## REPLACING THE BATTERY OR THE FUSE:

One 'feature' of TAPS that you may need to know. There is a fuse inside TAPS. If TAPS should cease responding and cease taking a charge (the charge indicator never starts blinking) but still responds when charger power is supplied, the fuse may have blown. To replace the fuse, or to replace the battery, you will first have to remove the connector endcap from TAPS.

Ensure that the 2-pin shorting plug is removed from TAPS. Do not charge TAPS while disassembling the unit.

## REMOVE CONNECTOR ENDCAP

Remove the four screws around the periphery of the case at the connector endcap end. Remove the nylon screw in the center of the endcap. Thread the 1/4"-20 threaded rod from the slap hammer into the tapped hole exposed when the nylon screw was removed. Use the slap hammer to break the endcap loose from the case.

**WARNING – If you have even the slightest suspicion that TAPS may have leaked, do not stand in front of the endcap when you remove it. Always stand to the side as you remove the retaining screws. People have been killed by flying endcaps.**

Lay the TAPS on a bench and pull the endcap/battery assembly part-way out of the case. Find the 3-pin Molex connector in the wiring channel and disconnect it. This removes battery power from the cable harness.

Next remove the endcap assembly from the pressure case. Pull it out carefully as the battery is attached to the endcap and the whole assembly is connected via a wire bundle to the electronics cage inside TAPS.

## REPLACE FUSE

With the endcap and battery unit out of the pressure case, remove the two 8-32 hex-head screws holding the endplate on the battery unit. Remove the plate and pull the battery unit (with the elastomer case) off the two round spacer rods.

- If you are replacing the battery, install the new battery unit in the same orientation as the old unit. Line up the two grooves on the side of the elastomer battery enclosure with the guide rods on the endcap assembly. The wire channel on the battery enclosure should align with the wire bundles. Slide the battery unit onto the guide rods and seat it fully. Replace the endplate and re-install the two 8-32 screws. Connect the battery to the matching connector in the wiring channel.

- If you are replacing the fuse, pull the battery partially out of the elastomer case to uncover the fuse. Unscrew the fuse assembly and replace the fuse with a 5 x 20mm 5A fuse (BUSS GMB 5A or equivalent). Spare fuses are provided in the TAPS accessory box. Reinstall the battery unit as described above.

## INSTALL CONNECTOR ENDCAP

Prior to re-installing the endcap, inspect the o-ring on the endcap and the o-ring seating surface for signs of foreign materials that may impair the seal. If there is any evidence of contamination, remove and thoroughly clean the o-ring. Run it carefully through your fingers and feel for any irregularities or nicks in the oring. Obviously, replace the o-ring if there is any doubt about it's integrity.

Clean the o-ring groove and the mating surface with mild solvent such as alcohol. Wipe the surfaces dry with a lint-free rag and re-inspect. Then wipe a thin layer of o-ring grease on the o-ring and reinstall it in the groove. A small amount of grease on the mating surface will also help the o-ring seat properly.

NOTE: grease is used to lubricate the o-ring to let it slide on the aluminum case. Grease is not a sealant and more grease will not make a better seal. Use only enough grease to ensure complete coverage of the sealing surfaces.

Install the endcap partway into the pressure case. Reconnect the 3-pin battery connector. Push the endcap into the pressure case, applying firm, even pressure to seat the unit. If the highpressure o-rings are installed, it may be necessary to use a rubber mallet to seat the endcap—the o-ring is a special, hard neoprene compound selected for high pressure applications.

TAPS is normally fitted with a 300 psia depth sensor. The maximum safe depth for this configuration is 398 meters. The o-rings installed in these TAPS are Shore-70 hardness, suitable for use at depths up to 550 meters.

NOTE: If you install a 500 psia or greater rated depth sensor in TAPS, use the Shore-90 hardness o-rings supplied with the spares package. These o-rings may require the use of a mallet to seat the endcaps.

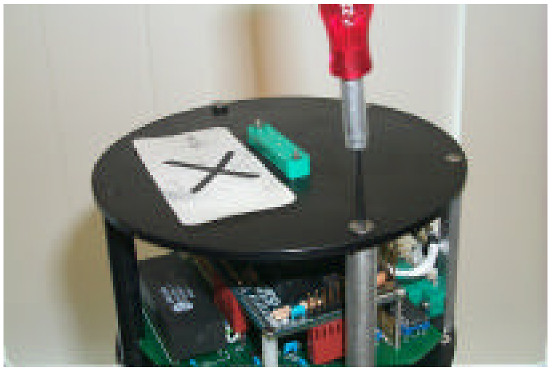
Rotate the endcap slightly to align the tapped retainer holes with the holes in the pressure case. Install the four nylon 10-32 endcap retainer screws using an anti-sieze compound or grease on the threads. These screws should be tightened firmly so they do not work loose but need not be excessively tight. The endcap is retained by the screw heads, not by the screws themselves.

## REPLACING THE EPROM

From time to time we may send you a new EPROM to upgrade the operating program in your TAPS. Anybody can install one! Here's how...

1. Open TAPS and remove the Electronics/Transducer Assembly (ETA). You already know how to remove the connector encap from the instructions above. To remove the ETA you need only remove the four screws around the periphery of the transducer endcap. Then place a wooden rod (such as a hammer handle) inside the pressure case to rest on one of the screw heads visible on the endplate. Tap the other end of this rod with a hammer and the ETA should pop free. Pull the assembly out of the pressure case.

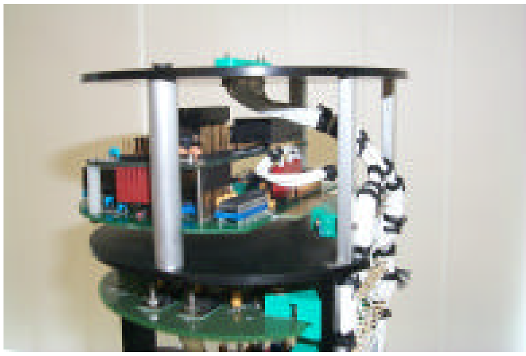
2. Stand the ETA on the transducer end. Loosen the two allen screws on the top on each side of the connector about 2-3 turns using a 5/64" allen wrench. Do not remove these screws.



3. Remove the black delrin PCB (printed circuit board) retainer by lifting the top plate slightly (this is why you loosened the screws) and pulling the top of the rod out.

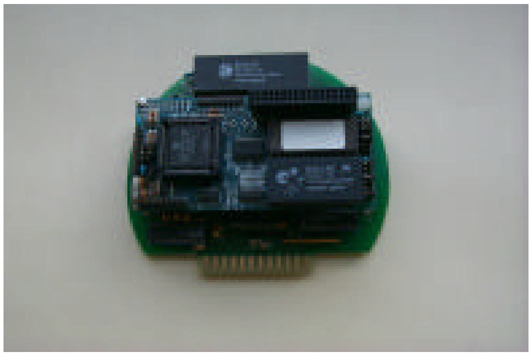
You may have to lift the rear edge of the PCB slightly to get the bottom peg out of it's hole.

4. Pull the PCB back by holding the sides of the PCB behind the two vertical guide posts and pulling straight back. Do not remove the PCB entirely yet.



Note the bundle of white wires running to a connector on the PCB. Reach in and lift this connector off the pins.

5. Remove the PCB. Note the large IC (integrated circuit) with a white paper label. Remove this IC by gently prying up under the end with the small notch with a small screwdriver. As the IC lifts, try reaching in farther with the screwdriver to lever it up more-or-less evenly.



6. Install the new EPROM in this socket. One method for doing this is to place the IC over the socket and align the nearest row of pins with the mating jacks in the socket. Push these pins into the jacks slightly—just so they are located. Holding the IC at the ends, pull the entire IC back towards you while rotating the other row of pins towards the socket. When the pins appear to be aligned, push the IC firmly into the socket.

   The notch on the new IC goes in the same direction as the old one—toward the middle of the PCB, facing the square socket and IC.

   After the EPROM is installed, inspect the IC and socket carefully. It is incredibly easy to install an IC with one pin bent under or sticking out of the socket.

7. Installation is the reverse of the steps above. Everything should go together with minimal force; if something will not go, stop and find out why before applying more pressure. Check that the connector on the top of the PCB is installed correctly. It is fairly easy to install it one pin off (and then TAPS will not work).

8. Before assembling TAPS into it's case, it would be prudent to connect the battery endcap to the ETA assembly for a quick test. Besides, you will want to check the setup of TAPS before you start taking data.

   Hook TAPS up to a computer and start a terminal program. Install the shorting plug and verify that TAPS is operational. You may have to press S to see the Status display. Check, for example, that the time and date are correct and the mode is the same as previously programmed.

   Go through the following screens to ensure TAPS is setup properly:

   PROGRAMMING (CTRL-P)—setup the mode you want to use and the operating parameters for that mode.

   FACTORY (CTRL-F) —you should see a reasonable serial number and a battery voltage scaling factor around 0.00065 or so.

   CONSTANTS (CTRL-Z) -- if the cal constants were ok on the status screen, just hit return at each line for these values. Enter the depth sensor rating (probably 300 psia). Check that the depth scale factor is around 1-1.3 and the temperature offset is around zero.

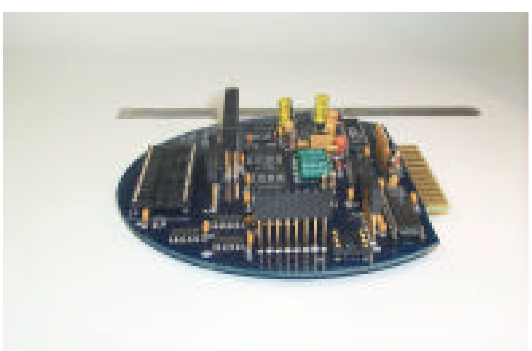
9. Turn TAPS off and reassemble into the pressure case. It would be wise to check operations one more time before operating TAPS to collect data.

## SWITCHING TO RS-485

Use of the long (600m) cable set pretty much demands that you convert the serial link to RS-485. The standard RS-232 link will work at these distances but only if you reduce the baud rate to 2400 or 1200 baud, possibly lower. You can test communications with TAPS using these long cables in the lab and determine a usable baud rate.

However, a lower baud rate will slow the process of data collection. In addition, a baud rate that works in the lab may not quite work in the field, leaving you stuck with no way to communicate with TAPS at all. Switching to RS-485 eliminates these worries.

Converting TAPS to RS-485 is fairly simple. You need to remove the Electronics/Transducer assembly to get at the CPU/IO card (as described above), remove one integrated circuit (IC) and install another. If it seems easier to you, you can remove the CPU/IO card completely. However, it is possible to do this swap with the CPU/IO card still installed.



This view of the CPU/IO card shows an empty 8-pin socket (on the edge close to the camera). This socket is for the MAX483 IC supplied with the TAPS spares kit. Install this IC to obtain RS-485 communications. The notch on the IC goes towards the inside of the PCB. Note that the CPU card is not installed in this view to make the socket easier to see; it is not usually necessary to remove the CPU card to change these IC's.

Immediately to the right of the 8-pin socket, just on the other side of the vertical 8-pin standoff, is a MAX3223 IC in a socket. This IC must be removed to obtain RS-485 comms.

Re-install the CPU/IO card (if it was removed) and follow the directions above to reassemble TAPS.

Before putting the TAPS back together in the case, it would be wise to test the communications link first. Connect the battery endcap unit to the electronics/transducer assembly and re-connect the battery.

Connect the TAPS to the Charger/IO box using one of the cable assemblies (it may be simpler at first to use one of the shorter charging cables to do this preliminary test). Connect the Charger I/O box to your RS-485 communications device.

A variety of RS-485 adaptors and plug-in cards are available; we have no way of knowing which you might have and thus cannot advise you how to connect and/or set it up. We have used a multi-channel RS-485 card from Sea Level Systems with good results (http://www.sealevel.com/). This application involved three TAPS systems recording SOUNDER data on a single computer.

We typically use an external adaptor for single-channel systems; our choice has been the R. E. Smith RFSC2-PIC (http://www.rs485.com/). This unit connects to a PC via an RS-232 link and converts data bi-directionally on the fly.

To aid in setting up RS-485 comms with these or other adaptors, a wiring diagram of the serial lines is provided at the end of this chapter. This diagram follows the signals from the MAX-483 integrated circuit to the DB-9 connector on the Charger/IO box. With a similar schematic for your adaptor, it should be straight-forward to setup this comm mode.

RS-232 comms can take place on a 3-wire link. One wire carries data from unit 1 to unit 2, one wire carries data from unit 2 to unit 1, and one wire is a common for both wires. In principle, both units could send data simultaneously.

RS-485 comms also use a 3-wire link. However, a pair of wires is used to transmit data in one direction at a time – the signal consists of a voltage difference between the two wires. The common return is not strictly required but is almost always included to ensure that there is not potential difference between the units.

Since RS-485 is only one direction at a time, there has to be a means for changing the direction of communi-cations. This is accomplished by some hardware – a data-direction pin on the interface IC – and a protocol. The protocol is termed Master-Slave communications; the Master unit (typically a computer) is normally in transmit mode and the Slave (or Slaves, there can be up to 32) is normally in receive mode. The Master sends data and the Slave receives it. If the data call for a response, the Master will switch it's hardware to receive mode and the Slave will switch it's hardware to transmit mode and the data will be sent on the same wire pair from the Slave to the Master. When the response has been sent, the Slave returns to receive mode and the Master to transmit mode.

RS-485 cards for PC's and their associated drivers can be set up to follow this protocol (it is normally the default). External adaptors that convert RS-232 to RS-485 need internal intelligence to determine the direction of data transmission.

## REPLACING DEPTH SENSOR

The depth sensor used in TAPS is a commercial stainless-steel strain gauge pressure sensor. These sensors are available in a variety of pressure ranges, from 100 psia to 3000 psia. The maximum depths that can be measured by these different pressure ranges are shown in the table below. Note that there is also a 'do not exceed' depth limit shown for each sensor range. This limit is the maximum depth the pressure sensor can withstand before the strain gauge is damaged, causing altered depth readings thereafter. The sensor can withstand higher pressures than this without bursting. For example, the 100 psia sensor can withstand up to 500 psi external pressure (over 300 m depth) without bursting—but the sensor will be ruined. Note also that the maximum safe depth for TAPS is 1000 meters, regardless of the depth sensor. The 'do not exceed' depth should be the lesser of the table value or 1500 meters.

| Psia | Max depth in meters | **Do not exceed depth** |
|---|---|---|
| 100 | 58 | **126** |
| 300 | 194 | **398** |
| 500 | 330 | **670** |
| 1000 | 670 | **1000** |
| 3000 | 2030 | **1000** |

The standard depth sensor supplied with TAPS (unless you specified another range when you ordered your TAPS) is 300 psia. The output of the depth sensor is a voltage in the range 0-200 mV. This voltage is amplified (on the Power Control PCB) to the range 0-4.096 V and converted with a 12-bit ADC. Ignoring noise and offsets, the resolution of the depth channel will thus be 300/4096 psia or 0.073 psia. In terms of depth, this is a resolution of 4.98 cm. If higher depth resolution is desired, a smaller depth range is necessary. The table below shows the maximum resolutions for the several pressure sensors.

| Psia | Max depth in meters | Depth resolution in cm |
|---|---|---|
| 100 | 58 | 1.66 |
| 300 | 194 | 4.98 |
| 500 | 330 | 8.30 |
| 1000 | 670 | 16.6 |
| 3000 | 2030 | 24.9 |

The depth sensor may be replaced by the user if so desired. These instructions are provided to facilitate user installation of depth sensors in the field. With some practice, it should take less than an hour to swap depth sensors and have TAPS back in the water.

**NOTE**: Just as with any other oceanographic instrument, lack of proper attention to cleanliness and o-ring integrity during this procedure can lead to leaks that could destroy the TAPS.

You will need the following items to replace the depth sensor:

- Depth sensor
- Depth sensor o-ring (AN-55)
- O-ring grease
- 1/16" allen wrench
- needle-nose pliers
- Silicon oil
- Rags or paper towels
- Antiseize compound

Begin by removing the TAPS connector endcap (instructions for this are contained elsewhere in this manual). Disconnect the interconnect cable and set the TAPS case aside. Rest the connector endcap, connectors up, on a roll of tape on the bench; raising the endcap up a bit helps to avoid crimping the wire bundles.

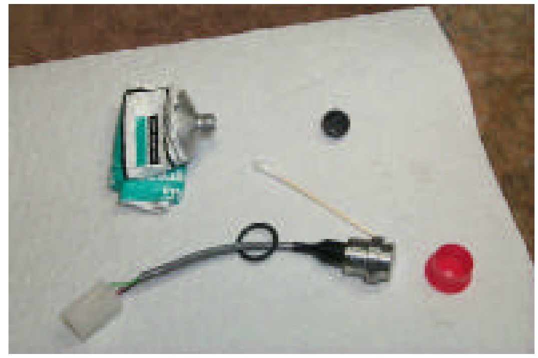
Remove the 4 allen-head screws holding the depth sensor retaining ring to the endcap (see below). This ring is made of zinc, to provide cathodic protection to TAPS. If it is badly corroded it should be replaced. Set it aside.

Remove the retaining ring and the neoprene membrane and set aside on a paper towel.

Blot up the oil remaining on the depth sensor. Then remove the delrin retaining ring that holds the depth sensor into it's cavity. A pair of needle-nose pliers can be used as shown to remove this ring.

Next, disconnect the molex connector under the endcap to free the depth sensor cable and remove the depth sensor.

Prepare the new sensor for installation by installing an o-ring as shown below. Use a modest amount of o-ring grease on the o-ring before installing it on the depth sensor.



Also, clean the cavity in the endcap with cotton swabs and alcohol to remove any old grease from the machined surfaces where the o-ring seals.

Feed the sensor connector through the hole in the endcap and press the depth sensor into the cavity firmly to seat the o-ring. The top of the sensor should be below the sealing ring surface when the depth sensor is fully seated.

Re-install the delrin retaining ring by hand until the ring contacts the depth sensor lip. Tighten the ring, using needle-nose pliers, to just begin to compress the o-ring. It is not necessary to apply much torque to this ring (it is only plastic), the goal is to obtain a small amount of pre-load on the o-ring so that it doesn't leak at low pressures. When TAPS is submerged to depth, the external pressure will compress this o-ring further, improving the seal.

Pour a small amount of silicon oil (or castor oil or cooking oil, if that is all you can obtain) on the depth sensor, filling the cavity up to the level of the cover. Better too much than too little oil.

Place the neoprene cover gently in place, aligning the holes in the cover with the screw holes before dropping it into place. Lay the retaining ring in place over the cover. Install the four screws loosely, using a small dab of antiseize on each first. When all screws are installed, tighten them in rotation, a bit at a time, until all screws are snug. No particularly high torque is required to retain this assembly so be prudent.

Clean off the excess oil and antiseize compound from the endcap. Connect the molex connector (note the alignment of the two connectors) and inspect your work.

If everything looks satisfactory, re-install the endcap. You will have to go into the CALIBRATION menu to set the depth sensor maximum range to match the new sensor just installed. You should enter the "psia" rating of the sensor; TAPS will calculate the step size for depth calculations automatically.

## TEST MODES

The TAPS operating program contains test routines that can be of value in troubleshooting problems with TAPS. In combination with the circuit descriptions and schematics provided in Appendix 4, it shoud be possible to test every function of TAPS.

The TEST menu can be accessed by typing 'CTRL-X' when connected to TAPS. This will result in a display like the following:

```
TEST MENU
0 = EXIT
1 = TRANSMIT TEST
2 = RECEIVE TEST
3 = MONITOR DEPTH
4 = MONITOR TEMPERATURE
5 = MONITOR INSTRUMENTS
6 = DISPLAY MEMORY POINTERS
7 = TEST MEMORY

ENTER CHOICE ->
```

Typing a number will start the indicated test running.

TRANSMIT TESTING

Typing a '1' will start the transmit test running. Power is applied to the transceiver cards and then you are asked to enter a channel number. Channel 1 is the first (lowest-frequency, 265 kHz) channel. This card is the first transceiver card below the Power Control card in the electronics rack. Channel 2 is the 420 kHz channel immediately below and so on. Channel 6, 3 MHz, is the transceiver closest to the transducer endcap.

When the channel number is entered, gate pulses will be applied to that channel. If the TAPs were suspended with it's transducers in a tank of water, then echoes from the tank boundaries should be detectable on the echo out pin on the backplane. Transmit voltages (several hundred volts peak-peak) should be observed on the transducer pins on the backplane.

This test mode is ideal for tracing signals in the transceivers using the schematics. Nornally, if you can see adequate transducer drive voltages and echoes from the boundaries of your test tank, the transceiver is probably working properly and any problems may lie elsewhere.

Pressing ENTER will cause the test to end and the TEST MENU to be displayed again.

RECEIVER TESTING

Typing a '2' will start a test of the Analog to Digital Converter (ADC) system. This mode is useful if you think there are problems with the ADC.

Again, you are asked for a channel number. Channel 1 is the 265 kHz echo envelope signal. Channel 2 is the 420 kHz echo envelope, ..., and channel 6 is the 3 MHz echo envelope. Channel 7 is the depth sensor voltage and channel 8 is the battery voltage input.

When the channel has been entered, the program will read the selected channel and display the result, in millivolts, on the screen. When you are done testing, press ENTER and the test will end. Note that this test mode applies power to the transceiver channels; thus you can check receiver noise levels in this test mode.

Pressing ENTER will cause the test to end and the TEST MENU to be displayed again.

MONITOR DEPTH

Typing a '3' will start the depth channel monitor routine. The depth sensor is read continuously, the value converted to depth, and displayed. You can press on the depth sensor and watch the depth values change. A typical hard press on the depth sensor should produce up to 30m of depth excursion.

Pressing ENTER will cause the test to end and the TEST MENU to be displayed again.

MONITOR TEMPERATURE

Typing a ‘4’ will start the temperature monitor routine. The thermistor resistance is sampled continuously, converted to temperature, and displayed. The display should indicate room temperature. Holding the thermistor between the fingers will increase the temperature up to body temperature, ca. 37C.

Pressing ENTER will cause the test to end and the TEST MENU to be displayed again.

MONITOR INSTRUMENTS

Typing a ‘5’ will start the external instrument test. Power is applied to the external instruments and the inputs read as frequencies. The frequencies are displayed as a pair: Instrument 1 followed by Instrument 2.

Pressing ENTER will cause the test to end and the TEST MENU to be displayed again.

DISPLAY MEMORY POINTERS

Typing a ‘6’ will result in a display of internal NVRAM data pointers. It is unlikely that this will be of any use to the user. This is a factory test routine only. After the pointers are displayed, the TEST MENU is displayed again.

TEST MEMORY

Typing a ‘7’ will start the NVRAM memory test routine. Since this test destroys data in memory, you will be asked if you are sure you want to proceed. Answering ‘y’ or ‘Y’ will cause the test to start. This test takes several seconds to complete. Bit patterns are written to NVRAM and read back. The number of write/read errors are accumlated and displayed when the test is complete. After the pointers are displayed, the TEST MENU is displayed again.

Test mode is exited by typing a ‘0’.

## R&R TAPS CARDS

Removing or replacing printed circuit cards in the TAPS is straightforward. The TAPS must be disassembled as described at the beginning of this section and the Electronics/Transducer Assembly (ETA) removed.

The CPU/IO card is contained in the upper bay of the ETA; removal of this card has already been described.

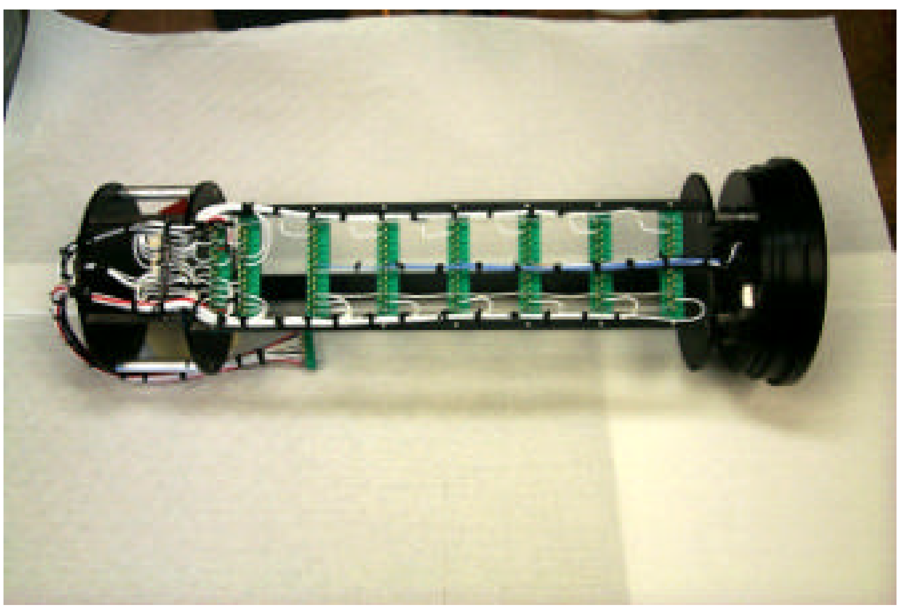
The Power Control card is the upper card in the lower bay. The Instrument Interface card, if installed, is immediately below. Transceiver cards, beginning with channel 1 (265 kHz) are located below this card.

These cards are retained by a single aluminum retaining strap running down the back of the frame (opposite the wiring side). This strap is fastened to the frame by two 6-32 hex-head screws, one at either end. Remove these screws and the retaining strap can be pulled off.

Grasp the card of interest on either side and pull it straight out of the connector. It may be necessary to jiggle the card side to side slightly to break it loose; do not jiggle the card up and down, however.

Install a card by aligning the two locating studs on the card connector plug with the matching holes on the wiring jack. Press the card into the connector until it seats firmly.

Installing the card retainer is a bit tricky. It helps to lay the ETA horizontal on a bench with the backs of the cards upright. Press the retainer strap into one of the end frames and align the first few slots over the closest printed circuit cards. Start the screw in this end. Then,



Electronics/Transducer Assembly (ETA) viewed from the wiring side. The CPU/IO card is contained in the small bay to the left. All other cards reside in the large card bay. The Power Control card is towards the left, channel 6 (3 MHz) transceiver is towards the right. The black bar visible behind the connectors is the PCB retainer strap.

working towards the other end, align cards with the slots in the retainer and press the retainer down, until you reach the other end of the retainer. Start the screw at this end.

Now press the retainer into each card working from one end to the other and take up slack in the screws at both ends. Repeat this until the retaining screws are firmly seated and the cards are all seated in the retaining strap. At this point you can set the ETA upright to verify that all cards are straight and seated.