



# Ocean Sensor Systems, Inc.

## Wave Staff XB, OSSI-010-025

### A Wireless Wave Staff with Self-Grounding Coaxial Staffs and Synchronized Sampling

---

#### General Description

The OSSI010-025 Wave Staff XB is a water level sensor that combines a rugged, IP67 resistant to water submersion package, Xbee RF Module, low power microprocessor and Anti-aliasing sensing circuit. Months of operation with two Industry standard C size alkaline batteries. Sensor Staffs from 0.25 meters long to 20 meters long. The self-grounding Coaxial Rod and Cable Staffs eliminate the need for a separate water ground wire. Laptops and PCs can easily receive the Wave Staff XB's data with any one of several optional wireless Adaptors. Time stamped data can be used to synchronize up to 8 Wave Staff XBs. A new, easy to use, PC Interface Program is available to download from our web site to configure, display, analyze and store the sensor data.

#### Features

- **Wireless connectivity: Xbee/XBee-Pro Modules, ZigBee Personal Area Network (PAN)**
- **GateWay: USB and RS232**
- **Up to 8 Wave Staff XB's per PAN Network**
- **Powered with 2 C size batteries, Alkaline or Rechargeable Nickel Metal Hydride**
- **Months of Battery Life**
- **Automatic Anti-aliasing filter**
- **Sample Rates: 1, 2, 4, 8, 16 & 32**
- **Continuous Sampling or Burst Mode**
- **Data output Continuous or Buffered**
- **Data format: ASCII, Binary Float or Binary Integer**
- **Configurable Start Time**
- **Time Tagged data**
- **Real Time Clock Auto Synchronizing feature**
- **Battery Voltage Monitor**
- **Normal Current & High Current Sensor Mode**
- **0.25% FS Accuracy 0-100% range**
- **Optional 0.1% FS Accuracy 0-100% range**
- **Automatic Calibration for any staff length**

---

Wave Staff with a Rod Staff



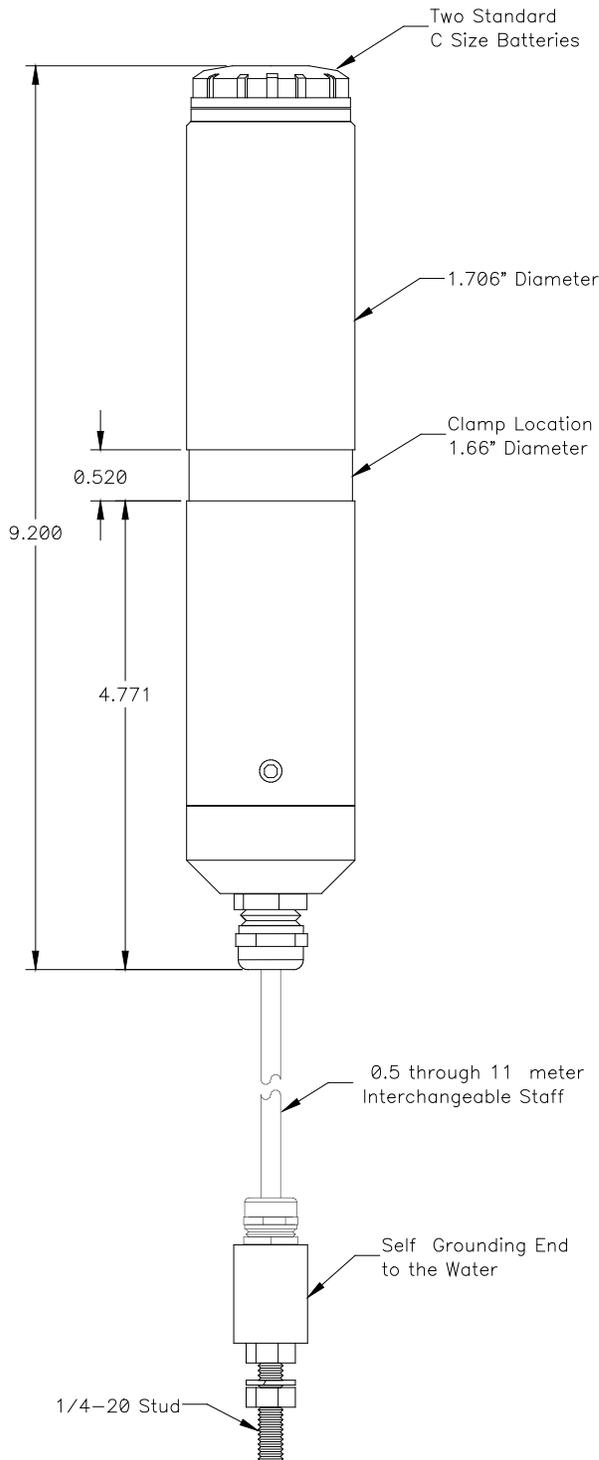
Wave Staff with a Cable Staff



Short End Rod Staff Option B



## Wave Staff XB OSSI-010-025



Batteries ALKALINE C 1.5V Energizer # EN93 International

## Wireless Computer Adapters

**XStick USB Adapter XU-Z11**  
OSSI-581-016



**XBee to USB Adapter Waterproof, IP67 with 5-meter-long cable.**

OSSI-015-020 Pro for North America  
OSSI-015-021 for International



**XBee RS232 Adapter XA-Z14-CS2PH**

OSSI-581-020-A Pro for North America  
OSSI-581-020-W for International



XBee-PRO® ZB Wall Router - Digi

End Stanchion #OSSI-015-018-E

Stanchion #OSSI-015-018-C

Bracket #015-018-B



Mounting Hardware Kits #Ossi-015-018-XX where XX is the Staff Length in meters

Add suffix E to the part number for 0.10% FS Factory Calibration Accuracy

Example: OSSI-010-025E-1R

### Wave Staff XB Part Numbers, Short End Rod Staff (0.95”), option B

Unit Type	Staff Length	Staff Type	Part Number
Wave Staff XB-B	0.25Meter Staff	Teflon Coated Coaxial Rod Short End	OSSI-010-025-0.25B
Wave Staff XB-B	0.5Meter Staff	Teflon Coated Coaxial Rod Short End	OSSI-010-025-0.5B
Wave Staff XB-B	1 Meter Staff	Teflon Coated Coaxial Rod Short End	OSSI-010-025-1B

## Wave Staff XB Part Numbers

Product	Staff Length	Staff Type	Part Number
Wave Staff XB	0.5Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025-0.5R
Wave Staff XB	1 Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025-1R
Wave Staff XB	1.5 Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025-1.5R
Wave Staff XB	2.0 Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025-2R
Wave Staff XB	0.5Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-0.5C
Wave Staff XB	1 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-1C
Wave Staff XB	1.5 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-1.5C
Wave Staff XB	2 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-2C
Wave Staff XB	3 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-3C
Wave Staff XB	4 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-4C
Wave Staff XB	5 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-5C
Wave Staff XB	6 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-6C
Wave Staff XB	7 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-7C
Wave Staff XB	8 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-8C
Wave Staff XB	9 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-9C
Wave Staff XB	10 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-10C
Wave Staff XB	11 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-11C
Wave Staff XB	12 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-12C
Wave Staff XB	13 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-13C
Wave Staff XB	14 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-14C
Wave Staff XB	15 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-15C
Wave Staff XB	16 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-16C
Wave Staff XB	17 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-17C
Wave Staff XB	18 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-18C
Wave Staff XB	19 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-19C
Wave Staff XB	20 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025-20C

Add suffix E to the part number for 0.10% FS Factory Calibration Accuracy

Example: OSSI-010-025E-1B

## Wave Staff XB-Pro Part Numbers

Unit Type	Staff Length	Staff Type	Part Number
Wave Staff XB-Pro	0.5Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025P-0.5R
Wave Staff XB-Pro	1 Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025P-1R
Wave Staff XB-Pro	1.5 Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025P-1.5R
Wave Staff XB-Pro	2 Meter Staff	Teflon Coated Coaxial Rod	OSSI-010-025P-2R
Wave Staff XB-Pro	0.5Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-0.5C
Wave Staff XB-Pro	1 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-1C
Wave Staff XB-Pro	1.5 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-1.5C
Wave Staff XB-Pro	2 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-2C

Wave Staff XB-Pro	3 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-3C
Wave Staff XB-Pro	4 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-4C
Wave Staff XB-Pro	5 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-5C
Wave Staff XB-Pro	6 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-6C
Wave Staff XB-Pro	7 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-7C
Wave Staff XB-Pro	8 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-8C
Wave Staff XB-Pro	9 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-9C
Wave Staff XB-Pro	10 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-10C
Wave Staff XB-Pro	11 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-11C
Wave Staff XB-Pro	12 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-12C
Wave Staff XB-Pro	13 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-13C
Wave Staff XB-Pro	14 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-14C
Wave Staff XB-Pro	15 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-15C
Wave Staff XB-Pro	16 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-16C
Wave Staff XB-Pro	17 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-17C
Wave Staff XB-Pro	18 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-18C
Wave Staff XB-Pro	19 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-19C
Wave Staff XB-Pro	20 Meter Staff	Teflon Coated Coaxial Cable	OSSI-010-025P-20C

Add suffix E to the part number for 0.10% FS Factory Calibration Accuracy

Example: OSSI-010-025PE-1R

### Wave Staff XB-Pro Part Numbers, Short End Rod Staff (0.95”), option B

Unit Type	Staff Length	Staff Type	Part Number
Wave Staff XB-Pro-B	0.25Meter Staff	Teflon Coated Coaxial Rod Short End	OSSI-010-025P-0.25B
Wave Staff XB-Pro-B	0.5Meter Staff	Teflon Coated Coaxial Rod Short End	OSSI-010-025P-0.5B
Wave Staff XB-Pro-B	1 Meter Staff	Teflon Coated Coaxial Rod Short End	OSSI-010-025P-1B

Add suffix E to the part number for 0.10% FS Factory Calibration Accuracy

Example: OSSI-010-025PE-1B

### Adapter Part Numbers

GateWay Products:	Certified Region	DiGi International	OSSI Part Number
XStick USB	US,CA,EU	XU-Z11	OSSI-581-016
XStick USB for Japan	JP	XU-Z11J	OSSI-581-016-J
XBee to USB adapter, Waterproof, 5-meter cable	International	OSSI	OSSI-015-021
XBee to USB adapter, Waterproof, 5 meter cable	North America	OSSI	OSSI-015-020
XBee to USB adapter, Waterproof	International	XA-Z14-CS2PH-W	OSSI-581-020-W
XBee ZB-PRO RS232 adapter, internal wire antenna	North America	XA-Z14-CE1P-A	OSSI-581-020-A

## Wireless Connectivity Table:

<b>Wave Staff Products:</b>	<b>Certified Region</b>	<b>Frequency</b>	<b>RF Line of Sight Range</b>	<b>Indoor/Urban Range</b>
Wave Staff XB	US, CA, EU, AU, BR, JP	2.4GHz	4000 ft. ( 1.2 Km)	200 ft. (60 m)
Wave Staff XB-Pro	US, CA, AU, BR	2.4GHz	2 miles ( 3.2 Km)	300 ft. (90 m)
<b>GateWay Products:</b>	<b>Certified Region</b>	<b>Frequency</b>	<b>RF Line of Sight Range</b>	<b>Indoor/Urban Range</b>
XStick USB	US, CA, EU, JP	2.4GHz	164 ft. ( 50 m)	66 ft. (20 m)
XBee to USB adapter, OSSI-015-021	US, CA, EU, AU, BR, JP	2.4GHz	4000 ft. ( 1.2 Km)	200 ft. (60 m)
XBee-PRO to USB adapter, OSSI-015-020	US, CA, AU, BR	2.4GHz	2 miles ( 3.2 Km)	300 ft. (90 m)
XBee ZB RS232 adapter, internal wire antenna	US, CA, EU, AU, BR, JP	2.4GHz	4000 ft. ( 1.2 Km)	200 ft. (60 m)
XBee-PRO ZB RS232 adapter, internal wire antenna	US, CA, AU, BR	2.4GHz	2 miles ( 3.2 Km)	300 ft. (90 m)

Note: The Wave Staff range is based on a Gateway Adapter having the same or greater rated range. For example a Digi XSick would limit the range to its lower rated range.

## Maximum Number of operating units on the same Personal Area Network (PAN) versus Sample Rate and Data Format:

<b>Data Format</b> Output Transmit Mode	<b>Sample Rate Hz</b>					
	1 Hz	2 Hz	4 Hz	8 Hz	16 Hz	32 Hz
ASCII 32 Samples (Buffered)	8	8	8	8	6	3
Float 32 Samples (Buffered)	8	8	8	8	8	4
Integer 64 Samples (Buffered)	8	8	8	8	8	8
ASCII 1 Sample	8	4	2	1	0	0

## Characteristics:

Parameter	Conditions	Min.	Typ.	Max.	Units
Battery Voltage, Total for 2 Two C size cells	2V = Battery Low Warning 1.8V = Battery Bad	1.8	3.0	3.3	Volts
Battery Life	See Days of battery Life Tables				days
Data Accuracy	0-100% of Full Scale (1) (6)		0.15	0.25	±% (2)
Data Accuracy, suffix E	0-100% of Full Scale (1) (6)		0.05	0.10	±% (2)
Data Resolution	ASCII 32 Samples (4)		1		mm
	Float 32 Samples (5)		0.1		mm
	Integer 64 Samples (5)		1		mm
	ACCII 1 sample (4)		1		mm
Data Range	ASCII 32 Samples (4)	0		99.999	meters
	Float 32 Samples (5)	-99.9999		+99.9999	meters
	Integer 64 Samples (5)	-30		+30	meters
	ACCII 1 sample (4)	0		99.999	meters
Data Linearity			0.15	0.25	± % (2)
Data Linearity, suffix E			0.05	0.10	± % (2)
Data Hysteresis			0.30		mm
Sample Frequency		1		32	Hz
Wireless Connection	XBee ZB or XBee-PRO ZB		2.4		GHz
Wireless Range	See Wireless Connectivity Table				
Sample Burst Time	Programmable	0		59	minutes
Sample Burst Interval	Programmable	1		60	minutes
Real Time Clock Accuracy	Typical at 25°C		10		PPM (3)
Auto Time Synchronize	Synchronize Time to PC's Clock		0.01		Seconds

Note 1: The unit may need to be calibrated in-situ to meet the Data Accuracy.

Note 2: Percent of Full Scale

Note 3: parts per million

Note 4: Buffered or Continuous output mode.

Note 5: Buffered output mode only

Note 6: Accuracy at 25°C water temperature. To correct for water temperature, use the following:

The Rod Staffs temperature coefficient is -0.033%/°C of reading from 0°C to 50°C.

The Cable Staffs temperature coefficient is -0.046%/°C of reading from 0 °C to 50°C

**Days of Battery Life:  
Wave Staff XB with Water Sensor in Normal Current Mode**

Data Format Output Transmit Mode	Sample Rate Hz	Battery Life in Days per Burst duty cycle, Length/Interval (1)				
		Continuous 100%	40% Burst	20% Burst	10% Burst	5% Burst
Continuous	1	38.5	78.0	118.5	160.2	194.5
Continuous	2	31.5	66.1	104.3	146.7	184.1
Continuous	4	23.1	50.7	84.2	125.6	166.6
Continuous	8	15.3	35.1	61.4	98.4	140.8
Buffered ASCII	1	46.5	90.6	132.6	172.7	203.3
Buffered ASCII	2	45.4	89.0	130.9	171.2	202.3
Buffered ASCII	4	44.1	87.0	128.7	169.3	201.0
Buffered ASCII	8	40.5	81.3	122.3	163.7	197.0
Buffered ASCII	16	34.1	70.7	109.9	152.2	188.4
Buffered ASCII	32	26.1	56.4	91.8	133.9	173.7
Buffered Binary Float	1	48.1	93.1	135.2	174.8	204.8
Buffered Binary Float	2	47.1	91.6	133.7	173.5	203.9
Buffered Binary Float	4	46.1	90.1	132.1	172.2	203.0
Buffered Binary Float	8	42.9	85.1	126.7	167.5	199.7
Buffered Binary Float	16	38.3	77.7	118.3	160.0	194.3
Buffered Binary Float	32	31.1	65.4	103.4	145.8	183.4
Buffered Binary Integer	1	48.9	94.3	136.5	175.9	205.5
Buffered Binary Integer	2	48.0	92.9	135.1	174.7	204.7
Buffered Binary Integer	4	47.1	91.6	133.7	173.5	203.9
Buffered Binary Integer	8	46.0	89.9	131.9	172.0	202.9
Buffered Binary Integer	16	43.2	85.6	127.2	168.0	200.1
Buffered Binary Integer	32	38.3	77.7	118.3	160.0	194.3

Note 1: Battery Life for two Standard C cell Batteries 17000 mWhr

Note 2: Battery life when Powered off or Burst sleep period is 247.24 Days

**Days of Battery Life:  
Wave Staff XB with Water Sensor in High Current Mode (2)**

Data Format Output Transmit Mode	Sample Rate Hz	Battery Life in Days per Burst duty cycle, Length/Interval (1)				
		Continuous 100%	40% Burst	20% Burst	10% Burst	5% Burst
Continuous	1	30.5	64.4	102.1	144.5	182.4
Continuous	2	25.9	56.0	91.4	133.4	173.3
Continuous	4	20.0	44.6	75.6	115.8	157.7
Continuous	8	13.9	32.0	56.7	92.2	134.4
Buffered ASCII	1	35.3	72.8	112.4	154.6	190.2
Buffered ASCII	2	34.7	71.7	111.2	153.4	189.3
Buffered ASCII	4	34.0	70.4	109.6	151.9	188.2
Buffered ASCII	8	31.8	66.6	104.9	147.3	184.6
Buffered ASCII	16	27.7	59.3	95.7	138.0	177.1
Buffered ASCII	32	22.2	48.9	81.6	122.8	164.1
Buffered Binary Float	1	36.3	74.3	114.3	156.3	191.5
Buffered Binary Float	2	35.7	73.4	113.2	155.3	190.8
Buffered Binary Float	4	35.1	72.4	112.0	154.2	189.9
Buffered Binary Float	8	33.3	69.2	108.1	150.4	187.1
Buffered Binary Float	16	30.4	64.2	101.9	144.4	182.3
Buffered Binary Float	32	25.7	55.5	90.7	132.7	172.7
Buffered Binary Integer	1	36.7	75.1	115.2	157.1	192.2
Buffered Binary Integer	2	36.2	74.2	114.2	156.2	191.5
Buffered Binary Integer	4	35.7	73.4	113.2	155.3	190.8
Buffered Binary Integer	8	35.1	72.3	111.9	154.1	189.8
Buffered Binary Integer	16	33.4	69.5	108.5	150.8	187.4
Buffered Binary Integer	32	30.4	64.2	101.9	144.4	182.3

Note 1: Battery Life for two Standard C cell Batteries 17000 mWhr

Note 2: High current Sensor adds 4.8 mWatts more to battery current

Note 2: Battery life when Powered off or Burst sleep period is 247.24 Days

**Days of Battery Life:  
Wave Staff XB-Pro with Water Sensor in Normal Current Mode**

Data Format Output Transmit Mode	Sample Rate Hz	Battery Life in Days per Burst duty cycle, Length/Interval (1)				
		Continuous 100%	40% Burst	20% Burst	10% Burst	5% Burst
Continuous	1	33.7	70.0	109.1	151.4	187.8
Continuous	2	27.0	58.0	93.9	136.1	175.6
Continuous	4	19.2	43.1	73.4	113.2	155.3
Continuous	8	12.3	28.5	51.1	84.7	126.2
Buffered ASCII	1	42.9	85.1	126.7	167.5	199.7
Buffered ASCII	2	41.4	82.8	124.0	165.2	198.0
Buffered ASCII	4	39.4	79.4	120.2	161.8	195.6
Buffered ASCII	8	34.6	71.5	111.0	153.2	189.2
Buffered ASCII	16	28.3	60.3	97.0	139.3	178.2
Buffered ASCII	32	21.0	46.5	78.3	119.0	160.6
Buffered Binary Float	1	43.3	85.8	127.4	168.1	200.1
Buffered Binary Float	2	42.6	84.7	126.1	167.0	199.4
Buffered Binary Float	4	41.2	82.4	123.6	164.8	197.8
Buffered Binary Float	8	38.2	77.5	118.1	159.8	194.1
Buffered Binary Float	16	32.5	67.8	106.5	148.8	185.8
Buffered Binary Float	32	25.4	55.0	90.0	131.9	172.1
Buffered Binary Integer	1	43.7	86.4	128.0	168.7	200.6
Buffered Binary Integer	2	43.3	85.8	127.4	168.1	200.1
Buffered Binary Integer	4	42.6	84.7	126.1	167.0	199.4
Buffered Binary Integer	8	41.2	82.4	123.6	164.8	197.8
Buffered Binary Integer	16	38.8	78.5	119.1	160.8	194.9
Buffered Binary Integer	32	33.1	68.9	107.8	150.2	186.8

Note 1: Battery Life for two Standard C cell Batteries 17000 mWhr

Note 2: Battery life when Powered off or Burst sleep period is 247.24 Days

**Days of Battery Life:  
Wave Staff XB-Pro with Water Sensor in High Current Mode (2)**

Data Format Output Transmit Mode	Sample Rate Hz	Battery Life in Days per Burst duty cycle, Length/Interval (1)				
		Continuous 100%	40% Burst	20% Burst	10% Burst	5% Burst
Continuous	1	27.5	58.8	95.1	137.3	176.6
Continuous	2	22.8	50.1	83.3	124.6	165.7
Continuous	4	17.0	38.6	66.7	105.1	147.5
Continuous	8	11.3	26.5	47.8	80.1	121.0
Buffered ASCII	1	33.3	69.2	108.1	150.4	187.1
Buffered ASCII	2	32.3	67.6	106.2	148.5	185.6
Buffered ASCII	4	31.1	65.4	103.4	145.8	183.4
Buffered ASCII	8	28.0	59.9	96.5	138.8	177.8
Buffered ASCII	16	23.7	51.9	85.7	127.3	168.1
Buffered ASCII	32	18.4	41.3	70.8	110.1	152.4
Buffered Binary Float	1	33.5	69.6	108.6	150.9	187.4
Buffered Binary Float	2	33.1	68.9	107.7	150.1	186.8
Buffered Binary Float	4	32.2	67.4	105.9	148.3	185.4
Buffered Binary Float	8	30.3	64.1	101.8	144.2	182.2
Buffered Binary Float	16	26.6	57.3	93.0	135.2	174.8
Buffered Binary Float	32	21.7	47.9	80.2	121.1	162.6
Buffered Binary Integer	1	33.7	70.0	109.1	151.4	187.8
Buffered Binary Integer	2	33.5	69.6	108.6	150.9	187.4
Buffered Binary Integer	4	33.1	68.9	107.7	150.1	186.8
Buffered Binary Integer	8	32.2	67.4	105.9	148.3	185.4
Buffered Binary Integer	16	30.7	64.7	102.6	145.0	182.8
Buffered Binary Integer	32	27.0	58.1	94.1	136.3	175.7

Note 1: Battery Life for two Standard C cell Batteries 17000mWHr

Note 2: High current Sensor adds 4.8 mWatts more to battery current

Note 2: Battery life when Powered off or Burst sleep period is 247.24 Days

## **Estimating Remaining Battery Service Life by measuring Battery voltage:**

3V (2 alkaline cells) Pack Battery with 20 mW load and 25°C:

- >2.85V = 80% to 100% Service Life remaining
- 2.73V to 2.85V = 60% to 80% Service Life remaining
- 2.67V to 2.73 = 40% to 60% Service Life remaining
- 2.62V to 2.67V = 20% to 40% Service Life remaining
- <2.62V = 0% to 20% Service Life remaining

1.5V (1 alkaline cell) Pack Battery with 20 mW load and 25°C:

- >1.42V = 80% to 100% Service Life remaining
- 1.37V to 1.42V = 60% to 80% Service Life remaining
- 1.33V to 1.37 = 40% to 60% Service Life remaining
- 1.308V to 1.33V = 20% to 40% Service Life remaining
- <1.308V = 0% to 20% Service Life remaining

## **Sensor Calibration Using the Interface Software:**

The Wave Staff XB's are calibrated at the factory with their attached Staffs and in most cases they do not need to be re-calibrated. If the Staff is exchanged you can do the re-calibration by following the steps below.

### **For Wave Staff XB with Version 2.00 Code or later:**

Multiple Point Sensor Calibration: Up to 12 calibrations points can be set for 0.05% FS accuracy.

1. Add two or more marks on the staff with a small piece of tape. Maximum 12 marks!

Example 1 mark locations: 20% and 80%

Example 2 mark locations: 0%, 5%, 25%, 50%, 75%, 95% and 100%.

2. With the staff submerged to one mark at a time set the "Calibrate Meters" value to the submerged point and press the Set button. Each Calibration point will be displayed on the Calibration Points table as they are added.

### **For Wave Staff XB with Version 1.00 Code:**

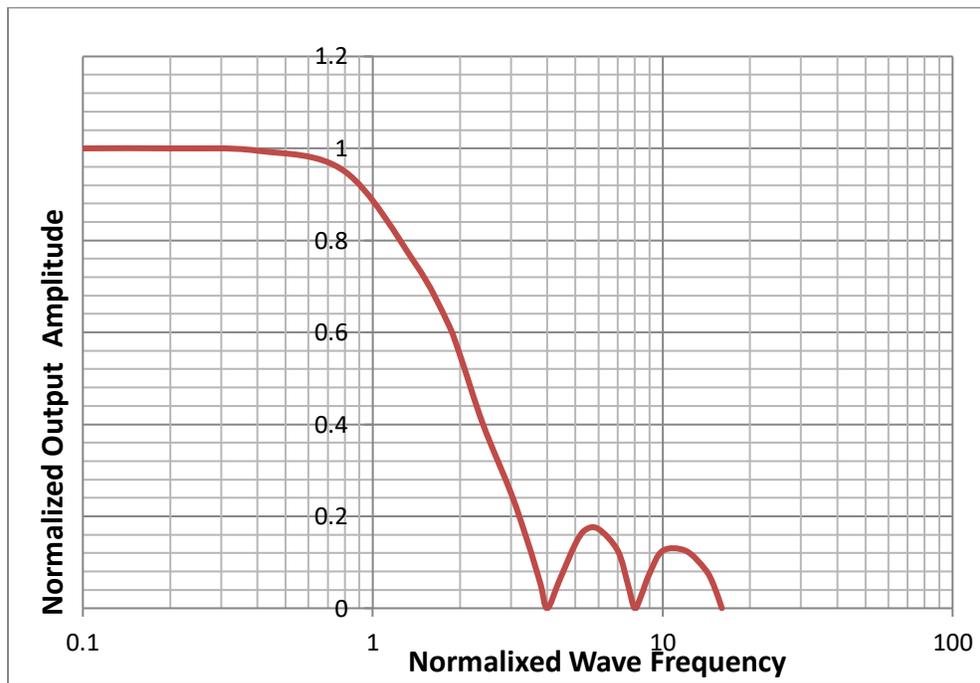
1. Add two marks on the staff with a small piece of tape. Typical locations are at 20% and 80%.
2. Enter the Low point and High point in meters from the bottom of the staff.
3. With the staff submerged to the Low mark on the staff, press the Auto Low button. The Low Point on the staff is the closest mark to the button of the staff.
4. Now with the staff submerged to the High mark on the staff press the Auto High button. The High Point on the staff is the furthest mark from the button of the staff.
5. The new Gain and Offset values are now displayed. Do not change these values unless previous values were recorded and you wish to return the Calibration back to the previous settings.

Note about Current Mode: Use normal current sensor mode in most cases and high current sensor mode only when fast small waves are to be measured in salt water.

## Sensor Automatic Anti-Aliasing Filter:

When the filter is switched on the output value is the average value of the total time interval for the last two sample periods. If the filter is disabled the output value is the average value of a 31.25mSec interval of time. The filter response changes automatically with the setting of the Sample Rate. The recommended Sample Rate is 8 or more times the maximum Wave Frequency that will be measured.

**Filter Response plot:** The Amplitude is normalized to the Wave Height and the Frequency normalized to 1/8<sup>th</sup> of the Sample Rate. Example if the Sample Rate is set to 8 Hz then the Normalized Wave Frequency was 1 Hz. If the Sample Rate is set to 16 Hz then the Normalized Wave Frequency was 2 Hz.



## RTC Calibration: (Factory Calibrated)

Method:

1. Determine the Real Time Clock (RTC) error in seconds per minute. (Example .0025 seconds per minute)
2. Calculate the RTC correction value.  $(32768 * \text{error})/4 = \text{correction value}$ . The value should be negative if the time is fast and positive if the time is slow.
3. Read the current correction value with the Interface Software and add it to the correction value.
4. Enter the new value with the Interface Software.

Example: The clock is 24 second slow every week and the correction value is 7.

$$-24 / (60\text{min} * 24\text{hour} * 7\text{days}) = -0.00239 \text{ seconds per minute}$$

$$(32768 * -0.00239) / 4 = -19.5 + 7 = -12.5$$

Enter the new correction value.

## User Interface Software:

A new, easy to use, Staff Product Interface Program is available to download from our web site. We recommend using the program to configure the Wave Staff XB for your particular requirements. It can also be used to display and analyze wave data. Sampled data can be saved to a file for future analysis with the Interface Software or other analysis software. Up to 8 Wave Staff XBs may be connected to the Interface Program at one time. Right click on any object while running the Interface Program for help.

## Output Plotting Tab:

The Output Plotting Tab can be used to plot data from Wave Staff XBs or from a saved file. All data is time tagged and plotted in real time. Vertical Line Cursors can be used to select a portion of the plot for analysis.

The screenshot displays the 'Ocean Sensor Systems - Staff Products Interface Program' window. At the top, there are control panels for 'Com Port and Unit Type Control' and 'Read File Control'. Below these are two main data monitoring sections: 'Device Status' and 'Output Data Monitoring'. The 'Device Status' section lists 8 devices with their power status, network addresses, and numbers. The 'Output Data Monitoring' section shows real-time data for each device, including rate, date and time, offset in seconds, and data meters. The 'Output Plotting' tab is active, showing a multi-trace waveform plot with 8 traces, each corresponding to a device. The plot shows relative time in seconds on the x-axis and meters on the y-axis. Below the plot are controls for 'Plot Control', 'Date and Time', 'Plot Scale, Meters', and 'Cursors'.

Power Status	Network Address	Number	Rate	Date and Time	Offset in Sec	Data meters	ZeroAbs
ON	0013A2004066B373	1	16	2014-04-08T20:56:08	2000	00.4595	Abs
ON	0013A2004066B375	2	16	2014-04-08T20:56:06	2000	01.4407	Abs
ON	0013A20040995FE5	8	16	2014-04-08T20:56:08	2000	07.4634	Abs
ON	0013A2004099605A	7	16	2014-04-08T20:56:08	2000	06.6585	Abs
ON	0013A2004099611F	5	16	2014-04-08T20:56:06	2000	04.4700	Abs
ON	0013A2004099624E	6	16	2014-04-08T20:56:08	2000	05.4642	Abs
ON	0013A2004099B794	3	16	2014-04-08T20:56:06	2000	02.4256	Abs
ON	0013A20040A1F0D	4	16	2014-04-08T20:56:04	2000	03.4343	Abs

## Spectral Analysis Tab:

Plotted Data can be Spectral Analyzed with this tab, with various window operations, data format and scaling. The Mean Water Level and Significant Wave Height are also displayed.

The screenshot displays the 'Spectral Analysis' tab in the 'Ocean Sensor Systems - Wave Staff XB' software. The interface is divided into several functional areas:

- Com Port Control:** Includes a 'Select Serial Com Port' dropdown, a 'Local PAN ID (XSTICK)' field with a numeric keypad, and 'Auto Time Sync' and 'Broadcast Power' checkboxes.
- Read File Control:** Features an 'Open File Name' field, a 'File Read Speed: KBytes Per Second' slider, and a 'Position KBytes' slider.
- Wave Staff XB Device:** A table for monitoring multiple devices with columns for Power Status, Network Address, Number, Rate, Date and Time, Offset mSec, and Data meters.
- Spectral Plotting:** A line graph showing wave spectral density. The Y-axis is labeled 'Meters (M)' and the X-axis is 'Frequency Hz'. The plot shows a peak around 0.25 Hz.
- Analysis Control:** Includes an 'Analyze' button, 'Trace to Analyze' (set to 1), 'X Axis Select' (set to Full), 'Window Operations' (set to Flat Top), 'Y-Axis Meters (M)' (set to Mrms), 'Y-Axis Scale' (set to Linear), and 'Device Number' (set to 1).
- Summary Metrics:** At the bottom right, it displays 'Mean Water Level' (1.693 meters) and 'Significant Wave Height (Hmo)' (0.699 meters).

At the bottom of the window, the Ocean Sensor Systems, Inc. logo and contact information are visible, along with the text 'Wave Staff XB Interface Program' and a note: 'Note: Right click on objects for help'.

## Configure Wave Staff XB Tab:

Use this tab to select and configure the Wave Staff XB for your particular requirements.

The screenshot displays the 'Ocean Sensor Systems - Wave Staff XB' interface. It is divided into several functional areas:

- Com Port Control:** Includes 'Select Serial Com Port' (ASRL12), 'Local PAN ID (XSTICK)' (0000000011111111), 'Auto Time Sync' (Off), and 'Broadcast Power' (On).
- Read File Control:** Features 'Open File Name', 'File Read Speed' (KBytes Per Second), and 'Position KBytes'.
- Wave Staff XB Device:** A table listing device details:
 

Power Status	Network Address	Number	Rate	Date and Time	Offset mSec	Data meters
ON	0013A2004066B373	1	16	2014-04-08T22:53:02	2000	01.0919
ON	0013A2004066B375	2	16	2014-04-08T22:53:02	2000	01.9770
ON	0013A20040995FE5	8	16	2014-04-08T22:53:00	2000	07.9468
ON	0013A2004099605A	7	16	2014-04-08T22:53:02	2000	06.9384
ON	0013A2004099611F	5	16	2014-04-08T22:53:02	2000	04.9587
ON	0013A2004099624E	6	16	2014-04-08T22:53:00	2000	05.9827
ON	0013A2004099B8794	3	16	2014-04-08T22:53:00	2000	02.9325
ON	0013A20040A01F0D	4	16	2014-04-08T22:52:52	2000	03.9799
- Configure Wave Staff XB:** Contains settings for 'Device Info' (Device Number: 1, Device Part Number: OSSI-010-027A, Serial Number: 13-04-22-001, Version: 01.00), 'Sample Rate' (16 Hz), 'Burst Length' (0), 'Burst Interval' (2), 'Filter' (Off), 'Data Format' (Float 32 Samples), 'Start Time' (2000-01-01 00:01), 'Clock' (2014-04-08 22:52:55), 'Power' (2.84V), and 'Calibrate' (Staff Type: Rod, Length meters: 1.00, Gain: 1.0000, Offset: 3.0000, Low Point: 0.200, High Point: 0.800).

Multiple Point Calibrate View for Version 2 code and later. Up to 12 calibrations points can be set for 0.1% FS accuracy.

The 'Calibrate' section includes the following controls and data:

- Current Mode:** Normal (selected) or High.
- Length meters:** 1.00
- Staff Type:** Rod (selected)
- Calibrate Meters:** 1.0000
- Buttons:** Set, Clear All, Clear, Factory Values, Auto Low, Auto High.
- Calibration Points Table:**

Point	Meters
1	0.1000
2	0.2500
3	0.9000
4	0.5000
5	0.7500

## Save Output Data to File:

The format of the data file saved by the Wave Staff XB Interface Software is as follows:

The first character of each string defines the data format. The Strings are terminated with a Carriage Return Line Feed.

The first letter defines:

C – ASCII 1 Sample

A - ASCII 32 Samples

F – Float 32 Samples

I - Integer 64 Samples

The ASCII 32 Samples and Float 32 Samples have the same format. The Integer 64 Samples has the same format except for its 64 Samples rather than 32. The value after the first letter is the Device Number followed with a comma. The value after the S is the Sample Rate followed with a comma. (Fixed 2 digit length) The value after the B is the Battery status followed with a comma. (0 = Good Battery, 1 = Low Battery and 2 = Bad battery). The next value is the Date and Time (YYYY-MM-DDThh:mm:ss) that the first sample data in the string was taken. Last is the sampled data. The format is a comma separated ASCII fixed 2.4 length value.

### Example - ASCII 32 Samples:

```
A001,S32,B0,2014-03-29T20:46:15,12.9990,...(32).....,15,12.9990\r\n
```

### Example - Float 32 Samples:

```
F001,S32,B0,2014-03-29T20:46:15,12.9999,...(32).....,15,12.9999\r\n
```

### Example - Integer 64 Samples:

```
I001,S32,B0,2014-03-29T20:46:15,12.9990,...(64).....,15,12.9990\r\n
```

The ASCII 1 Samples format has separate strings for Battery status and Date Time. The value after the D defines the string type followed with a comma. The Date and Time lines are added every 32 samples.

D1 – Sampled Data Example: C001,D1,S08,04.0290\r\n

D8 – Date YYYY-MM-DD Example: C001,D8,2014-03-29\r\n

D9 – Time hh:mm:ss Example: C001,D9,22:26:21\r\n

D7 – Battery Status Example C001,D7,GoodBattery\r\n

## Wireless Adapter for Laptops and PCs:

Two types of adapters are available to connect to the Wave Staff XBs. Either a Digi International Inc. XStick or the longer range XBee-PRO ZB adapter.

### Digi's XStick:

Digi's XStick is an easy-to-use USB to XBee Wireless Personal Area Network (WPAN) adapter, providing local connectivity to wireless networks. Simply plug the XStick into the USB port of a laptop or PC for instant access to an XBee network and its connected devices. This compact, USB-powered wireless adapter enables local network configuration, diagnostics or device monitoring.

### Digi's XBee-PRO ZB adapters:

Digi's XBee-PRO ZB adapters deliver wireless connectivity to electronic devices through advanced mesh networks. These adapters utilize the ZigBee PRO Feature Set, for robust self-healing, self-configuring networks. They are ideal for wirelessly enabling sensors, controllers and other devices in legacy wired applications, or where a common hardware interface is preferable.

### The Adapter Configuration:

The following Configuration changes were made from the default values using the Digi X-CTU software:

Function Set – ZIGBEE COORDINATOR API

Update to the latest code.

ID – PAN ID set to same as the Wave Staffs

BD - Baud Rate = 7 (115,200)

AP – API Enable = 2 API with escaping (note: Digi X-CTU software bug reading with escaping )

SP – Cyclic Sleep Period = AFO

SN – Number of Cyclic Sleep Periods = 150

NH – Maximum Hops = 2

SC - Scan Channels = FFFF for XBee and or 7FFF for XBee pro modules

The following pages are reference information only:

*The following information is for reference and is not needed when the Wave Staff Interface Software is used with Wireless Adapters from Ocean Sensor Systems.*

### The Wave Staff XB's ZigBee RF Modules:

The Wave Staff XB's ZigBee RF Module was configured to following using the OSSI-100-029 adapter board with the Link Select switch set to XBee:

Update to the latest code.

ID - PAN ID set to the specific customer PAN ID

CE - Not a Coordinator for end points

AP - API Enable = 2 API with escaping

BD - Baud Rate = 7 (115,200)

AO - API output mode Native = 0

SC - Scan Channels = FFFF for XBee and or 7FFF for XBee pro

D6 - RTS Flow Control = 1

D7 - CTS Flow Control = 1

SM - Pin Hibernate for End = 1

DH - Set Destination Address to Coordinator = 00000000

DL - Set Destination Address to Coordinator = 00000000

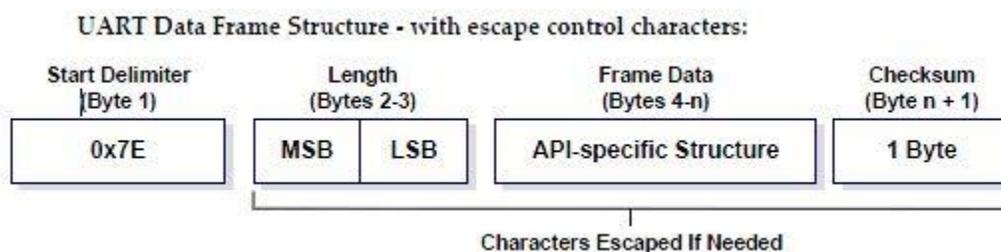
ZS - ZigBee Stack Profile = 0

NH - Maximum Hops = 2

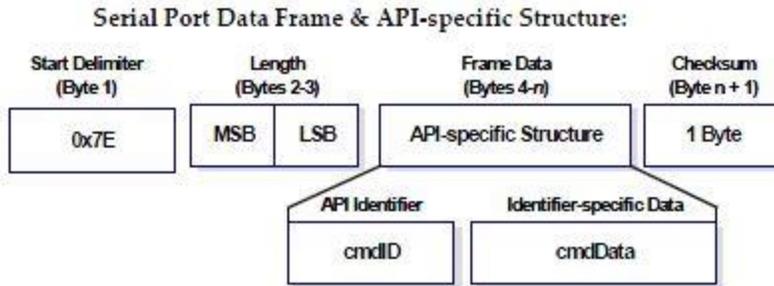
### Wireless Adapter Communication format:

#### API Frame Specifications:

API Operation - with Escape Characters (AP parameter = 2) The UART data frame structure is defined as follows: (For more information refer to the Digi manual XBee®/XBee-PRO® ZB SMT RF Modules 90002002\_G.pdf)



The Frame data of the serial port data frame forms an API-specific structure as follows:



## The Following is the Wave Staff XB format of the cmdData:

cmdData is the Wave Staff XB's data in one of 4 formats (ASCII 1 Sample, ASCII 32 Samples, Float 32 Samples and Integer 64 Samples). The format is the same as the Save Output Data file by the Wave Staff XB Interface Software except for the sample data. The Sample data is as follows: ASCII 32 Samples: Data Format ASCII characters 0 thru 9 (0 to 9999 millimeter) with a resolution of 1.0 millimeter. Float 32 Samples: Data Format Binary Float (4 bytes) with a resolution of 0.1 millimeter. Integer 64 Samples: Data Format 16 bit unsigned integer (0 to 19999 millimeter) with a resolution of 1.0 millimeter.

## Direct Command and controls:

The followings commands can be made using the OSSI-100-029 adapter board with the Link Select switch set to PIC24. These are the same commands used in the cmdData section of the API frame.

Enter help to see the command list (adapter board only)

### To read configuration values:

Enter RH to read the Part number

Enter RK to read the Software version

Enter RD to read the Serial number

Enter RX to read the Device Number (1 to 255)

Enter RS to read the Sample Rate

Enter RL to read the Burst Length

Enter RI to read the Burst Interval

Enter RF to read Filter Enable Status (1=yes 2=no)

Enter RR to read Start Time Enable Status (1=yes 2=no)

Enter RT to read the Time and Date (YY-MM-DDThh:mm:ssZ)

Enter RQ to read the Start Time and Date minus 1 minute (YY-MM-DDThh:mmZ)

Enter RV to read the Battery Voltage

Enter RM to read Output Local Enable Status (1=yes 2=no)

Enter RN to read Output XBee Enable Status (1=yes 2=no)

Enter RZ to read Time & Date Sync to Second (YY-MM-DDThh:mm:ssZ)

Enter RB to Read latest Sensor data

Enter RW to read water Sensor Current (1=Normal & 2=High) (3=TestSignal)

Enter RO to read Output Data Format (1=ASCII, 2=Binary float, 3=Binary Int & 4=Continuous ASCII)

Enter RJ to read Output Offset Count (0 to 1023) 7.8125mS per count

Enter RP to read Power State (1=on & 2=off)

Enter RC to read the RTC Cal clock per Min. (-127 to 128)

**To write new configuration values:**

Enter WZ,? to Enable/Disable Text Interface(1=on & 2=off)\  
Enter WS,?? to write the Sample Rate (1,2,4,8,16 or 32 Hz)  
Enter WL,?? to write the Burst Length (1 to 59 Minutes, 0 for Continuous)  
Enter WI,?? to write the Burst Interval (1 to 60 Minutes)  
Enter WF,??? to write Filter enabled (1=yes & 2=no)\r\n"  
Enter WX,?? to write new Device Address Number(1 to 255)  
Enter WR,? to write Start Time enabled (1=yes & 2=no)  
Enter WW,? Write Water Sensor Current (1=Normal & 2=Hihh) (3=TestSignal)  
Enter WT,YY-MM-DDThh:mm:ss to write New Time and Date  
Enter WQ,YY-MM-DDThh:mm to write New Start Time and Date  
Enter WO,? to write Output Data Format (1=ASCII, 2=Binary float, 3=Binary Int & 4=Continuous ASCII)  
Enter WP,? to write Power On and Off (1=on & 2=off)  
Enter WJ,?? to write Output Offset Count (0 to 1023) 7.8125mS per count  
Enter WC,??? to write the RTC Cal clock per Min.(-127 to 128)

**To read Normal Current Mode Calibrate values:**

Enter GT to Get Staff Type in meters (1 = Rod, 2= cable)  
Enter GS to Get the Staff Size in meters  
\*Enter GL to Get the Low calibration point  
\*Enter GH to Get the High calibration point  
\*Enter GG to Get the Gain calibration value  
\*Enter GO to Get the Offset calibration value  
\*\*Enter GA to Get all Low Current calibration points

**To read High Current Mode Calibrate values:**

Enter TT to Get Staff Type in meters (1 = Rod, 2= cable)  
Enter TS to Get the Staff Size in meters  
\*Enter TL to Get the Low calibration point  
\*Enter TH to Get the High calibration point  
\*Enter TG to Get the Gain calibration  
\*Enter TO to Get the Offset calibration value  
\*\*Enter TA to Get all High Current calibration points

**To Set Normal Current Mode Calibrate values:**

Enter FT,??,??? to Set Staff Type in meters <Ref only> (1 = Rod, 2= cable)  
Enter FS,??,??? to Set Staff Size in meters <Ref only> (0.500 to 20)  
\*Enter FL,? to Set the Low calibration point <Ref only>  
\*Enter FH,? to Set the High calibration point <Ref only>  
\*Enter FX,? to Calculate & Save Gain & offset using Low Point reading(? = water point on staff in meters)  
\*Enter FY,? to Calculate a Save Gain & offset using High Point reading(? = water point on staff in meters)  
\*Enter FG,? to manually Set the Gain calibration value  
\*Enter FO,? to manually Set the Offset calibration value  
Enter FF,1 to restore the factory calibration value  
\*\*Enter FP,? to Set a Low current calibration point <Ref only>  
\*\*Enter FN,? to Clear a Low current calibration point <Ref only>  
\*\*Enter FC,1 to Clear all Low current calibration points <Ref only>  
\*\*Enter FF,1 to restore the factory calibration value

**To Set High Mode Calibrate values:**

Enter ST,?.??? to Set Staff Type in meters <Ref only> (1 = Rod, 2= cable)

Enter SS,?.??? to Set Staff Size in meters <Ref only> (0.500 to 20)

\*Enter SL,? to Set the Low calibration point <Ref only>

\*Enter SH,? to Set the High calibration point <Ref only>

\*Enter SX,? to Calculate & Save Gain & offset using Low Point reading(? = water point on staff in meters)

\*Enter SY,? to Calculate a Save Gain & offset using High Point reading(? = water point on staff in meters)

\*Enter SG,? to manually Set the Gain calibration value

\*Enter SO,? to manually Set the Offset calibration value

Enter SF,1 to restore the factory calibration value\r\n

\*\*Enter SP,? to Set a High current calibration point <Ref only>

\*\*Enter SN,? to Clear a High current calibration point <Ref only>

\*\*Enter SC,1 to Clear all High current calibration points <Ref only>

**Other Commands:**

Enter OL,? Local Output Device Data (1=yes & 2=no)

Enter LB,ee to link Local to XBee Device cycle power to quit

\* Version 1.00 code

\*\* Version 2.00 code or later