AWP-24
Wave Height Gauge

Acquiring Minimum Noise Data
Application Note

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1. Acquiring Minimum Noise Data

The wave height gauge is a high quality sensor capable of measuring wave heights with a high degree of accuracy. Achieving this degree of accuracy in the measured data requires the proper selection and configuration of the measurement system. The cabling and grounding scheme also has a significant affect on both the measurement accuracy and the degree of noise present in the measured data.

In a typical configuration, the wave height gauge is placed a considerable distance from the data acquisition system used to record the output voltages. The proper selection and configuration of the measurement system as well as the appropriate cabling and grounding scheme is required to produce accurate measurements with minimal noise. The measurement system and cabling recommendations provided below describe how to achieve accurate, reduced-noise measurements.

1.1 Local Environment

The environment in which wave height gauges are used can vary considerably. Background noise types and sources, grounding practices and connection practices can all affect the quality of the measurements. Some experimentation may help to identify modifications to the cabling scheme presented below. In some cases, the modified scheme will result in improved measurements for the specific environment in which the wave height gauges are deployed.

1.2 Measurement System

A differential-input measurement system is recommended. Such a system is preferable since it can reject noise picked up from the environment as well as rejecting grounding induced errors. Single-ended measurement systems are only suitable if the signal cabling is short and the environment is relatively noise-free; neither of which typically apply.

Ideally, the analogue signal will be filtered using an active filter with a cut-off frequency of 10 Hz. The filtered signal should then be sampled at a minimum rate of 20 samples per second using a 14-bit or 16-bit digital-to-analogue converter.

1.3 Connections

The recommended connections are shown in the figure below.

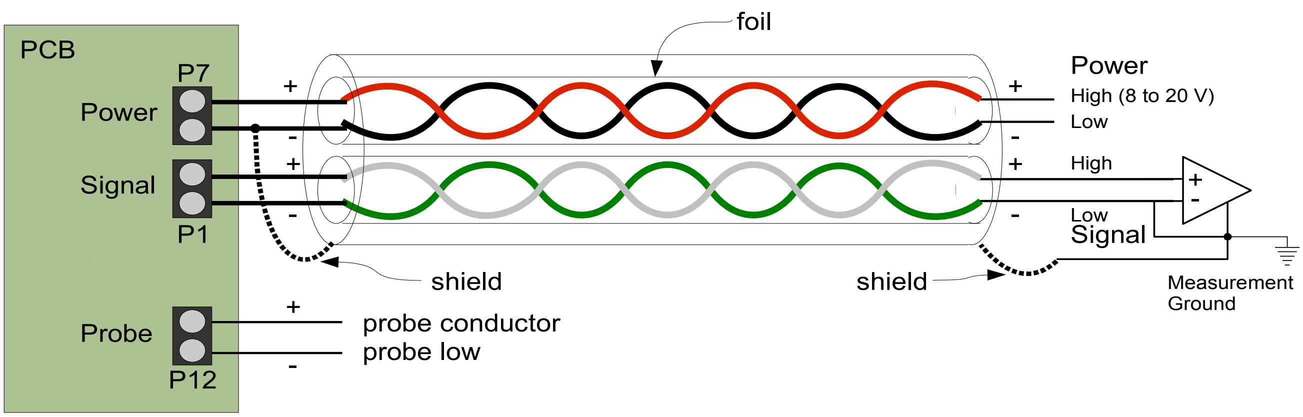

Figure 1-1: Sensor and Measurement System Connections

The key aspects of the connections shown in Figure 1-1 are:

- PCB to wave probe head connections:
  - the probe has high and low connections that are attached at P12
  - the length of the cable between the probe and the PCB should be minimized
  - the probe ground **is not** connected to any other ground
- PCB to cable connections:
  - an external wire connects the power low to the shield. For a wave height gauge supplied with an enclosure, this connection is made at the wiring harness inside the enclosure
- Cable to measurement system connections:
  - the signal high and low are connected to the + and – pins of the measurement system differential-input amplifier
  - the signal low and shield are tied together at the analogue ground of the measurement system amplifier. **This is the only ground reference in the system**.
  - The length of the connections between the end of the cable and the connection terminals of the measurement system should be minimized
- Cable to power supply connections:
  - the power high and low of the power supply are connected to the red and black power conductors in the instrumentation cable
  - the power low **is not** tied to ground at the power supply

2. Troubleshooting Noise Problems

The following guide can be used to assist in the identification of potential noise sources. It is presented as a series of tests that can be performed on your specific set up. The tests begin at the data acquisition system and move out towards the sensor. Each test typically involves the acquisition and analysis of a short data sample (e.g. 30 seconds). The analysis should compute the minimum, maximum, mean and standard deviation of the sample.

1. **How clean is the data acquisition system itself?** This can be determined by disconnecting the cable from the analogue input channel, shorting the channel's signal high, signal low and channel ground together and then analysing a sample of acquired data. The analysis should show a mean value of 0 volts, a very low standard deviation and a minimal difference between the minimum and maximum of the sample. If the analysis shows that the data acquisition device is operating within acceptable noise limits, move on to the next test. These noise values represent the best that you could possibly achieve. Representative values for this test taken using our data acquisition system are a min-to-max value of 1.6 mV and a standard deviation of 0.2 mV.
2. **How much does the cable affect the measurement noise?** This can be determined by reconnecting the instrumentation cable to the analogue input channel and shorting the signal high to the signal low at the transducer end of the cable (furthest away from the data acquisition system). The power through the cable should be turned off for this test. These noise values represent the best that could be achieved using a zero noise transducer. If the noise values are not acceptable, the cable, cable orientation and the environment are all possible sources of noise. If the analysis shows that the noise is within acceptable noise limits, move on to the next test. Representative values for this test taken using 200 ft of Beldon cable are a min-to-max value of 7.1 mV and a standard deviation of 0.8 mV.
3. **How much does the unpowered transducer affect the measurement noise?** This can be determined by connecting the wave height gauge to the far end of the instrumentation cable but leaving the device unpowered. The noise values for this test should be very similar to the noise values for the previous test.
4. **How much does powering the transducer affect the measurement noise?** This can be determined by turning on the power to the wave height gauge using the set up from the previous test. For this test, the coaxial cable to the wave probe head should be left disconnected. The noise values should be similar to those measured for the unpowered transducer. If the noise values are higher than expected, the transducer itself may be the cause of the noise. Representative values for this test are a min-to-max value of 6.2 mV and a standard deviation of 0.7 mV. In our case, these values are nearly identical to the noise value measured using only the cable attached.
5. **How much does connecting the wave probe head affect the measurement noise?** This can be determined by connecting the probe head to the wave height gauge electronics; the device should be powered and the water surface should be as calm as possible. The noise values from this test indicate the amount of noise added by the probe head. Expect the noise measurements to increase. A large increase in noise could be the result of wave activity, problems with the probe head, problems with the electronics or electrical noise coupled through the probe. These noise values will be higher if the wave height gauge has been configured and the output range adjustment procedure has been completed. This is caused by the gain applied within the electronics and is expected. Representative values for this test are a min-to-max value of 10 mV and a standard deviation of 1 mV. It is interesting to note that adding an additional ground at the wave probe doubled the min-to-max noise to 20 mV and increased the standard deviation to 1.4 mV.