CHARGING THE SPARE BATTERY

The spare battery (if supplied) will discharge over time if left unused. Every few months (3 months is reasonable), this battery should be charged. If you don't have a 21.6V NiCad battery charger, here is a way you can do it using TAPS equipment.

Remove the connector endcap part-way, just enough to get at the battery connector in the wiring channel beside the battery. Disconnect the battery and plug the spare battery into the mating connector.

Now hook TAPS to the charger box using the charging cable. Turn the charger on and go away for several hours.

When the charge indicator is flashing rather rapidly, the spare battery is charged. Turn power off and disconnect the battery. Re-connect the internal battery and re-insert the endcap.

This would be a good time to freshen the charge on the internal battery, too, wouldn't it?

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 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 high-pressure 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.

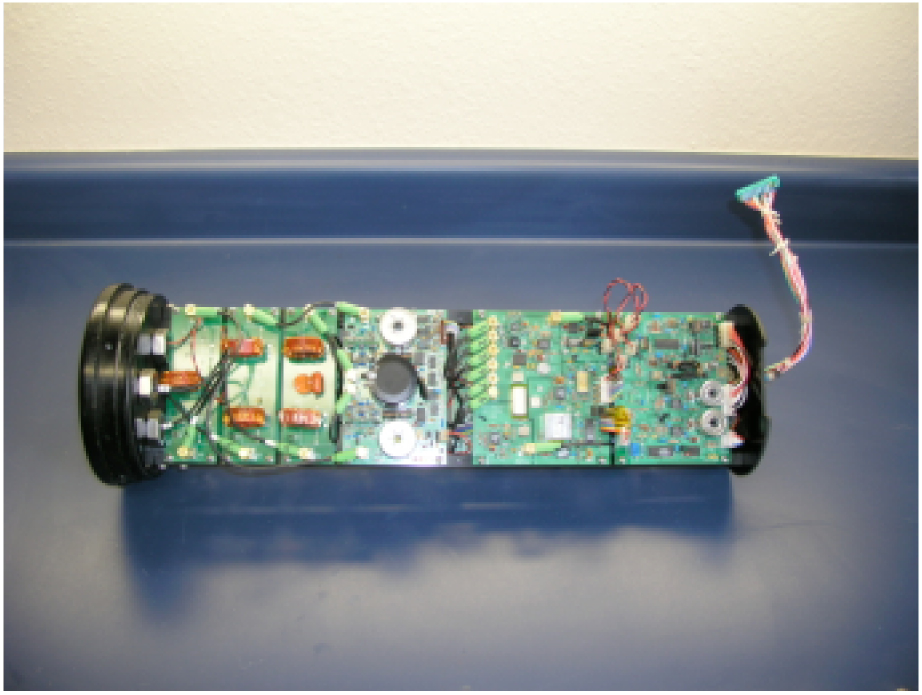
TAPS is normally fitted with a 300 psia depth sensor. The absolute maximum depth for this configuration is 398 meters. The o-rings installed in these TAPS are Shore-70 hardness, suitable for use at depths up to 550 meters.

> 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 8-32 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.

DISASSEMBLING TAPS

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 rubber mallet and the ETA should pop free. Pull the assembly out of the pressure case.



TAPS electronics assembly. Cards are fastened to an aluminum frame with screws and nylon standoffs.

REPLACING THE 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, and only when the hard o-rings are installed. The 'do not exceed' depth should be the lesser of the table value or 1000 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 14-bit ADC. Ignoring noise and offsets, the resolution of the depth channel will thus be 300/16384 psia or 0.00183 psia. In terms of depth, this is a resolution of 1.25 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	0.42
300	194	1.25
500	330	2.08
1000	670	4.15
3000	2030	12.5

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.

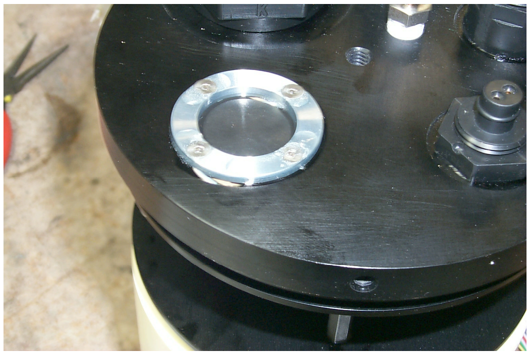
NOTE: Just as with any other oceanographic instrument, lack of proper attention to cleanliness and o-ring integrity during this procedure can lead to leaks that could destroy the TAPS.

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.

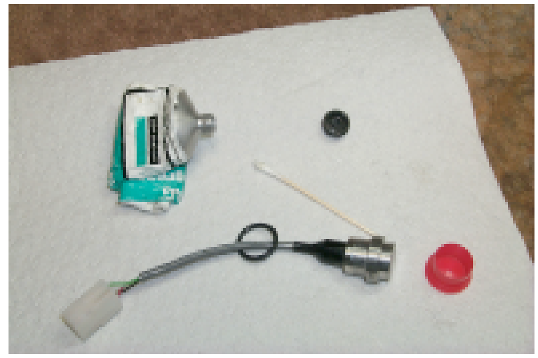


Remove the retaining ring and the neoprene membrane and set aside on a paper towel.

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 REPROGRAM menu in CAST MODE 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 should be possible to test every function of TAPS. These routines were developed to test the functions of TAPS during circuit and code development, after all.

The TEST menu can be accessed by loading the TAPSTEST program when first connecting to TAPS (see Chapter 4, PROGRAMMING). This will result in a display like the following:

```
TEST MENU
TAPSTEST.4TH
0 = END
1 = XMIT/DDS TEST
2 = RECEIVER TEST
3 = TAPS EMULATION TEST
4 = ENV/DEPTH/VOLTSADC TEST
5 = TEMP ADC TEST
6 = TVG TEST
7 = FREQ INPUT TEST

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 transmitter and receiver cards and then you are asked to enter a channel number. Channel 1 is the first (lowest-frequency, 265 kHz) channel. Channel 2 is the 420 kHz channel and so on. Channel 6, 3 MHz, is the highest-frequency channel.

When the channel number is entered, the transmit frequency (times four) will be generated by the Direct Digital Synthesizer (DDS) on the CPU card. This frequency can be monitored on the CPU card or on any of the three dual-transmitter cards. Pressing ENTER will change this frequency to the local oscillator frequency -- channel frequency plus 35 kHz. This frequency can likewise be monitored on the CPU card or on the reciver card.

Pressing ENTER again causes gate pulses to be generated. 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 envelope out testpoint on the receiver -- SO THE TAPS TRANSDUCER HEAD SHOULD BE SUBMERGED IN WATER DURING THIS TEST! Transmit voltages (several hundred volts peak-peak) should be observed on the transducer test jack on the appropriate dual-transmitter card.

This test mode is ideal for tracing signals in the transmitters and/or receiver 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 Reciever only. This test presumes that you will be applying input signals to the receiver or to the transducer leads and following the signal through the receiver system.

Again, you are asked for a channel number. Channel 1 is the 265 kHz channel. Channel 2 is the 420 kHz channel, ..., and channel 6 is the 3 MHz channel.

When the channel number has been entered, the CPU will generate the proper local oscillator frequency, set the digital gain, and select the MUX channel to allow signals into the receiver. The message "ENABLE T/R SWITCH WITH JUMPER NOW" will be displayed. If you are tracing signals from the transducer leads through the T/R switch and preamp on the transmitter card, you should install the T/R switch jumper now.

The message "REMOVE T/R JUMPER WHEN DONE AND PRESS ANY KEY" is provided to remind you to remove the jumper when you are done.

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

TAPS EMULATION TEST

Typing a ‘3’ will start the TAPS emulation test. This test is simply CAST MODE operation without saving data. Each channel pings in turn -- SO THE TAPS TRANSDUCER HEAD SHOULD BE SUBMERGED IN WATER DURING THIS TEST!

This test is the quickest way to find a bad channel.

ENV/DEPTH/VOLTS ADC TEST

Typing a ‘4’ will start the main ADC test.

This test measures and displays the voltage at any of the four ADC inputs. Input #0 is the echo envelope channel. Usually, you would test this channel by removing J2 from the CPU/IO card and applying a DC voltage (0-4.095V) from pin 1 to ground.

Input #2 is is the depth channel input. Pressing on the depth sensor while monitoring this channel can indicate whether or not this channel is working. This choice is also used for setting the depth channel gain (see CALIBRATIONS below).

Input #3 is the battery voltage channel. The battery voltage is divided in a precision resistor network, filtered, and applied to this ADC input.

Input #4 is the external sensor voltage channel. DC signals could be applied to the external connector (4-pin) to test the continuity of this signal path. (For example, after changing the V/F connector in the wiring harness.) Check the wiring diagram for pinout information.

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

TEMP ADC TEST

Typing a ‘5’ 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.

TVG TEST

Typing a ‘6’ will start the TVG test routine. This test sets the TVG output voltage to a series of pre-set values (0, .25, .50, .75, and 1.0 VDC). The TVG voltage may be monitored on a test jack on the CPU card. Press ENTER to switch from one output level to another.

Pressing ENTER after the 1.0 VDC output will cause the TVG voltage to sweep from 0 to 1 V using the TVG values in the stored TVG table. This ramp will be non-linear, concave-upward, as the voltage-controlled gain function in the receiver pre-amp is linear-in-db.

Press ENTER again to return to the TEST MENU.

FREQ INPUT TEST

Typing a ‘7’ will start the frequency input test. An external frequency must be applied to the appropriate pins of the external sensor jack (nominally 1Vpp sinewave). You will be asked to select sensor #1 or #2. Enter this number and the input frequency will be counted and the result displayed.

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

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 cards are bolted to aluminum guide rails attached to the transducer endcap and a flat end-plate. Each card is fastened with 6-32 screws, lock washers, and a short plastic standoff. These parts are interchangeable between cards.

The locations of the cards are fixed, however. Each card has a pre-assigned location. Never remove more than one card at a time without carefully noting and labelling the cards and the guide frame so that TAPS can be re-assembled correctly.

To remove a card, begin by disconnecting and labelling each connector. There are IDS style (pins and plugs) connectors and SMA style (screw-on coaxial) connectors. Move these disconnected cables aside.

Remove the screws and lockwashers from the card. If you are careful, you can remove the card and then collect the plastic standoffs.

Re-installation is the reverse of this process. The most likely area for errors in re-assemble involve the connectors. To the greatest extent practicable, we have used unique numbers of pins on these connectors. Some cables, such as those from the CPU card to the transmitter cards, have to be identical so it is necessary to be very careful when re-connecting these cables. Use the inter-card wiring diagram to double-check your work.

The SMA connectors are screw-type connectors. They should be finger-tightened until firm; a 5/16" box wrench can then be used to snug the connector up. Do not over-tighted these connectors.This wrench may be needed to loosen the connectors for card removal also.

Replacing the transmitter card is a bit involved. Complete instructions for this are given near the end of this chapter.

CALIBRATIONS

TAPS measures a number of properties of the water column: depth, temperature, and acoustic backscattering at six frequencies. These measurements are obtained from various sensors, all of which depend upon accurate calibrations for their accuracy.

The original design of TAPS was as an instrument to be used in conjunction with a CTD; TAPS to measure the acoustic properties and the CTD to measure the physical properties of the water column. Depth and temperature channels were then added to allow use of TAPS as a stand-alone instrument. Tracor (later BAE SYSTEMS) did not have the facilities to do precision calibration of temperature or pressure, however, so 'calibration' was accomplished by comparison with a commercial ctd. This is the procedure recommended for users to follow, as well.

The following sections describe procedures for calibrating the various sensors in TAPS.

DEPTH CHANNEL

There are two steps to calibrating the depth sensor on TAPS. First, the gain of the depth amplifier should be measured and, if necessary, adjusted. This gain check should also be done whenever the Power Control card is replaced.

Apply a DC voltage of 100-200 mV to TP13 (+) and TP12 (-). Load the TEST program and select ENV/DEPTH/VOLTS ADC TEST. Select channel 1 when asked. Adjust the gain trim potentiometer R42 to obtain a gain of 20.475 as computed by the ratio of the output displayed on the screen to the input voltage (in mV).

As a second check, TAPS depths should be compared to a known-accurate standard such as a CTD in a stepped-depth cast.

Further adjustment is made by changing the depth scale factor (CTRL-Z reprogramming menu).

TEMPERATURE

The only sensible way to 'calibrate' the temperature sensor is by comparison with a known-accurate standard such as a CTD. This can be done on a stepped-depth cast such as that used to compare TAPS and CTD depths, above. An offset constant is available to bring TAPS temperatures in line with a known standard.

ACOUSTIC

Whenever possible, TAPS acoustic channels should be calibrated using a standard transducer supplied by a reputable calibration facility. These are not always available and, even when available, may not cover the frequency span of TAPS (265 - 3040 kHz).

It is possible to use other transducers to calibrate TAPS if they are calibrated first. We have used un-calibrated broadband NDTE transducers from a commercial source (Panametrics is one) to do TAPS calibrations. The choice of a broadband transducer allows the use of one transducer to cover several TAPS channels. We use a 500 kHz transducer to calibrate 265, 420, and 700 kHz channels and a 2.25 MHz transducer to calibrate 1100, 1850, and 3040 MHz channels. We calibrate these transducers ourselves via a surface reciprocity calibration.

In a surface-reciprocity calibration, the transducer is submerged in a tank of water with the major response axis pointing up. The transducer is pulsed to generate a short pulse of sound and the echo from the surface measured. An air-water interface reflects very nearly 100% of the sound energy back into the water. Mathematically, a transducer creating echoes from a perfect reflector located a distance H away is precisely like a transducer transmitting to an *identical* transducer located a distance 2H away. We generally call this imaginary identical transducer an image transducer.

If a transducer is driven with an RMS voltage Vd, then the source level (SL) at 1m distance from this transducer is

$$SL = SPV + 20 * \log10(Vd)$$

where SPV is the transmitting response in Source level Per Volt of drive. (Note that we are using the sonar equation form for these equations. Thus we express all quantities in decibels. See the Basic Acoustics section for more details. Also, we are ignoring absorption here under the assumption that calibration of TAPS will occur at essentially the same range.)

At the image transducer, the sound pressure level (SPL) will be the SL adjusted for the actual range, i.e.

$$SPV = SL - 20Log(2H)$$

where the range is twice the water depth above the real transducer.

The voltage out of the image transducer, Vr, will be

$$20\log(Vr) = SPL + RS$$

where RS is the receiving response of the transducer.

Putting this all together, we find

$$20\log(Vr) = SL + RS - 20\log(2H)$$

or, re-arranging and substituting terms,

$$SPV + RS = 20\log(Vr/Vd) + 20\log(2H)$$

Thus, we can measure the sum of transmitting and receiving sensitivities using the 'perfection' of the surface as a reflector. Sadly, we cannot measure these sensitivities separately.

But—as we shall see below, the essential calibration needed for TAPS is the sum of the transmit and receiving sensitivities. So calibrating TAPS with a surface-reciprocity-calibrated transducer will be adequate.

In practice, a gated-output signal generator is used to drive the transducer and the echo from the surface is observed on an oscilloscope. Triggering on the gate signal allows both the drive voltage and the echo to be viewed. The transducer is then physically moved to maximize this echo to align the MRA with the vertical. This can be tedious, of course, if doing so disturbs the water surface as you have to wait for the surface to become still to make a measurement. One option that sometimes helps is to mount the transducer on the tank bottom and level the tank itself with wedges or screw-legs.

Also, if you do not disconnect the transducer from the signal generator during the time the surface echo is being received, the echo level will be diminished by a voltage divider effect of the generator impedance (50 Ω) and the transducer impedance (often 20-500 Ω). One way to overcome this is to use a fast reed relay to disconnect the signal generator briefly after the end of the transmit gate. A circuit that works for this purpose is included on the cd in the SCHEMATICS section. Otherwise, the signal generator must be kept connected to the transducer both when transmitting to the TAPS and when receiving signals from the TAPS.

Note also that RMS voltages were specified in the equations. Fortunately, the only time we actually use them, in the last equation above, they occur as a ratio (Vr/Vd). Thus, we can use peak-peak or simply peak values for both values if that proves easier to measure.

CALIBRATING TAPS

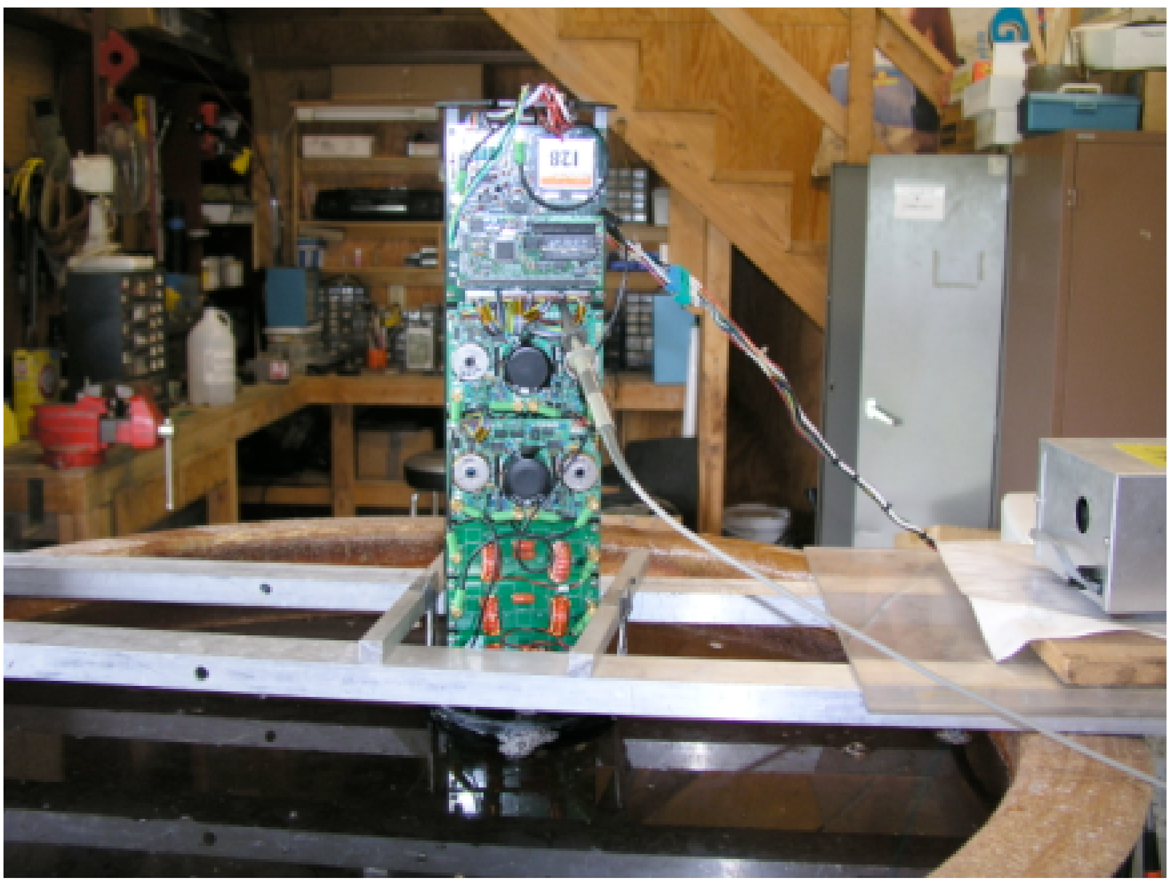
Given that we have a calibrated transducer available, calibration of the

TAPS acoustic channels is relatively straightforward.

Physical mounting is a matter of choice but, since calibration requires observing signals on the TAPS cards and installation of a jumper for receive testing, it makes sense to remove the pressure case. This means that the only feasible way to do the calibrations is to suspend TAPS in the air above the test transducer.

The figure on the next page shows one way of mounting TAPS for calibrations. Two T-shaped brackets must be fabricated. The vertical leg is made from sheet stock and has a hole near the bottom for a screw that fastens into the tapped hole on the endcap. The longer crosspieces are solid stock and rest on rectangular tube stock that lays on top of the tank. As shown here, TAPS may be slid along the cross tubes and the entire assembly moved as necessary to align TAPS transducers with the test transducers mounted (in this case) on the bottom of the tank.

This figure also shows an oscilloscope probe connected to the CPU/IO card--in this case to sample the transmit gate signal. In this figure, a test cable and power supply are being used to run TAPS but it is perfectly acceptable, perhaps preferable, to use the battery in the endcap. In this case, of course, provision must be made for keeping the endcap out of the water.



TAPS mounted on a cylindrical test tank. The horizontal tubes provide a level surface for the T-mounts to slide on when locating TAPS above the test transducers. The test transducers, in this case, are mounted on a frame on the bottom of the tank.

The TAPS TEST program is the one you will need to employ when you do your tank tests. When you select this mode, the program goes directly to this options menu:

```
BAE SYSTEMS
TAPS NEW GENERATION
CPU TEST CODE V3.0


TEST MENU
TAPSTEST.4TH
0           END
1           XMIT/DDS TEST
2           RECEIVER TEST
3           TAPS EMULATION TEST
4           ENV/DEPTH/VOLTS ADC TEST
5           TEMP ADC TEST
6           TVG TEST
7           FREQ INPUT TEST
```

The XMIT/DDS and RECEIVER test modes will be the most useful for the tank work. The former choice is appropriate to measure transmitting sensitivity. The latter choice is appropriate for measuring receiving sensitivity. The results of both measurements are required to calculate calibration constants.

When you choose XMIT/DDS TEST, you will see the following screen:

```
TRANSMIT/DDS TEST, ENTER CHANNEL # : 3
FREQUENCY =  700 KHZ
XMIT FREQUENCY CHECK; PRESS ANY KEY TO CONTINUE

LO FREQUENCY CHECK; PRESS ANY KEY TO CONTINUE

PULSED OPERATION CHECK; PRESS ANY KEY TO END
```

where the italized lines appear after you press a key to go on. The first two modes let you verify the proper frequencies, if you desire. The third mode starts TAPS pinging on the selected channel (1-6).

With TAPS pinging, you should move TAPS on the suspension bars to center it over the test transducer. This is best done while observing the signal from the test transducer on an oscilloscope. Since test tanks are notoriously reverberant, it is sometimes difficult to tell which signal is the direct-path signal and which is a multiple-path echo. It is usually best to put a probe on TP9 on the CPU/IO card (see the figure on the previous page) to monitor XGATE. Trigger the oscilloscope with this signal and view the output of the test transducer on another channel. The first signal after the transmit gate will be the direct-path signal. Move TAPS to maximize this signal.

Keep in mind that alignment is a 3-D process. Move TAPS left and right and back and forth as you search for the largest echo. Test the alignment further by tilting TAPS and/or the tank suspension tubes to make sure the axes of TAPS and the test transducer actually coincide.

Keep in mind also that both TAPS and the test transducer have sidelobes. It is possible to 'maximize' the signal on a sidelobe by sliding TAPS around--but the results will be peculiar. In addition to the acoustic alignment, make a visual check to make sure that the test transducer is reasonably aligned with the TAPS transducer.

When the alignment is satisfactory, measure the signal amplitude as Volts peak-to-peak. This value can be entered in the Excel spreadsheet provided in the **CH -> TstDucer voltage** box.

There is a possibility that the signal sampled at the test transducer may be distorted. If the positive-going sine waves are not the same amplitude as the negative-going sine waves, then harmonic distortion is present. In this case, it is necessary to filter the signal to obtain the fundamental signal for measurement. A commercial low-pass filter is useful here. The bandwidth need only be around 1 MHz as distortion is seldom seen above 700 kHz.

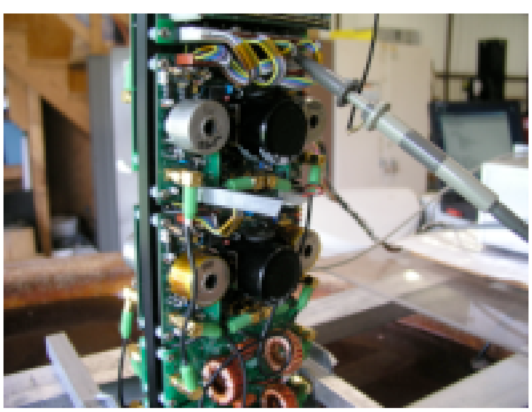
Remember--if you use a low-pass filter on the signal, you will have to measure the loss in the filter to correct the observed signal.

While TAPS is aligned with the test transducer, it might be efficient to measure receiving sensitivity also. Press a key to exit the transmit test routine. Select the receiver test mode. Again, you will see

```
RECEIVER TEST, ENTER CHANNEL # : 3
FREQUENCY =  700 KHZ
ENABLE T/R SWITCH WITH JUMPER NOW
GAIN SET FOR 1M RANGE -- EXTSOUNDER MODE
PRESS ANY KEY TO CHANGE GAINS
GAIN SET FOR CAST MODE & NO-TVG SOUNDER MODE
REMOVE T/R JUMPER WHEN DONE AND PRESS ANY KEY
```

where, again, the italized lines appear after pressing a key.

There is a 2-pin jumper in the toolbox labeled for use in RECEIVER testing. Use this to open the T/R switch on the appropriate transmitter board when you are transmitting TO TAPS from another transducer. See the figure below for an example.



Each transmitter card contains two transmitters and two T/R switches. The frequency for each channel should be labeled on the transformer can (silver can in the figure). There are jumpers on each side near the SMA connector that leads to the tuning boards. They are not symmetric but there is only one jumper on each side in this general area. Slide the shorting plug over the appropriate jumper to enable signals to reach the receiver.

Note that there are two possible gain settings for the TVG on the receiver card--the high-gain value used in CAST mode and in NO-TVG EXTERNAL SOUNDER MODE and TVG set for a range of 1m for calibrating the receive channels for EXTERNAL SOUNDER mode (which uses the TVG). You will need to check both gains when you do your own calibrations.

Use an external gate source to gate the signal generator. Set the frequency to match the channel frequency (shown on the terminal program screen). Put a scope probe on TP12 on the Receiver card. Set the vertical channel for DC. Use the gate source to trigger the oscilloscope.

You should see a detected-envelope signal on the oscilloscope. Adjust the signal generator drive to obtain a signal envelope of about 3Vdc. Measure the test transducer drive voltage (Vpp) and the signal envelope value (Vdc). Put these values in the spreadsheet under **TstDucer drive V 1M gain** and **Detected echo V 1M gain**.

Press ENTER and the receiver gain will increase by about 23 dB. Reduce the test transducer drive until you obtain a detected signal in the 3-4V range. Put these values in the spreadsheet under **TstDucer drive V high gain** and **Detected echo V high gain**.

Press ENTER again and ***REMOVE THE JUMPER*** from the T/R switch. You are now ready to calibrate another channel.

At some point in the calibrations, you will need to measure the range from TAPS to the test transducer(s). Enter these values in the spreadsheet under **Range**; the values should be in meters.

TRANSMITTER REPLACEMENT

A generic spare transmitter card is supplied with TAPS. In the event of a transmitter card failure, this spare can be used in any position. Obviously, calibrations will no longer be correct and a re-calibration will be necessary at some point.

Since the card is generic, some work needs to be done to fit this card to the particular channels to be replaced. The changes involve installing two jumpers and installing two bandpass filter cards (these are provided with the spares kit).

The jumpers determine which transmitter channel corresponds to which MUX code value. If you hold the transmitter card with the SMA jacks to the bottom, the jumpers will be located at the top middle of the card. Install two wire jumpers on the spare card to match the jumpers on the card being replaced.

The bandpass filters are small PCB's soldered onto the transmitter card, one for each channel. They are located on the bottom of the transmitter near each edge. The channel on the left is the lower-frequency and the channel on the right is the higher-frequency channel. Find the proper bandpass filters in the spares and install them just as they are on the card being replaced.