Users Manual
Ocean Sensor Systems
# *Wave Staff III*

Introduction: The Ocean Sensor Systems Wave Staff III has been designed to provide a high-resolution measurement of liquid surface height at a data rate of up to 30Hz. Uses include the measurement of waves, wakes, tides, sinkage, lake levels, pond levels, tank levels, pool levels. Additionally, the programmable alarms/switches allow use for control applications. The Wave Staff is very robust with solid-state electronics sealed in a waterproof housing. The cable can be ordered in a variety of lengths and are interchangeable but will require recalibration. Please see the data sheet available on our web site at www.oceansensorsystems.com for detailed information.

This manual is designed for the user who is unfamiliar with the details of RS232 communications and instrumentation science. In addition to the web site, please call 1-954-796-6583 for personal assistance by one of our application engineers. We at Ocean Sensor Systems are dedicated to making your use of our equipment as easy and rewarding as possible.

Mounting: The physical mounting of the unit at the measurement site requires no special protection from spray, rain or sun though it should not be mounted underwater. The Wave Staff III may be used in any fluid compatible with glass, PTFE, stainless steel, and ABS plastic. The unit is mounted with the electronics head on the top and the cable projecting down into the fluid. The output is a relative measurement of the height of the air/fluid interface. Order a unit long enough to measure over the full vertical range of the surface without the electronics housing coming in contact with the fluid.

Electronics Housing

Sensor Cable Connector
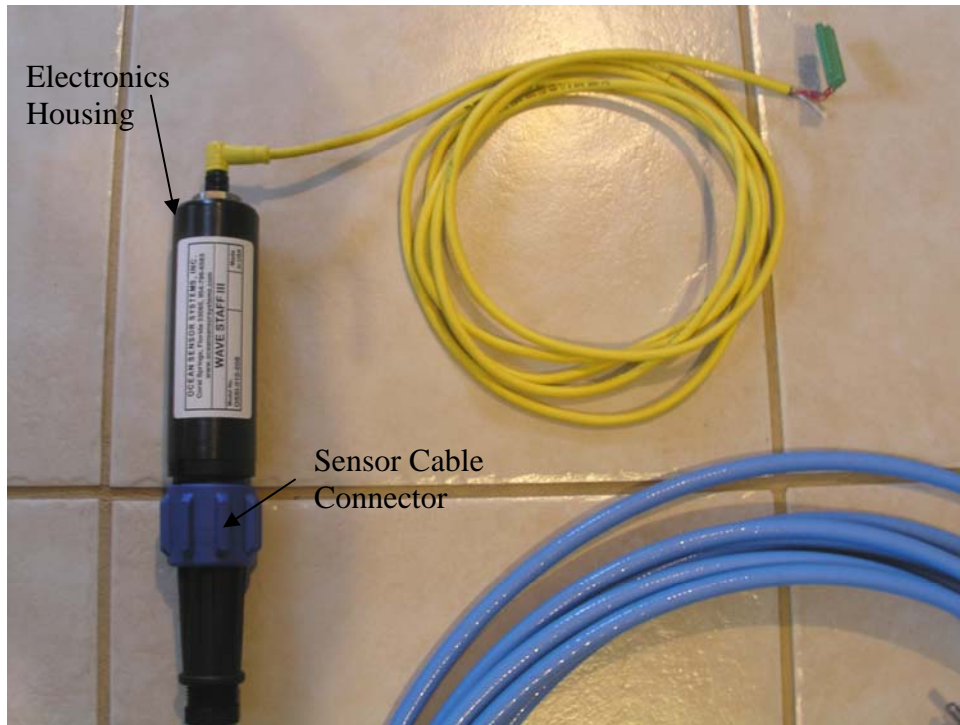
The black plastic housing is 2" in diameter and is strong enough to allow using 'U' bolts to secure the device to any surface. Optional mounting hardware kits are available. The cable is a weather-proof neoprene jacketed cable. The cable should be rigidly secured and not be allowed to hang unsupported for distances greater than 24". The cable is designed to be mounted in tension by either suspending a weight on the bottom or with a spring or bungee cord creating the tension. The tensioning device may be secured to the end of the cable using the 5/16" stud.

The tensioning should not exceed 10lbs though the unit is designed to take up to 100lbs. This will allow for dynamic loading due to the wave forcing without exceeding the maximum allowable load. In addition, intermediate supports may be used along the length of the cable. The supports should cover as little of the vertical section of the staff as they will create distortion in the measurements. The supports should hold the cable

securely without crushing the blue PTFE plastic cover. The supports must be designed so that they do not wear through the plastic cover. Specially designed supports are available from OSSI. The blue part of the staff should be mounted about 6" but never less than 4" away from any metallic or grounded surface. Accuracy can be improved by performing an in-situ calibration on the unit after it is mounted.

Power Requirements: The power supply requirements for the wave staff are very flexible requiring 5.5 to 40 volts dc. A simple solution is to connect a 9volt transistor radio battery to the unit with a single battery providing enough power for several days of operation. It is important to exercise caution when working with electricity around water. It is recommended that the supply voltage be kept below 16 volts to reduce the electrical hazard. Any connections to 110volts AC must be ground fault protected. The red and Red/Black wires from the wave staff are connected to the positive and negative of the power supply respectively.

Wave Staff III Cable Color Code
Red   Power +5.5 to 40vdc
Red/Black   Ground
Red/Yellow   RS232 Receive
Red/White   RS232 Transmit
Green   0 – 5vdc analog output (When enabled)

Serial Communications: The Ocean Sensor Systems Wave Staff is an intelligent device and allows for data exchange and reconfiguration through RS232 communications to a computer. There are two commonly used types of RS232 ports on computers: the DB9 and the DB25 where the number refers to the number of pins. Only three conductors are needed to connect to the computer; transmit, receive and ground.

RS232 Connections, and wiring up serial devices

DB25 MALE SERIAL CONNECTOR
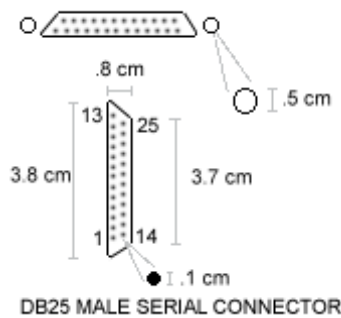
RS232 Pin Assignments (DB25 PC signal set) To Wave Staff cable	
Pin 1	Protective Ground
Pin 2	Transmit Data --Red/Yellow
Pin 3	Received Data --Red/White
Pin 4	Request To Send
Pin 5	Clear To Send
Pin 6	Data Set Ready
Pin 7	Signal Ground ---Red/Black
Pin 8	Received Line Signal Detector (Data Carrier Detect)
Pin 20	Data Terminal Ready
Pin 22	Ring Indicator

The connector on the PC has male pins, therefore the mating
cable needs to terminate in a DB25/F (Female pin) connector.

DB9 FEMALE SERIAL CONNECTION
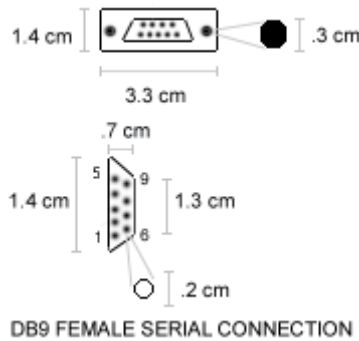
RS232 Pin Assignments (DB9 PC signal set) To Wave Staff cable	
Pin 1	Received Line Signal Detector (Data Carrier Detect)
Pin 2	Received Data ---Red/White
Pin 3	Transmit Data ---Red/Yellow
Pin 4	Data Terminal Ready
Pin 5	Signal Ground --Red/Black
Pin 6	Data Set Ready
Pin 7	Request To Send
Pin 8	Clear To Send
Pin 9	Ring Indicator

The connector on the PC has male pins, therefore the mating
cable needs to terminate in a DB9/F (Female pin) connector.

Once the Wave Staff is connected to the computer, open the Hyper Terminal Program in the accessories programs of your PC. Configure the baud rate to 9600 with no flow control. Next, power up the Wave Staff and you should see either one or three dots appear in the Hypertext window. If one dot appears, the unit is programmed to operate in sync mode. If three dots appear, the unit is programmed to run in free-run mode and within 4 seconds, data will begin to stream to the window (please see the data sheet for more information on modes of operation).

Maintenance: The Ocean Sensor Systems Wave Staff should require no maintenance other than wiping any slime buildup off of the blue PTFE cable. The PTFE offers a very slippery surface and any attached material will be easily removed. The only other maintenance is to check the electrical connections for corrosion.

Replacing the cable: The cable may be separated from the electronics housing. This feature allows for replacement of the staff should it become damaged and also allows for different cables to be used for different applications. Replacement cables in a variety of lengths are available from Ocean Sensor Systems. The cable is held to the electrical housing by the large electrical connection on the bottom of the electronics head. To remove the cable, The large blue hand nut may then be unscrewed (CCW) from the housing. The cable connector should only be screwed into and removed from the housing hand tight. Do not use any tools to clamp onto the cable as this will damage the soft Teflon cover.

Water Level Sensor Interface Board: Ocean Sensor systems has available an interface board that simplifies powering and communicating with the Wave Staff III. This small highly integrated module has connections for communications to a PC, a 9volt battery receptacle and connections/LEDs for monitoring the alarm and analog outputs. This board is highly recommended for those unfamiliar with electronics or interfacing to an RS232 port.

Data Analysis: The output of the Wave Staff is the actual level of the surface of the liquid being measured in *count* units. Counts can be converted to millimeters with the simple formula: counts*(staff length in millimeters)/4095. If this is the surface of an open body of water, the significant wave height may be estimated with 4*(standard deviation). It is usually more convenient to sample the Wave Staff in free run mode and log the data for subsequent analysis. If a lower sample rate than 10Hz is required, simply discard the redundant information. When using an array of Wave Staffs to determine phase information about the surface being measured, SYNC mode is preferred though if the phase speed is of the order of several seconds, free run sampling at 30Hz will result in negligible delay error.

The internal temperature is given in units 16*Celcius so the actual temperature is found by dividing by 16.

Default Configuration: The Wave Staff is shipped with the following configuration. Alternative configurations may also be requested.

- Free run
- Enabled internal temperature
- Disabled external temperature
- Enabled analog output
- 9600 baud
- ASCII output
- RS232 enabled
- 10Hz sample rate
- Calibrated 0-4095 output

Software Interface: Water Level Sensor interface software is available from Ocean Sensor Systems. This software contains all of the features necessary to calibrate, configure and display data. It will run on most Windows based machines. If the software does not start on your windows based computer, please call tech support at 1-954-796-6583 for assistance.

Instrument Accuracy: The Water Level Sensor is accurate to 0.25% of full scale between 20% and 80% of the cable length. If greater accuracy is desired, the unit may be calibrated in-situ and the data may be post-processed with a 3rd order curve fit. Both techniques are for the advanced user and will result in better than 0.1% accuracy over the full range of the unit.

Appendix B: Wave Staff and Wave Staff III Calibration Procedure

Every Staff and Wave Staff Unit has a variance in characteristics. A calibration must be performed after the two are assembled together.   If the Staff is changed, without recalibration, the accuracy of the calibration could be off as much as 10%.

To calibrate the newly assembled unit the following steps must be performed:

1. Connect the Wave Staff to a PC using a serial cable.

2. Start the Wave Staff Interface Software on the PC.   An Interface Program may be downloaded from our web site www.oceansensorsystems.com.
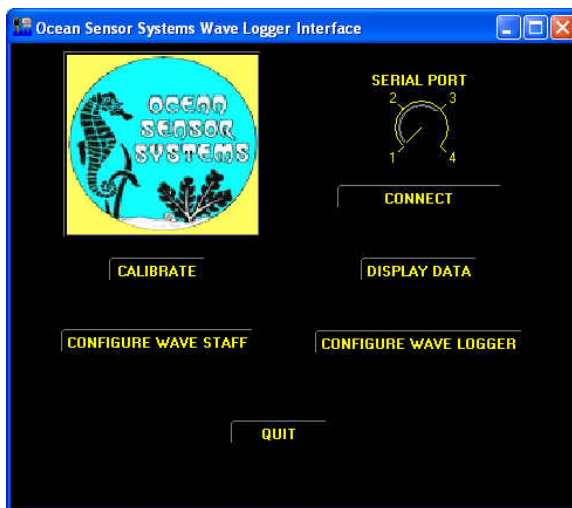

3. Select the serial port (typically #1) then click the CONNECT button. You should see a new window stating that you have successfully connected.

4. Now return to the first window and click on the CALIBRATE button.   A Calibrate Wave Logger window should appear. In the new window, enter the staff length of the unit you are calibrating and the staff Type.

For Wave Staff III and Wave Logger III with Coaxial Rod Staff select Int Gnd Rod

For Wave Staff III and Wave Logger III with Coaxial Cable Staffs select Int Gnd Cbl

For Wave Staff and Wave Logger with Rod and Cable Staff select Ext Gnd Rod/Cbl
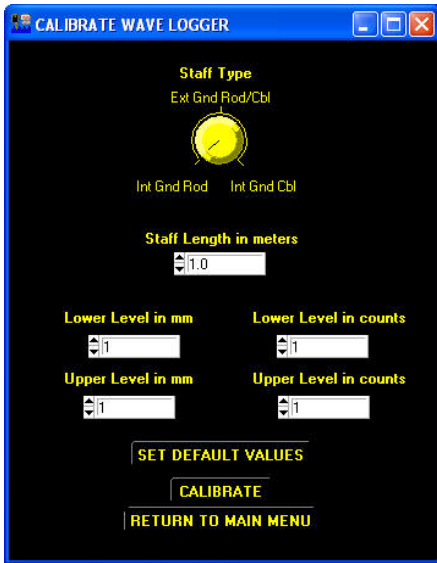
5. Then click on the SET DEFAULT VALUES button. You should see a SUCCESS window.

If the Set Default Test Results are available for the staff SET DEFAULT VALUE and skip to step 10.
These Default Test Results may be received from us when extra staffs are purchased with a unit or units and we have calibrated them for you. See paperwork that shipped with units.

6. Return to the start window and click the CONFIGURE button.
The unit will need to be configured to take two measurements for the calibration.
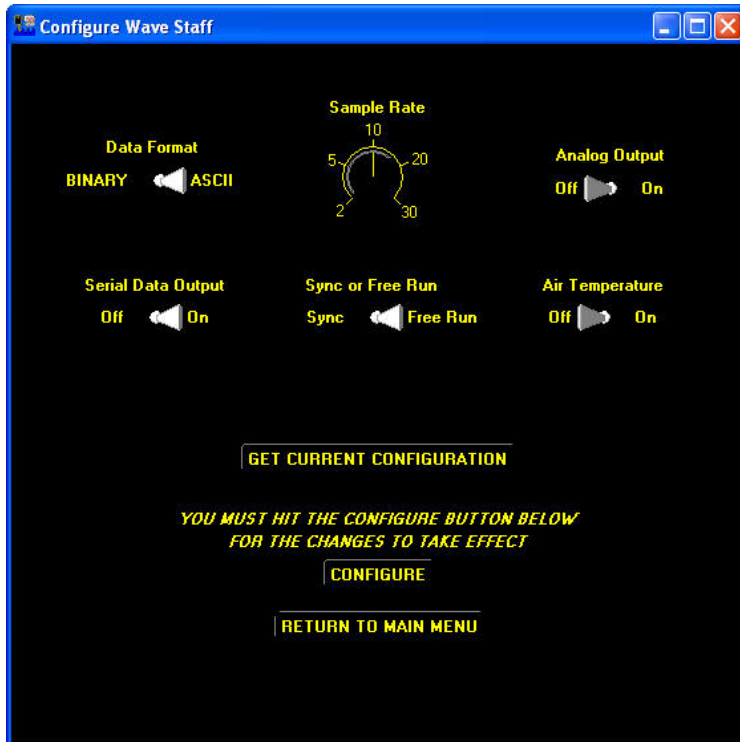
Make sure the settings are configured:
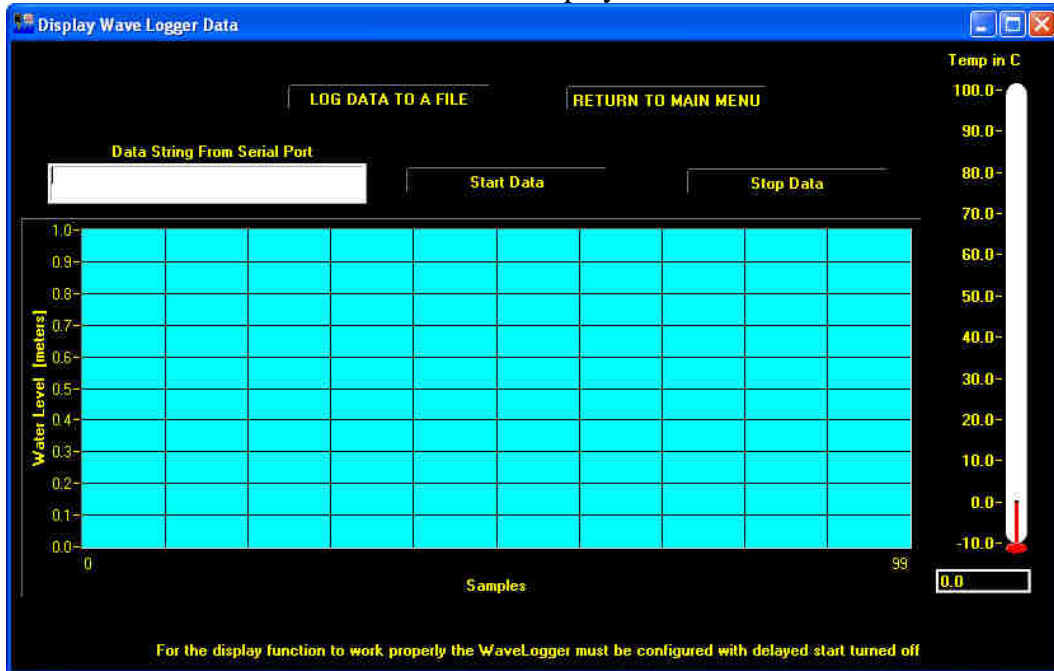Set Data Format to ASCII
Set Water Temperature to off
Set Serial Data Output to On
Set Sync or Free Run to Free Run

Now click the CONFIGURE button. You should see a SUCCESS window.

7. Return to the start window and click Display Data to view the data.

8. With a small piece of tape mark two points on the staff; typically at 20% and at 80% of the length of the staff.

9. Now take two readings at the marked locations in a convenient pool or pond.   Be sure to have the ground stud with wire connected to the water and keep the staff at least 6 to 12 inches from other objects. The data readings are the first 4 digits in the window marked "Data String From Serial Port".

10. Now return to the first window and click on the CALIBRATE button.   A Calibrate Wave Staff window should appear. In the new window enter the staff length of the unit again and staff type.

11. Enter Lower Level measurement point (20% typically) in mm and the Data measurement in counts.

12. Enter the High Level measurement point (80% typically) in mm and the Data measurement in counts.

Example: A 4 meter staff at 20% and 80 % would be 800mm / 850 counts for the lower measurement and 3200mm / 3010 counts for the higher measurement

13. Click the CALIBRATE button. You should see a SUCCESS window.

14. Now if you take the same two measurements again the data should be correct. Typically better than 0.1% however it depends on how accurate you were in taking the measurements. The object here is to be very accurate both times.

To convert the Data measurement in counts to meters: multiply the Staff length in meters, times the reading, divided by 4095.
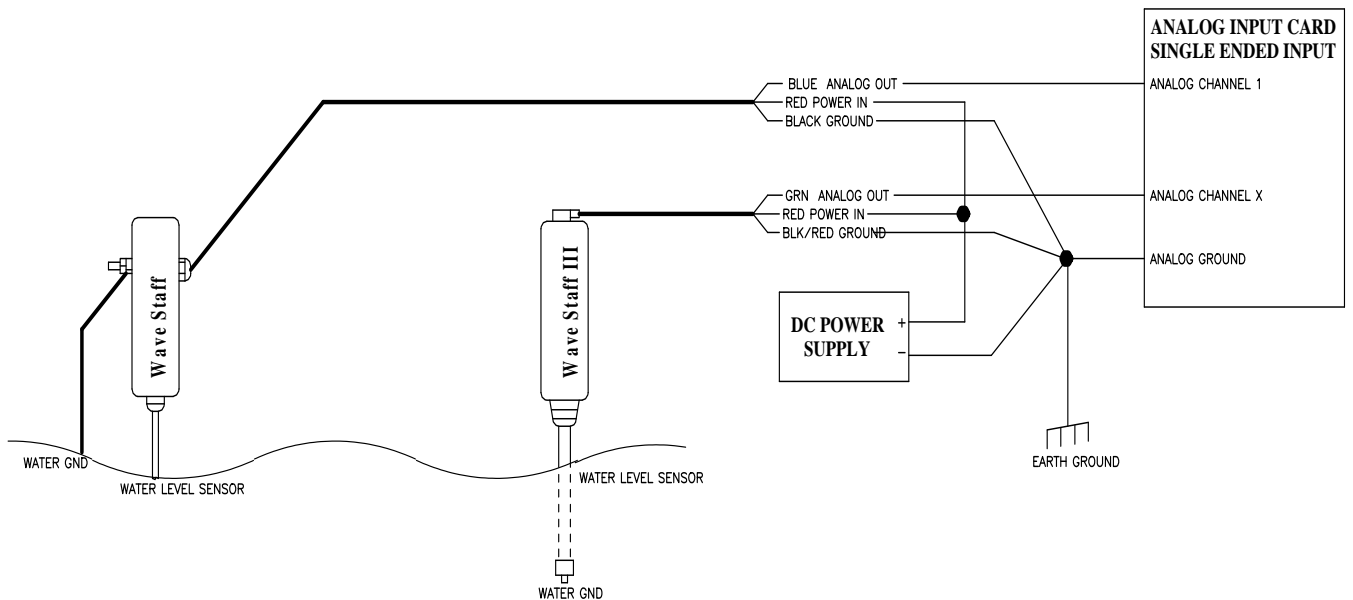
15. After you finish Calibrating the Unit you must remember to reconfigure the unit to your desired requirements.

Appendix C: Typical Wiring

Wave Staff & Wave Staff III Typical Wiring
Using the RS232 Serial Output
Connected to a PC Computer
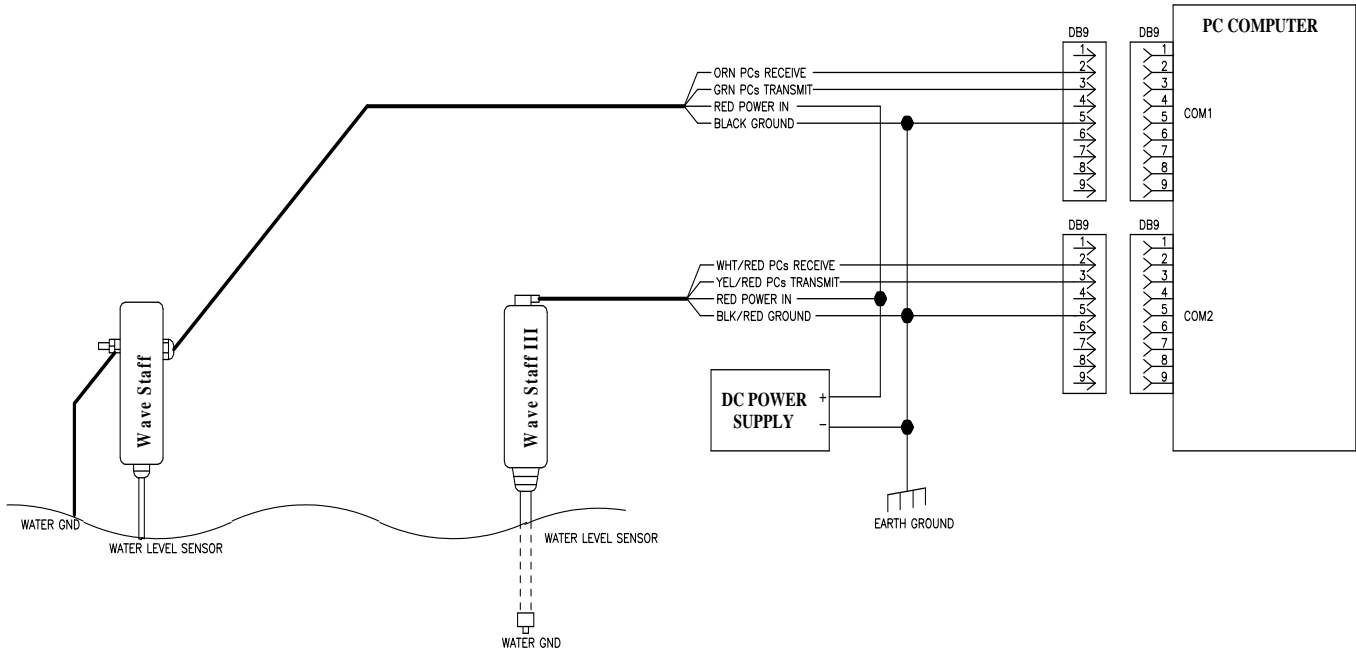
Wave Staff & Wave Staff III Typical Wiring
Using the 0 to 5 volt Analog Output
Connected to a Single Ended Analog Input Card

Wave Staff Typical Wiring
Using the 0 to 5 volt Analog Output
Connected to a Differential Analog Input Card

ANALOG INPUT CARD
DIFFERENTIAL INPUT

BLUE ANALOG OUT —————— + ANALOG CHANNEL 1

RED POWER IN

BLACK GROUND —————— − ANALOG CHANNEL 1

Wave Staff

DC POWER +
SUPPLY −

ANALOG/DIGITAL GROUND

WATER GND

WATER LEVEL SENSOR

OPTIONAL
EARTH GROUND