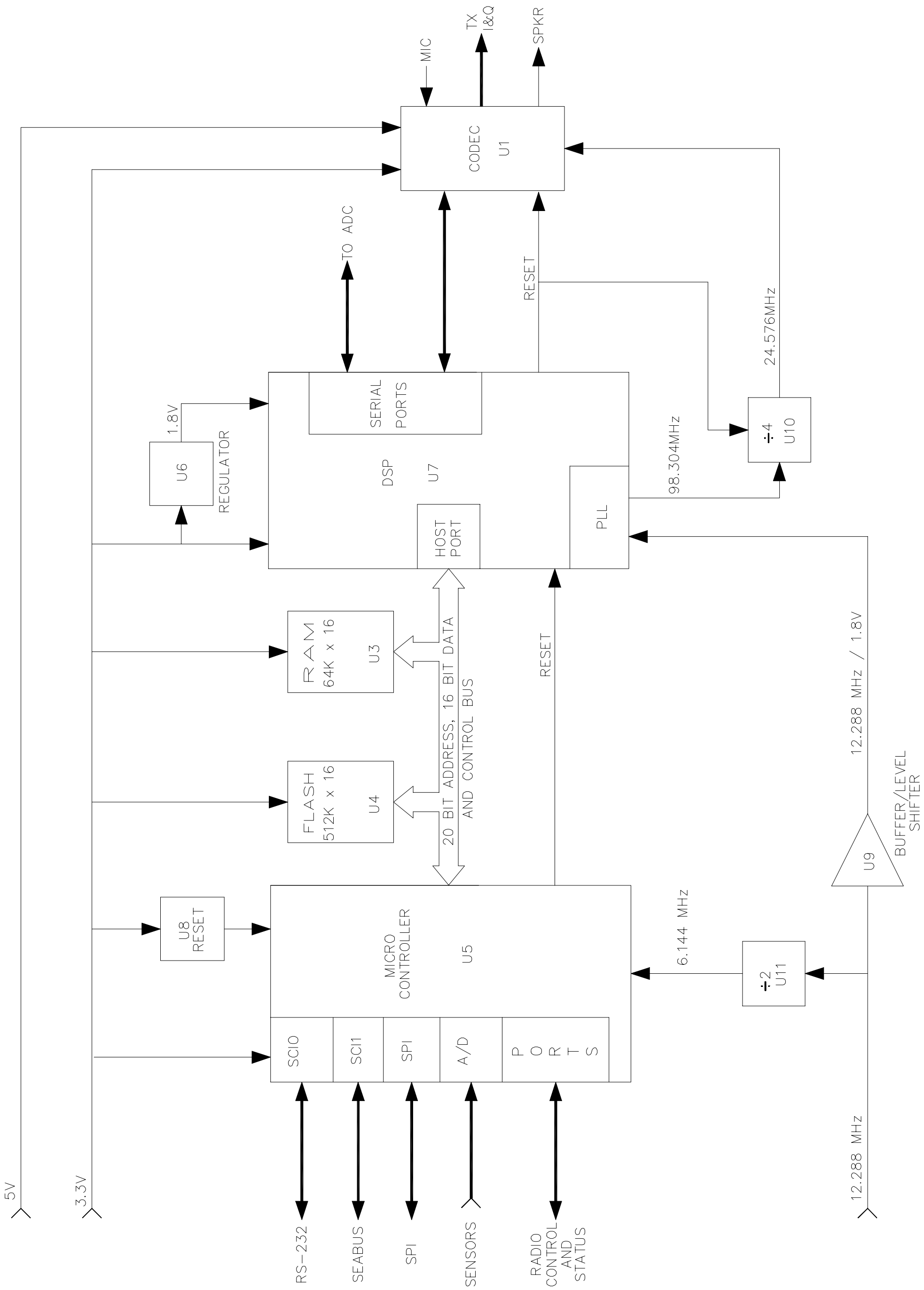
The Mainboard microcontroller and digital signal processor (DSP) are contained on a separate assembly (ASY-0245-04). The microcontroller is a Motorola MC68C812A4 operating from a 6.144 MHz clock. This is a low voltage (3.3V) 16-bit processor with two asynchronous serial ports, a serial peripheral interface (SPI), a timer and pulse accumulator module, an 8-channel 8-bit A/D converter, 1 Kbyte of RAM, 4 Kbytes of EEPROM and memory expansion logic with chip selects. It also has many bidirectional ports for general purpose I/O. The DSP is a TI TMS32OVC5402. This is a 32-bit fixed-point DSP capable of 100 MIPS operation. It includes 16 Kwords (16-bit) of internal RAM, two sophisticated multichannel serial ports and a parallel host port interface.

5.7.2 BLOCK DIAGRAM

Figure 5.7.1 shows a block diagram of the processor assembly.

5.7.3 CLOCK DISTRIBUTION

The 12.288 MHz master clock is supplied through P2 to the processor assembly (ASY-0245-04). U11A divides this clock by two to provide a 6.144 MHz clock to the microcontroller, U5. U9 buffers the clock and converts it to a 1.8 volt level suitable for the DSP, U7. The DSP has an internal PLL which generates a 98.304 MHz clock phase locked to the 12.288 MHz reference. The 98.304 MHz clock is used as the cycle clock for the DSP and is also divided by 4 by U10 to produce a 24.576 MHz clock for the CODEC, U1. This clock divider can be reset by the DSP in order to insure a known phase relationship between the CODEC clock and the DSP clock. This is necessary for reliable communication between the CODEC and the DSP.



SEA 245 Processor Assembly
Block Diagram
Figure 5.7.1

5.7.4 MICROCONTROLLER OPERATION

Reset generator, U8 provides a reset pulse to microcontroller U5 at startup or if there is a dip in the power supply. At startup the microcontroller has access only to the internal resources. It runs software contained in the internal EEPROM. This software configures the chip and either boots a program from the RS-232 port (Useful for service and reprogramming functions) or transfers control to the flash memory. The flash memory contains most of the software for running the radio. The radio channel list also resides in flash as well as software to be downloaded to the DSP. A 64 kword external RAM is provided for workspace and stack space. Additional memory for scratchpad channel storage and radio configuration parameters is contained in the nonvolatile internal EEPROM. The microcontroller may also communicate with the DSP as a memory-mapped device on the bus.

The processor has two asynchronous serial interfaces (SCI's). SCI0 is used to provide an RS-232 interface to the radio which can be used for computer control or for reprogramming the flash memory. SCI1 is used to provide a SEABUSS interface to the front panel or a remote controller. The processor also has a serial peripheral interface (SPI) which is used to communicate with the synthesizers as well as a shift register which provides control signals to the PA/Filter Assembly.

The processor has an 8-channel analog to digital converter port. Not all of these A/D converter channels are in use but some of them are used to read temperature sensors, power sensors and synthesizer lock detection signal ports.

Finally there are quite a few general purpose I/O ports used to control the radio. For example these are used to control gates to route audio signals, to communicate with an Automatic Antenna Tuner, to control receiver gain steps, to switch the cooling fan and the reset the DSP.

5.7.5 DSP OPERATION

At startup the DSP, U7, is reset by a port signal from the microcontroller, U5. The microcontroller then transfers the firmware from the flash memory, U4, to the DSP via the host port interface on the microcontroller's bus. This firmware runs out of the DSP's internal RAM.

The DSP has two serial ports. One of these is used to communicate with the previously described A/D converter on the Mainboard. This stereo 24-bit converter samples signals from the Main Receiver and the Watch Receiver 96000 times per second. During each sample two 24-bit words (One for each receiver) are transferred over the serial port to the DSP. The DSP generates the 96KHz clock which provides a framing signal to the A/D to select between the two channels. The other serial port is connected to the CODEC, U1, which is described further below. The interface is similar to the A/D interface but the sample rate is 48 KHz.

The operation of the DSP depends on whether the radio is receiving or transmitting. When receiving the DSP reads receiver samples from the A/D. The digitized SSB samples are processed to convert them to the audio band, filter out undesired signals and provide gain control and noise blanking. Watch Receiver signals are also FSK demodulated in order to detect Digital Selective Calling (DSC) data. Audio samples from the Main Receiver are passed to the speaker audio circuit through the CODEC monophonic output. DSC data is passed to the microcontroller over the host port for further data decoding. In transmit mode microphone audio samples are read by the DSP from the CODEC, U1. the DSP performs speech processing on these samples and converts them to inphase and quadrature signals at an IF of approximately 15 KHz. These I and Q samples are transferred to the I/Q Modulator through the CODEC.

In both transmit and receive modes, the DSP also communicates regularly with the microcontroller over the host port. In receive mode the DSP regularly sends gain information to the microcontroller as well as DSC data. In the transmit mode the DSP must obtain power sensor data from the microcontroller in order to implement Automatic power Level Control (ALC). The DSP also receives mode information from the microcontroller which determines operating parameters of the DSC such as PTT status, transmitter power level and receiver bandwidth.

5.7.6 CODEC OPERATION

U1 is an AC '97 compliant 18-bit stereo CODEC operating with a 48 KHz sample rate. On board multiplexers can select between two stereo inputs and three mono inputs. It also has selectable stereo or mono outputs. Each channel has independent gain and mute controls. All of the control and status as well as the stereo input and output sample data is passed over the serial connection to the DSP. the stereo output is used for transmit I and Q samples for the modulator. The mono output is used for speaker audio. Two of the inputs are used for microphone audio and an alternate low level audio input. The other input channels are not used.

6 THE SEA 245 FRONT PANEL/CONTROLLER SYSTEM

6.1 GENERAL

The SEA 245 Front Panel/Controller unit is a complete SEABUSS controller and is designed in such a manner as to permit direct installation on the front of a standard SEA 245 as well as in remote installations. The SEA 245 will support a SINGLE remote controller and a SEABUSS compatible Antenna Tuner such as the SEA 1631. The maximum TOTAL length of SEABUSS cable not to exceed 200 feet (60 meters). The stand-alone Controller (SEA 2450) is designed for shipboard mounting. Keypad and display are backlighted for operator convenience

Figure 6.1 shows the outline dimensions of the SEA 2450 with mounting bracket. For information regarding flush mounting, contact the SEA, Inc. factory.

Interconnection between the Front Panel/Controller and the SEA 245 Mainboard Assembly (ASY-0245-01) when the Controller is directly attached to the radiotelephone is through an 8-pin DIP connector which carries the standard SEABUSS interface connections (See Front Panel/Controller (ASY-0245-03) schematic diagram). This connector (P1) connects to connector J3 on the Mainboard Assembly (ASY-0235-01) through a short, 8 conductor ribbon cable.

Remotely located Controllers use the standard 9-pin Phoenix style SEABUSS connector and interconnection is, as stated above, through standard SEABUSS cable (CAB-2350-XX). The recommended cable is designed to provide adequate interconnection for the +12VSW line and the PTT line, as well as providing two shielded, twisted pairs to support the SEABUSS audio circuit and the SEABUSS data circuit. Note that all SEABUSS cable interconnections are pin-for-pin and that the shielded twisted pairs are used for audio and data interconnection. See Figures 4.5 and 4.6 for details regarding system interconnections.

6.2 THEORY OF OPERATION

Figure 6.2 shows a block diagram of the Front Panel/Controller Assembly.

The controller(s) are essentially "dumb terminals" configured specifically as the front panel of a Single Sideband Transceiver. Radiotelephone functions are controlled by the keypad, transceiver parameters are indicated by the liquid crystal display (LCD), microphone audio is processed by the circuitry on the Front Panel/Controller PC board and then routed to the transceiver circuitry through the SEABUSS audio interconnection, and receiver audio is received from the transceiver through the SEABUSS audio interconnection and then processed through the volume control, squelch gate and loudspeaker amplifier to the loudspeaker.

The controller circuitry is contained on the Front Panel/Controller PC assembly (ASY-0245-03). This printed circuit board contains the keyboard interface, microphone audio to SEABUSS and SEABUSS to loudspeaker audio circuitry, the LCD display and display driver circuitry and the controller CPU.

The primary power source for the Front Panel/Controller Assembly is the +12VSW bus from the SEA 245 Mainboard Assembly. This power bus is part of the SEABUSS interconnection.

Most of the Front Panel/Controller circuitry operates from a +5 volt regulated line derived from the +12VSW rail through regulator, U16. The SEABUSS PTT line is a buffered output from the Front Panel/Controller board CPU. When the controller microphone requests PTT, the controller CPU processes this request and signals the SEA 245 Mainboard Assembly through buffer amplifier Q7.

6.2.1 KEYBOARD SUPPORT

The SEA 245/SEA 2450 keyboard has a total of 19 keys. Key status is determined by scanning the matrix through control lines from the CPU chip, U1.

6.2.2 THE LCD DISPLAY AND DISPLAY LIGHTING

DISPLAY: The front panel display is a LED backlighted LCD graphic module. Various display configurations are provided which permit the operator to monitor all the various radiotelephone parameters such as channel number, power level, memory mode, etc. The display is controlled by the Front Panel/Controller microprocessor, U1. Display contrast is controlled through U1 by a voltage level from D/A converter chip U6 and operational amplifier U17A. This trimming voltage is applied to Vo (Pin 3 on connector P7).

BACKLIGHTING: Similarly, the backlighting level is controlled through microprocessor U1 by a voltage level from D/A converter chip U6 and emitter follower Q2. This control voltage is applied to the base of control transistors Q3 and Q4. Varying the control voltage will vary the current through the backlighting LEDs, thus adjusting the backlight level.

6.2.3 THE SQUELCH FUNCTION

In the SEA 245/SEA 2450, the squelch function is a software voice-operated "constant SINAD" squelch system which functions by examining the audio stream to determine the presence of a voice signal.

A sample of the receiver audio from the SEABUSS audio receiver (U10A) is amplified and limited by U9A/B, processed by the software routine running in U1 and used to control the audio to the volume control. When the squelch program senses that a signal is present, the control signal to the gate of shunt transistor Q6 goes LOW, permitting audio to pass. Although the computer controlled squelch is relatively immune to changing noise conditions, in some cases it may be advantageous to reset the squelch trigger threshold. This is a software function and may be accomplished through the keypad. (See operator's instructions).

6.2.4 BILATERAL AUDIO CIRCUITRY

The receiver audio path in the Front Panel/Controller Assembly is from the bilateral, balanced SEABUSS audio terminals (P1, Pins 6 and 7), through the balanced to unbalanced audio line receiver (U10A), the squelch gate (Q6), the volume control (R2) and the audio power amplifier (U14) to the loudspeaker. The squelch limiter (U9A and U9B) connects to the audio upstream of the squelch gate. The hard limited output of the limiter is connected to the input of the controller CPU, U1.

The transmitter audio path is from the microphone to the microphone mute transistor (Q5) and from there on to the microphone amplifier/SEABUSS driver consisting of U10C and U10D. SEABUSS audio level is nominally 2.0 volts peak-to-peak (0dBm).

6.2.5 SEABUSS DATA CIRCUITRY

The serial data stream which links the controller(s) and the transceiver connects to the controller(s) at P1, Pins 4 and 5. The data transducer is a bidirectional data transceiver (U6) 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 on the data transceiver. Communications between the controller(s) and the SEA 245 Mainboard Assembly are bidirectional and fully interactive. This means that when the SEA 2450 Remote Controller is used, the status of the SEA 245 is reflected at both operating stations. Controller-SEA 245 data is sent in packets and is error checked. Collision protection is provided for all data sources. Baud rate is 9600 bps. For further data on the format of the SEABUSS command structure used in the SEA 245, contact SEA, INC. at 7030 220th St. S.W., Mountlake Terrace, WA, 98043. Or call (425) 771-2182.