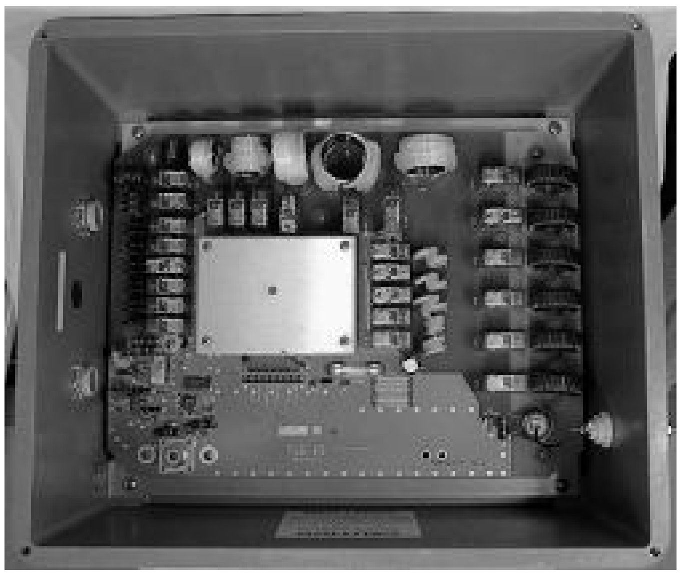
SEA 1630

Automatic Antenna Tuner



Instruction and Maintenance Manual

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1630

IMPORTANT

NOTICE TO INSTALLERS

The 1630 is designed to be weatherproof when properly installed. Be sure all fasteners are tight and cable entries sealed. No warranty claims will be allowed for water damage to the contents.

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1. GENERAL INFORMATION

1.1 OVERALL DESCRIPTION

The SEA 1630 is a fully automatic antenna coupler, intended for a wide range of MF and HF applications. Although designed specifically as a companion unit to the SEA 330 radiotelephone, the SEA 1630 is also capable of operation as an independent unit.

When used with the SEA 330 radiotelephone, the SEA 1630 resides on the SEABUSSTM, and is a peripheral of the SEA 330 central CPU system. In this mode, the antenna coupler is interactive with the SEA 330, and supports such advanced features as an algorithm which allows the control computer to remember which network constants are required for a given operating frequency. This feature permits the antenna coupler, once the “learning” operation is completed, to retune a given frequency automatically. The coupler operation is completely automatic and requires no operator intervention. If the antenna system is altered or replaced, the coupler will automatically “relearn” the required constants. During the learning period, operation is somewhat slower, and, depending on the particular frequency and antenna combination, up to 5 seconds may be required to achieve a matched condition. Once the antenna is properly matched, the coupler signals this condition to the radiotelephone. When operating with the SEA 330, the signal takes the form of a serial communication on the SEABUSS, which illuminates the SEA 330 “TUNED” annunciator. Note that the power output level of the SEA 330 is limited to a maximum of 150 watts until the SEA 1630 signals that the antenna system has been properly matched. If the SEA 1630 is being used independently in the “stand-alone” mode*, the signal takes the form of a tuned “flag” line going low. This control signal may be used to operate an “all tuned” indicator of some kind at the operator’s T-R position. Such an indicator is provided on the SEA 222 and SEA 322 radiotelephones.

* NOTE: “Stand-alone” mode requires the radio’s PTT line be connected to the SEA 1630 PTT terminal

Note also that when used in the “stand-alone” mode, transmitter power should be held to a maximum of 100 to 150 watts during the antenna coupler tune cycle.

When used with the SEA 330, the SEA 1630 has a “demand-tune” feature. This allows the operator to command the coupler to go through the tune cycle again. The demand-tune function is initiated by pressing the “MODE” key on the SEA 330 controller WHEN THE PTT LINE IS LOW. (During transmit)

1.2 ELECTRICAL CONFIGURATION

The coupler matches the antenna by selecting the proper network from a possible combination of 64 values of input C, 32 values of output C and 261 values of series L. Network configuration is automatically determined during the tune cycle, and may be either of two types of L network. Note that the six 8 uHy toroidal inductors (L8 through L13) are used below 4 MHz in a coarse-tuning arrangement. These inductors provide up to 48 uHy to resonate the effective capacity of the typical short whip or wire used in marine applications and represents approximately 600 ohms of inductive reactance at 2 MHz. This, together with the additional 16 uHy of air dielectric inductors, will provide sufficient inductive reactance at 2 MHz (800 ohms) to properly match antennas down to approximately 7.5 meters (25 feet) in length. Since ONLY the air dielectric inductors are used above 4 MHz, the maximum inductive reactance available is approximately 400 ohms at 4 MHz. This approximates the reactance of a 7.5 meter whip at 4 MHz. From these data, it can be seen that for optimum operation of the antenna system, a MINIMUM length of 7.5 meters is required. In practice, a 10-meter whip (35 feet) will give greatly improved results in the 2-5 MHz radio spectrum.

Tuneup is entirely automatic, and is accomplished on voice signals, making it unnecessary to use any sort of “CW tune” signal. When used with the SEA 330, transmitter power is restricted to the “INTERMEDIATE” power level until antenna matching is completed. (INTERMEDIATE power level is approximately 75 watts in the MF band and 150 wafts in the HF band). After tuneup is completed, the antenna coupler “flags” the radiotelephone to switch to “HIGH” power operation. Note that the power rating for the SEA 330/SEA 1630 radiotelephone system is 150 watts in the MF band and 300 watts in the HF band. The use of a -30 dB coupler in the VSWR sensors allows the error detectors to function down to power levels of 25 to 50 watts. This allows the use of radio equipment which has “high VSWR shutdown” circuitry.

1.3 MECHANICAL CONFIGURATION

All of the circuitry of the SEA 1630 is contained on two printed circuit boards. These two boards are ASY-1630- 01, the Main Board, and ASY-1630-02, the Computer Board. The Computer Board is mounted under a shield cover on the Main Board assembly. The Main Board is mounted on an aluminum shield plate with eight 6-32 stainless steel screws. The shield plate is held in the weather housing with four 10-24 stainless steel screws.

The printed circuit board is solder-masked, which helps to prevent corrosion and moisture problems.

Both the S0-239 R.F. Connector and the nine-terminal SEABUSS connector strip are mounted on the printed circuit board itself. The SEABUSS connector accepts wire ends directly, eliminating any requirement for special lugs or lugging tools. A PL-259 type R.F. Plug must be fitted to the coaxial feed line, however.

1.4 WEATHER HOUSING

The SEA 1630 antenna coupler is housed in a weatherproof polycarbonate case designed to withstand the environmental conditions encountered aboard ship when mounted on the weather decks. The internal construction is designed to withstand the shock and vibration of marine service. Corrosion-resistant hardware and passivated alloys are employed throughout.

Stuffing glands for the RF and DC cables are provided on one end of the weather housing, along with a 1/4-20 stainless steel ground stud. The antenna connects to the ceramic insulator on the opposite end of the weather housing.

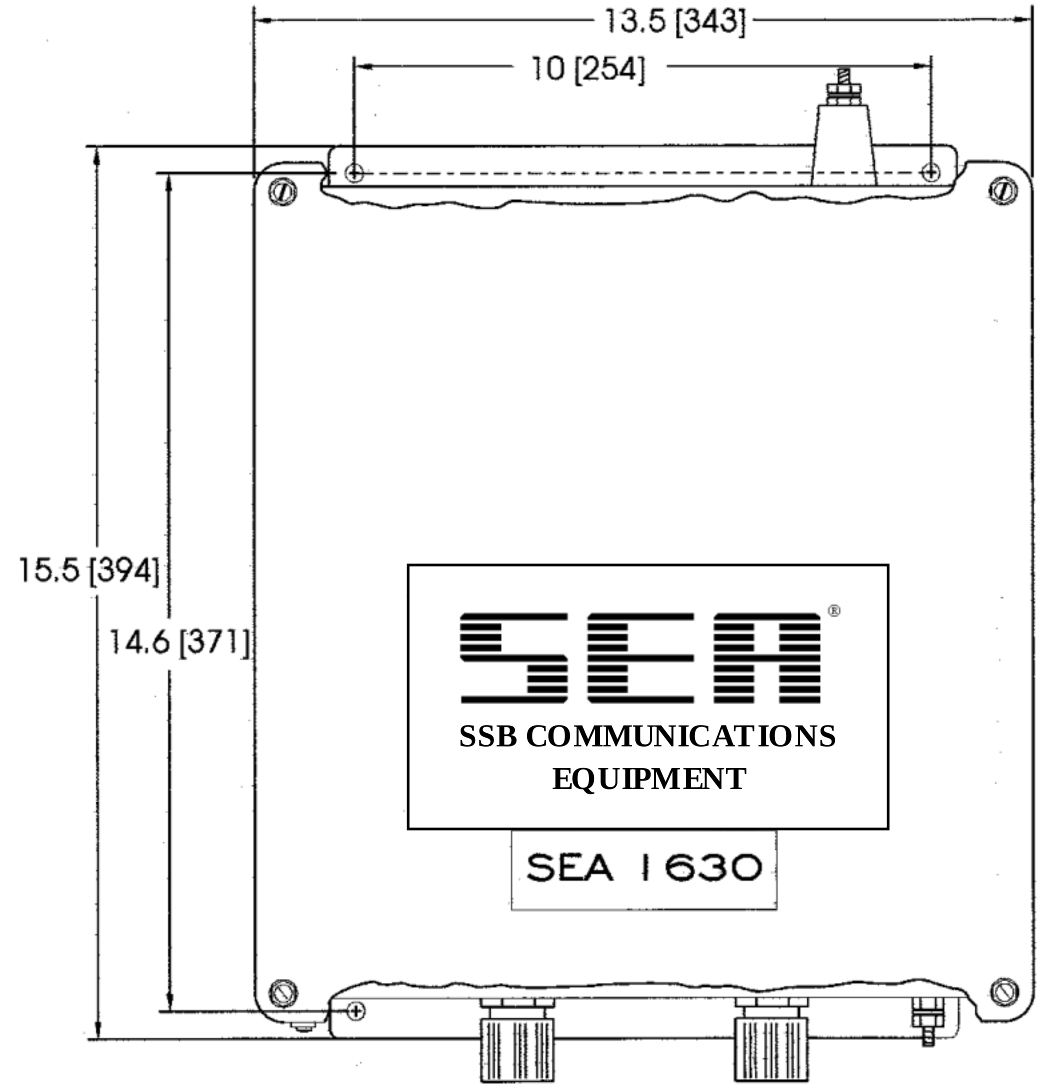
2. SPECIFICATIONS/EQUIPMENT FURNISHED

2.1 SPECIFICATIONS

Frequency Range	1.6 to 30.0 MHz
RF Power Capability	150 watts PEP (MF rating) 300 watts PEP (HF rating)
Input Impedance	50 ohms
VSWR	1.5:1 or better
Power Requirements	12 Vdc, Negative Ground
Operating Current	<2 Amps
Tuning Time	"Learn Mode" typically less than 5 sec. "Recall Mode" typically less than 20 msec.
Antenna	End fed type (Marconi) of 7-50 m (23-165 ft.) with suitable RE ground. See installation procedure for details.
Mounting	Any position
Environmental Temp. Range	-30C to +60C
Size	15" X 12" X 5.5"
Weight	10 Ibs./4.5 kgs.
Case Construction	Waterproof, Polycarbonate
Control Cable	CAB-1630-xxx

2.2 EQUIPMENT FURNISHED

1. Antenna Coupler with Cover and Bushings
2. Instruction Manual
3. 1 ea. CON-0028-001 SEABUSS CONNECTOR
4. 8 ea. FER-0005-001 Decoupling ferrites
5. 4 ea. Mounting Feet
6. 4 ea. Cover screws



Dimensions are inches and [mm]
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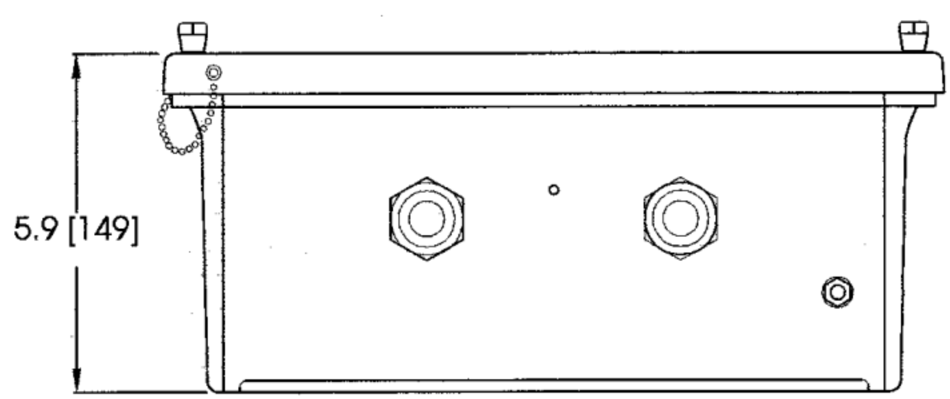

3. PRINCIPLE OF OPERATION

3.1 NETWORKS

Figure 6.1 shows the schematic diagram for the two basic network configurations. Note that the “L” network as viewed from the generator may be configured as either shunt “C in” or “C out,” whichever is required by the load. In either case, the end of the network containing the shunt C element will be the HIGHER impedance end of the network.

3.2 SCHEMATIC DIAGRAMS

Figures 6.2.2 and 6.3.2 are the schematic diagrams of the antenna coupler and computer board, respectively. Referring to Figure 6.2.2, RF input is applied to UHF fitting, J1. The +12 Volt supply is connected to pin 2 of the SEABUSST connector, P1, and the -12 Volt rail is connected to either pin 1 or 9 of P1. When used with the SEA 330, the PTT line (pin 3) and the DATA lines (pins 4 and 5) of P1 are also connected. CAB-1630-xxx cable is especially designed with an appropriate shielded, twisted pair for the data lines and the other conductors. Each conductor should be isolated with the ferrite beads provided in the installation kit (See Figure 6.4).

An appropriate antenna system is connected to the feedthrough insulator and the ground system is connected to the stainless steel stud provided on the housing.

NOTE: When the SEA 1630 is used as a “stand-alone” system* , the “ALL TUNED” flag line is available on pin 8 of P1. This line may be used to operate a remote “ALL TUNED” indicator. When the SEA 1630 is used with the SEA 222 or SEA 322 radiotelephone, the flag line is connected to the “TND” line on the rear panel terminal strip on the radio.

* NOTE: “Stand-alone” mode requires the radio’s PTT line be connected to the SEA 1630 PTT terminal. Stand alone mode was discontinued in operating system software revisions later than Rev 2.0. Contact factory if such operation is desired.

3.3 AUTO TUNE OPERATION

When RF power is applied to the antenna coupler, it is first passed through an array of detector devices which determine the antenna reactance and the load VSWR. Forward power is also monitored, since the control computer requires an indication of both forward and reflected power in order to allow tuning to proceed. In practice, the forward power detector is used by the computer as a truth check to insure that the measurements made are indeed a result of applied RF and not spurious levels from the data conversion system. Tuneup will ONLY proceed when sufficient forward power is present to provide this truth check. After passing through the detector system, the RF is applied to the tuner array. This consists of 6 capacitors in shunt on the input arm of the network, arranged in binary increments, 13 inductors in the series arm, arranged in binary increments to 8 uHys, and 5 more capacitors in shunt on the output arm, also arranged in binary increments. Relays are provided in conjunction with each lumped constant, which allow removal or entry as desired. Thus, it is possible through the manipulation of 25 relays to build a network having 64 values of input shunt C, 32 values of output shunt C, and up to 261 values of series L.

Note that inductors L1 through L7A/B are arranged in a system of binary increments. This allows up to 15.875 uHy of inductance to be selected by relays K7 through K13A/B. As discussed above, this configuration provides sufficient inductance to properly match antennas of lengths greater than 7.5 meters at frequencies above 4 MHz. Inductors L1 through L7A/B are air wound and capable of operation at power levels of up to 300 watts PEP. Inductors L8 through L14 are ALL identical 8 uHy inductors wound on iron core toroids. These inductors are used ONLY in the MF bands below 4 MHz and are NOT capable of sustained operation at power levels greater than 150 watts PEP. Note also that the array of output capacitors, C12 through C21, are connected into the inductor “tree” at the junction between L7B and L8.

Since these capacitors are used ONLY in such instances where the antenna system is:

A. Higher than 50 ohms in impedance.
B. Higher than 50 ohms in impedance and inductive.

It is possible to protect these capacitors and their switching relays from the extremely high voltages which are normally present at the antenna terminal when very short antenna are used in the MF spectrum. Connecting the output capacitors at the junction of L7B and L8 effectively "taps down" on the inductor tree and reduces the voltage stress. Note also that the toroidal inductors, L8 through L13, are NOT used in the HF bands, and are effectively shorted out at frequencies higher than 4 MHz.

3.4 VSWR DETECTOR

Current transformer T2 and voltage transformer T1, in conjunction with termination resistors R5 and R7 make up a 30 dB dual-directional coupler. This directional coupler is inserted in the 50 ohm transmission line between the input connector, J1, and the tuning network. A sample of FORWARD power appears across termination R8. The RF samples are detected by diodes CR4 and CR5. The resultant voltages are ratiometrically related to the load VSWR . The control computer samples each of these voltages through an A/D converter, and calculates the VSWR on an ongoing basis. The signal from the FORWARD power detector is monitored to insure that all data sensors are providing valid information.

3.5 PHASE DETECTOR

T3, Al and the associated components form a phase detector, which indicate the state of any reactance associated with the antenna/coupler as seen from the generator. Operationally, a line current sample is compared in phase with a voltage sample in a double-balanced mixer. Output polarity is POSITIVE for a net CAPACITIVE reactance. The output of the phase detector, Al, is connected to the control computer A/D converter.

3.6 THE CONTROL COMPUTER

Actual antenna-matching is implemented through a tuneup algorithm contained in the memory provided in the computer system (See Figure 6.3.2). The computer itself is designed around the HCMOS 68HC705C8FN CPU. This device was chosen for its versatile instruction set and on-chip clock, RAM and ROM. Control of the antenna coupler relays is done through U4, U5 and U6 on the -01 board. These devices are serial-to-parallel relay drivers. The CLOCK and DATA inputs of the UCN-5841s are driven from CPU ports PB0 and PB1, respectively. In operation, data is transferred into the CPU under program control from the array of sensor/buffers through U3, a multiport serial A/D converter. Essentially, the program monitors the status of the input sensors and, starting from a preset condition status, manipulates the RF elements through its control algorithm to achieve a correctly-tuned condition. At the completion of the tuning algorithm, the computer generates a table in non-volatile memory, which correlates the status of the various network relays with the applied RF frequency. This table is stored in EEPROM U4 and is used to provide the "learning" feature in the SEA 1630. After storing and latching the network status, the CPU returns to the "STOP" mode and waits for another "TUNE REQUEST" condition. When a "TUNE REQUEST" is received, the first step in the control algorithm is to measure the frequency of the signal which has generated the request. From the frequency data, the computer then looks into the table stored in U4 for any frequency/network status which may be stored. If data is found, it is immediately tested. If the data is valid, the required "end of tune" conditions will be sensed by the RF sensors, the data will be latched in place, and the CPU will again return to the "STOP" mode. This process takes about the same length of time that is required to close the network relays, or about 20 milliseconds. When operated as a companion to the SEA 330, the SEA 1630 can also operate interactively with the SEA 330, exchanging information on the SEABUSS. For example, the RF antenna current is monitored by the components associated with T4 on the -01 board. The raw data is read by the A/D and CPU on the -02 board and communicated to the SEA 330 via the SEABUSS data interface. This data is then used as an antenna RF current indication on the Controller bargraph. This feature is operational in the MF band, and is required in some European nations.

3.7 INITIALIZATION AND FIREUP

Since any microcomputer generates RF noise while running, the SEA 1630 controller CPU is normally in the "STOP" mode, and requires an interrupt signal to start program implementation. This IRQ signal is derived from the SEABUSS PTT line and/or the FWD power sensor as follows: The positive output from the FORWARD power detector is buffered through U6B and Q1 on the -02 board. Gates U7E and U7A provide extra logic shaping before the "FWD" signal is applied to the CPU chip on port PC4. Since the presence of forward power is indicated by a logical low at this point, the IRQ line on the CPU is also pulled low through diode CR6. Similarly, the SEABUSS PTT line is buffered by gates U7D and U7B before being applied as a logical low to PC3 of the CPU chip. As with the forward power signal, this logical low signal is steered to the IRO line through diode CR5. Thus the control computer is not only turned on, it is also instantly aware of the presence of a PTT signal if the SEABUSS is connected.

3.8 INFORMATION READ

The data sensors (previously described) are interfaced with the CPU through the A/D converter, U3. Once the tune algorithm is running (following an interrupt request as outlined above and lacking any applicable prestored data) the program can access any desired variable by merely “looking” at the desired input port. Since the comparators effectively preprocess the desired data, “reading” any specific variable requires only that the program “look” at the required port as that variable is desired.

3.9 INFORMATION WRITE

When the CPU requires a change in the lumped RF tuner parameters, it writes the desired data into the series to parallel relay drivers, U4, U5, and U6. This is done by outputting the desired status of the network relays in a serial data stream from PB1 on the CPU. Clocking is derived from PB0. For example, it is desired at some point in the tuneup sequence to INCREASE the inductance by one binary increment. To accomplish this, the CPU examines the binary number representing the status of the L control relays, decrements that number by one and clocks that number one bit at a time into the registers in the relay driver chips (Note that in order to INCREASE the inductance, it is necessary to DECREASE the binary number in the CPU register. This is due to the fact that a data 1 equals a CLOSED relay which equals a shorted inductor. In a similar fashion, the CPU is able to control the bits which control the input and output C banks).

3.10 THE PROGRAM

The control algorithm is contained in the onboard EPROM in the CPU chip. The actual program consists of many subroutines and branch statements in “machine language” for the 68HC705C8FN. For that reason, no detailed treatment of the program will be given here. A general understanding of the process employed may be had by examination of the key steps the program makes in determining the lumped constants required to tune a 25-foot antenna (for example) at a frequency of 4 MHz. Upon sensing that a tune sequence is required, the program will first examine the EEPROM table for applicable data. In the event that no previously-stored data is found, or that any such data is tested and found incorrect, the program will initiate a tuneup sequence by setting the initial conditions (all lumped constants out). By examination of the phase detector the determination is made that the antenna is short (capacitive) at the drive frequency, and so series L is inserted in lumps until the phase detector indicates that the load is no longer capacitive. At this point, the program branches and measures the VSWR. It will generally be greater than 2:1 at this time, and if so, the program increments the input C while manipulating series L to simultaneously raise the input impedance and maintain a resistive match. Once the VSWR has nulled, the exact value is compared with prestored criteria. If the VSWR is LESS than 1.5:1, a SEABUSS command is sent to the SEA 330, which allows the radiotelephone to return to the full power mode, the “TUNED” annunciator is set and the configuration of the tuning elements is stored in EEPROM in a memory location determined by the frequency measurement already made. The program is then terminated. Additional subroutines are included in the program which set various “breakpoints” in the allowable constants as a complex function of frequency. In fact, the overall “program” actually consists of a program set which is designed to allow maximum flexibility, while still maintaining high operating speed. With the addition of the onboard memory and frequency counter, many more complex programming techniques are possible, adding greatly to the actual complexity of the program.

Since the SEA 1630 is designed to be interactive with the SEA 330, a number of advanced techniques can be employed. Such modes as NECODE scanning as well as Voice and Telex scan modes can be incorporated in the SEA 330 without modification or augmentation of the basic coupler.

The SEA 1630 tunes with channel input from the SEA 330. The coupler is “tuned” on receive, provided the channel has been tuned previously.

4. INSTALLATION PROCEDURE

4.1 MECHANICAL CONSIDERATION

The SEA 1630 requires only that a source of 12-14 Volts DC, an RF transmission line (RG-58/U up to 30 feet, RG-8/U over 30 feet), ground seeking PTT, and a suitable antenna/ground system be attached. No bandswitch information, low power tune, or "handshake" is REQUIRED to the RF generator, since the coupler tunes on voice signals. Power consumption is nominally less than 1 amp, allowing the use of light 2 or 3-conductor cable for reasonable run lengths. (NOTE: When used with the SEA 330, the SEABUSS interface is required for full feature operation. The use of CAB-1630-xxx is recommended. This cable is similar to the standard SEABUSS cable with fewer conductors.)

The SEABUSS interface connector, P1, is clearly marked, and as with other SEABUSS peripherals, the interconnection is simply point-to-point. Pin 2 of P1 is the +12 Volt DC connection, pins 1 and 9 are ground (negative rail shields). Pin 3 supports the PTT line and the shielded, twisted pair in CAB-1630-xxx is connected to pins 4 and 5. Observe polarity on the interconnection of the twisted pair. That is, pin 4 to pin 4, pin 5 to pin 5 on either end of the SEABUSS cable. Weatherdeck mounting is permitted for the SEA 1630 but years of marine experience indicate that inside mounting or even just splash-protected mounting is to be preferred, particularly in cold, damp environments.

The base of the antenna should be connected to the high voltage feedthrough insulator on one end of the SEA 1630 weather housing. Note that this insulator is not designed to support heavy mechanical loads. If such loading is encountered, the use of a strain insulator is desirable.

The ground system should be connected to the 1/4 inch stainless steel stud protruding from the opposite end of the weather housing. Connection to the ground system and the ground system itself are of extreme importance for a successful installation. Ground runs of over a few inches should be made from 4-inch wide copper strap or better. The actual ground system should be as good as possible, and may consist of screening embedded in decks or roofs, coamings, rails, stack shrouds, water and/or fuel tanks, etc. Ships with a non-conducting structure, such as fiberglass, require careful attention to detail to provide an adequate ground system. Please note that this attention to ground integrity is NOT unique to the SEA 1630. ALL shipboard installations have the same requirements. However, autotune couplers in general require the antenna parameters to be within the range of the tuning parameters, or the coupler will not find a satisfactory match. It should always be remembered that the tiny computer in the SEA 1630 is unable to second-guess the installer! A PROPER ANTENNN GROUND INSTALLATION IS OF PARAMOUNT IMPORTANCE!

4.2 ELECTRICAL CHECKOUT

After mechanical installation is completed, the SSB transmitter should be adjusted to the HIGHEST frequency desired, a directional wattmeter such as the BIRDTM Model 43 inserted into the transmission line, and the transmitter energized. Upon application of RF energy, the coupler should begin to tune, indicated by a general "clattering" of the PC-mounted relays. If the antenna length and ground parameters are within range, a few syllables of speech should immediately cause the relay noise to cease. The reflected power on the wattmeter will drop, a value consistent with a better than 1 .5:1 VSWR will appear, and pin 8 of P1 (The "FLAG" line) will go to a logical low. (If a remote "TUNED" indicator is provided, such as the "TUNED" annunciator on the SEA 330, this indicator should also light.)

The SSB transmitter should now be adjusted to the LOWEST desired frequency, and the speech test repeated. Again, the SEA 1630 should immediately sense the mismatch, switch into the tune mode and retune the antenna system. The tune cycle will take somewhat longer at the lower frequencies, since the algorithm must search through more possible values of L and C to find an appropriate combination. A few seconds of speech should result in an "all tuned" indication. If the antenna parameters are within the specified range, and the above tests have been performed successfully, the SEA 1630 installation and tuneup may be considered complete.

A useful feature of the SEA 1630 (when used in conjunction with the SEA 330 radiotelephone) is the "RETUNE" function. This function allows the operator to demand a retune, even when the SEA 1630 has found a matched condition and shut down. This might be invoked by the operator when a mast or boom has caused a previously good match to deteriorate to the point where the SEA 330 has sensed sufficient VSWR to cause transmitter power to reduce to "INTERMEDIATE." The

“RETUNE” is commanded by pressing the “MODE” key on the Controller keypad when the PTT line is low (During transmit). The SEA 1630 will power up and go through a normal tune cycle as if for the first time.

Note that, as received, the memory system in the SEA 1630 will most likely NOT contain prestored data appropriate to your installation. For this reason, the memory feature will likely NOT be impressive at first. To allow the SEA 1630 to “learn” your antenna’s requirements, simply proceed from frequency to frequency, allowing the normal tuneup to take place. As more and more frequencies are “memorized” by the computer, it should be possible to return to a previously used frequency and discover that the computer immediately flashes the “ALL TUNED” flag, usually before the first syllable is completed. It should be further noted that the EEPROM memory system is capable of storing hundreds of individual frequency/relay combinations, but that most of these combinations are actually used in the first 4 or 5 MHz of operating frequencies. This is done in order to provide better memory resolution at the lower frequencies where antenna systems are inherently narrowband. Very often, one or two memory positions will give adequate band coverage at frequencies in the higher marine bands.

5. SEA 1630 TROUBLE SHOOTING AID

NOTE: Rev 3.0 will not operate in the stand alone mode unless the radio's PTT line is connected to P1-3 PTT.

5.1 COUPLER WILL NOT TUNE - NO RELAY ACTION

1. Apply +12vdc to the coupler and measure the dc voltages:

a. +12vdc on both sides of F1

b. +12vdc on pin 10 of U4, U5, and U6

c. +5vdc on positive side of C4 on CPU board

2. The relays should initialize in the following way:

K1 thru K6 - open
K7 thru K13B - closed
K14 thru K18 - open
K19 thru K24 - closed

This will indicate that the CPU and associated circuitry is probably working correctly. (unless intermittent)

3. With an oscilloscope check for clock, data and chip select activity when power is applied to the coupler. These points are pins 2, 3 and 7 respectively.

4. Provided that step 3 passed, U4, U5, or U6 may be defective. Substitute I.C.s will be needed to confirm.

5.2 RELAYS OPERATE BUT NO TUNE (one or all frequencies)

1. The software tune status must be set to ON. Enter the program mode on the SEA 330 ('AUX, 8'). At the 'CH?' prompt, enter 'AUX, 4, ENT'. At the 'TUNE' prompt on the display, press '1, ENT'. This will allow the coupler to retune if a bad VSWR is encountered. If you press '0, ENT' at the prompt, the coupler will recall the tune information from memory but will not retune if bad.

2. Check the sensor diodes (CR4 and CR5) for correct operations by using the diode test scale of a digital meter. The typical forward voltage drop will be approximately 0.32vdc. If you have doubts on the reverse

direction reading, remove one lead of the diode from the board and recheck. The reverse reading should then be open when lifted from the board.

3. Connect a voltmeter to R5l and ground using the 1vdc scale.

4. Connect the SEA 1630 to an appropriate antenna simulator and apply R.F. power to the coax connector J1. The relays should begin to operate by increasing the inductance. The meter should read a positive voltage of approx. 0.25vdc when the antenna is capacitive and approx. -0.25vdc when inductive.

5. Check that pin 2 of U1 is going low when R.F. power is applied. (You must have forward power and a VSWR of 4:1 or higher).

6. A 5vp-p square wave should be present at U2 pin 6 while transmitting. The frequency will be the radio's frequency divided by 2048.

7. The most typical problems encountered with no tune operation have been due to bad diodes, a relay not energizing, or T1 broken or burnt. All can be caused by near-by lightning.

5.3 COUPLER TUNES BUT NO MEMORY

1. Check for both clock and data at U4 during a memory access. Memory is accessed at the start of the tune cycle and at the end of tune.

2. If step one above is correct then U4 is defective.

5.4 NO HIGH POWER OR TUNE INDICATOR

1. Recheck the Data lines between the radio and coupler. The wires should be connected the same on both ends of the cable (1 to 1, 2 to 2, etc.). Do not connect any wires on pins 6, 7, or 8. Also be sure to use the supplied ferrite beads to the wires on each end of the cable.

5.5 SINGLE STEP TUNING

You can make the coupler step one relay at a time while tuning by pressing the PTT button on the microphone and tapping on the microphone. The coupler will not tune unless it has a bad tune AND forward power. Every time the microphone is tapped, a noise burst is transmitted giving forward power. If a bad tune is present (VSWR of 4:1 or higher) then the coupler will step one position in the program. This can be helpful in the event of a slow relay or if arcing is occurring. It will also give an indication if a tune can be found. NOTE that in order to single step the coupler, a carrier can not be present.

5.6 GROUNDING

You MUST have a good ground when working on the H.F. frequencies. This requires a minimum of 100 sq. feet. All connections should be made with wide copper strap to ensure that the ground losses are kept to a minimum. Keep the ground connections as short as possible.