Teledyne Benthos Acoustic Telemetry Modem

QUICK START GUIDE

For ATM-900 Series Acoustic Telemetry Modems

P/N M-270-27

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INTRODUCTION

The following guide will help you ready the Teledyne Benthos ATM-900 Series Acoustic Telemetry Modems for setup and deployment. An understanding of the various modes of operation is required to get the modems ready for use. There are three primary modes of operation: Online Mode, Command Mode and Data Logger Mode. Each mode has a very specific function and gives the modem the ability to acoustically transmit data, parse commands or log data to internal flash memory for later recovery. See Section 5 of the ATM-900 Series Acoustic Telemetry Modems User's Manual for more detail.

Online Mode

Online Mode, commonly referred to as pass-through, real-time or transparent mode, allows the modem to take data in through the serial port(s) and transmit these data through the acoustic link to a receiving modem. These transmissions are directed by the settings of the local and remote addresses. When in online mode, data sent to the modem serially are transmitted acoustically regardless of the characters or content. The modem does not parse characters to detect an end of transmission. Data are transmitted when one of two of the following events occur, the 4 KB transmit buffer is filled or the forwarding delay is reached. The exception is the online interrupt command "+++". To use the +++ command must be an idle period of less than 1 second between each + before entering the command and greater than 1 second between the 1st + and any other data.

Command Mode

Command mode is where the modem is configured and commanded by the user. Each command is handled by the command parser and initiates a process inside the modem. This is where configuration parameters are changed, range commands are processed, and the time, date are set as well as a host of functions. For a complete list of the available commands please see Sections 5 and 6 of the ATM-900 Series Acoustic Telemetry Modems User's Manual.

Datalogger Mode

Datalogger mode is where the modem records all incoming data from the serial port(s) or acoustic link to its internal storage in flash memory. The standard available space for storage in the data logger is 6,144Kbytes (6MB). The data is stored as discrete records in the data logger and can be later transmitted acoustically to a surface unit or other acoustic modem. This data can also be dumped to a serial port once the modem is recovered.

Dual Serial Port Feature

In its standard configuration a modem allows input of data from a single instrument to port 1 for the purpose of transmitting the data to a remote modem or storing the data in the modem's data logger memory. However, an optional Dual Serial Port feature is available which allows two instruments to be connected to a single modem for the same purpose. However, note that only port 1 can be used in command mode. The Dual Serial Port feature requires the purchase and installation of a feature key in the internal flash memory of the modem.

GETTING STARTED

Verify all items are received and in good operating order (See Section 4 for more information). Testing the hardware is the first step to determine the equipment is functioning properly. It is recommended to connect the laptop or PC to the modem before use on external devices or host processors. The laptop or PC will be used to configure the modem and ready it for deployment.

Items Required:

- Laptop or PC with at least one (1) available serial communications port
- Terminal emulator program: Use Tera Term – Included on USB Flash Drive
- Serial programming cable supplied with all ATM-900 Series modems
- DB9 to DB9 straight serial cable (null cable not used on laptop or PC)
- AC power or DC power (if required by modem)

The terminal emulator program is the interface into modem configuration and command mode and must be configured as following: (default settings)

Serial Baud Rate:	**9600 baud**
Parity:	**None**
Data Bits:	**8**
Stop Bits:	**1**
Flow Control:	**None**

Entering Command Mode

All modem commands are run in command mode. To enter command mode follow steps 1 through 4 below:

1. Boot laptop or PC and open the selected terminal emulator program.
2. Using the supplied serial programming cable connect the modem serial port to the laptop or PC serial port with the settings shown above.
3. Power on the modem and look for the banner message below:

   Teledyne Benthos ATM-900 Series
   LF Frequency Band
   Standard version 8.x.x
   Jan 1 2011 00:00:00
   CONNECT 00800 bits/set

4. To enter command mode use the command mode interrupt: +++
5. At the command prompt enter the cfg all <enter> command to view all modem settings.
6. To change any required setting at the command prompt type @[parameter]=[value] <enter>

   Example: @TxRate=1200 <enter> will change the acoustic transmit bit rate to 1200 bits per second.

Verify Acoustic Operation

It is best to check the acoustic receive capability of the modem before deploying the system in the water. While in command mode, a simple procedure can determine if the modem receiver is functioning in a basic mode.

Note: This is a not a scientific method and should not be used to determine sensitivity of modem. See the Acoustic Test in Section 5 of the ATM-900 Series Acoustic Telemetry Modems User's Manual.

1. At the command prompt type: ATTN1 <enter> to test the AGC
2. Values for the AGC should be scrolling across the screen at one sample per second.
3. Using only the hand lightly rub and tap the transducer of the modem to see the AGC number react.
4. The number should decrease the more vigorously the transducer is rubbed and tapped.
5. Verify the AGC measurement changes.
6. To stop the AGC measurements type ATTN0 <enter>.

Setting up Acoustic Modems for In-Air Testing

The ATM-900 Series can be tested in air with no risk of damaging the hardware when used at power levels at or below -6dB or @TxPower=-6dB. It is preferred to operate the modems at the lowest possible power setting of -21dB or @TxPower=-21dB which allows for better connections. The transducers should be placed 6 inches (15cm) or less away from each other and must not be in hard contact with each other or communications will be difficult. If the connection is poor it may be necessary to add an acoustic baffling material such as bubble wrap to reduce or eliminate outside noise and multipath interference. Remember to always make sure the transducers have an unobstructed line-of-site to the other modem transducer. This process will need to be done for all modems tested in air.

In-Air Testing of the Modem

It is advisable to test the system completely before being deployed in the water. The modems should be setup with only a laptop or PC connected. The acoustic link should be stable before any host instrument is added to the system. Follow the procedure below to ensure the modems are functioning properly. This process should be completed before any other testing is preformed.

1. Place the acoustic modems approximately 6 inches (15cm) apart with the transducers facing each other.
2. Power on both the subsea modem and topside modem.

   Do not connect any devices to the modems other than power supply if needed
3. At the command prompt type: ATXn <enter>

   Where n is the address of the remote modem (default address is 0 for all modems)
4. Verify the output is similar to:

   00800 bits/sec
   MOD:05 ERR:000 SNR:27.1 AGC:07 SPD:+00.0 CCERR:014
5. Repeat steps 1 through 4 for all other modems.
6. Refer to the sections on in water testing to properly select the correct acoustic bit rate and acoustic transmit power level.

Preparing a Modem Pair for Real-Time Data Transfer (Online Mode)

One of the modes of operation of the acoustic modem is real-time data transfer or online mode. For online data transfer a pair of modems is required, one topside modem and one subsea. All modems are shipped with a default address of 0 and are in online mode. Thus any data entered into either serial port of the topside or subsea modem will be transmitted acoustically to the other modem and vice versa. However, it is best to give each modem a unique address. The following is an example on how to set up the topside modem with address 2 and the subsea modem with address 3.

1. Connect the modem to be used as the subsea modem to the laptop or PC serial communications port.
2. Enter command mode by using the +++ interrupt.
3. At the command prompt type: @LocalAddr=3<enter>
4. At the command prompt type: @RemoteAddr=2 <enter>
5. At the command prompt type: cfg store <enter> , this will store this configuration.
6. At the command prompt type: ATO <enter>
7. Connect the modem to be used as the topside modem to the laptop or PC serial communications port.
8. Enter command mode by using the +++ interrupt.

9. At the command prompt type: @LocalAddr=2 <enter>
10. At the command prompt type: @RemoteAddr=3 <enter>
11. At the command prompt type: cfg store <enter> , this will store this configuration.
12. At the command prompt type: ATO <enter>
13. Any data entered into either serial port of the topside or subsea modem will now be transmitted acoustically to the other modem. A modem pair has been formed.

Preparing a Modem for Data Logging

The modem contains a flash storage area that can be used to record serial and acoustic data. Use the following procedure to set up in datalogger mode.

1. Connect the modem to be used as the data logging modem to the laptop or PC serial communications port.
2. At the command prompt use the command: @OpMode=Datalog <enter>to change to datalogger mode.
3. Reenter command mode by using the +++ interrupt.
4. Optional: To enable the ring buffer mode at the command prompt type: @RingBuf=Ena
5. At the command prompt type: cfg store <enter>
6. Reboot the modem.
7. The datalogger mode setting is complete.

Downloading Data Acoustically from Remote Data Logging Modem

Data that is stored in a modem can be downloaded acoustically. To download data from a logging modem, a pair of modems is required, one topside modem and one logging modem.

1. Using the topside modem enter command mode.
2. At the command prompt use the RDLLIST <n> command to verify data exists on the remote modem.

   Where <n> is the address of the logging modem
3. At the command prompt use the RDLRECS <n> command to query the number of records, size of the data to be transferred and calculate the time to transfer it.

See Page 5-22 of the ATM-900 Series Acoustic Telemetry Modems User's Manual for complete RDLRECS syntax.

Example: RDLRECS 1 -6 -1 would display the info including the number of bytes of the last 6 records from the data logger.

4. If the result of the RDLRECS command is less than or equal to 64KB than use the RDLFIND command with the same syntax as the RDLRECS command to transfer the data.

See Page 5-21 of the ATM-900 Series Acoustic Telemetry Modems User's Manual for complete RDLFIND syntax.

Example: RDLFIND 1 -6 -1 would download the last 6 records in the datalogger

IN-WATER ACOUSTIC OPERATION

Connect User Instruments and Test in Air

It is recommended to connect all user instrumentation and run the system as a complete telemetry system in air before deployment in water. Running the system for a length of time can help determine if there are settings to be changed or other common issues to be worked through. Refer to the documentation for the instruments to be connected to the ATM-900 Series Acoustic Telemetry Modems for all connections information. For modem connection information refer to Section 4 of the ATM-900 Series Acoustic Telemetry Modems User's Manual.

Deploying Acoustic Modems in Water

All acoustic modems, transducers and cables offered by Teledyne Benthos are pressure tested to rated depth before shipment. Before deploying however it is recommended that the user check all housing, end-caps, cables, transducers and any other hardware to be immersed in water for structural integrity. If any damage is seen do not deploy the equipment. Before deployment it is recommended to check the internal battery of all acoustic modems that use batteries. See 8-3 of the ATM-900 Series Acoustic Telemetry Modems User's Manual for detailed instructions. Before deployment into the water it is recommended to mount the modem to the mooring, frame, buoy or other chassis and test both on-shore and on the ship. This gives the user the knowledge that the equipment was operational before entering the water. Making sure all equipment is powered on, operation and connected properly. Once in the water the acoustic link will need to be tuned for each and every environment. Use the following guidelines to properly tune the acoustic bit rate and acoustic transmit power level.

Characterization of a Good Signal

In order to characterize a signal you must obtain signal information by running the ATYn and ATXn test commands. These commands allow the user to obtain the signal information required to properly configure the acoustic modems for each environment. Using the results of these will allow the user to properly tune the modem acoustic bit rate and acoustic transmit power levels.

ATYn Command: For multiple acoustic bit rate tests

1. At the command prompt type: ATYn <enter>

   Where n is the address of the remote modem

2. Verify the output is similar to the following:

   02400 bits/sec
   MOD:08 ERR:000 SNR:28.0 AGC:08 SPD:+00.0
   01200 bits/sec
   MOD:07 ERR:000 SNR:26.9 AGC:06 SPD:+00.0 CCERR:014
   01066 bits/sec
   MOD:06 ERR:000 SNR:27.5 AGC:08 SPD:+00.0 CCERR:013
   00800 bits/sec
   MOD:05 ERR:000 SNR:26.7 AGC:07 SPD:+00.0 CCERR:013
   00600 bits/sec
   MOD:04 ERR:000 SNR:27.5 AGC:06 SPD:+00.0 CCERR:013
   00300 bits/sec
   MOD:03 ERR:000 SNR:28.1 AGC:06 SPD:+00.0 CCERR:014

3. Repeat Steps 1 and 2 to obtain a good average of signal information.
4. Using this signal information and the information below to determine the best acoustic bit rate based on the corresponding values for ERR, SNR and AGC values for each acoustic bit rate.

ATXn Command: For verification of currently set remote modem acoustic bit rate

1. At the command prompt type: ATXn <enter>
   (Where n is the address of the remote modem)
2. Verify the output is similar to the following:

   01200 bits/sec
   MOD:07 ERR:000 SNR:26.2 AGC:08 SPD:+00.0 CCERR:014
3. Repeat Steps 1 and 2 to obtain a good average of signal information.
4. Using this signal information and the information below to determine the best acoustic bit rate based on the corresponding values for ERR, SNR and AGC values for each acoustic bit rate.

Using the output from the ATY and ATX commands:

- Error Count (ERR) - This value indicated the number of errors in the received test data. This number should always be zero (0). If the ERR is higher than zero (0) than the corresponding acoustic bit rate should not be used.
- Signal to Noise Ratio (SNR) – This is a metric that provides information on the quality of the processed signal. Note that this value is not related to the input SNR, but instead takes into account the all the processing and affects of multipath. Using the following chart as a guideline for adjusting the power level and acoustic bit rate.

SNR Value	Action Required
20+	Signal quality high, Could lower power level
19-15	Signal quality good
14-12	Signal quality acceptable, for extra margin try a higher power level if available
<12	Signal quality poor, use higher power level, If multipath is suspected as the cause try a lower power level. Try a lower acoustic bit rate at all power levels

- Automatic Gain Control Level (AGC) - The AGC value is how much gain the modem is putting behind the signal coming into the DSP. The higher the AGC value the higher the gain of the incoming signal. Based on the chart below adjust the power level and/or acoustic bit rate accordingly.

AGC Value	Action Required
00-15	Extremely strong incoming signal, try a lower power level or higher bit rate
16-25	Strong signal, try a lower power level or higher bit rate
26-31	Average incoming signal, some noise exists in channel
32-40	Low incoming signal, try a higher power level or lower bit rate
41-49	Weak incoming signal, try a higher power level or lower bit rate
>50	Extremely weak incoming signal, try higher power level or lower bit rate

Adjusting Acoustic Transmit Power Levels

The ATM-900 Series modems have a user selectable acoustic transmit power level. The power level must be adjusted for each environment. The highest power level is not the ideal power level for all environments, especially high multipath environments. In shallow water, 500m or less, and short range, 1000m or less, the lower power levels are used if there is little to no noise. In deep water, greater than 500m, or long range, greater than 1000m, higher power levels can yield better signals. The following acoustic transmit power levels are available and are measures as dB down from full power.

Maximum Power							**Minimum Power**
0 dB	-3dB	-6dB	-9dB	-12dB	-15dB	-18dB	-21 dB

To adjust the remote modem power level:

1. At the command prompt type: #n @TxPower=m <enter>

   Where n is the address of the remote modem and m is the new setting

   Example: @TxPower=-21dB (not case sensitive)

2. After changing the acoustic bit rate, rerun the ATX command.

Adjusting Acoustic Bit rates

The ATM-900 Series modems have a user selectable acoustic bit rate. Each acoustic bit rate uses varying error correction coding and multipath guard periods and must be adjusted for each environment. In areas with high multipath possibilities an acoustic bit rate using as much multipath guard period as possible is desired. The highest rates (2400, 15360 and 10240) have no convolutional coding and should only be used when there is a very high SNR. There are two modulation schemes implemented in the various acoustic bit rates. MFSK is the more reliable of the two when in noisy environments. PSK is designed for very low noise environments with low occurrence of multipath. The PSK modulation scheme is only able to be received on the UDB-9400 Deck Unit and any ATM-900 Series modem ordered or modified to use the PSK receiver.

The following are the available acoustic bit rates:

15360 bits/sec PSK

10240 bits/sec PSK

7680 bits/sec PSK, with convolutional coding

5120 bits/sec PSK, with convolutional coding

2560 bits/sec PSK, with convolutional coding

2400 bits/sec MFSK

1200 bits/sec MFSK with convolutional coding

1066 bits/sec MFSK with convolutional coding and 3.125-ms multipath guard period

800 bits/sec MFSK with convolutional coding and 12.5-ms multipath guard period

600 bits/sec MFSK with convolutional coding and 25-ms multipath guard period

300 bits/sec MFSK repeated twice with convolutional coding and 25-ms multipath guard period

140 bits/sec MFSK repeated four times with convolutional coding and 25-ms multipath guard period

To adjust the remote modem acoustic bit rate:

1. At the command prompt type: #n @TxRate=m <enter>

   Where n is the address of the remote modem and m is the new setting

   Example: @TxRate=1200 (not case sensitive)

2. After changing the acoustic bit rate, rerun the ATX command.