SOUNDNINE INC

Helping build successful monitoring systems

X-TP Sensor with Inductive Telemetry

Temperature, Pressure and Tilt

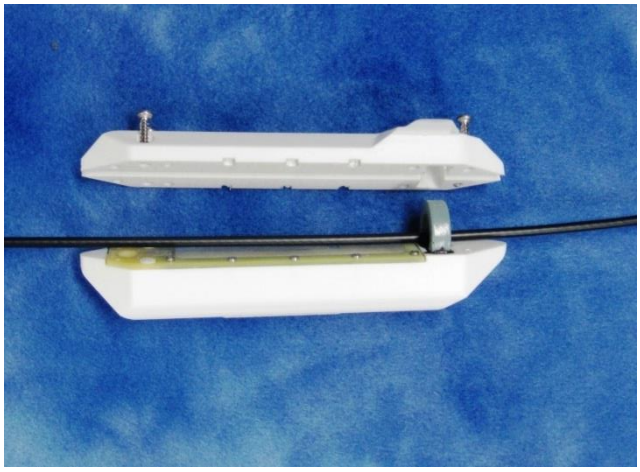
The XTP sensor is an e**X**pendible **T**emperature, **P**ressure (optional) and tilt sensor that transmits data in real time over plastic-jacketed wire rope via inductive telemetry. It communicates with S9's Ulti-modem (or Sea-Bird IMM).

Inductive telemetry uses the mooring wire as the data transmission medium, eliminating bulky, expensive and failure-prone underwater electrical cables and connectors. The XTP is small, lightweight and robust, and it can be positioned at any point on the wire to optimize sensor spacing. Users can easily reposition sensors to suit changing conditions.

The XTP sensor is ideal for expendable temperature profiling drifters and thermistor chain applications requiring high resolution profiles with high accuracy and stability. The internal battery allows sampling every 10 minutes for 1100 days when new, or 750 days after 4 years of storage. Initial accuracy is ± 5 millidegrees. The battery is not user serviceable, but can be replaced by S9 when the sensor is returned for calibration.

In a system with ten sensors sampling every ten minutes the internal battery lasts about three years.

The XTP is concentric on the cable and tapered to reduce drag, snagging and fouling.



Slide sensor to desired position and secure with wire clamp. Clamps are available for any cable size up to 10mm outer diameter.

Specifications:

Temperature

Range:	-5 to +45°C
Accuracy:	± 0.005°C (-5 to +35°C)
Stability:	0.0003°C/month typical
Resolution:	0.001°C
Time constant:	800 milliseconds (still water)

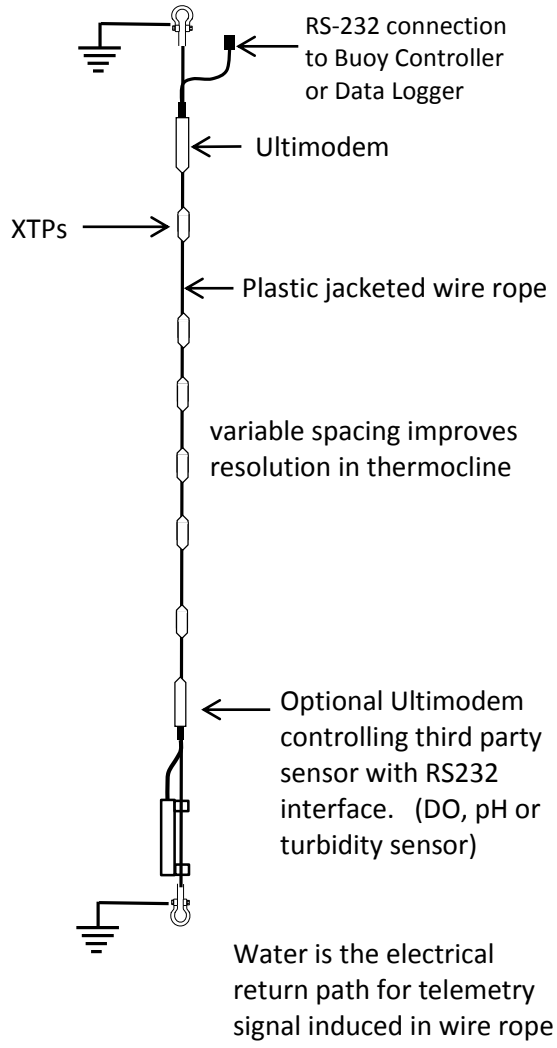
Pressure (optional)

Range:	**0-20 dbar**	or	**0-100 dbar**
Accuracy (absolute)	± 0.2 dbar		± 1.0 dbar
Resolution:	0.003 dbar		0.01 dbar

Tilt

Range:	+/- 180°	(+/- 2g acceleration)
Accuracy:	± 2°	(+/- 25 mg)
Resolution:	0.1°	(0.1mg / 0.15mg/rtHz)

Mechanical: 130 mm (L) x 33 mm x 28 mm
Housing: PET, 250 meters depth rating
Weight: 105 grams (in air), 35 grams (in seawater)



Note: The XTP pressure housing contains no user-servicable components. Customers should not open the XTP pressure housing. Opening the XTP pressure housing voids our warrantee and may compromise the pressure seal.

Data Retrieval and Format

Data format updated 2017-01-01. For units shipped before this date see XTP Spec Sheet R6.

With an Ultimodem, use FCL command
followed by XTP command:

```
S>FCL
OK; 0 Events
S9>
S>XTP
.....................
#G0:SCT01:X014,21.248,2167.782,89.772,4.097,49,1d,1*45*41244,32*
#G0:SCT02:X015,21.263,2520.654,89.584,4.078,16,b,1*7B*41107,32*
#G0:SCT03:X018,21.279,2503.380,89.884,4.058,31,13,1*42*41768,32*
#G0:SCT04:X019,21.273,2199.033,89.510,3.922,a2,3f,1*04*41236,32*
#G0:SCT05:X01A,21.197,2109.080,89.562,4.068,8a,38,1*38*41315,32*
#G0:SCT06:X01C,21.301,2066.829,88.442,4.081,8b,36,1*49*41763,32*
#G0:SCP07:X01F,21.277,2102.446,89.998,15.129,18.59,3.910,a6,3b,1*52*41438,32*
OK; 0 Events
S>
```

SCT format (no pressure):
#G0:SCTxx:temperature(C), thermistor resistance, tilt,battery voltage,wake-up count, sample count, Firmware Rev*CRC7*IM Signal Strength, IMS count

SCP format (with pressure):
#G0:SCPxx:temperature(C), thermistor resistance, tilt, pressure (psi), pressure temperature(C), battery voltage, wake-up count, Firmware Rev*CRC7*IM Signal Strength, IMS count

Tilt: compound tilt in degrees from vertical.
Pressure Temperature: approximate temperature of the pressure sensor – not calibrated. This is used for automatic internal temperature compensation of the pressure sensor.
xx: Logical ID assigned to the XTP. This determines the reporting order. This is not the same as an inductive device ID. It is assigned by the factory and cannot be changed.
Wake-up count: Number of times the sensor detected a signal on the IM line.
Sample Count: Number of times the sensor responded to sample request on the IM line.
Firmware Rev: integer firmware revision counter.
CRC7: transmission checksum, see last page of this document for details.
IM Signal Strength: Receive signal strength indicator (Generated by Ultimodem, not available with Sea-Bird IMM's)
IMS Count: number of samples used to calculate signal strength (Generated by Ultimodem, not available with Sea-Bird IMM's)

Note: XTP's do not respond to inductive !xx commands.

CRC7 Checksum

The checksum allows reliable detection of communication errors. The sensor calculates the checksum of the bytes transmitted and appends this checksum to the end of the transmission. The receiving system can verify the transmission by calculating the chesum of the received bytes – if the result of this calculation does not match the received checksum then there was a communication error.

Each sensor generates its own checksum. The checksum includes all bytes from the start of the line up to but not including the first *. It is a 7-bit Cyclic Redundancy Code (CRC), generated with the following code:

```
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,
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;
}
```