SOUNDNINE INC

S9

Helping build successful monitoring systems

Enduro Operating Manual

Soundnine Inc Document #R010R
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S9

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Quick Start

All Enduro sensors are shipped sealed with a new battery, desiccant and SDHC memory card. This is the factory configuration:

- 60 second sample period
- Record time, temperature, pressure (if equipped), tilt and raw accelerometer values
- Store both raw data and data in engineering units
- Logging not started
- Inductive modem device id set to the last two digits of the sensor serial number. For example, sensor serial number A01B is set to device ID=1B.

With Ultimodem

Most users can use an Ultimodem to change configuration and start logging:

1. Connect an Ultimodem to a computer serial port and start a terminal program (19200 baud, 8 bits, no parity, 1 stop bit, handshaking set to either software, Xon/Xoff or none.
2. Create an IM loop by passing one end of a wire through the IM coupler of the modem, through the coupler of one or more Enduro sensors, then connect the two ends of the wire together.
3. Press enter a few times in the terminal program to get a S9> prompt from the Ultimodem.
4. Send the commands in the table below, replacing device id '1B' with the last two digits of the serial number of the Enduro you wish to configure:

Command	Action	Notes
FCL	Starts modem transmitting to IM line	Wait 1 second to be sure Enduro detected the signal before sending the next command.
!1Bperiod=60	Sets the sampling period in seconds (1 to 3600)	
!1Btime=2016-06-20T133000	Sets the time	
!1Bgetsd	Displays status	verify the time was set properly and there are no warning messages
!1Bgetcd	Displays configuration	
!1Bstart	Starts logging	
!1Btsc	Take sample, include checksum	Refer to Temperature Resolution Control The TMODE command sets the temperature resolution. Higher resolution requires more time to take a measurement and consumes more power. TMODE=1 provides 0.001C resolution, which is appropriate for most applications and minimizes power consumption.

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		TMODE=2 provides the maximum resolution (0.0001C), but consumes more power. Note the AMODE and PMODE commands are reserved for similar features with the accelerometer and pressure sensor. These may include burst sampling modes. Retrieving Data with Checksums for details on checksum calculation
!1Bglc	Gets last sample with checksum	
*SAMPLE	Sample all endure on the line	**Refer to Temperature Resolution Control** The TMODE command sets the temperature resolution. Higher resolution requires more time to take a measurement and consumes more power. TMODE=1 provides 0.001C resolution, which is appropriate for most applications and minimizes power consumption. TMODE=2 provides the maximum resolution (0.0001C), but consumes more power. Note the AMODE and PMODE commands are reserved for similar features with the accelerometer and pressure sensor. These may include burst sampling modes. **Retrieving Data with Checksums** Several commands return data with checksums. These commands should be used whenever possible instead of the similar commands without checksums. The checksums should be verified whenever possible to prevent single-bit communication errors

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		from contaminating sensor data.
		The checksum is a CRC7. Example code is included below (CRC7 Checksum Code). The checksum includes all bytes from the start of the line up to but not including the *.
		Examples:
		S9>tsc A01A,ATPE,2000-01-01T00:58:10,26.7679,-0.4065,54.7356,0.5653392,-0.4064664,19607,-19607,-19607*79 OK; 0 Events S9>tssc A01A,ATPE,2000-01-01T00:58:16,26.7588,-0.4072,54.7356,0.5655401,-0.4071817,19607,-19607,-19607*5E OK; 0 Events S9>glc A01A,ATPE,2000-01-01T00:58:16,26.7588,-0.4072,54.7356,0.5655401,-0.4071817,19607,-19607,-19607*5E OK; 0 Events S9>
		Using *SAMPLE section below

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1. Open the housing and connect the USB cable.
2. Wait for the green light to flash once per second – this means the Enduro is connected to USB.
3. Open a terminal program and select the correct COM port. Use the highest available baud rate, no parity, 1 stop bit.
4. Press enter a few times to get a S9 prompt from the Enduro.
5. Send the following commands:

Command	Action	Notes
period=60	Sets the sampling period in seconds (1 to 3600)	
time=2016-06-20T133000	Sets the time	
getsd	Displays status	verify the time was set properly and there are no warning messages
Getcd	Displays configuration	
start	Starts logging	
ts	Take sample	
gl	Gets last sample	

Data Recording

The Enduro records each sample as a line of plain text with values separated by commas. Data is first stored in a RAM buffer (the S file). This RAM buffer is periodically recorded to a 7 Megabyte circular FLASH memory buffer (the D file). This FLASH memory buffer is periodically recorded to the removable SDHC memory card.

Removing the SDHC Memory Card

Always press the button and wait for the green light to flash before removing the memory card. The yellow light will flash quickly while Enduro transfers data. Three long yellow flashes indicate a problem writing to the memory card. One green flash means all data transferred and you can remove the card.

Data Format

Data downloaded from the Enduro or stored on the SDHC memory card is in a simple comma-separated table format. The data order is always the same:

TIME, Temp (C), Pressure (dbar), Tilt (deg)), raw thermistor, raw pressure, accel x, accel y, accel z

Depending on the FORMAT setting, some data may not be recorded. These values are left blank, so the data table always has 9 columns.

Time can be either IS0-9601 style (2016-07-20T13:38:00) or an integer number of seconds since 2000-01-01T00:00:00, referred to as SY2K – seconds since year 2000.

See the FORMAT command section to change the data format.

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Examples:

Format ATE:

```
2016-07-21T11:22:57,29.7038,,87.3609,0.5045745,,,-6660,76,307
```

Format ATES:

```
522419600,29.3002,,88.4524,0.5124578,,,-6662,72,180
```

Opening and Closing the Housing

Opening

NOTE: If there is any indication of water inside the pressure housing then handle it with caution! Rattling or sloshing inside the housing, hissing or other noises may indicate water intrusion in the housing. If there is any chance the housing might contain water then please wear safety glasses and chemical resistant gloves – there could be pressure inside the housing or hazardous chemicals if the battery leaked. Please do not ship or transport the housing if it may have water in it.

1. Upon recovery rinse the housing with fresh water and dry it off.
2. Wait for the housing to reach room temperature. If the housing is below room temperature when opened then water may condense on and damage the electronics.
3. Place the housing on a clean surface with the faceplate facing up.
4. Remove the six faceplate screws with 3/32" hex driver
5. Lift the faceplate off. A few drops of water may cling to the underside of the faceplate – take care not to let water drip into the electronics.
6. Gently wipe the o-ring groove and faceplate with a tissue to remove any water.
7. Remove the desiccant bag and set it aside. The desiccant cannot be reused unless properly recharged.

Sealing

NOTE: The faceplate screws are titanium for optimal corrosion resistance. Screws of any other material will rapidly fail due to galvanic corrosion.

1. Remove the o-ring and inspect for tears or any irregularity. Wipe it clean if necessary – make sure there are no hairs, sand, water or dirt on the o-ring or in the o-ring groove.
2. If the o-ring is new or feels dry then lubricate it with a small amount of Molykote M44.
3. Place the o-ring in the o-ring groove. Make sure it is installed uniformly and not twisted.
4. Place a new or recharged desiccant bag over the battery.
5. The outside surface of the faceplate is flat, the inside is milled to match the opening in the housing. Align the faceplate to match the opening in the housing and gently press it in place.
6. Install all six screws partially before tightening, then tighten each screw finger tight – just enough to fully close the gap between the faceplate and the housing. Do not overtighten.

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Command Set

Commands

Commands are not case sensitive. All commands must end with a carriage return (CR, '\r') character (automatically generated by a terminal program when you press enter). If a line feed character follows (LF, '\n') it will be ignored.

Any arguments or parameters may be separated by either a space or an equals sign(=). Note that Enduro accepts '=' or a space, but not both.

Status Commands

GETCD

Displays sensor configuration.

```
S9>getcd
<Config type='Enduro-AT' sn='A00G' v='0'>
<Hardware>
  <Assembly>5010B</Assembly>
  <Firmware>ENDURO APT V0.74</Firmware>
</Hardware>
<Cal>
  acx=0
  acy=0
  acz=0
  asx=16384
  asy=16384
  asz=16384
  bcx=0
  bcy=0
  bcz=0
  bsx=16384
  bsy=16384
  bsz=16384
  c0=1.1934415e-03
  c1=2.8425242e-04
  c2=0.0000000e+00
  c3=0.0000000e+00
  r0=3.3000000e+03
  p0=0.0000000e+00
  p1=1.0000000e+00
</Cal>
<Settings>
  ID=0G
  GROUP=E
  stype=ATES
  period=1
  amode=2
  arate=4
```

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```
  ascale=0
  mscale=0
  STARTED
</Settings></Config>

OK; 0 Events
S9>
```

GETSD

Displays sensor status. This includes the battery voltage, memory status and SD card status. It is common for the sensor to pause for a moment during the GETSD command while the SD card initializes (this pause does not interrupt sampling).

Warnings are displayed in the GETSD response if the memory card is not installed or cannot be written to. These warnings mean the sensor cannot save data to the memory card and data recording is limited to the 7 megabyte internal memory. These are the two warning messages:

No memory card installed:

```
S9>getsd
<Status type='Enduro-AT' sn='A00G' v='0'>
<DataBuffer>
  nextWrite=956323
  not saved=38819
  total=38819
</DataBuffer>
<SDHC_CARD>
  ***WARNING:   SDHC MEMORY CARD NOT INSTALLED!***
  lastSampleTime=2016-07-10T10:00:03
  Vbat=2.303
  Vtx=2.377
  TIME=2016-07-10T10:00:03
  STARTED
</Status>
```

Cannot write to memory card:

```
S9>getsd
<Status type='Enduro-AT' sn='A00G' v='0'>
<DataBuffer>
  nextWrite=988984
  not saved=71480
  total=71480
</DataBuffer>
<SDHC_CARD>
  SDHC card installed
  ***WARNING: 71480 DATA BYTES NOT SAVED TO CARD!***
  ***WARNING: 603 STATUS BYTES NOT SAVED TO CARD!***
  <File  Name='none'  Size='0' />
  <File  Name='none' Size='0' />
```

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```
</SDHC_CARD>
   lastSampleTime=2016-07-10T10:09:37
   Vbat=3.607
   Vtx=3.057
   TIME=2016-07-10T10:09:37
   STARTED
</Status>
```

This is the GETSD response when the memory card is working properly:

```
S9>getsd
<Status type='Enduro-AT' sn='A00G' v='0'>
<DataBuffer>
   nextWrite=1002342
   not saved=2968
   total=84838
</DataBuffer>
<SDHC_CARD>
   SDHC card installed
   <File  Name='S9A00G.TXT'  Size='84.8KB'  />
   <File  Name='S9A00GS.TXT' Size='903'  />
</SDHC_CARD>
   lastSampleTime=2016-07-10T10:16:18
   Vbat=3.604
   Vtx=3.057
   TIME=2016-07-10T10:16:18
   STARTED
</Status>
```

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>getec
<EventData>
numEvents = 0
</EventData>
```

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

VER

Displays sensor hardware and firmware version.

```
S9>ver
HTYPE 5010B
CD AB0B0AE0, 12000002
```

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```
CODE TYPE ENDURO
FIRM ENDURO APT V0.74
CDATE Jul 12 2016 23:01:08
```

Configuration Commands

Refer to Configuration Settings for a full list of settings.

ERASE CONFIG

This command resets all configuration settings to default values, but does not change calibration coefficients. Note the default ID setting is the last two digits of the serial number. Default settings from the GETCD response are listed here:

```
S9>getcd
<Config type='Enduro-AT' sn='A00G' v='0'>
…
<Settings>
  ID=0G
  GROUP=E
  stype=ATE
  period=60
  amode=2
  arate=4
  ascale=0
  mscale=0
  STOPPED
</Settings></Config>
```

TIME

The TIME command both sets and displays Enduro's current time. To display the time just enter the time command by itself:

```
S>time
time=2013-11-05T01:24:47
OK - 0 Events
```

To set the time include the current time in IS0-9601 format with no time zone. Multiple time formats are allowed:

```
time=2015-11-05T14:24:47
time 2015-11-05T14:24:47   (the = is optional)
time=20151105T142447
```

Note that Enduro accepts '=' or a space, but not both.
When the time is accepted the reply looks like this:

```
S9>time 2016-07-21T112000
Time changed to 2016-07-21T11:20:00
```

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```
OK; 0 Events
```

FORMAT

The FORMAT command both displays and sets the data recording format. To display the current format enter the command by itself:

To change the format, use the command followed by any combination of the letters A, T, P, E and S (with no spaces).

A – Accelerometer
T – Temperature
P – Pressure
E – Engineering unit conversion. Saves temperature in degrees C, pressure in decibars and tilt in degrees from vertical.
S – Seconds since year 2000 time format (SY2K). Default is ISO-9601 format if the S is not included.

If you omit A, T or P from the sample format then the omitted sensors will not be sampled. This may be desired to save power.

Examples

Acceleration, temperature, engineering units and time in seconds since year 2000:

```
OK; 0 Events
S9>format
stype=ATE
TIME (ISO),TEMP (C), ,TILT (deg), THERM RAW, ,AX, AY, AZ
OK; 0 Events

S9>format ates
```

STYPE means sample type. This is a sample in format 'ATE':
```
2016-07-21T11:22:57,29.7038,,87.3609,0.5045745,,,-6660,76,307
```

Utility Commands

PWROFF or SLEEP

Returns the sensor to low-power sleep mode. This command is not allowed when the USB interface is active.

RESET

Forces a full reset (like a reboot). This forces sensor to return to low-power sleep mode, abandoning all in-process activity. When sending this command over USB you must disconnect the USB cable and close the terminal program, then reconnect the cable and open the terminal program.

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RESETEC

Resets the event counters.

File Commands

The sensor has several files in RAM, flash memory and the SDHC memory card. Files are identified by one or more letters (F, S, D, ST, STR, SD).

Available Files

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 table.

D File

The D file is a 7 Mbyte circular buffer for ASCII data. This file is too large to read over inductive modem, but it can be read in the USB interface. Data in the D file is periodically copied to the SDHC memory card.

S File

The S file is a short RAM buffer of recent samples, typically less than 2KB. This is the only data buffer readable through the inductive modem. Note that the GETSD command clears the S buffer, and the S buffer is automatically cleared periodically when Enduro transfers data to the D file in flash memory.

STR File

The STR file is a short status log file stored in RAM. This log includes power cycling, time changes and notes of any hardware or firmware events. It is readable through the inductive modem. Note that the GETSD command clears the STR buffer, and the STR buffer is automatically cleared periodically when Enduro transfers data to the ST file in flash memory.

ST File

The ST file is a circular status log file in flash memory. It is too large to read through the inductive modem. Data in the ST file is periodically copied to the SDHC memory card.

SD File

This is the data file on the SDHC memory card. This file is too large to read through the inductive modem, and may take tens of minutes to read through USB.

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WRITE

Writes data to a file. Not all files support this command.

READ

Retrieves data from a file

ERASE

Erases a file.

RUN

Runs a script file. Only allowed with the F file.

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.

(Not including calibration setting commands)

Command	Blocks	Parameters	Description
GETCD			Displays configuration settings
GETSD			Displays status data
GETEC			Displays event counters
VER			Displays hardware and firmware version
ERASE CONFIG			Resets all configuration to default values, does not change calibration values
PERIOD		1-3600	Sets the sample period in seconds
FORMAT		A,P,T,E and / or S	Displays or sets the data recording format
TS			Take sample, do not record the sample **TSC command is preferred for new applications!**
TSS			Take sample and store **TSSC command is preferred for new applications!**
TSC			Take sample, do not record the sample, include checksum
TSSC			Take sample and store, include checksum
GL GETLAST			Gets the last sample (if there is one) **GLC command is preferred for new applications!**
GLC			Gets the last sample (if there is one), includes checksum
START			Starts logging
STOP			Stops logging
TIME			Sets or reads the time

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TXTEST			Transmits a test pattern for IM communications testing
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	F, D	Writes to a file.
READ	FILE IM*	F, D, S, ST, STR, SD	Reads a file. *READ S and READ STR are allowed on IM interface. READ D, READ F, READ ST and READ SD are allowed only on USB interface.
ERASE	FILE	F, D, MEM	Erases a file (ERASE MEM clears all files except those on the SDHC memory card)
RUN	FILE	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.
MODEM OFF	IM		Disables the inductive modem completely. This is recommended for logging applications where the inductive modem will not be used. **Must be entered through USB, can only be reversed through USB**
MODEM ON			Enables the inductive modem
TMODE		1-2	Temperature resolution mode: 1 is 0.001 C resolution (saves power) 2 is 0.0001 C resolution (maximum)
PMODE			Pressure mode – reserved for future use
AMODE			Accelerometer mode - reserved for future use
ARATE		1-50	Accelerometer sample rate – reserved for future use
ASCALE		0-3	Sets full scale range of the accelerometer (in g- for gravity) 2g,4g,6g,8g
MSCALE		0-3	Sets full scale range of the magnetometer (in gauss) 2g, 4g, 8g, or 12g

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:
```
ID 01
```
and
```
ID=01
```
Are both acceptable.

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Command	Parameter default value in ()	Description
ID	00-ZZ (01) Always two alphanumeric digits.	Modem ID for IM network.
GROUP	0-9; A-Z (E)	Group address for IM network.
PERIOD	1-3600	Sets the sample period in seconds
FORMAT	A,P,T,E and / or S	Displays or sets the data recording format
AMODE		Accelerometer mode - reserved for future use
ARATE	1-50	Accelerometer sample rate – reserved for future use
ASCALE	0-3	Sets full scale range of the accelerometer (in g- for gravity) 0=+/- 2g 1=+/- 4g 2=+/- 6g 3=+/- 8g
MSCALE	0-3	Sets full scale range of the magnetometer (in gauss) 0=+/- 2g 1=+/- 4g 2=+/- 8g 3=+/- 12g

Calibration Settings

Note the name of each calibration setting is also a command to modify that setting. Use a space or = between the command and parameter value:
ASX 0
and
ASX=0
Are both acceptable.

Setting	Range	Description
C0	-1 to 1	Temperature coefficient 0
C1	-1 to 1	Temperature coefficient 1
C2	-1 to 1	Temperature coefficient 2
C3	-1 to 1	Temperature coefficient 3
P0	-30 to 30	Pressure coefficient 0 (offset)
P1	0 to 5	Pressure coefficient 1 (scale)
ACX	-500 to 500	Accelerometer X offset
ACY	-500 to 500	Accelerometer Y offset
ACZ	-500 to 500	Accelerometer Z offset
ASX	14000 to 18000	Accelerometer X offset
ASY	14000 to 18000	Accelerometer Y scale

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ASZ	14000 to 18000	Accelerometer Z scale
BCX	-500 to 500	Magnetometer X offset
BCY	-500 to 500	Magnetometer Y offset
BCZ	-500 to 500	Magnetometer Z offset
BSX	14000 to 18000	Magnetometer X offset
BSY	14000 to 18000	Magnetometer Y scale
BSZ	14000 to 18000	Magnetometer Z scale

Temperature Resolution Control

The TMODE command sets the temperature resolution. Higher resolution requires more time to take a measurement and consumes more power. TMODE=1 provides 0.001C resolution, which is appropriate for most applications and minimizes power consumption. TMODE=2 provides the maximum resolution (0.0001C), but consumes more power.

Note the AMODE and PMODE commands are reserved for similar features with the accelerometer and pressure sensor. These may include burst sampling modes.

Retrieving Data with Checksums

Several commands return data with checksums. These commands should be used whenever possible instead of the similar commands without checksums. The checksums should be verified whenever possible to prevent single-bit communication errors from contaminating sensor data.

The checksum is a CRC7. Example code is included below (CRC7 Checksum Code). The checksum includes all bytes from the start of the line up to but not including the *.

Examples:

```
S9>tsc
A01A,ATPE,2000-01-01T00:58:10,26.7679,-0.4065,54.7356,0.5653392,-0.4064664,19607,-19607,-19607*79
OK; 0 Events
S9>tssc
A01A,ATPE,2000-01-01T00:58:16,26.7588,-0.4072,54.7356,0.5655401,-0.4071817,19607,-19607,-19607*5E
OK; 0 Events
S9>glc
A01A,ATPE,2000-01-01T00:58:16,26.7588,-0.4072,54.7356,0.5655401,-0.4071817,19607,-19607,-19607*5E
OK; 0 Events
S9>
```

Using *SAMPLE

The Enduro – Ultimodem combination allows sampling all Enduro sensors on a mooring with a single command (*SAMPLE). Note *SAMPLE is an Ultimodem command, not an Enduro command.

The Ultimodem *SAMPLE command tells all Enduro sensors on the line to immediately take a sample. These samples will be synchronized in time to within a few milliseconds. Each endure then waits for an opportunity to transmit the sample.

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The *SAMPLE system relies on the Enduro's ability to detect when other devices transmitting. This may be interfered with by mechanical or electrical noise on the mooring. Such interference may result in one or more sensors not responding.

If a sensor did not respond, it is very likely it did take a synchronized sample but did not detect an opportunity to transmit. In this case it may be polled individually with the GLC command.

Example:

```
PWRUP
S9>fcl
OK; 2 Events
S9>*sample

AT:A008,ATES,297,28.5816,,90.0000,0.5268511,,-6826,118,0*46*39535,32*
AT:A01H,ATES,186,22.8815,,89.4202,0.6660873,,-988,-16,-10*4E*40216,32*
AT:A021,ATES,192,27.2567,,89.1177,0.5546510,,-6623,-34,102*73*40720,32*
AT:A022,ATES,310,22.3738,,89.0272,0.6730605,,-6478,7,110*14*40126,32*
AT:A01T,ATPES,188,22.7412,,88.4345,0.6631864,,-6842,31,187*49*40287,32*

OK; 2 Events
S9>
```

CRC7 Checksum Code

This code calculates a CRC7 checksum. This is provided as-is with no warrantee for the free use of S9 customers and integrators.

```
const uint8_t crc7Table[256] = {
0x00, 0x09, 0x12, 0x1b, 0x24, 0x2d, 0x36, 0x3f,
0x48, 0x41, 0x5a, 0x53, 0x6c, 0x65, 0x7e, 0x77,
0x19, 0x10, 0x0b, 0x02, 0x3d, 0x34, 0x2f, 0x26,
0x51, 0x58, 0x43, 0x4a, 0x75, 0x7c, 0x67, 0x6e,
0x32, 0x3b, 0x20, 0x29, 0x16, 0x1f, 0x04, 0x0d,
0x7a, 0x73, 0x68, 0x61, 0x5e, 0x57, 0x4c, 0x45,
0x2b, 0x22, 0x39, 0x30, 0x0f, 0x06, 0x1d, 0x14,
0x63, 0x6a, 0x71, 0x78, 0x47, 0x4e, 0x55, 0x5c,
0x64, 0x6d, 0x76, 0x7f, 0x40, 0x49, 0x52, 0x5b,
0x2c, 0x25, 0x3e, 0x37, 0x08, 0x01, 0x1a, 0x13,
0x7d, 0x74, 0x6f, 0x66, 0x59, 0x50, 0x4b, 0x42,
0x35, 0x3c, 0x27, 0x2e, 0x11, 0x18, 0x03, 0x0a,
0x56, 0x5f, 0x44, 0x4d, 0x72, 0x7b, 0x60, 0x69,
0x1e, 0x17, 0x0c, 0x05, 0x3a, 0x33, 0x28, 0x21,
0x4f, 0x46, 0x5d, 0x54, 0x6b, 0x62, 0x79, 0x70,
0x07, 0x0e, 0x15, 0x1c, 0x23, 0x2a, 0x31, 0x38,
0x41, 0x48, 0x53, 0x5a, 0x65, 0x6c, 0x77, 0x7e,
0x09, 0x00, 0x1b, 0x12, 0x2d, 0x24, 0x3f, 0x36,
0x58, 0x51, 0x4a, 0x43, 0x7c, 0x75, 0x6e, 0x67,
0x10, 0x19, 0x02, 0x0b, 0x34, 0x3d, 0x26, 0x2f,
0x73, 0x7a, 0x61, 0x68, 0x57, 0x5e, 0x45, 0x4c,
0x3b, 0x32, 0x29, 0x20, 0x1f, 0x16, 0x0d, 0x04,
0x6a, 0x63, 0x78, 0x71, 0x4e, 0x47, 0x5c, 0x55,
0x22, 0x2b, 0x30, 0x39, 0x06, 0x0f, 0x14, 0x1d,
0x25, 0x2c, 0x37, 0x3e, 0x01, 0x08, 0x13, 0x1a,
0x6d, 0x64, 0x7f, 0x76, 0x49, 0x40, 0x5b, 0x52,
```

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```
0x3c, 0x35, 0x2e, 0x27, 0x18, 0x11, 0x0a, 0x03,
0x74, 0x7d, 0x66, 0x6f, 0x50, 0x59, 0x42, 0x4b,
0x17, 0x1e, 0x05, 0x0c, 0x33, 0x3a, 0x21, 0x28,
0x5f, 0x56, 0x4d, 0x44, 0x7b, 0x72, 0x69, 0x60,
0x0e, 0x07, 0x1c, 0x15, 0x2a, 0x23, 0x38, 0x31,
0x46, 0x4f, 0x54, 0x5d, 0x62, 0x6b, 0x70, 0x79
};

/**
 * calculate CRC7
 */
uint8_t crc7Calc(char *data, uint8_t len){
    uint32_t i;
    uint8_t crc = 0;

    for (i = 0; i<len; i++) {
        crc = crc7Table[(crc << 1) ^ data[i]];
    }

    return crc;
}
```

Hardware

Size: 200 mm x 35 mm x 40 mm

Materals: PET & Titanium

Depth Rating: 1,000 meters

Mass: 308 grams

The Enduro assembled on a mooring cable is nearly concentric and will fit through a 5 cm diameter opening.

Serviceable Parts

Battery

Enduro 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.

O-Ring

Enduro 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.

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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.

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.

Desiccant

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

Coupler Clamp

The coupler clamp assembly both clamps the Enduro 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 Enduro 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.

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 (standard)	4-40 x 1/4" titanium socket head cap screw	20584	95435A338
Faceplate screws (long)	4-40 x 3/8" titanium socket head cap screw	20586	95435A350
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	
Coupler Clamp	Custom polyester and ferrite assembly	50031 **Specify cable diameter when ordering**	

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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) Connect the USB cable
2) Open a terminal program (we prefer TeraTerm) and select the appropriate COM port
3) Set the port flow control to Xon/Xoff or 'SOFTWARE HANDSHAKING' (under Setup->Serial Port in TeraTerm)[1].
4) Press enter to get a S9> prompt from the sensor.
5) Type the VER command to check the current firmware version of your sensor
6) Send the firmware update file to the sensor. (no encoding – in TeraTerm use File->Send File)
7) Wait for the file transmission to finish.
8) 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 sensor will respond with:
   ```
   Confirmed – ready to program
   ```
9) Enter the PROGRAM command to start the firmware update. The firmware update takes only a few seconds. Do not disconnect the battery or USB cable within 10 seconds of sending the PROGRAM command, doing so may corrupt the firmware and disable the controller.
10) After the firmware update completes the sensor will be in sleep mode and the USB connection needs a full reset. Close the terminal program and disconnect the USB cable.
11) Reconnect the USB cable.
12) Open the terminal program and select the appropriate COM port.
13) Press a key to wake the sensor and use the VER command to verify the new firmware version.

---

[1] Xon/Xoff handshaking is not required for Enduro, but is included in these instructions for consistency with other S9 products where it is required.

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