

# A ModemÔ

Acoustic Modem Application Software for the EM-2 or the EM-2M Module

## Technical Reference Manual



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# 1. Introduction

A.MODEM V1.10 is a simple modem application for the EM-2 and EM-2M module.

A station which is running A.MODEM will behave similar to a telephone modem, except that the transmission medium is water and not a telephone line. Data received through the serial port is coded and transmitted via sonar through the water. Sonar data received by A.MODEM is decoded and transmitted via the module's serial port.

Unlike a full duplex telephone modem however, A.MODEM is half duplex. This means that only one party can transmit at any given time. It is up to the user's software to ensure that only one party is transmitting. If a 'data collision' does occur, no party will receive valid data. Also unlike telephone modems, A.MODEM is not restricted to two-party communication. You may have any number of stations in the network.

## 2. The Serial Data Link

When operating A.MODEM, the station's serial data link operates at 600 Baud, 8 Data Bits, Odd Parity, 1 Stop Bit (600 8O1). We recommend that you use a properly configured terminal or a terminal emulator programming running on a PC or other computer to test A.MODEM. VT-100 terminals and terminal emulators are known to work well with A.MODEM. Some terminals will not properly work with parity. Try using a no-parity setting if you have trouble communicating.

## 3. The Acoustic Data Link

A.MODEM transmits each two bytes it receives as a single six-ping word. When selecting speed codes 0, 1, 2 or 3, the six pings are transmitted on four sonar channels to mitigate the effects of multi-path propagation (echoes). The four channels are 33.898 kHz, 36.364 kHz, 38.462 kHz and 40.816 kHz. Multi-channel data reception is not supported by the EM-0 module. When communicating with this module, speed codes 4, 5 or 6 must be selected. These speed settings use single channel data transmission at 33.898 kHz.

Highly energy efficient pulse position coding is used to transmit the six-ping data words: The first ping of each word is the synchronizing ping. This is followed by four data pings and finally one checksum ping. Each ping is located within one of the 16 time sub-windows that form a ping window. The sixteen sub-windows are used to represent four bits of information. If a ping occurs is transmitted in the first sub-window, it is understood to represent the pattern 0000. A ping in the second sub-window represents pattern 0001 etc. If a ping occurs in the last (16th) sub-window, it signifies pattern 1111. A complete six-ping word thus contains the synchronization ping, 16 bits of data and a 4-bit checksum.

Seven speed settings are available. Note that settings 0-3 are make use of multi-channel data transmission while settings 4-6 are single-channel transmissions.

Speed	Ping Window	Equivalent Bit Rate	Word Transmit Time	Effective Data Rate
0	260 ms	15 bits/sec	1400 ms	11 baud
1	104 ms	38 bits/sec	560 ms	29 baud
2	52 ms	77 bits/sec	280 ms	57 baud
3	26 ms	153 bits/sec	140 ms	114 baud
4	760 ms	5 bits/sec	4400 ms	4 baud
5	314 ms	13 bits/sec	1820 ms	9 baud
6	104 ms	38 bits/sec	560 ms	29 baud

**Table 1: Data Exchange Speeds**

Data transmission is more reliable at lower speeds and less reliable at higher speeds. Speed zero will work in almost any environment, including high-echo pools and tanks. Speeds one and two are well adapted for operation in harbors, shallow waters etc. Speed three may work in some open ocean applications and will also work for dry tests (transmission through air). Speeds four, five and six must be used for transmit when communicating with a EM-0. However, the EM-0 does include a multi-channel transmitter, and thus speeds 0-3 may be used for receive.

### 3. Modem Control & Data Modes

A.MODEM features a control mode and a data mode. Upon initialization, the modem will be in control mode.

- Send the character 'D' to switch from control to data mode.
- Three or more successive '+' characters are used to switch the modem from data to control mode.

The statement <control mode> will be transmitted to the terminal by A.MODEM whenever control mode is entered.

Modem parameters can be modified while in control mode. Once all parameters are set as desired, enter data mode. You are now ready to exchange data. If data is received by A.MODEM while in control mode, the raw 20-bit data pattern and a time tag are transmitted via the serial port. This data is useful for debugging purposes. Data cannot be transmitted by A.MODEM while in control mode.

To review current parameter settings, make sure that A.MODEM is in control mode. Then hit 'H' on your terminal. The following help screen will appear:

```

TX Speed [S#:0-6]:      1
RX Speed [R#:0-6]:      1
Power [P###:000-255]:  255
P'length [L####:0100-5000]: 4000
Gain [G#:0-3]:          2
T'hold [T##:0-99]:      16
Filter [F#:0-5]:         0
Checksum [C#:0-1]:       1

```

Type <D> for data exchange mode  
Type <++++> to return to control mode  
Type <Q> to switch the modem OFF

To change a parameter, enter the appropriate command code followed by the desired parameter value. The '#' signs in the help screen indicate how many parameter digits are expected. A.MODEM expects to see the proper upper case character followed by the proper number of parameter value digits. No other characters (such as ENTER) are needed. To verify that desired parameter settings have been accepted, use the 'H' command. For example, to select a transmit pulse length of 560 microseconds, type L0560. To set the transmit speed to three type S3.

The default parameters assumed by A.MODEM after power-up are a good starting point for robust communication. The meaning of the parameters is described in following.

Command	Format	Range	Default Value	Description
Data Transmit Speed	S#	0-6	1	The data transmit speed and multi-channel or single-channel transmit selection. See table 1.
Data Receive Speed	R#	0-6	1	The data receive speed and multi-channel or single-channel receive selection. See table 1.
Transmit Power	P###	0-255	255	Sonar transmit power. Higher power for larger settings. 255 units is equivalent to a source level of approx. 185 dB re. 1 $\mu$ Pa. Every halving of the number will reduce transmit power by about 6 dB. Use max. power in open water. Power level may be reduced in high-echo environments.
Transmit Pulse Length	L####	100-5000	4000	Transmit pulse length in microseconds. If the pulse length is less than about 3000 microseconds, the receiver will not see a full strength signal. Short pulses however save energy and may be beneficial in closed/high-echo environments.
Receiver Gain	G#	0-3	2	The gain of the receiver. Higher numbers indicate greater gain. The gain step size is 10 dB. Receiver gain may have to be reduced in high-noise environments.
Receiver Detection Threshold	T##	0-99	16	The receiver detection threshold. Increase the number to make the receiver less sensitive, decrease it for higher sensitivity. Detection threshold and receiver gain are interdependent. The default setting of gain 2, threshold 16 is equivalent to a source level of approx. 110 dB. The receiver sensitivity of the EM-2 and equivalent stations is about 88 dB or gain 3, threshold 4.
Receiver Filter Number	F#	0-5	0	The EM-1 and equivalent stations make use of a programmable switched capacitor bandpass filter. This filter can be programmed for different bandwidths. Six filters are implemented by the software. Experiment for best results.
Checksum Status	C#	0-1	1	Checksum may be switched ON (1) or OFF (0). If checksum is ON, words with an invalid checksum are discarded. If checksum is OFF, all received words are transmitted to the terminal via the serial link. Data is always transmitted with a checksum, independent of the setting of this parameter.

**Table 2: A.MODEM Parameters**

## 4.1. Communicating With A EM-2 or EM-2M Modem

Read this section if your data link consists of a model STM-1 surface station and a model EM-2 or EM-2M underwater modem. Read section 4.2. if your underwater modem is a model EM-0 or EM-0M.

Before using the EM-2, review this checklist. Please also refer to the EM-2 technical manual.

- Connect 9V to 12V power to connector P6 using the supplied power cable. The yellow conductor is '+', the black conductor is '-'. Receive mode power consumption is about 100 mA. Transmit power consumption can peak at up to 1.5 Ampere.
- Connect the data exchange cable to P2 and your PC or terminal. The data exchange cable uses a six-pin connector which must be connected to the 12-pin P2 header on the board such that the black conductor connects to pin 1 of P2. Pin 1 of P2 is marked by a beveled edge on the silk-screen. See drawings 4-2 and 4-9 in the EM-2 documentation.
- Connect the sonar transducer to pins 1 and 2 of P4 (see drawing 4-2). The transducer polarity does not matter.
- A.MODEM V1.00 is factory installed on your EM-2. Use DiveTerm to select it as the default application or to download a newer version of A.MODEM.
- Module EM-2 will activate as soon as power is applied and pins 1 and 2 of P2 are temporarily (1 second) or permanently shorted. A 'jumper' is installed by the factory to jump the short. With the jumper installed, the module will **not** be able to enter sleep mode. To use sleep mode, remove the jumper and provide a switch or transistor based temporary short. Be aware that A.MODEM V1.00 does not support sleep mode. It is however supported by the SmartDive software.
- The EM-2 module can be RESET by cycling power. An alternate method is to permanently short pins 1 and 2 of P2. When shorting and releasing pins 1 and 3 of P2, the module is RESET. If pins 1 and 2 are not permanently shorted, short pins 1 and 3 to switch the module off. Then, short pins 1 and 2 to re-activate the module. Note: RESET or power-on by means of power cycling may cause the processor to 'crash' if power spikes exist. In this case, the RESET process has to be repeated.
- Any A.MODEM speed setting can be used when communicating with a model EM-2, EM-2M modem. Use a single-channel transmit speed setting (4-6) when communicating with a module EM-0 or EM-0M. Multi-channel receive speed settings may be used in all cases.

## 4.1. Communicating With A EM-0 or EM-0M Modem

Read this section if your data link consists of a model STM-1 surface station and a model EM-0 or EM-0M underwater modem. Read section 4.1. if your underwater modem is a model EM-2 or EM-2M.

Before using the EM-0, review this checklist. Please also refer to the EM-0 technical manual.

- Connect 9V to 12V power to connector P1 using the supplied power cable. The red conductor is '+', the black conductor is '-'. Receive mode power consumption is about 20 mA. Transmit power consumption can peak at up to 1 Ampere.
- Connect the data exchange cable to P3 and your PC or terminal. The data exchange cable uses a five-pin connector which must be connected to the 5-pin P3 header on the board such that the black conductor connects to pin 1 of P3. Pin 1 of P3 is marked by a beveled edge on the silk-screen. See figures 2 and 8 in the EM-0 manual.
- Connect the sonar transducer to pins 1 and 2 of P12 (see figure 2 in EM-0 manual). The transducer polarity does not matter.
- The STM-1 surface station and the EM-0 module will only communicate if the STM-1 transmit speed matches the EM-0 receive speed and the STM-1 receive speed matches the EM-0 transmit speed. Use the A.MODEM control commands to set the STM-1 data exchange speeds. Define the EM-0 data exchange speeds by setting the switches as described in figure 16B of the EM-0 documentation. Note that the EM-0 reads the switches only once after power-up. RESET or power-cycle the EM-0 to activate a new configuration.
- Module EM-0 will activate as soon as power is applied and pins 1 and 2 of P2 are temporarily (1 second) or permanently shorted. A 'jumper' is installed by the factory to jump the short. With the jumper installed, the module will **not** be able to enter sleep mode. To use sleep mode, remove the jumper and provide a switch or transistor based temporary short. Be aware that the EM-0 does not support sleep mode when operating as a modem. It is however supported by the acoustic tracking & data acquisition mode.
- The EM-2 module can be RESET by cycling power. An alternate method is to permanently short pins 1 and 2 of P2. When shorting and releasing pins 1 and 3 of P2, the module is RESET. If pins 1 and 2 are not permanently shorted, short pins 1 and 3 to switch the module off. Then, short pins 1 and 2 to re-activate the module. Note: RESET or power-on by means of power cycling may cause the processor to 'crash' if power spikes exist. In this case, the RESET process has to be repeated.

We recommend the use of the 'Different Transmit & Receive Speed' mode (Switch S8 ON) when an acoustic data link is established between a STM-1 surface station and an EM-0 modem. In this setting, the data uplink will gain the speed advantage of multi-channel operation while the normally less data intensive downlink path operates in single channel mode to support the EM-0 single channel sonar receiver.