SOUNDNINE INC

Helping build successful monitoring systems

Ultimodem Operating Manual

Soundnine Inc Document #R010Q

rev 2020-12-02

This manual describes these products:

Figure 1: Ultimodem (Standard)

Figure 2: Ultimodem PCH; PET Plastic Housing (25mm cable option shown)

Figure 3: Ultimodem TCH; Titanium Housing (15mm cable option shown)

Figure 4: OEM Ultimodem Direct Connect Board (18122)

Figure 5: OEM Ultimodem; S9 footprint

Figure 6: OEM Ultimodem; SBE IMM Compatible footprint with power supply

Contents

1 Ultimodem Housing

Size: 230 mm x 35 mm x 46 mm

Materals: PET & Titanium

Depth Rating: 1,000 meters

Mass: 380 grams

The Ultimodem assembled on a mooring cable is nearly concentric and will fit through a 5 cm diameter opening. Allow at least 28 cm length for the modem and mating connector.

1.1 Serviceable Parts

1.1.1 Battery

The modem uses a single AA 3.6V lithium battery. Saft LS14500 or equivalent. The LS14500 is rated 2.6 amp-hours, we usually de-rate to 2.0 amp hours to account for self-discharge and temperature effects.

A typical IM system sampling six times per hour will last a bit longer than one year on this battery.

1.1.2 O-Ring

Modem uses an x-profile double-sealing o-ring. They are available from Soundnine or McMaster-Carr. We recommend Molykote M44 lubricant on the o-ring. Excess lubricant is not desirable, use just enough to wet the surface of the o-ring on all sides.

1.1.3 Faceplate Screws

The faceplate and screws are titanium. Replacement screws must be titanium – use of other materials will cause significant galvanic corrosion. Replacement screws are available Soundnine or McMaster-Carr.

1.1.4 Faceplate

Replacement faceplates are available from Soundnine. The faceplate should be replaced if accidentally bent, scratched on the o-ring sealing surface or otherwise damaged.

1.1.5 Desiccant

The desiccant package should be replaced every time the housing is opened. Replacement desiccant is available from Soundnine or McMaster-Carr.

1.1.6 Coupler Clamp

The coupler clamp assembly both clamps the modem to the mooring line and clamps the ferrite toroid half of the IM coupler in position. This clamp must be fully closed to guarantee reliable communications. There should be no gap between the coupler clamp and the modem housing.

The coupler clamp size must match the outer diameter of the mooring cable. Coupler clamps are available in a variety of sizes, please specify your cable outer diameter and if that diameter is a measured value or a nominal value when ordering.

1.1.7 Connector

The MCBH connector should be replaced only by Soundnine. Some customers may be able to perform this service, but it requires using a soldering iron next to a plastic o-ring sealing surface – this is best done with the appropriate jigs and tools to protect the sealing surface.

1.2 Replacement Parts List

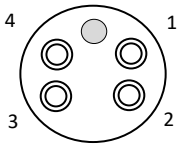
Item	Description	Soundnine Part Number	McMaster-Carr Part Number
O-ring	Double-Seal X-Profile O-Ring, Buna-N, Number 032	202CA	90025K426
Desiccant	0.6”x1.1” silica gel	2039E	2189K12
Faceplate screws	2-56 x 3/8” titanium socket head cap screw	2034B	95435A219
Coupler Clamp Screws	M4-18mm Socket head cap screw, 316 stainless steel	2040A	92290A161
Coupler Clamp Screw Retainer o-ring	O-Ring, Buna-N, 1MM wide, 3MM ID,	2041F	9262K441
Faceplate	Custom machined titanium	50035	
Connector	Subconn MCBH4-M		
Coupler Clamp	Custom polyester and ferrite assembly	50036 **Specify cable diameter when ordering**	

1.3 Power & Communication Connector

The UltiModem accepts input voltages from 3.5V to 28V. The input power is linearly regulated to 3.3V, so use the lowest available input voltage within the acceptable range to conserve power.

Power can be connected or removed at any time in normal operation[1]. There is no danger of corrupting the modem’s configuration by removing power unexpectedly. If power is removed while the modem is writing to a file in flash memory then the data may not be recorded properly, but the data structure will not be corrupted.

Note the MCBH connector pinout RX and TX lines are reversed from the most common configuration – this allows 1-1 wiring of cables connecting the UltiModem to most instruments.



Male Face View
MCBH 4M

Signal	PCB Pin	Wire Color	MCBH4 Pin
GND	1	Black	1
+VDC	2	Green	4
Transmit Out	3	White	2
Receive In	4	Red	3

[1] Do not remove power when performing firmware updates.

2 OEM Modem

We offer OEM modems for manufacturers in both a S9 standard footprint and a larger footprint for replacing IMM's from Sea-Bird Electronics. OEM components are circuit boards with no housings.

2.1 Standard Footprint

The standard S9 footprint allows socket or solder mount on the application PCB. No screws or standoffs are required.

Figure 7 S9 Footprint PCB Layout

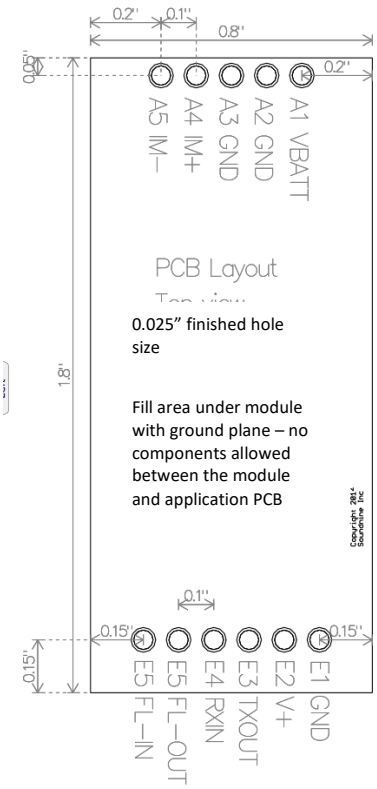


Table 1 S9 Footprint Pin Descriptions

Pin	Name	Description
A1	VBATT	Optional power supply input connection. 3.0V – 4.5V
A2	GND	
A3	GND	
A4	IM+	IM transmit + to coupler
A5	IM-	IM transmit – to coupler
E1	GND	
E2	V+	Positive power supply input 3.3V – 26V
E3	TXOUT	Serial transmit output (RS232 or logic level)
E4	RXIN	Serial receive input (RS232 or logic level)
E5	FLAGOUT	3.3V logic level flag output
E6	FLAGIN	3.3V logic level flag input

Module height over application PCB is 7mm

S9 Part numbers:
RS232 serial interface: 15011B-1
Logic-level serial interface (3.3V): 15011B-2

2.2 Sea-Bird Electronics IMM Compatible Footprint

S9 part number 15032B. Standoffs are not included – see mechanical drawing for standoff size and part numbers.

Table 2 SBE IMM Fooprint J1 10-pin Connector

Pin	Name	Description
1	IM+	IM transmit + to coupler
2	IM-	IM transmit – to coupler
3	FLAGIN	3.3V logic level flag input
4	FLAGOUT	3.3V logic level flag output
5	LLS TX OUT	Logic level serial transmit output (15032A-2 hardware only)

6	TXOUT	RS232 transmit output (15032A-1 hardware only)
7	LLS RX IN	Logic level serial receive input (15032A-2 hardware only)
8	RXIN	RS232 receive input (15032A-1 hardware only)
9	Vin +	Input voltage (3.3V – 26V)
10	GND	Power supply return

Table 3 SBE IMM Fooprint J2 4-pin Connector

Pin	Name	Description
1	IM+	IM transmit + to coupler
2	GND	Power supply return
3	IM-	IM transmit – to coupler
4	Vin +	Input voltage (3.3V – 26V)

Figure 8 SBE IMM Footprint PCB layout

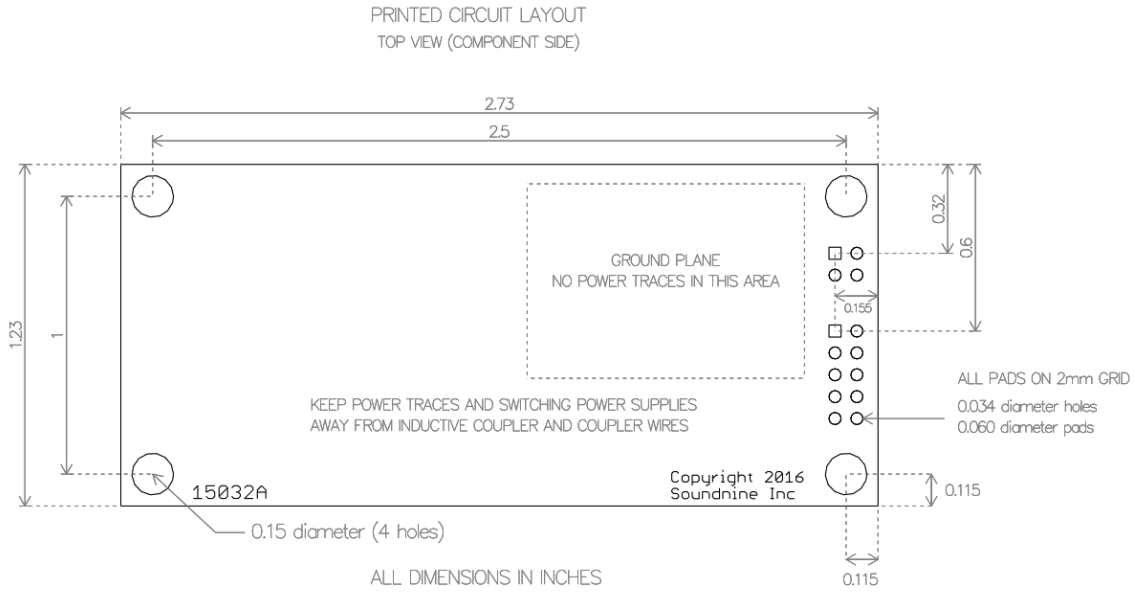
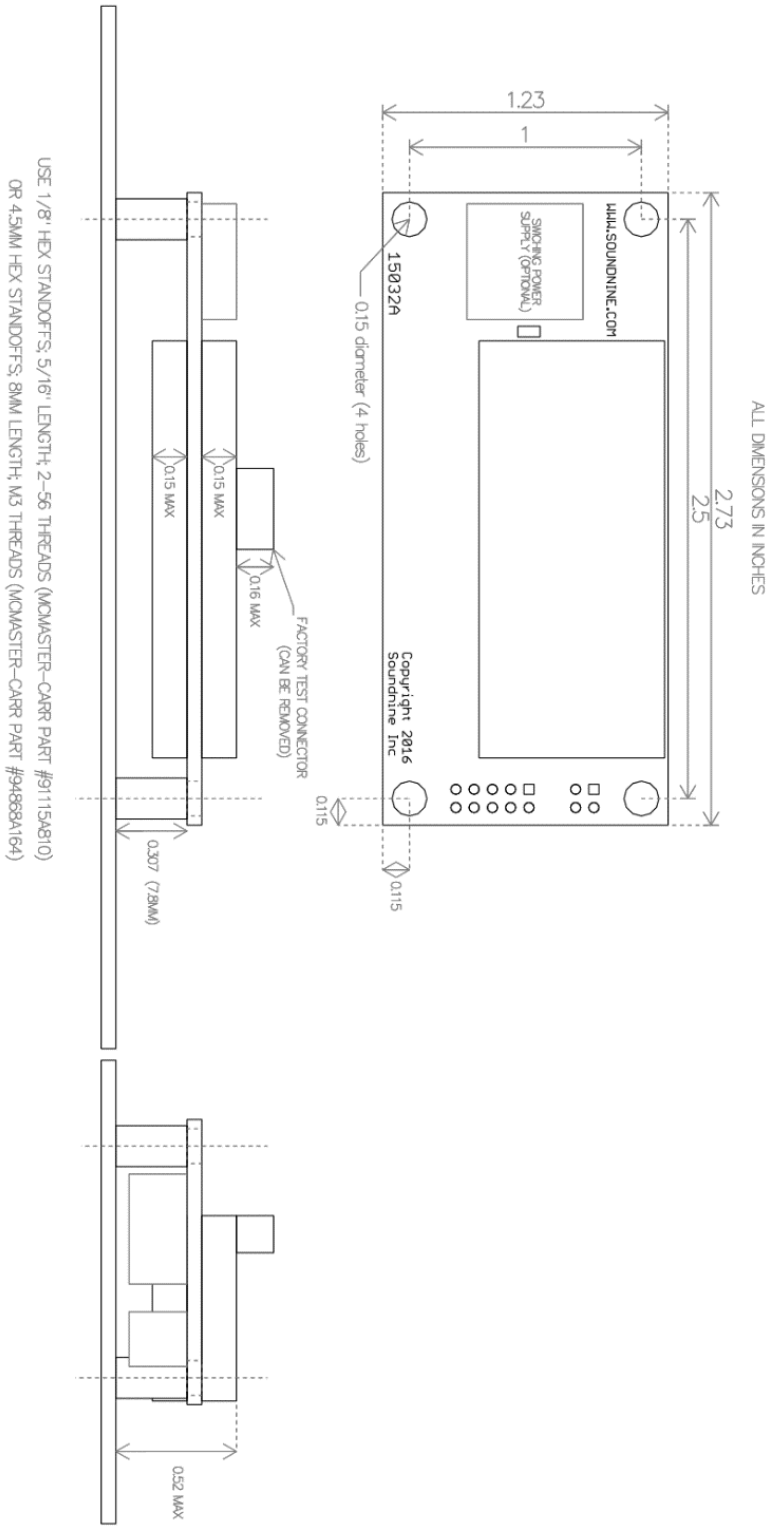


Figure 9 SBE IMM Footprint Mechanical Drawing



3 Operating Modes

3.1.1 Startup Mode

After connecting power to the modem the modem enters Startup mode. Startup mode initializes clocks and prepared the modem for normal operation. Startup mode lasts up to 1.5 seconds after the power input is stable.

Startup mode may be triggered at any time if the power supply to the modem is interrupted or drops below the minimum specified value even for a very short time. This may be a concern for OEM users. Switching power to other devices may cause supply voltage to the modem to drop for a few microseconds and trigger Startup mode.

If the power supply is not stable during startup mode it may be necessary to disconnect power and wait for the voltage at the modem supply input to drop to 0.3V or lower to fully reset the hardware.

3.1.2 Sleep Mode

After a Startup Mode, a PWROFF command, or a timeout the modem enters a low power Sleep mode. Power consumption in Sleep mode is typically 30 microamps. The modem wakes from Sleep according to the WAKEUPSRC setting.

3.1.3 Host Service Mode

Host Service mode is when the modem responds to commands from the RS232 serial port. This mode is used to initiate communication with other modems. Host service mode can be disabled with the WAKEUPSRC command. It is enabled by default.

When the modem wakes in response to activity on the RS232 serial port it immediately activates host service mode. Host Service mode is disabled if the WAKEUPSRC setting is 2 (IM only). Note that Host Service mode and IM Service mode may be active simultaneously (if the WAKEUPSRC setting is 0).

The RS232 serial interface default settings are 19200 baud, 8 bits, no parity, 1 stop bit.

When starting Host Service mode the modem:

1. activates the RS232 driver
2. waits 2 milliseconds
3. clears the receive buffer -- to clear the partially received character which caused the wakeup
4. waits 10 milliseconds for the RS232 driver fully power up
5. transmits:

```
PWRUP
S9>
```

The modem is ready to accept command as soon as this prompt is transmitted.

3.1.3.1 Returning to Sleep (Exiting Host Service Mode)

Use the SLEEP or PWROFF command to exit host service mode (these commands are identical). Modem behavior depends on the state of the modem when the command is received:

1. If IM line is captured:
    a. Send "SENDING PWROFF" to RS232 serial port
    b. Send PWROFF to the IM network.
    c. Wait for the PWROFF command to be transmitted
    d. Wait 10 milliseconds
    e. Disable the IM transmitter
    f. Wait another 10 milliseconds
2. Send "SLEEP" to the RS232 serial port
3. Disable serial output
4. Enter sleep mode if IM Service mode not active

3.1.3.2 Forcing Sleep Mode

The operator can force the modem to enter sleep mode (regardless of any other active modes) with the RESET command.

3.1.3.3 Timeout from Host Service Mode

The modem will automatically exit Host Service mode and return to sleep after a timeout period if no valid commands are entered. The cmdTO setting controls this timeout. Units are seconds, the default is 60 seconds. Each valid command resets this timeout. The timeout will not occur while a command is running. Note cmdTO also controls timeouts in IM Service mode.

3.1.4 IM Service Mode

The modem enters IM Service mode in response to activity on the IM network. When IM Service mode is active the modem can receive and reply to commands from the IM network. IM Service mode is disabled if the WAKEUPSRC setting is 1 (RS232 only). Note that Host Service mode and IM Service mode may be active simultaneously (if the WAKEUPSRC setting is 0).

3.1.4.1 Timeout from IM Service Mode

The modem will automatically exit IM Service mode and return to sleep after a timeout period if no valid commands are received. The cmdTO setting controls this timeout. Units are seconds, the default is 60 seconds. Each valid command resets this timeout. The timeout will not occur while a command is running. Note cmdTO also controls timeouts in Host Service mode.

Valid commands addressed to other modems do not reset this timeout counter. Valid group commands do reset this timer.

If the timeout occurs while a remote device is transmitting then the modem will quickly re-enter IM Service mode -- but there will be a brief window in which a command addressed to the modem may be missed.

3.1.5 Sample Mode

The only way to enter Sample mode is with the RUN A command. This tells the modem to run the A file as a sample script. Sample mode typically operates at the same time as IM Service mode, as when the modem receives a !iiRUN A or !G0:RUN A command. In this case IM Service mode remains active in parallel with Sample mode. IM Service mode may end (due to inactivity, for example) while the Sample mode continues, or the sample script may terminate while IM Service mode remains active. In either case the modem returns to Sleep after both Sample and IM Service become inactive.

It is possible to re-enter IM service mode any number of times while Sample is active without first returning to sleep.

If the RUN A command is received while Host Service mode is active, the sample script takes control of the serial port – essentially pausing Host Service mode. This may be useful in testing, but is not recommended in the field.

3.1.6 Power Off

Power to the modem may be disconnected at any time except during firmware operations. Removing power while writing to the D or F files may corrupt the file requiring an erase command to restore normal operations. This can be avoided by waiting for the S9> prompt before disconnecting power.

Any time power to the modem is interrupted the voltage at the supply input pin of the modem must be allowed to fall to 0.3V or less before reapplying power to guarantee proper startup.

4 Application Roles

The Ultimodem serves either as a ‘master’ modem attached to a controller / data logger controlling an IM network, as a ‘slave’ modem connecting a single instrument to an IM network, or as a ‘peer’ in a network with more symmetric operation. The same modem hardware serves all of these application roles.

4.1 Master Applications

When all communication on an IM network is initiated by a single modem, that modem may be referred to as a master. Often a modem connected to a buoy controller or data logger serves as a master.

When a modem serves as a master it usually should not wake from sleep into IM Service mode – because all communication is initiated from the master. Disable IM Service mode with the WAKEUPSRC command. WAKEUPSRC=1 prevents the modem from responding to unexpected signals on the IM network.

4.2 Slave Applications

When all communication with a particular modem is initiated remotely that modem may be referred to as a slave. Modems connected to instruments or sensors usually serve as slaves. In most applications modems serving as slaves should not enter Host Service mode in response to activity on the RS232 serial port. This could lead to situations where the serial instrument sends a prompt to the modem then the modem responds with a S9> prompt, resulting in an error message from the instrument, followed by an error message from the modem... creating an infinite loop wasting energy and preventing correct operation.

To prevent this, use the WAKEUPSRC command to disable Host Service mode. WAKEUPSRC=2 prevents the modem from responding to unexpected signals on the RS232 serial port.

4.3 Peer Applications

When an application requires a modem to both receive transmissions initiated from a remote modem and initiate communication with remote modems it acts as a 'peer'. Peer networks are more complex because:

1. multiple devices may attempt to communicate on the IM network at the same time.
2. commands arriving from either the IM network or RS232 port may attempt to access the same modem resources at the same time. For example, reading a data file through the IM network while writing to the file on the RS232 interface.
3. data for the RS232 port (a # command) may arrive from the IM network while the modem is accepting commands on the RS232 port.

The Ultimodem supports peer operation. Peer applications require significantly more planning and testing compared to master/slave networks.

5 Sending Commands from Master to Slave with Response from Slave

Most controllers use polling to collect data from remote instruments. The master sends a command to the slave and the slave responds to the command.

5.1 Maximum Command Length

The length of the command sent by the master is limited by the modems 256 character maximum command length[2]. Note this limit includes the address of the slave modem: #37test counts as 7 characters towards this command limit.

[2] Modems with firmware versions before 0.96C were limited to 127 characters. IMMs and other products from Sea-Bird Electronics have different limits – sometimes as few as 64 characters.

5.2 Maximum Response Length

There is no specific maximum response length. The response is limited by timing settings, specifically THOST3, which is the maximum reply time. The maximum THOST3 setting is 3 minutes, which means about 21Kbyte at 1200 baud (mod=1) and 86kByte at 4800 baud (mod=4).

5.3 Master Slave Polling Example

U004 (master – datalogger)	Receive	U02N (connected to instrument) Transmit
PWRUP S9>fcl OK; 0 Events S9>swt ..... OK; 0 Events S9>id? <Remote> id = 37</Remote> <qs>28678</qs> OK; 0 Events S9>#37this is a test command	(CR) 10 millisecond delay this is a test command(CR)(LF) The first CR and 10 mS delay are because HOSTWAKEUP=2. Note THOST0=0 in this test. If THOST0 were not zero the modem would add additional delay before sending the data string. The CR LF at the end is because TERMTOHOST=254.	
<Remote> <Host>this is a test response</Host> TERM 5 </Remote> <qs>143143</qs> OK; 0 Events S9>sleep OK; 0 Events S9>SENDING PWROFF SLEEP		this is a test response(CR) This response can be long. The CR at the end of the response ends the response because TERMFROMHOST=13. Note the response may also be terminated by the THOST2, THOST3 or THOST4 settings.

5.3.1 <Remote> Tag

The master modem generates the <Remote> opening tag and </Remote> closing tag. All data between these tags is from the slave modem replying to the IM command.

5.3.2 <Host> Tag

The slave modem generates the <Host> opening tag and </Host> closing tag. All data between these tags is from the instrument connected to the RS232 port.

The TERM 5 after the </HOST> tag is the slave modem signaling the reply termination type. See 5.3.3:Reply TERM codes.

5.3.3 Reply TERM codes

Reply TERM codes explain why a modem ended the reply transmission after a #nn command. The replying modem transmits a TERM code after the </HOST> tag before ending the transmission.

Table 4: Reply TERM Code List

Number	Text Message (transmitted if debuglevel>0)	Description
1	THOST2 timeout (reply start)	No start of reply signal received (THOST2 setting)
2	THOST3 timeout (max reply time)--no first byte	Maximum reply time setting (THOST3) exceeded without receiving a single byte from the host instrument
3	THOST4 timeout (ICD)	Inter-character delay termination (THOST4)
4	THOST3 timeout (max reply time)	Maximum reply time setting (THOST3) exceeded.
5	term from host	Termination character received from host instrument

5.3.4 QS Tags

QS tags indicate IM signal strength. In the example above, note the QS tag:

```
<qs>143143</qs>
```

The Master modem sends this tag. The tag contains a measurement of the signal strength received from the remote modem. The background noise level with no interference sources is 30-50. Use the MLN command to test the background noise level. Signal strengths of 10000 or more are recommended for normal operation. Typical QS values on moorings up to 1KM cable length are on the order of 100000, and on 100 meter moorings up to 1000000.

Note this QS tag is present even in the case where no remote reply was detected:

```
S9>!00ver
```

```
<qs>294</qs>
Error:No reply
OK; 0 Events
S9>
```

If this QS tag indicates a high signal value it indicated either there is significant noise on the IM line – which could be the reason for the missing reply – or it may indicate the remote device did reply but the first bytes of the reply were read incorrectly. In this case it is important to wait until the remote device finishes the reply because if two devices are transmitting at the same time communication will not work.

6 Commands

Commands are not case sensitive. In Host Service mode they must be terminated by a carriage return character (CR, 0x0D). If a line feed (LF, 0x0A) follows the carriage return character it will be ignored. This may cause line feed characters to be dropped in file operations.

6.1 Command Responses

6.1.1 Normal Response in Host Service Mode

The typical command response looks like this:

```
OK; 0 Events

S9>
```

`OK` means the command was executed with no error.
`0 Events` means there are no new events in the Event counter.
The S9 prompt means the modem is ready to receive a new command.

6.1.2 Normal Response in IM Service Mode

Replies to commands received through the IM interface are different in three ways

1) They do not include the S9> prompt in the reply.
2) They include a QS value showing the IM signal strength detected when the remote modem entered IM service mode:

```
OK; 2 Events; qs 2024
```

3) The entire reply from the remote device is wrapped in a <Remote></Remote> tag. In the example below only the text in bold was generated by the remote device, the rest was generated by the local device:

```
S9>!0sgetec
<Remote>
 <EventData>
  MinWakeups=0
  SoftWakeups=0
numEvents = 0
nextAddr = 1020
</EventData>

OK; 0 Events; qs 1995
</Remote>
<qs>1953</qs>

OK; 0 Events
```

6.1.3 Error Response

If there is any error the response looks like this:

```
Error: error message

S9>
```

`Error:` is the indicator of an error. The error message is variable. Most error messages are listed in the table below.

Please Note: the table below is not a complete list.

Table 5: List of Error Messages

Error Message	Notes
NOT ALLOWED IN FILE	Command not permitted in script file
NOT ALLOWED FROM IM	Command not permitted over IM interface
NOT ALLOWED WHEN IM IDLE	Command not permitted when IM line not captured
NOT ALLOWED WHEN IM ACTIVE	Command not permitted when IM line captured
NOT ALLOWED FROM RS232 PORT	
BLOCKED - MULTIPLE INTERFACE ACTIVE	Command not permitted when both IM Service and Host Service active
PROGRAM A ALREADY RUNNING	Possible response to RUN A command
Command only works in MOD 4!	The XT2 command is permitted only in MOD 4
FAILED - device type error	
FAILED - repeat firm command	
expected hex	
invalid ID	
invalid Group	
invalid argument	
missing argument	
invalid format	
not implemented	
invalid addr	
invalid len	
addr out of range	
SERIAL INTERFACE BUSY	
D FILE BUSY	D file access is limited to one interface at a time
No reply	No reply detected from remote device

MAX REPLY TIME (TMODEM3)	

6.1.4 User Abort Response

Commands aborted with the escape character are not treated as errors. If a mode is cancelled the modem send an abort message followed by a normal response. In this example a write to the D file is ended with the escape character:

```
S9>write d
USE 'END S9D' OR ESCAPE TO END

USER ABORT (ESC)
OK; 0 Events
S9>
```

6.2 Command types

6.2.1 Standard Commands

Most commands complete in a few milliseconds.

6.2.2 Commands with Special Modes

Some commands initiate Special Modes which take several seconds or longer. Most Special modes can be cancelled with an escape character (0x1B). These include READ, WRITE, APPEND, SWT, FCL, IMMON, XTP, XT2, all IM transmission commands (!xx, #xx). When the command completes the

Please note: When receiving a reply from a remote device the escape character (0x1B) will exit receive mode and allow new commands; but it will not cancel the reply in process from the remote device. It is important to wait until the remote device completes its reply before sending new IM transmissions because reliable communication is not possible when two devices are transmitting at the same time.

6.2.3 Commands Resulting in Reset

Some commands reset the modem or enter Sleep mode. These include SLEEP, RESET, FIRM, MOD.

6.2.4 Status Commands

6.2.4.1 GETCD

Displays modem configuration.

```
S9>GETCD
<Config type='Ultimodem' sn='U00S' v='0'>
<Hardware>
  <Assembly>50109</Assembly>
  <Firmware>ULTIMODEM V0.96H</Firmware>
</Hardware>
<Settings>
  baud=19200
  mod=1200 baud@4.8k (1)
  id=0S
```

```
  group=0
  wakeupsrc=IM & RS232 (0)
  hostPrompt=S>
  cmdTO=60
  asyncRx=1
  telMode=1
  hostWakeup=2
  termFromHost=13
  termToHost=254
  thost0=0
  thost1=5
  thost2=3000
  thost3=12000
  thost4=500
  thost5=5
  tmodem2=500
  tmodem3=18000
  icd=1
  echo=1
  sflow=1
  debuglevel=1
</Settings></Config>
OK; 0 Events
S9>
```

6.2.4.2 GETSD

Displays modem status. This includes the battery voltage. Note the battery voltage may be low or zero when the modem is powered externally.

```
S9>GETSD
<Status type='Ultimodem' sn='U00S' v='0'>
<DataBuffer>
  nextWrite=2097152
  len=0
  CRC=FFFFFFFF
  lastEntryLen=0
  lastEntryCRC=FFFFFFFF
</DataBuffer>
  Vbat=3.498
  Vtx=3.25
   IM IDLE
   RS232 ACTIVE
</Status>
OK; 0 Events
S9>
```

6.2.4.3 GETEC

Displays event counters. Event counters are a useful debugging tool for S9. Most events to not indicate a problem. If you are concerned about events recorded on your modem please feel free to forward the GETEC response to S9.

```
S9>
<EventData>
numEvents = 1
nextAddr = 1040
   0, EA73, .././Usart2.c:66-1
</EventData>
```

In the example above the event was Usart2.c, line 66. This means a framing error on the RS232 serial port input.

6.2.4.4 VER

Displays modem hardware and firmware version. Note the HTYPE (hardware type) is different for OEM modems (14032-1) vs modems in housings (15011-1).

```
S9>VER
HTYPE 14032-1
CD AB0B0AE0, 12000002
CODE TYPE ULTI A
FIRM ULTIMODEM V0.6B
CDATE Feb  1 2016 14:37:24

OK; 0 Events
S9>
```

6.2.5 Configuration Commands

Modem configuration is extremely important. An improperly configured modem may seem unresponsive to either the RS232 port or the IM network. Use GETCD to retrieve the modem's configuration settings.

The name of each configuration setting is also a command to modify that setting. For example, the THOST1 setting can be changed with:

```
THOST1 100
```

or

```
THOST1=100
```

6.2.5.1 SETDEFAULTS

This command resets all modem configuration to default values.

6.2.6 Utility Commands

6.2.6.1 TXTEST

Supported in IM Service mode only. This transmits a series of characters as a communications test.

6.2.6.2 PWROFF or SLEEP

Terminates the current mode (IM Service or Host Service) allowing the modem to return to low-power sleep mode.

6.2.6.3 RESET

Forces a full reset (like a reboot). This forces the modem to return to low-power sleep mode, abandoning all in-process activity.

6.2.6.4 RESETEC

Resets the event counters.

6.2.7 File Commands

The modem has several files in flash memory (A, F, D) and one file in RAM (S). Files are identified by a single letter. Some files may be run as simple command scripts, others are reserved for data storage & transfer. Additional script files and file commands will be added soon.

6.2.7.1 Available Files

6.2.7.1.1 F File

The F file is used for scripts – most importantly firmware update scripts. Firmware update files are streamed to the F file, then the file is run with the RUN F command. The F file can may also be used for custom scripts where each line of the file is a modem command. Note that some commands cannot be used in scripts – check the 'blocks' section of the command summary for details.

6.2.7.1.2 D File

The D file is a 6 Mbyte circular buffer for ASCII data. It is intended for automatic data-transfer applications which are not yet fully developed.

6.2.7.1.3 A File

The A file is a script file used to retrieve data or perform other functions though the RS232 serial port. This file is described in more detail in Data Collection Scripts.

6.2.7.1.4 S File

The S file records data collected while the A file is running. The S file resides in RAM and can be read through the IM interface.

6.2.8 File Command Summaries

6.2.8.1 WRITE

Writes data to a file.

```
S9>write d
USE 'END S9D' OR ESCAPE TO END
this is being written to the file
USER ABORT (ESC)
OK; 0 Events
S9>
```

6.2.8.2 APPEND

Appends data to a file.
Please note: as of 2020-11-02 the APPEND command is implemented only for the A file.

```
S9>erase a
OK; 0 Events
S9>append a this is a new line
OK; 0 Events
S9>append a this is another line
OK; 0 Events
S9>read a
<FILE>
this is a new line
this is another line

</FILE>

OK; 0 Events
S9>
```

6.2.8.3 READ

Retrieves data from a file. See example above under APPEND.

6.2.8.4 ERASE

Erases a file. See example above under APPEND.

6.2.8.5 RUN

Runs a script file.

6.2.8.6 DUMPFLASH

A utility command to retrieve the entire contents of flash memory. This allows significant data recovery if the D file is accidentally erased. This command takes about ten minutes to run.

6.2.9 IM Commands

6.2.9.1 CL or FCL (Capture Line)

This captures the IM network. Only one device can transmit at a time on an IM network. CL or FCL starts transmitting a carrier signal on the IM network. This is required prior to transmitting commands to the IM network.

Prior to firmware version 0.99Q the FCL command returned almost immediately. In later firmware versions FCL sends a short wakeup tone and takes about 350mS to complete.

6.2.9.2 SWT (Send wake-up Tone)

Sends a wake-up tone to the IM network. A wake-up tone is a 4800Hz tone which triggers many IM instruments (including older instruments from Sea-Bird Electronics) to wake from their sleep modes and start listening for commands on the IM network.

Please note: When using MOD 4 setting in firmware prior to version 0.99Q the SWT command is required to wake remote modems. When using MOD 1 setting the wakeup tone is recommended but not required (unless using older SBE devices)

6.2.9.3 MLN (Measure Line Noise)

Measures the noise on the IM line. The units of this measurement roughly match the units of the QS signal strength tags. The MLN command is not available while transmitting to the IM line.

Prior to firmware version 0.99Q the MLN command except the MLN had maximum measurement value of about 1800 and used a format like this:

```
S9>mln
00072
00097
00061
00082
00085
00076
00083
00085
00068
00080

OK; 0 Events

S9>
```

After firmware version 0.99Q the limit on the MLN value was removed and the format changed to this:

```
S9>mln
<MLN>
72
97
61
82
85
76
83
85
68
80
</MLN>

OK; 1 Events

S9>
```

6.2.9.4 IMMONITOR or IMMON

Starts a monitor mode where the modem attempts to decode signals from the IM network regardless of whether any devices are transmitting. If nothing is transmitting the modem will probably send a stream of random characters – including non-ASCII characters.

Press Escape (0x1B) to exit from this mode.

6.2.9.5 XTP

Performs a single sample and retrieves data from all XTP sensors on the IM network. Press escape (0x1B) to exit this mode early. If you exit this mode early any XTP's on the IM network may still be transmitting data. The IM line is released when the XTP command finishes.

For a known number of XTP sensors use XTP N – where N is the number of sensors. This saves time and therefore power by exiting the XTP command and releasing the line after all sensors have responded.

6.2.9.6 XT2

Performs a single sample and retrieves data from all version 2 XT sensors on the IM network. Press escape (0x1B) to exit this mode early. If you exit this mode early any XT sensors on the IM network may still be transmitting data. The IM line is released when the XT2 command finishes.

6.2.9.7 REL

Releases the IM line. This is the opposite of CL or FCL.

6.3 Communicating with Remote Devices

Communicating with other modems is currently a three-step process:

1) Capture the IM line with CL or FCL
2) Send IM commands to either remote modems (using ! commands) or through remote modems to the instruments connected to them (using # commands)
3) Release the IM line when finished

Most IM communication uses an addressing scheme where the first few characters of a transmission are the device ID (address) of the intended recipient. These address characters are followed by the data or commands to transmit. Only the modem with matching address replies.

6.3.1 Example Communication Session

```
PWRUP
S9>
S9>fcl
OK; 0 Events
S9>ID?
<Remote>
 id = 0A</Remote>
<qs>4049</qs>
OK; 0 Events
S9>!0Aver
<Remote>
HTYPE 14032-1
CD AB0B0AE0, 12000002
CODE TYPE ULTI A
FIRM ULTIMODEM V0.6B
CDATE Jan 21 2016 10:29:58

OK; 0 Events; qs 11780
</Remote>
<qs>4843</qs>
OK; 0 Events
S9>#0Atest
<Remote>
 <Host>
This is the reply from the remote serial port
</Host>
</Remote>
<qs>4843</qs>
OK; 0 Events
S9>rel
OK; 0 Events
S9>sleep
```

6.3.2 Communicating with Remote Modems

Communication with remote modems (as opposed to serial instruments connected to those modems) uses the ! command. In the Example Communication Session above, the line:

```
!0Aver
```

sent the VER command to the modem on the IM network with device ID=0A. The reply from modem 0A was surrounded with the <Remote> tag.

6.4 Communicating with Instruments Connected to Remote Modems

Communication through remote modems to their RS232 serial ports uses the # command. In the Example Communication Session above, the line:

```
#0Atest
```

Sends the string “test” to the RS232 port of the modem with device ID=0A. Any reply from the serial port is wrapped in the <host> tags. Both the reply and any errors or other communication from the remote modem are wrapped in the <Remote> tags.

The Ultimodem follows several steps when sending arriving data to the serial port and forwarding responses from the serial port. Most of these steps can be customized by changing configuration settings.

6.4.1 Stages of Processing Received #ii Commands

6.4.1.1 Serial Port Access

1) If the receiving modem is in Host Service mode when a #ii command is received:
    a. If configuration asyncRX setting is zero: the modem will not forward the received data – instead it will respond with a "SERIAL INTERFACE BUSY" Error.
    b. If configuration asyncRX setting is one: the modem will send "\r\n<IMRXA>\r\n" to the serial port to signal the asynchronous reception of a #ii command.

6.4.1.2 Host Wakeup

If the receiving modem is not in Host Service mode when a #ii command arrives it will

2) Initialize the serial port at the speed specified in the BAUD configuration setting
3) Disable software flow control
4) Wait 50mS for the RS232 driver to fully activate. This 50 mS delay occurs even in modems with logic level serial interfaces.
5) Wake the host according to the hostWakeup setting:
    a. If hostWakeup=1 the IMflag signal will go active. Note the active polarity of the IMFlag output is changed by the imfConfig setting.
    b. If hostWakeup=2 the modem will transmit ‘\r’ to the serial port and wait 10mS after the transmission completes.
    c. If hostwakeup=3 the modem will activate the IMFlag output for 10mS, then deactivate the output
    d. If hostWakeup > 3 the modem will set a serial break condition for 10mS times the hostWakeup value. For example, hostWakeup=100 generates a 1000 mS break condition.

6.4.1.3 Confirming Host Wakeup

After the Host Wakeup stage the modem confirms the host is awake before sending the received data. There are several ways to confirm host wakeup.

6) Confirm host wakeup by:
    a. THOST0 timeout, measured from the end of the Host Wakeup stage
    b. Receipt of the hostPrompt from the serial port. HostPrompt is a configuration setting.
    c. Receipt of more than 15 characters from the serial port.

Note that wakeup confirmation with the Hostflag input signal is not implemented. Please contact S9 if you need this feature.

6.4.1.4 Delay after Wakeup

7) THOST1 allows a configurable delay after confirming host wakeup. This delay is measured from the end of Host Wakeup Confirmation.

6.4.1.5 Sending Received Data to the Serial Port

8) The data received in the #ii command is forwarded to the serial port.

   If the ICD configuration setting is not zero then inter-character delay will be added. In this case the modem sends a single byte to the port, waits for the character to transmit, then waits the ICD time before sending the next character.

6.4.1.6 Terminating Data Transmission to Host

9) After sending the data received in the #ii command to the serial port, the modem sends additional characters as defined by the TERMTOHOST configuration setting.
   a. If TERMTOHOST=0 then no additional characters are transmitted.
   b. If TERMTOHOST=1 then the modem sends "\r\n". The ICD setting applies in this transmission.
   c. If TERMTOHOST is any other value the modem sends a byte of that value to the serial port.

6.4.1.7 Start of Host Reply

10) The modem waits according to the THOST2 configuration setting for the first byte of reply from the serial port.
    a. If THOST2=0 then the first byte timeout is disabled
    b. If THOST2 timeout expires with no bytes received from the serial port the modem disconnects from the serial port, responds with TERM 1, and if DEBUGLEVEL is greater than 0 the message "THOST2 timeout (reply start)"

Note the THOST3 setting applies at the same time as THOST2. THOST3 should never be set shorter than THOST2, but if it is and the THOST3 limit is reached before the THOST2 limit the modem will respond with TERM 2, and if DEBUGLEVEL is greater than 0 the message "THOST3 timeout (max reply time)--no first byte"

6.4.1.8 Host Data Relay

After the Start of Reply the modem forwards all data received from the serial port through the inductive modem. This continues until one of the Termination from Host conditions occurs.

The modem has an 8kB circular buffer for data received from the serial port. If the host will send more than 8kB it may be necessary to pause the data stream to avoid overflowing this buffer. If the buffer

overflows a UERR 4 error will be logged in the event counters[3] and some of the data sent by the host will not be transmitted to the remote modem. A good rule when TELMODE=3 is to estimate 100 bytes per second leaving the buffer when MOD=1 and 400 bytes per second leaving the buffer when MOD=4.

Note the TELMODE setting in the receiving and transmitting modems must match for proper communication. TELMODE 3 is required for binary data when the remote modem is an Ultimodem from S9. TELMODE 1 or 2 is required when the remote modem is an IMM from SEA-Bird Electronics, depending on the IMM's BINARY setting. TELMODE 1 is required when the remote modem is a SIM from Sea-Bird Electronics.

6.4.1.9 Termination from Host

The Host Data Relay may be terminated by THOST3, THOST4 or receipt of one or more characters defined by the TERMFROMHOST configuration setting.

11) The Host Data Relay continues until:
    a. THOST4 inter-character delay timeout occurs with no additional bytes received. In this case the modem responds with TERM 3 and if DEBUGLEVEL is greater than 0 the message "THOST4 timeout (ICD)"
    b. THOST3 max reply timeout occurs. In this case the modem responds with TERM4 and if DEBUGLEVEL is greater than 0 the message "THOST3 timeout (max reply time)"
    c. Receipt of the TERMFROMHOST character(s):
        i. If TERMFROMHOST=0 there is no special character used to mark the end of data from the host
        ii. If TERMFROMHOST=254 then the string "\r\n" marks the end of data from the host
        iii. If TERMFROMHOST is any other value then receipt of a byte with that value from the serial port marks the end of data from the host.

    If data from the host is terminated as in either ii or iii described above then the modem responds with TERM4 and if DEBUGLEVEL is greater than 0 the message "term from host"

6.4.1.10 Wait for IM Transmission

The baud rate from the serial port may be much faster than the rate of transmission to the remote modem. In theory there could be nearly 8kB of data remaining in the serial receive buffer waiting for transmission to the remote modem when the Termination from Host occurs. This data may take as much as 90 seconds to transmit in MOD 1, or 25 seconds in MOD 4.

[3] Note the UERR event logs multiple types of UART errors, please refer to Table 6 Events with Text Codes for more details.

12) The modem keeps the serial port open, RS232 driver enabled, and IMFlag signal active (if HOSTWAKEUP=1) until the last bytes received from the serial port are transmitted to the remote modem.

    During this time the THOST3 timeout can still occur. Be sure to allow enough time in THOST3 for IM transmission of the entire reply from the host with the selected MOD and TELMODE settings.

6.4.1.11 End of Transmission

After the last bytes from the serial port are transmitted to the remote modem the modem sends some additional data and performs a few more tasks before ending the IM transmission.

13) The modem sends "</Host>\r\n" to mark the end of data received from the serial port
14) The modem sends the TERM x message, including the numeric code signaling what terminated the host communication
15) The modem sends any additional messages enabled only when DEBUGLEVEL is greater than zero
16) If the modem was in Host Service mode with ASYNCRX=1 when the # command arrived then it sends </IMRX> to the serial port to signal the end of the #ii command interaction.
17) If HOSTWAKEUP=1 the modem deactivates the IMFlag output
18) The modem disables the serial port RS232 driver and waits 10mS for the driver to disable -- unless the modem was in Host Service mode with ASYNCRX=1 when the # command arrived, in which case it leaves the serial port active.
19) The modem ends the IM transmission

6.5 Data Collection Scripts

There are two types of script files. One is a command script (the F file) used for firmware updates or configuration scripts. The other is a data collection script (the A file) used to collect data from the RS232 serial port. Data collection scripts use a special limited command set. These commands are almost identical to commands used in the DANTE buoy controller and Ultibuoy controller to collect data from serial instruments.

When the A file script is running all data received from the serial port is recorded in the S file. Most applications run the A file then retrieve the data collected from the S file.

It is possible to save data to the D file instead of the S file. This allows much more memory. Refer to the SAVE D sample command .

6.5.1 Data Collection Example

This is an example of running a data collection script on a remote modem and retrieving the result:

```
S9>fcl
OK; 0 Events
S>!0Arun a
<Remote>
 RUNNING PROGRAM A

OK; 0 Events; qs 11056
</Remote>
<qs>3471</qs>

OK; 0 Events
S>!0Aread s
<Remote>
<FILE id='S'>
This text was recorded from the serial port while file A script ran
</FILE>

OK; 0 Events; qs 11056
</Remote>
<qs>3636</qs>

OK; 0 Events
S9>
```

6.5.2 Script Commands

6.5.2.1 SERIAL ON

Enables the modem serial port at the specified baud rate. The baud rate may be any multiple of 1200 up to 115200.

```
SERIAL ON 9600
```

Enables the serial port at 9600 baud (8-bits, no parity, 1 stop bit, no flow control)

6.5.2.2 SERIAL OFF

Disables the modem serial port

6.5.2.3 HEX

Sets the modem RS232 port to operate in binary HEX mode (default is ASCII). In binary mode all data received from the sensor is converted to ASCII hex. Note that data is stored as ASCII hex in the data buffer, meaning number of bytes stored in the sample data buffer is twice the length of the received binary data.

6.5.2.4 Binary

Sets the modem RS232 port to operate in binary mode. In binary mode all received characters are stored as a single byte except '\', 0x00 and 0xFF.

Please note: when handling binary data the SFLOW setting must be 0 to disable software flow control, otherwise the XON /XOFF characters will not be processed correctly.

6.5.2.5 ASCII

Sets the modem RS232 port to ASCII mode (default is ASCII). In ASCII mode all data sent to and received from the serial port is expected to be plain text. Non-text characters (>0x7F) may be ignored, cause events in the event counters and / or be replaced with other characters ('X', '$' or '*').

6.5.2.6 CLEARBUFFER

Clears the contents of the S file (the receive data buffer). This is intended to remove characters that result from transients on the serial data lines when a sensor is powered. Any data received before a CLEARBUFFER command is lost and not recorded in any log file.

6.5.2.7 SAVE D

Saves the S file to the D file and clears the S file. Data from the S file is wrapped in <UMSample> tags with sample number, length and CRC parameters. Note the sample number increments each time the sample script runs (each RUN A command). It does not increment during a SAVE D command. The SAVE D command may be used more than once in a script.

6.5.2.8 DELAY

Waits a specified time in milliseconds, up to a maximum of 15 minutes. (15 min * 60 seconds/min*1000 milliseconds per second = 900000 milliseconds).

```
DELAY 100
```

Waits 100 milliseconds

6.5.2.9 TIMESTAMP

The TIMESTAMP command is not yet implemented. The modem has a real time clock and can be updated to track time.

6.5.2.10 BREAK

Sends a serial break. Minimum is 10, maximum is 10000 (10 seconds).

BREAK 100

Sends a 100 millisecond serial break.

6.5.2.11 IMFLAG

Use IMFLAG 0 and IMFLAG 1 to set / clear the IMFlag output. Use IMFLAG 2 to output a 10mS pulse on the IMFlag output. Note the imfConfig setting affects polarity.

The IMFlag output is not automatically reset when the script terminates. Changes to IMFlag state persist until explicitly changed, a reset or a power cycle.

6.5.2.12 SEND

Transmits characters to the modem serial port. Behavior of this command depends on the ASCII/Binary setting (see ASCII and BINARY commands)

6.5.2.12.1 ASCII Mode (default)

```
SEND "a string\r"
```

Sends 'a string' followed by carriage return (hex 0D) to the serial port.

The maximum string length is 64 characters.

A few common character sequences are available to send special or non-printing characters to the modem serial port:

Sequence	Description	Hex Value
\r	Carriage Return	0D
\n	Line Feed	0A
\\	Front slash	2F
\"	Quote	22
\t	Tab	09

So `SEND "test\r\n"` will send 'test' followed by CR (hex 0D) and LF(hex 0A)

6.5.2.12.2 Binary Mode

```
SEND "6120737472696E670D"
```

Sends 'a string' followed by carriage return (hex 0D) to the serial port.

The maximum string length is 32 binary characters, which is 64 bytes of ASCII hex.

6.5.2.13 WAITFOR

Waits for a string to arrive on the modem serial port, with a maximum delay. If the maximum delay time is reached without receiving the target string then the modem adds 'UM-TIMEOUT'

to the received data buffer and proceeds to the next line of the script. Behavior of this command depends on the ASCII/Binary setting (see ASCII and BINARY commands)

6.5.2.13.1 ASCII Mode

```
WAITFOR "S>",3000
```

Waits for the string 'S>' for up to 3 seconds. Note the ',' character is required before the delay

The maximum string length is 64 characters.

6.5.2.13.2 Binary Mode

```
WAITFOR "533E",3000
```

Waits for the string 'S>' for up to 3 seconds. (0x53 is hex for 'S', 0x3E is hex for '>')

The maximum string length is 32 binary characters, which is 64 bytes of ASCII hex.

6.5.2.14 GETEC

The GETEC command records the modems event counters in the S file (like the normal GETEC command and resets the modems event counters. This is intended to help debugging of sample scripts.

6.6 Retrieving Data from XTP Sensors

XTP's are eXpendible Temperature and Pressure sensors with built-in inductive modems. XTP's use a simplified IM communication protocol with no device ID's. Use the XTP command to retrieve data from XTP sensors. The IM network must be idle for at least five seconds before sending the XTP command. The XTP command retrieves data from all XTP sensors on the IM network.

6.7 Retrieving Data from Version 2 XT Sensors

Version 2 XT sensors are a new line of real-time sensors for parameters including temperature, pressure, conductivity, acceleration, tilt, and dissolved oxygen. These sensors allow simultaneous sampling and fast data collection with high speed communication. Please refer to R0123 XT Sensors V2.pdf on the Soundnine website for more details, including communication examples and data formats.

7 Event Counters

Event counters are an important tool for firmware testing, application testing, and debugging. The Event Counter is a system for recording potentially important events in the modem. It includes a dedicated space in nonvolatile memory to store these events. Most events are recorded in the order in which they occurred, but some events that occur in interrupt service routines are recorded later for maximum reliability.

Each event record includes a time code, a short text string, an integer number and a number of times the event occurred in a row. For most events the text string is the name of the source code file and the integer number is the line number of that file where the event is detected. Some events use a text / number identifier instead of a file and line number.

7.1 Event Resets

If the firmware detects a potentially serious error it will reset the modem. Every time the modem is reset it logs two events when it restarts. The first event is "EVENT RESET". The next event records the reason for the reset. The integer is always 555 for the second event event.

Most Event Resets indicate serious problems. One exception is the RESET command, which resets the modem and records both an EVENT RESET and a RESET Cmd event.

Table 6 Events with Text Codes

Error Text	Error Number	Description
OSC32FAIL	NA	The 32KHZ oscillator did not start up properly.
IMTXUR	NA	IM transmit interrupt latency error—transmission may have error
IMRXOF	NA	IM receive buffer overflow – a received character may be missing
UERR	0 not used 1 rx overwrite 2 framing error 3 rx buffer overflow 4 tx underflow 5 unknown error 6,7 not used	One or more serial port errors occurred. The error code uses bit flags to identify the error. The numbers on the left are bit numbers. For example, a UERR 5 means both a receive overwrite error and a receive buffer overflow error (2^1 + 2^5)
EVENT_RESET	NA	The firmware reset the modem. The next event records the reason for the reset.
RESET Cmd	NA	Indicates the Event Reset was cause by the RESET command.

7.1.1 MinWakeups

MinWakeups are when the modem detects a signal on the IM line and enters a low power state to determine if the signal is an actual IM signal. If it is not the modem logs the minwakeup and returns to sleep. If it is potentially an IM signal the modem enters IM Service mode.

7.1.2 SoftWakeups

Softwakeups are when the modem enters IM Service mode then detects 10 or more invalid characters in the IM data stream within the first 500 milliseconds. The modem assumes the wakeup was caused by noise, logs a SoftWakeup and returns to sleep.

8 Retrieving Data with a Script

In this example the master controller commands the slave to run a pre-configured script. The slave runs the program and records data from its host instrument. The master retrieves the data later when the program is completed.

8.1 Data Collection Scripts

There are two types of script files. One is a command script (the F file) used for firmware updates or configuration scripts. The other is a data collection script (the A file) used to collect data from the RS232 serial port. The A file data collection script uses a special limited command set. These commands are almost identical to commands used in the DANTE buoy controller to collect data from serial instruments.

When the A file script is running all data received from the serial port is recorded in the S file. Most applications run the A file then retrieve the data collected from the S file.

8.2 Script Related Modem Commands

Command	Notes
WRITE A	Writes to the A file
READ A	Reads the A file
READ S	Reads the S file
RUN A	Runs the A file. When run from the serial interface the command interface is disabled until the script ends.

8.3 The S File

The S file is a RAM buffer. It records data from the host instrument during the script. Scripts can use CLEARBUFFER to empty this file and SAVE D to save the current contents to the D buffer before clearing the file.

The maximum length of the S file is 6kB. If the host instrument sends more than 6kB then the script can use multiple SAVE D commands with an appropriate time delay in between.

8.4 A File Script Commands

These are the only commands available in the A file script.

Command	Examples	Notes
SERIAL ON	SERIAL ON 19200 SERIAL ON 9600	Enables the serial port at the specified baud rate
SERIAL OFF		Disables the serial port
CLEARBUFFER		Erases the contents of the S file
SAVE D		Saves S file to D file and clears S file

DELAY	DELAY 100 DELAY 10000	Pauses for a specified number of milliseconds (maximum 900000 – which is 15 minutes)
TIMESTAMP		Reserved – will add an ISO9001 time stamp in the S file.
BREAK	BREAK 100 BREAK 1000	Sends a break condition on the serial port for a specified number of milliseconds. (10 to 10000)
SEND	SEND "ts\r" SEND "SL\r"	Sends a string to the serial port. Common escape codes \r, \n, \t, \"and \\ are implemented. Use \e to send an escape character (0x1B);
WAITFOR		

8.4.1 SERIAL ON

Enables the modem serial port at the specified baud rate. The baud rate may be any multiple of 1200 up to 115200.

```
SERIAL ON 9600
```

Enables the serial port at 9600 baud (8-bits, no parity, 1 stop bit, no flow control)

8.4.2 SERIAL OFF

Disables the modem serial port

8.4.3 CLEARBUFFER

Clears the contents of the S file (the receive data buffer). This is intended to remove characters that result from transients on the serial data lines when a sensor is powered. Any data received before a CLEARBUFFER command is lost and not recorded in any log file.

8.4.4 SAVE D

Saves the S file to the D file and clears the S file. Data from the S file is wrapped in <UMSample> tags with sample number, length and CRC parameters. Note the sample number increments each time the sample script runs (each RUN A command). It does not increment during a SAVE D command.

8.4.5 DELAY

Waits a specified time in milliseconds, up to a maximum of 15 minutes. (15 min * 60 seconds/min*1000 milliseconds per second = 900000 milliseconds).

```
DELAY 100
```

Waits 100 milliseconds

8.5 TIMESTAMP

The TIMESTAMP command is not yet implemented. The modem has a real time clock and can be updated to track time.

8.5.1 BREAK

Sends a serial break. Minimum is 10, maximum is 10000 (10 seconds).

BREAK 100

Sends a 100 millisecond serial break.

8.5.2 BINARY

Sets the modem RS232 port to operate in binary data mode (default is ASCII). In binary mode all data received from the sensor is converted to ASCII hex. Note that data is stored as ASCII hex in the data buffer, meaning number of bytes stored in the sample data buffer is twice the length of the received binary data.

8.5.3 ASCII

Sets the modem RS232 port to ASCII mode (default is ASCII). In ASCII mode all data sent to and received from the serial port is expected to be plain text. Non-text characters (>0x7F) may be ignored, cause events in the event counters and / or be replaced with other characters ('X', '$' or '*').

8.5.4 SEND

Transmits characters to the modem serial port. Behavior of this command depends on the ASCII/Binary setting (see ASCII and BINARY commands)

8.5.4.1 SEND in ASCII Mode

```
SEND "a string\r"
```

Sends 'a string' followed by carriage return (hex 0D) to the serial port.

The maximum string length is 64 characters.

A few common character sequences are available to send special or non-printing characters to the modem serial port:

Sequence	Description	Hex Value
\r	Carriage Return	0D
\n	Line Feed	0A

\\	Front slash	2F
\"	Quote	22
\t	Tab	09
\e	Escape	1B

So `SEND "test\r\n"` will send 'test' followed by CR (hex 0D) and LF(hex 0A)

8.5.4.2 SEND in Binary Mode

```
SEND "6120737472696E670D"
```

Sends 'a string' followed by carriage return (hex 0D) to the serial port.

The maximum string length is 32 binary characters, which is 64 bytes of ASCII hex.

8.5.5 WAITFOR

Waits for a string to arrive on the modem serial port, with a maximum delay. If the maximum delay time is reached without receiving the target string then the modem adds 'UM-TIMEOUT' to the received data buffer and proceeds to the next line of the script. Behavior of this command depends on the ASCII/Binary setting (see ASCII and BINARY commands)

8.5.5.1 WAITFOR in ASCII Mode

```
WAITFOR "S>",3000
```

Waits for the string 'S>' for up to 3 seconds. Note the ',' character is required before the delay

The maximum string length is 64 characters.

8.5.5.2 WAITFOR in Binary Mode

```
WAITFOR "533E",3000
```

Waits for the string 'S>' for up to 3 seconds. (0x53 is hex for 'S', 0x3E is hex for '>')

The maximum string length is 32 binary characters, which is 64 bytes of ASCII hex.

8.6 Example Retrieving Data with a Script

In this example the slave modem is preconfigured with a script in the A file. The Slave WAKEUPSRC=1.

8.6.1 Sample Script Setup

This is the sample script pre-programmed in the slave modem:

```
S9>read a
<FILE>
serial on 19200
send "test command"
waitfor "end",10000
save d
</FILE>
OK; 0 Events
S9>
```

Master		Slave
	Receive	Transmit
PWRUP S9>fcl OK; 0 Events S9>!37run a <Remote> RUNNING PROGRAM A OK; 0 Events; qs 5421 </Remote> <qs>96216</qs> OK; 0 Events		
	test command	
		response: abcdefghijklmnopqrstuvwxyz0030 abcdefghijklmnopqrstuvwxyz0060 abcdefghijklmnopqrstuvwxyz0090 abcdefghijklmnopqrstuvwxyz0120 abcdefghijklmnopqrstuvwxyz0150 abcdefghijklmnopqrstuvwxyz0180 abcdefghijklmnopqrstuvwxyz0210 abcdefghijklmnopqrstuvwxyz0240 abcdefghijklmnopqrstuvwxyz0270 abcdefghijklmnopqrstuvwxyz0300 end

```
S9>!37read s
<Remote>
<FILE id='S' len='0'
crc='FFFFFFFF'></FILE>
OK; 0 Events; qs 5421
</Remote>
<qs>154654</qs>
OK; 0 Events
```

S file is empty because the sample script used SAVE D to move data to the D file.

```
S9>!37read dl
<Remote>
<FILE id='DL' len='381' crc='
48DD8BA'><UMSample v='0' n='9'
l='323'
crc='CFCD4D0C'>response:
abcdefghijklmnopqrstuvwxyz0030
```

```
abcdefghijklmnopqrstuvwxyz0060
abcdefghijklmnopqrstuvwxyz0090
abcdefghijklmnopqrstuvwxyz0120
abcdefghijklmnopqrstuvwxyz0150
abcdefghijklmnopqrstuvwxyz0180
abcdefghijklmnopqrstuvwxyz0210
abcdefghijklmnopqrstuvwxyz0240
abcdefghijklmnopqrstuvwxyz0270
abcdefghijklmnopqrstuvwxyz0300
end</UMSample>

</FILE>
OK; 0 Events; qs 5421
</Remote>
<qs>117921</qs>
OK; 0 Events
```

The READ DL command returns only the data from the most recent script. Read D could be used to read all data.

9 Using the D File

The D file is a general purpose text file stored in nonvolatile memory. The D file is intended for ASCII text, but it can store any characters except 0x00, 0x08, 0x1B, 0x7E and 0xFF. The D file is a circular buffer with maximum length 5Mbytes (5242880 bytes). Writing past this maximum length will delete the oldest data first in chunks of 65536 bytes.

9.1 Reading the D File

There are two commands to read the D file. The READ D command reads the entire D file. The READ DL command reads only the last entry in the D file. Both are accepted through the serial interface or IM interface.

Note some terminal programs may change lines ending in CR to CR LF and vice versa. Terminal programs may display lines differently depending on these characters. When using TeraTerm Version 2.82 we recommend configuring Setup->Terminal-> New-line receive CR+LF and transmit CR. This avoids confusion caused by new lines printing on top of previous lines. Another good technique is to log the data to a file and view the file in a text editor.

9.2 Writing to the D File

There are two ways to write data to the D file. On is the WRITE D command available through the serial interface. The other is the SAVE D command in a script (the A file). WRITE D allows immediate storage of data in the D file. SAVE D moves data from the S file to the D file (leaving the S file empty).

9.2.1 D File Last Entry

Each WRITE D command on the serial port or script run containing a SAVE D command resets the lastSampleLen and lastSampleCRC. This allows the READ DL command to respond with the data saved in the most recent entry and the CRC matching this data.

9.2.2 D File Status

Use the STATUS D command to read status of the D file. This data is also included in the GETSD command reply. The nextWrite value indicates the next write address within the modem's nonvolatile memory. It is included only for debugging purposes.

```
S9>status d
<DataBuffer>
  nextWrite=2097219
  len=67
  CRC=4D995C9D
  lastEntryLen=67
  lastEntryCRC=4D995C9D
</DataBuffer>
OK; 0 Events
S9>
```

9.2.3 Writing to D File Over Serial Interface

The example below uses CR (not CR+LF) at the end of each line. Data recording continues until the modem receives either 'END D' on a line by itself or the escape character (0x1B) or ~(0x7E).

```
S9>write d
USE 'END D' OR ESCAPE TO END
test1
end d

OK; 0 Events

S9>read d

<FILE id='D' len='6' crc='AC00FCE4'>test1
</FILE>

OK; 0 Events
```

Note the CR between 'test1' and 'end d' is included in the recorded data. To avoid this use the escape key (0x1B) or ~ (0x7E) to end the write.

```
S9>write d
USE 'END D' OR ESCAPE TO END
```

```
test2
end d

OK; 0 Events

S9>read d

<FILE id='D' len='12' crc='1963B1B7'>test1
test2
</FILE>
```

Note the second WRITE D command appended the data to the file.

```
OK; 0 Events

S9>read dl

<FILE id='DL' len='6' crc='872DAF27'>test2
</FILE>

OK; 0 Events

S9>
```

The READ DL command read only the data from the most recent write.

9.2.3.1 Unexpected LF characters

Some terminal programs send both CR and LF when the enter key is pressed, while others send only CR. The Ultimodem accepts the WRITE D command on the CR. If your terminal then sends LF then the data written to the D file will start with LF.

9.2.4 D File Command Table

Command	Notes
READ D	Read the entire D file
READ DL	Reads the last entry in the D file
WRITE D	Appends a new entry to the D file
ERASE D	Erases the entire D file
STATUS D	Returns the status of the D file including length and checksums of both the entire file and the last entry

9.2.5 Saving to D File in a Script

When used in a script (program A) the SAVE D command appends the contents of the S fileto the D file. The data is wrapped in <UMSample> tags with separate length, sample number and CRC data. In the example below the S filecontained “TEST DATA\r” when the WRITE D command was processed. The sample number was 2 (n=’2’). The length is 10, which includes the CR at the end.

```
S9>read dl
```

```
<FILE id='DL' len='67' crc='4D995C9D'><UMSample v='0' n='2' l='10'
crc='957ADEB7'>test data
</UMSample>

</FILE>
```

It is appropriate to use the SAVE D command multiple times in a single script. This results in multiple <UMSample> tags with the same sample number. The READ DL command will return all data saved within the script even with multiple SAVE D commands in the program.

9.3 Example Retrieving Data Through D File

In this example a controller connected to the slave modem saves data to the D file and the controller on the master modem retrieves the data. Note for this example the slave WAKEUPSRC is set to 0 to allow the attached controller access to the serial command interface.

The master could also use the READ DL command to read only the last data written to the D file.

This example used MOD=4 for faster communication.

Note

Master

```
PWRUP
S9>fcl
OK; 0 Events
S9>!37read d
<Remote>
<FILE id='D' len='323'
crc='AE54A710'>test d file:
abcdefghijklmnopqrstuvwxyz0030
```

Slave

```
PWRUP
S9>write d
USE 'END D' OR ESCAPE TO END
test d file:
abcdefghijklmnopqrstuvwxyz0030
abcdefghijklmnopqrstuvwxyz0060
abcdefghijklmnopqrstuvwxyz0090
abcdefghijklmnopqrstuvwxyz0120
abcdefghijklmnopqrstuvwxyz0150
abcdefghijklmnopqrstuvwxyz0180
abcdefghijklmnopqrstuvwxyz0210
abcdefghijklmnopqrstuvwxyz0240
abcdefghijklmnopqrstuvwxyz0270
abcdefghijklmnopqrstuvwxyz0300
end d
OK; 0 Events
S9>sleep
OK; 0 Events
S9>SLEEP
```

```
abcdefghijklmnopqrstuvwxyz0060
abcdefghijklmnopqrstuvwxyz0090
abcdefghijklmnopqrstuvwxyz0120
abcdefghijklmnopqrstuvwxyz0150
abcdefghijklmnopqrstuvwxyz0180
abcdefghijklmnopqrstuvwxyz0210
abcdefghijklmnopqrstuvwxyz0240
abcdefghijklmnopqrstuvwxyz0270
abcdefghijklmnopqrstuvwxyz0300
</FILE>
OK; 0 Events; qs 5569
</Remote>
<qs>155866</qs>
OK; 0 Events
S9>sleep
```

10 GDATA Commands

Sensors from Sea-Bird Electronics use commands like GDATA, DATA and SENDGDATA to synchronize sampling of all instruments on a mooring.

The Ultimodem now supports these commands.

10.1 SENDGDATA

Sends GDATA global command to all remote sensors. The IM line must be captured. This global command tells all sensors to take a sample.

10.2 GDATA

When an Ultimodem receives the GDATA global command it runs the A file data collection script. Refer to previous sections for details about the A file.

10.3 DATA

This returns the contents of the S file, which holds data collected by the A file script. Refer to previous sections for details about the S file.

Note there is no DATAii command. The master modem should use !nnDATA to retrieve data.

11 Possible Communication Failures

Several types of communication failures are possible. Proper handling of at least

11.1 No Reply

If noise occurs as the master transmits the command to the slave, the slave may not understand the command and may not reply.

```
S9>!37ver
Error:No reply

S9>
<qs>130</qs>

OK; 0 Events
```

11.1.1 No Response with Incorrect Reply Detection

If the slave modem did not reply there is a chance the master modem will read a start of reply marker in the background noise. In this case the master sends the <Remote> tag but the characters received are just noise.

11.2 Reply Detection Fail

If noise occurs at the start of a reply the master may not detect the slave modem reply. In this case the master must attempt to transmit until the slave reply terminates – otherwise two devices transmit at the same time and results are unpredictable.

```
S9>!37ver
Error:No reply

S9>
<qs>143143</qs>
```

Note the large number in the <qs> tags – this means something is transmitting. The controller should release the line (REL) and wait until the MLN command shows low noise.

Table 7: MLN Response With and Without IM Activity

Nothing Transmitting	Slave Modem Transmitting
S9>rel	S9>rel
OK; 0 Events	OK; 0 Event
S9>mln	S9>mln
00067	01166
00052	00993
00040	01190
00062	01220
00060	00920
00058	01002
00037	00978
00065	01128
00068	00900
00043	01195

```
OK; 0 Events          OK; 0 Events
```

11.3 Wrong Slave Responds

If noise corrupts the target slave address it is possible for the wrong slave to respond. This is most common with many slave devices on a mooring. The most reliable way to avoid this is to avoid using sequential slave addresses. Using slave addresses 01,02,03 is much more likely to have this issue than using 11,22,33.

11.4 Multiple Slave Response

Similar to Wrong Slave Responds, noise during the slave address portion of the signal can cause more than one slave to respond. This means more than one device transmits on the IM line at the same time. Usually the result looks like noise and garbage characters. This case may appear the same as No Response with Incorrect Reply Detection and it should be handled the same way.

12 XON XOFF Software Flow Control

By default the modem uses XON / XOFF software flow control. When the modem serial receive buffer reaches 380 characters the modem sends the XOFF character (0x13) requesting the host pause transmission, and when the buffer has emptied to 128 characters the modem sends the XON character (0x11) telling the host it is ok to continue transmission. This setting is particularly important for sending files, such as the F file used for firmware updates.

12.1 Disabling Software Flow Control

The XON and XOFF characters may cause confusion if they are not processed properly by the host instrument controller or terminal program. They can be disabled by setting SFLOW 0. Use SFLOW 1 to enable software flow control. This setting is included in the GETCD response.

12.2 Serial Buffer Length

The modem serial buffer size is 8kBytes. Writing more than 8kbytes with flow control disabled allows a risk the modem might not be able to handle the data fast enough and may drop some bytes.

13 Complete Command Set

Command	Blocks	Parameters	Description
GETCD			Displays configuration settings
GETSD			Displays status data
GETEC			Displays event counters
VER			Displays hardware and firmware version
SETDEFAULTS			Resets all configuration to default values
TXTEST	RS232		Transmits a IM test string

PWROFF			Same as SLEEP. Terminates active mode (IM Service or Host Service)
SLEEP			Same as PWROFF. Terminates active mode (IM Service or Host Service)
RESETEC			Resets (clears) the event counters
RESET			Resets the modem – ending all processes and forcing return to sleep mode.
WRITE	FILE	A, F, D	Writes to a file.
APPEND	FILE	A	Appends a file
READ	FILE IM*	A, S, F, D	Reads a file. *READ S and READ A are allowed on IM interface. READ D and READ F are allowed only on serial interface.
ERASE	FILE	A, S, F, D	Erases a file
STATUS		A, S, F, D	Displays status about a file (not implemented for all files)
RUN	FILE	A, F	Runs a file as a script. RUN F runs F file as a simple command script. RUN A runs the A file as a data collection script.
DUMPFLASH	FILE IM		Outputs the entire contents of the flash memory. May take 10 minutes to complete.
FCL	IM IM ACTIVE		Same as CL. Captures the IM line.
CL	IM IM ACTIVE		Same as FCL. Captures the IM line.
SWT	IM		Sends a wake-up tone
MLN	IM IM ACTIVE		Measures noise on the IM line.
VTX			Reports the transmitter voltage level
IMMONITOR (same as IMMON)	IM IM ACTIVE		Same as IMMON. Starts a monitor mode displaying all characters received from the IM network.
IMMON (same as IMMONITOR)	IM IM ACTIVE		Same as IMMONITOR. Starts a monitor mode displaying all characters received from the IM network.
XTP	IM IM ACTIVE		Retrieves a sample from each XTP sensor on the IM network.
REL	IM		Releases the IM line
!	IM IM IDLE		Sends a command to a remote modem
!G	IM IM IDLE		Sends a group IM command to the network. There are no replies to group commands.
ID?	IM IM IDLE		Retrieves the device ID of the modem on the IM line. NOTE: this command does not work when more than one IM device is on the network!
#	IM IM IDLE		Sends a command through a remote modem to its serial port.

#G	IM IM IDLE	Sends a command through a group of remote modems to their serial ports.

14 Configuration

14.1 Modulation

Set both master and all slave modems to mod=4 to use 4800 baud IM communications. This mode is not compatible with modems from Sea-Bird Electronics. Use MOD=1 on all modems for 1200 baud IM communications.

Please note: When using MOD 4 setting in firmware prior to version 0.99Q the SWT command is required to wake remote modems. When using MOD 1 setting the wakeup tone is recommended but not required (unless using older SBE devices)

14.2 Wakeup Source

The WAKEUPSRC setting is often an important difference between the master modem and slave modems.

Master: WAKEUPSRC=1 so the master modem will not waste time / power looking for IM signals initiated from other instruments.

Slaves: WAKEUPSRC=2 so the slave units will not respond to RS232 activity from the slave instruments except at request of the master. This prevents situations where the modem and instrument echo characters or invalid commands to each other in an infinite loop.

14.3 Configuration Summary

Below are the configurations of the master and slave modems used in this example.

U004 (master – datalogger)

```
S9>wakeupsrc=1
OK; 0 Events
S9>getcd
<Config type='Ultimodem' sn='U004'
v='0'>
<Hardware>
  <Assembly>50109</Assembly>
  <Firmware>ULTIMODEM
V0.96A</Firmware>
</Hardware>
<Settings>
  baud=19200
  mod=1200 baud@4.8k (1)
  id=04
  group=0
  wakeupsrc=RS232 Only (1)
  hostPrompt=S>
  cmdTO=60
  asyncRx=1
  telMode=1
```

U02N (connected to instrument)

```
S9>wakeupsrc=2
OK; 0 Events
S9>getcd
<Config type='Ultimodem'
sn='U037' v='0'>
<Hardware>
  <Assembly>50109</Assembly>
  <Firmware>ULTIMODEM
V0.96A</Firmware>
</Hardware>
<Settings>
  baud=19200
  mod=1200 baud@4.8k (1)
  id=37
  group=0
  wakeupsrc=IM Only (2)
  hostPrompt=S>
  cmdTO=60
  asyncRx=1
  telMode=1
```

```
  hostWakeup=2
  termFromHost=13
  termToHost=254
  thost0=0
  thost1=5
  thost2=3000
  thost3=12000
  thost4=500
  thost5=5
  tmodem2=500
  tmodem3=18000
  icd=1
  echo=1
  sflow=1
</Settings></Config>

OK; 0 Events
S9>
```

```
  hostWakeup=2
  termFromHost=13
  termToHost=254
  thost0=0
  thost1=5
  thost2=3000
  thost3=12000
  thost4=500
  thost5=5
  tmodem2=500
  tmodem3=18000
  icd=1
  echo=1
  sflow=1
</Settings></Config>

OK; 0 Events
S9>
```

15 Configuration Settings

Note the name of each configuration setting is also a command to modify that setting. Use a space or = between the command and parameter value:
`BAUD=19200`
and
`BAUD 19200`
Are both acceptable.

Command	Parameter default value in ()	Description
ID	00-ZZ (01) Always two alphanumeric digits.	Modem ID for IM network.
GROUP	0-9 (0)	Group address for IM network.
WAKEUPSRC	0 (RS232 and IM) (0) 1 (RS232 only) 2 (IM Only)	Selects interfaces which can wake the modem from sleep mode
MODULATION (same as MOD)	1-4 (1)	Selects the encoding used for IM communication – this determines the speed of communication on the IM network. Use MOD=4 for 4800 baud communication
MOD (same as MODULATION)		
BAUD	1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200	Baud rate for serial port.

HOSTPROMPT	11 characters max, no spaces	Prompt expected from host serial device. This is one method of confirming host wake up.[4]
MODEMPROMPT	11 characters max, no spaces, S9>	Prompt displayed by Ultimodem in Host Service mode
CMDTO	10-300 (60) (seconds)	Time-out setting for Host Service mode. Host Service ends if no valid commands received for this length of time.
ASYNCRX	0 (off) 1 (on)	Enables/disables # commands on IM line when Host Service mode active. Only applies when WAKEUPSRC=0.
TELMODE	1 (old SBE compat) (1) 2 (IMM binary compat) 3 (max bandwidth)	Selects encoding of data on the IM network – allows full compatibility with IMMs, SIMs and instruments from SEA-Bird Electronics.
HOSTWAKEUP	0-255 (\r)	Selects action taken to wake host before forwarding data from incoming # commands. 0 - no action 1 – set IMFlag output to high state to wake host (note imfConfig may invert state) 2 – send CR (\r) followed by 10mS delay to wake host. 3 – pulse IMFlag output high for 10mS to wake host (note imfConfig may invert state) >3 – wake host with a serial break of length 10mS times HOSTWAKEUP setting. (HOSTWAKEUP=10 causes a 100mS break)
TERMFROMHOST	0-255 (0)	Selects a character from the host to trigger the end of a reply to an incoming # command. 0 – no termination character. 1-253 – termination character Note this reply may also be terminated by the THOST2, THOST3 or THOST4 settings.
TERMTOHOST	0-255 (254)	Selects a character to send to the host to terminate incoming # commands. 0 – no termination character 254 – CR (0x0D) followed by LF (0x0A)
THOST0	0 – 1000 (0)	Maximum wait for host wakeup confirmation
THOST1	0-300 (5)	Delay after confirming host wakeup (in tens of milliseconds)
THOST2	0-3000 (3000)	Maximum wait for start of host reply (in tens of milliseconds)
THOST3	100 – 18000 (12000)	Maximum host reply transmission time (in tens of milliseconds)
THOST4	5-18000 (500)	Inter-character delay timeout for host reply (in tens of milliseconds)
THOST5	5-3000 (5)	Not implemented
TMODEM2	0-3000 (500)	Max wait for start of IM reply (in Host Service mode, in tens of milliseconds)
TMODEM3	0-60000 (18000)	Max IM receive time (in Host Service mode, in tens of milliseconds)
ICD	0-50 (1)	Delay inserted between characters sent to host. Units are milliseconds.

[4]The Sea-Bird Electronics IMM has a modemprompt setting controlling the prompt sent in host service mode by the IMM. The Ultimodem has no such setting – its prompt is always S9>

DEBUGLEVEL	0-5(0)	debuglevel > 0 enables verbose messages when handling host commands (#ii commands)
imfConfg	0-1 (0)	IMFlag output configuration 0-IMFlag uses normal polarity (active signal is 3.3V) 1-IMFlag uses inverted polarity (active signal is 0V) NOTE: some hardware may have external inverting buffers or open-drain transistors on the IMFlag signal.

Note: THOST, TMODEM and a few other settings are implemented with function similar to the like-named settings in Sea-Bird Electronics IMM's. This is for the convenience of customers seeking the superior performance of the UltiModem in applications already using older IM modems.

15.1 Reading the D File

There are two commands to read the D file. The READ D command reads the entire D file. The READ DL command reads only the last entry in the D file. Both are accepted through the serial interface or IM interface.

Note some terminal programs may change lines ending in CR to CR LF and vice versa. Terminal programs may display lines differently depending on these characters. When using TeraTerm Version 2.82 we recommend configuring Setup->Terminal-> New-line receive CR+LF and transmit CR. This avoids confusion caused by new lines printing on top of previous lines. Another good technique is to log the data to a file and view the file in a text editor.

15.2 Writing to the D File

There are two ways to write data to the D file. On is the WRITE D command available through the serial interface. The other is the SAVE D command in a script (the A file). WRITE D allows immediate storage of data in the D file. SAVE D moves data from the S file to the D file (leaving the S file empty).

15.2.1 D File Last Entry

Each WRITE D command on the serial port or script run containing a SAVE D command resets the lastSampleLen and lastSampleCRC. This allows the READ DL command to respond with the data saved in the most recent entry and the CRC matching this data.

15.2.2 D File Status

Use the STATUS D command to read status of the D file. This data is also included in the GETSD command reply. The nextWrite value indicates the next write address within the modem's nonvolatile memory. It is included only for debugging purposes.

```
S9>status d
<DataBuffer>
  nextWrite=2097219
  len=67
  CRC=4D995C9D
```

```
  lastEntryLen=67
  lastEntryCRC=4D995C9D
</DataBuffer>
OK; 0 Events
S9>
```

15.2.3 Writing to D File Over Serial Interface

The example below uses CR (not CR+LF) at the end of each line. Data recording continues until the modem receives either 'END D' on a line by itself or the escape character (0x1B) or ~(0x7E).

```
S9>write d
USE 'END D' OR ESCAPE TO END
test1
end d

OK; 0 Events

S9>read d

<FILE id='D' len='6' crc='AC00FCE4'>test1
</FILE>

OK; 0 Events
```

Note the CR between 'test1' and 'end d' is included in the recorded data. To avoid this use the escape key (0x1B) or ~ (0x7E) to end the write.

```
S9>write d
USE 'END D' OR ESCAPE TO END
test2
end d

OK; 0 Events

S9>read d

<FILE id='D' len='12' crc='1963B1B7'>test1
test2
</FILE>
```

Note the second WRITE D command appended the data to the file.

```
OK; 0 Events

S9>read dl

<FILE id='DL' len='6' crc='872DAF27'>test2
</FILE>
```

```
OK; 0 Events

S9>
```

The READ DL command read only the data from the most recent write.

15.2.3.1 Unexpected LF characters

Some terminal programs send both CR and LF when the enter key is pressed, while others send only CR. The Ultimodem accepts the WRITE D command on the CR. If your terminal then sends LF then the data written to the D file will start with LF.

15.2.4 D File Command Table

Command	Notes
READ D	Read the entire D file
READ DL	Reads the last entry in the D file
WRITE D	Appends a new entry to the D file
ERASE D	Erases the entire D file
STATUS D	Returns the status of the D file including length and checksums of both the entire file and the last entry

15.2.5 Saving to D File in a Script

When used in a script (program A) the SAVE D command appends the contents of the S fileto the D file. The data is wrapped in <UMSample> tags with separate length, sample number and CRC data. In the example below the S filecontained “TEST DATA\r” when the WRITE D command was processed. The sample number was 2 (n=’2’). The length is 10, which includes the CR at the end.

```
S9>read dl
<FILE id='DL' len='67' crc='4D995C9D'><UMSample v='0' n='2' l='10'
crc='957ADEB7'>test data
</UMSample>

</FILE>
```

It is appropriate to use the SAVE D command multiple times in a single script. This results in multiple <UMSample> tags with the same sample number. The READ DL command will return all data saved within the script even with multiple SAVE D commands in the program.

15.3 Example Retrieving Data Through D File

In this example a controller connected to the slave modem saves data to the D file and the controller on the master modem retrieves the data. Note for this example the slave WAKEUPSRC is set to 0 to allow the attached controller access to the serial command interface.

The master could also use the READ DL command to read only the last data written to the D file.

This example used MOD=4 for faster communication.

Note

Master

```
PWRUP
S9>fcl
OK; 0 Events
S9>!37read d
<Remote>
<FILE id='D' len='323'
crc='AE54A710'>test d file:
abcdefghijklmnopqrstuvwxyz0030
abcdefghijklmnopqrstuvwxyz0060
abcdefghijklmnopqrstuvwxyz0090
abcdefghijklmnopqrstuvwxyz0120
abcdefghijklmnopqrstuvwxyz0150
abcdefghijklmnopqrstuvwxyz0180
abcdefghijklmnopqrstuvwxyz0210
abcdefghijklmnopqrstuvwxyz0240
abcdefghijklmnopqrstuvwxyz0270
abcdefghijklmnopqrstuvwxyz0300
</FILE>
OK; 0 Events; qs 5569
</Remote>
<qs>155866</qs>
OK; 0 Events
S9>sleep
```

Slave

```
PWRUP
S9>write d
USE 'END D' OR ESCAPE TO END
test d file:
abcdefghijklmnopqrstuvwxyz0030
abcdefghijklmnopqrstuvwxyz0060
abcdefghijklmnopqrstuvwxyz0090
abcdefghijklmnopqrstuvwxyz0120
abcdefghijklmnopqrstuvwxyz0150
abcdefghijklmnopqrstuvwxyz0180
abcdefghijklmnopqrstuvwxyz0210
abcdefghijklmnopqrstuvwxyz0240
abcdefghijklmnopqrstuvwxyz0270
abcdefghijklmnopqrstuvwxyz0300
end d
OK; 0 Events
S9>sleep
OK; 0 Events
S9>SLEEP
```

16 Telemetry Settings

The Ultimodem supports multiple inductive communication protocols. The two most important settings are the modulation and the encoding. The MOD setting controls modulation, the TELMODE setting

controls the encoding. For two modems to communicate reliably they must be set to the same modulation and encoding.

16.1 Support for Sea-Bird Electronics SIM

MOD 1 / TELMODE 1 matches the modulation and encoding of the Surface Inductive Modem (SIM) from Sea-Bird Electronics.

16.2 Support for Sea-Bird Electronics IMM

MOD 1 / TELMODE 2 supports the IMM from Sea-Bird electronics.

16.3 High Speed Communication

The highest speed communication currently supported is MOD 4 / TELMODE 3. This allows 4800 baud inductive communication. The encoding allows single-character transmission for all but three characters.

Please note: When using MOD 4 setting in firmware prior to version 0.99Q the SWT command is required to wake remote modems. When using MOD 1 setting the wakeup tone is recommended but not required (unless using older SBE devices)

17 IM Signal Strength and QS Values

IM signal strength is the signal level on the IM line as detected by a receiving modem. The signal strength values are referred to as QS values (from Quality of Service). The Ultimodem measures QS values at the following times:

1) At the start of reply to every #ii or !xx command
2) During the reception of data from each sensor in response to an XTP or XT2 command
3) Immediately upon entering IM Service mode (when a remote device captures the IM line)
4) When running the MLN command.

The units of these measurements are not defined. The scale is linear. All measurements are about 20% accuracy and will vary with temperature and clamping force on IM couplers.

The background noise level of the IM amplifiers is typically 30 to 60 units.

The threshold for reliable communication with no external noise is 200-500.

The threshold for reliable communications in the presence of noise is completely dependent on the type or noise, noise source, and spectral composition of the noise.

Typical QS values on a 1KM mooring are on the order of 100000.

Maximum QS values are about 5000000

Transmitting between two standard Ultimodems with properly clamped couplers and a 10K series resistor in the IM loop results in signal strength of 1000.

Transmitting between two standard Ultimodems with properly clamped couplers and a zero series resistance in a short the IM loop results in signal strength of 5000000.

17.1 Transmitter Voltage Level and Vtx Values

The IM transmitter is current limited to protect the modem hardware from damage. This results in lowering of the transmit voltage as the current drawn from the transmitter increases. The Vtx value in the GETSD reply and the VTX command allow monitoring of the transmit voltage. Transmit voltage changes with type and condition of the IM coupler and the series resistance of the IM loop as seen by the transmitting device.

The transmitter voltage is an important debugging and testing tool. A low transmitter voltage indicates higher current draw in the transmitter. This may be caused either by an IM coupler which is damaged or not clamped properly or by an IM loop with little or no series resistance.

The maximum transmitter voltage is 3.3V. There is no minimum voltage required for communication.

Table 8: Vtx values vs Coupler Condition

Device	Coupler Properly clamped	Coupler Loosely clamped, 0.2mm gap	Coupler halves not mated
Standard Ultimodem Mod 1	2.76	0.99	0.66
Standard Ultimodem Mod 4	2.76	2.41	0.70

Table 9: Vtx Values Vs Device and IM Loop Impedance

Device	Infinite (no loop)	12 ohms	1.2 ohms	Zero Ohms
Standard Ultimodem Mod 1	2.76	2.71	2.39	0.78
Standard Ultimodem Mod 4	3.19	3.13	2.70	1.23
OEM Direct Connect (18122) Mod 1, 100 ohm shorted,10uf series	3.21	3.08	3.08	3.08
OEM Direct Connect (18122) Mod 1, 100 ohm shorted,10uf shorted	3.21	2.68	1.8	1.4
OEM Direct Connect (18122) Mod 4, 100 ohm shorted, 10uf series	3.26	2.90	2.82	2.82
OEM Direct Connect (18122) Mod 4, 100 ohm shorted,10uf shorted	3.26	2.77	1.91	1.45

18 Firmware Updates

Firmware update files are text files with firmware encoded in ASCII hex. They are sent to the modem through the RS232 serial connection. Follow these steps to perform a firmware update:

1) Make sure the serial interface and Host Service mode are enabled. If the WAKEUPSRC is set to 2 you need to change WAKEUPSRC to 0 through the IM interface using another modem.
2) Set mod=1. Firmware updates do not work when modulation setting is higher than 1.
3) Make sure the modem's battery has some life left in it – or connect an external power source. Firmware updates require a stable power supply.
4) Open a terminal program (we prefer TeraTerm)
5) Set sflow=1 to enable software flow control in the modem. This eliminates the possibility of dropped bytes when streaming the firmware update file.
6) Change the baud rate if desired – this allows the file to transmit faster. To do this, send BAUD 115200.
7) Reset the modem by sending the SLEEP command. This guarantees all changes to serial port settings take effect.
8) Set the terminal program port flow control to Xon/Xoff or 'SOFTWARE HANDSHAKING' (under Setup->Serial Port in TeraTerm).
9) Change the baud rate setting in the terminal program if required.
10) Press enter to get a S9> prompt from the modem.
11) Type the VER command to check the current firmware version of your modem
12) Send the firmware update file to the modem. (no encoding – in TeraTerm use File->Send File)
13) Wait for the file transmission to finish. This may take a minute or two at 19200 baud.
14) Enter the RUN F command to initiate parsing, integrity checking and device type verification. This may take 10 to 15 seconds. If the file is OK the modem will respond with:
    `Confirmed - ready to program`
15) Enter the PROGRAM command to start the firmware update. The firmware update takes only a few seconds. Do not disconnect power within 10 seconds of sending the PROGRAM command, doing so may corrupt the firmware and disable the controller.
16) After the firmware update completes the modem will be in sleep mode. Press a key to wake the modem and use the VER command to verify the new firmware version.

19 Power Consumption

Power consumption depends significantly on hardware, settings and operating mode. Modems with RS232 interface require significantly more power than modems with logic level serial interface. Modems with built-in switching power supplies are much more efficient at input voltages above 3.6V compared to modems optimized for use with 3.6V lithium batteries.

19.1 Units with Linear Voltage Regulators

The Ultimodem includes standard linear voltage regulators. These draw the same amount of current regardless of the voltage applied at the power input. For best efficiency use the lowest allowable voltage.

19.2 Units with High Efficiency Switching Voltage Regulators

The 15032B and 15122 circuit boards include switching voltage regulators. These draw a nearly fixed power, so reducing the input voltage increases the current draw and increasing the input voltage decreases the current draw.

We recommend OEM customers use units with built-in switching power supplies in systems with input voltages of 5V or greater.

Table 10 Power Consumption When MOD=1

Mode	15032B or 18122 Logic level 10 V Supply Current (uA)	15032B or 18122 RS232 10 V Supply Current (uA)	15011B logic level, 3.3V Supply Current (uA)	15011B RS232 3.3V Supply Current (uA)	Ultimodem In Housing R2232 3.6V battery Current (uA)
MOD 1 (1200 baud, SBE compatible)					
Sleep	27.5	30.2	28	30	30
19200 baud					
Host service					
Idle	260	1777	708	4846	4460
IM transmitting (FCL)	529	2120	1443	5782	6420
IM receiving (IMMON)	270	1810	736	4936	4450
IM Service					
IM receive	265	270	723	736	590
IM transmit (!xxTXTEST)	517	581	1410	1585	2600
57600 baud					
Host service					
Idle	370	1966	1009	5362	4610
IM transmitting (FCL)	641	2266	1748	6180	6720
IM receiving (IMMON)	380	1970	1036	5373	4690
IM Service					
IM receive	378	384	1031	1047	840
IM transmit (!xxTXTEST)	630	698	1718	1904	2600
115200 baud					
Host service					
Idle	370	1975	1009	5386	4620
IM transmitting (FCL)	641	2327	1748	6346	6730
IM receiving (IMMON)	380	1970	1036	5373	4730
Write D	835	2980	2277	8127	6010
Read D	3342	5630	9115	15355	12290
IM Service					
IM receive	378	385	1031	1050	840
IM transmit (!xxTXTEST)	631	696	1721	1898	2600

Table 11 Power Consumption When MOD=4

Mode	15032B or 18122 Logic level 10 V Supply Current (uA)	15032B or 18122 RS232 10 V Supply Current (uA)	15011B logic level, 3.3V Supply Current (uA)	15011B RS232 3.3V Supply Current (uA)	Ultimodem In Housing R2232 3.6V battery Current (uA)
MOD 4 (4800 baud)					
Sleep	28	30	28	30	30
19200 baud					
Host service					
Idle	583	2120	1590	5782	5100
IM transmitting (FCL)	785	2370	2141	6464	5720
IM receiving (IMMON)	629	2190	1715	5973	5260
Write D	740		2018		4550
Read D	1158		3158		6300
IM Service					
IM receive	651	667	1775	1819	1460
IM transmit (!xxTXTEST)	824	885	2247	2414	1890
57600 baud					
Host service					
Idle	584	2185	1593	5959	5250
IM transmitting (FCL)	790	2375	2155	6477	5650
IM receiving (IMMON)	630	2245	1718	6123	5280
Write D	950		2591		6600
Read D	2351		6412		9790
IM Service					
IM receive	651	667	1775	1819	1470
IM transmit (!xxTXTEST)	827	881	2255	2403	1900
115200 baud					
Host service					
Idle	584	2188	1593	5967	5260
IM transmitting (FCL)	790	2436	2155	6644	5630
IM receiving (IMMON)	630	2250	1718	6136	5330
Write D	1280	3730	3491	10173	7140
Read D	3900	6360	10636	17345	13650
IM Service					
IM receive	655	668	1786	1822	1470
IM transmit (!xxTXTEST)	828	885	2258	2414	1900