# Test Plan for At-sea
# Acoustic Modem Burial Tests

*4/11/2011 – 4/13- Santa Cruz Wharf*

***Rev 2.0***

## 1. Environment

One LF acoustic transducer will be buried ~1m beneath the surface of the sandy seafloor with cable extending up to the wharf. It will be pointed down. Positioning of the buried transducer will be either east or west of the furthest wharf piling so as not to interfere with horizontal testing off the side of the wharf.

This transducer will be connected to a deck box and laptop. A second LF transducer connected to a second deck box and laptop will be suspended in the water and used to communicate with the buried transducer. Data will be sent from the seafloor transducer to the topside transducer at varying data rates. Transmission power will be varied on the buried transducer to simulate larger slant ranges than what is achievable in the shallow water where the test is to be performed.

## 2. Outcome

**Goals of this test are**:

- Determine maximum data throughput
    - Pass if > 300bps?
- Measure signal attenuation through sediment
    - Pass if < 33 dB/m (based on 1km slant range through sea water and BED buried 3m. Assume no ambient noise)
- Determine if sediment-to-sediment transmission experiences less attenuation than water-to-sediment transmission
    - Pass if channel is calculated to be horizontal

## 3. Dates/Times

MBARI

- 03/17 Test Tank reserved – initial setup completed
- 04/? Dock Test

SC Wharf

- 4/11 – Morning dive and placement of transducers
- 4/12- Testing
- 4/13 – Contingency and recovery

## 4. Equipment

- Universal deck boxes (1 BEDs, 1 ESP)
- 2 LF transducers (1 BEDs, 1 ESP)
- Tape measure
- Electrical tape
- Connector covers / protectors
- BEDs laptop w/ serial port adapter
- Additional laptop w/ serial port (Kieft)
- Extension cords and power strips
- Underwater still camera (Adventure Depth & Tech)
- 200m transducer cable
- 100m transducer cable
- GFCI adapter
- Recovery line for buried transducer (> 30m length)
- Deployment line for topside transducer (> 15m length)

## 5. Pre-Test Configuration

Configure both modems in serial mode at 300 bps. Transmit at full power. Verify communications in tank with ~642 byte ASCII file from bottom (BEDs) transducer to topside transducer. Do same with file 8.2Kb or greater. Capture ambient noise in tank for reference via ATTN command.

For all tests, log CRC, MPD, SNR, and AGC values. A file transfer passes if the CRC matches at the end of transfer. Conversely, it fails if the CRC doesn't match. Initial configuration is for packet retry to be off since it is hard to determine how many retries have occurred.
Two test parameters can be varied on the deck box: Frequency and transmit power. For all ping/range tests, low frequency is the low allowable end of the device, high frequency is the high allowable end of the device, and mid-frequency will be the nearest divisible value to the middle that the hardware allows. Power can be varied in increments of 3dB from 0dB to -21dB.

## 6. **Procedure – Vertical Channel Testing**

**Setup 1: This test measures signal degradation through sediment.**

Topside transducer submerged in water to top of body. No baffle installed. Configure bottom transducer to ping with a pulse width less than 20ms (10m water depth * (3) / speed of sound in water). This insures signal is not coming from third bounce and is actually using vertical channel. Set frequency to lowest possible in the bandwidth via deck box touch screen. Set full power transmit.

6.1. Record values of S registers for buried systems (perhaps using the same deck box?) via the ATS? command.
6.2. Record topside S register values
6.3. Record topside ambient noise with ATTN command (1 min average)
6.4. Record ping from downward pointing transducer for 1 minute
6.5. Record range (ATR)
6.6. Record ambient noise with ATTN command (1 min average)
6.7. Reduce transmit power to -21 dB (S6 == 01)
6.8. Repeat 6.4 – 6.8. Increase TX power if necessary to achieve communication.
6.9. Restore transmit power to 0 dB (S6 == 08) and change frequency to approximate middle of bandwidth. Repeat ping test above 6.4 – 6.10
6.10. Restore transmit power to 0 dB (S6 == 08) and change frequency to highest possible in the bandwidth. Repeat ping test above 6.4 – 6.10

**Setup 2: Full power baud rate test**

Serial mode. 300 BPS acoustic baud rate. Topside transducer submerged in water to top of body positioned vertically over buried system. Full transmit power on buried system. No baffle installed. Log CRC, MPD, SNR, and AGC values.

6.11. Record values of S registers for buried system via the ATS? command.
6.12. Record topside S register values
6.13. At 300 bps transfer ~642 byte file from bottom to top 4 times. Log values
6.14. At 800 bps transfer ~642 byte file from bottom to top 4 times. Log values
6.15. At 1066 bps transfer ~642 byte file from bottom to top 4 times. Log values
6.16. Continue increasing baud rate until all 4 fail

6.17. At 300 bps transfer 8.2Kb byte file from bottom to top 4 times. Log values
6.18. At 800 bps transfer 8.2Kb byte file from bottom to top 4 times. Log values
6.19. Continue increasing baud rate until all 4 fail

**Setup 3: Low power baud rate test**

Serial mode. 300 BPS acoustic baud rate. Topside transducer submerged in water to top of body positioned vertically over buried system. Reduce transmit power on buried system to **-21 dB**. No baffle installed. Log CRC, MPD, SNR, and AGC values.

6.20. repeat test 6.11 – 6.19. If no transmissions occur, increase TX power by 3 dB increments until transmissions occurs. Continue to increase power in these increments until 100% transmission occurs reliably.

**Setup 4: Near bottom test; optimum baud rate/minimum power**

Serial mode. Maximum successful acoustic baud rate from previous test. Minimum successful transmit power from previous test. Topside transducer submerged in water to within ~1 m of bottom positioned vertically over **downward** pointing buried system. Log CRC, MPD, SNR, and AGC values.

6.21. repeat test 6.11 – 6.19. Decrease TX power incrementally as much as possible if not at -21 dB and repeat.

## 7. Procedure – Horizontal / Slant Channel Testing

**Setup 1: Range test**

Topside transducer submerged in water to top of body ~40 m meters (approx 4x water depth) North up wharf away from buried system. No baffle installed. Serial mode. Log CRC, MPD, SNR, and AGC values.

7.1. Record values of S registers for buried system(s) (perhaps using the same deck box?) via the ATS? command.
7.2. Record topside S register values
7.3. Repeat data transfer tests from 6.11 – 6.19 to find minimum transmit power and maximum baud rate.
7.4. Record range (ATR)
7.5. Continue doubling topside transducer distance N up wharf and repeat test until failure.

## 8. **Procedure – Sediment to Sediment Communications***

***** Need diver support for this test just prior to recovery?

**Setup 1: Close range sed-to-sed test**

Topside transducer with ~10lb. weight affixed. Positioned in sediment as close as possible to buried system. Serial mode. Log CRC, MPD, SNR, and AGC values.

8.1. Record values of S registers for buried system(s) (perhaps using the same deck box?) via the ATS? command.
8.2. Record topside S register values
8.3. Repeat data transfer tests from 6.11 – 6.19 to find minimum transmit power and maximum baud rate.
8.4. Record range (ATR)
8.5. Move topside transducer **TBD** additional meters N and position in sediment. Repeat test.

**Setup 2: Long range sed-to-sed test**

Topside transducer with ~10lb. weight affixed. Positioned in sediment *X* meters from buried system where *X* is at least 4 times the water depth to the buried modem. Configure bottom transducers to ping with width less than *W* calculated as time for ping to travel distance *X* measured above. Set frequency to middle of bandwidth and note.

8.6. Record range (ATR) information for 1 minute
8.7. Record information associated with ping receipt for 1 minute
8.8. Record ambient noise (ATTN)