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Sounding Better!

Grounding Options in Analog Monitor

By Dave Maddock

The January, 2018 issue of *Sounding Better!* included an article detailing how to wire and configure a National Instruments Analog-to-Digital (A/D) converter for use with analog side scan sonars and sub-bottom profilers. The present article will discuss in further detail the possible grounding configurations available, under what circumstances each should be used, and how to configure the HYPACK Analog Monitor to use the desired mode.

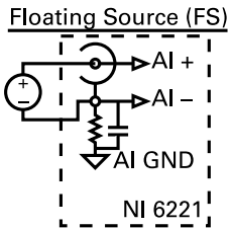
Grounding Complications in a Marine Environment

In the marine environment, electrical grounding issues can be complicated. A typical boat may have as many as four separate ground connections—one each for the AC and DC systems as well as grounds for lightning and RF systems. Wiring any of these directly to submerged metal components can cause corrosion due to electrolytic effects just as wiring them all together can introduce various operational problems and dangers. In addition to the above, a survey vessel may also have additional power sources for equipment such as batteries and generators which may not share the same grounding as the vessel's on-board electrical system.

Since the way equipment is grounded can affect how the A/D box digitizes the analog signal it receives from the sonar or profiler, it is important for the surveyor to be aware of how her vessel and equipment is wired and grounded in order to collect optimal data.

Signal Source Grounding

Analog systems output a voltage signal which is digitized by the computer during data acquisition. Assigning a color to each reading relative to a min/max voltage range is the basic idea behind turning a voltage time series reading from a transducer into an image. But because voltage is "measured as the potential difference across two points," how an input signal is referenced affects the voltage measured.



A signal source (AI) can be either grounded or floating. A **grounded signal** is one measured against an absolute reference (typically the earth). A **floating** signal has no such fixed reference. Given the considerations and complications discussed in the prior section, the input signals from a sonar or other device external to the NI-DAQ box is best considered a floating source.

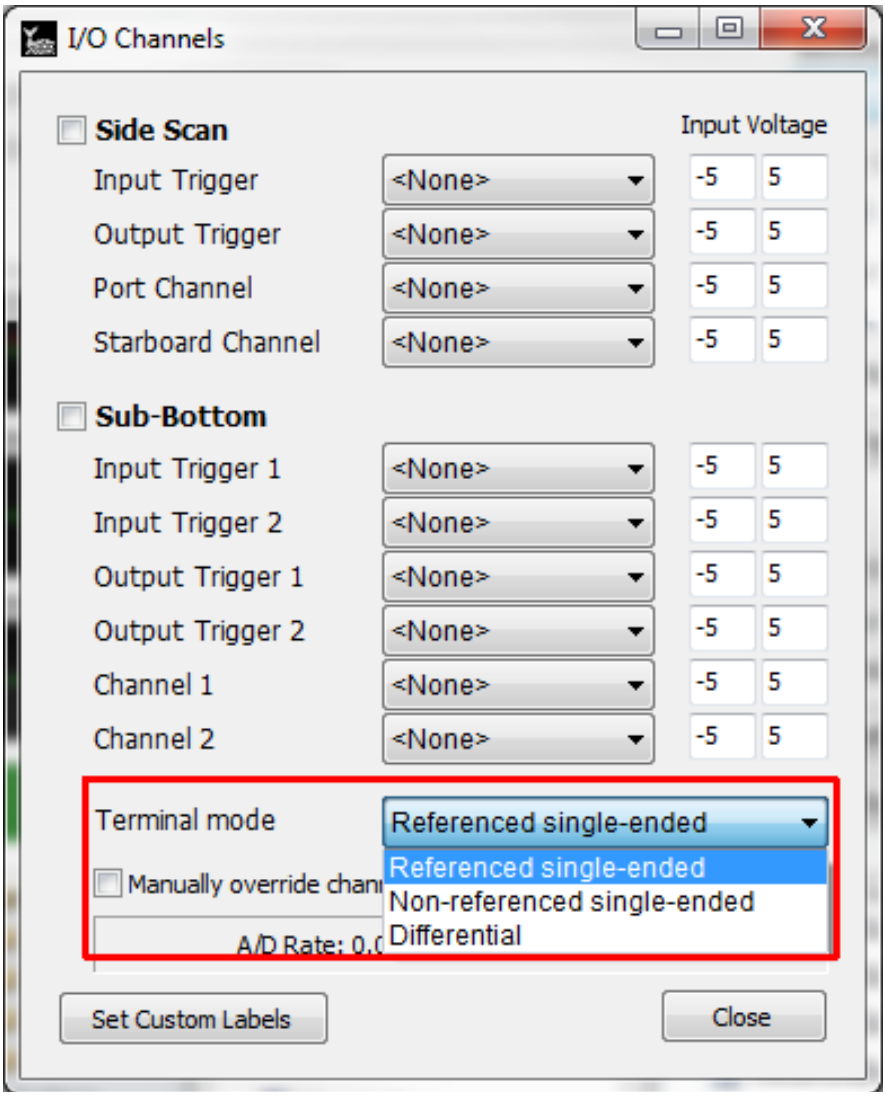
NI-DAQ Terminal Configurations

National Instruments equipment provides several possible terminal configurations depending on the grounding methodology. These include referenced single-ended (RSE), non-referenced single-ended (NRSE), and differential.

Single-ended modes require one or more additional inputs which tell NI-DAQ what the ground reference is. First, the AI GND line should be wired to the desired ground—preferably, the one used by the input device. This is the ground reference that **RSE mode** will use. **Non-referenced mode** takes an additional input, AI SENSE, which specifies a potential which may vary from AI GND against which to measure.

Differential mode has no inputs tied to a fixed reference and thus responds only to the potential difference between the AI +/- terminals. Voltage present on both positive and negative terminals is considered “common-mode voltage” and is disregarded. This feature can therefore be useful for eliminating noise.

FIGURE 1. *I/O Channels Dialog*



TERMINAL CONFIGURATION IN ANALOG MONITOR

Prior to HYPACK® 2018, Analog Monitor always operated in RSE mode.

In HYPACK® 2018 and later, terminal mode can be configured on the I/O Channels dialog. The selected mode is applied to all active input channels. Analog Monitor defaults to Referenced single-ended, as this is the most common and recommended mode.

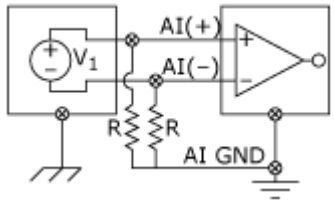
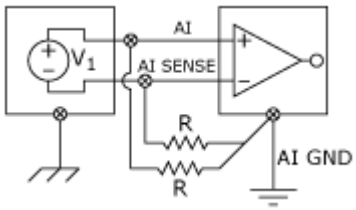
Use Cases for Each Mode

RSE is unsuitable for grounded signals as the potential difference between the NI-DAQ chassis ground and the AI GND may differ, introducing ground loops. For this reason, HYPACK recommends treating input signals as floating. The advantage of this mode is that it does not require the use of bias resistors on the input wiring.

Because they do not reference AI GND, NRSE and Differential modes can be used to mitigate noise and other signal interference observed when in RSE mode. The downside of these modes is the additional wiring necessary for correct operation. In each of these modes, bias resistors must be used to anchor the signal voltage to AI GND or AI SENSE.

Bias Resistors

In the non-referenced modes, a floating voltage can move outside of the valid range supported by the device. To avoid this problem, bias resistors (10-100 kΩ) should be added between each input and the measurement system ground to anchor the input to some reference within these bounds.

Differential	Non-referenced single-ended
	

Conclusion

For the majority of HYPACK® users, the default RSE mode combined with the floating source (FS) switches on the input lines of the NI-DAQ box will give satisfactory results. If your particular environment is injecting a lot of noise into your acoustic data, then HYPACK® 2018 now supports operating in Differential or NRSE modes.

References

"Field Wiring and Noise Considerations for Analog Signals." White Papers, National Instruments, 21 Apr. 2016, www.ni.com/white-paper/3344/en/.

"Marine Grounding Systems." Stan Honey, The West Advisor - West Marine, 15 Oct 1996, www.westmarine.com/WestAdvisor/Marine-Grounding-Systems.