



December 2016

## ASK THE EXPERTS: Procedure for Verifying Magnetic Pickup Signal Integrity Using a Windrock Portable Analyzer

QUESTION: Does Windrock have some standard procedures for verifying magnetic pickup signal integrity while using the portable analyzer?

“This is a question I have received often while helping customers with product support. I have put together the following document as a set of standard procedures to help with magnetic pickup testing.” – Pete Flanagan, Product Support Technician

### **Preface:**

If your RPM is unstable, flip the Hole-Pin (H-P) switch on your encoder and see if the RPM stabilizes. If your environment has a lot of electromagnetic interference and you are using a multi-event encoder, you may need to install a termination cap on your tooth count port if the following procedure does not help to resolve your trouble.

### **Purpose**

The purpose of this document is to provide the detailed instructions on how to test the signal strength and polarity of a magnetic pickup signal using the 6320 portable analyzer and a voltage input cable. The information contained in this report was gathered using the following test equipment.

- Windrock Model A6320 Performance analyzer
- Windrock Model A6040 Multi-Event Encoder
- Windrock Model A6021 Shaft Encoder
- Windrock Voltage Input Cable A6019-00-06
- Magnetic Pick-up
- Mag pick up cable (two options available A6015-00-06A & A6015-00-06B)

### **Operational Theory**

In order to achieve the best results with Windrock’s portable analyzer and encoders when using a magnetic pick-up for speed input, it is important that the applied signal be a positive going signal similar to the Figure 1. Top Dead Center (TDC) is triggered in the figure below when the wave crosses zero.

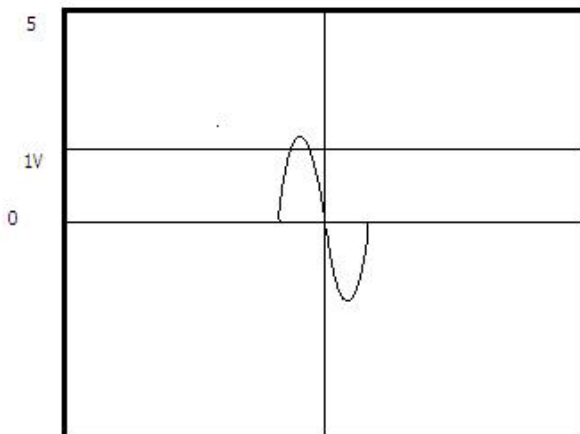


Figure 1

The amplitude (or strength) of the signal should be at least 1V peak (2 volts peak-peak), as shown in Figure 1, and should not exceed 5V peak (10 volts peak-peak). While a signal smaller than 1V peak may drive the encoder, the signal will be sensitive to false triggers from stray noise. Stray noise can be caused by debris on the flywheel surface, other grooves or holes in the flywheel surface, or electrical noise from the engine/compressor room environment. While in real world conditions, it may be nearly impossible to remove all stray noise from the magnetic pick-up signal, care should be taken to input a signal as free of noise as possible. If care is not taken to minimize signal noise, it is possible to experience problems with erratic speed readings and data phasing due to false trigger events.

A once per turn RPM generation is best suited to equipment with very stable speeds. The hardware divides the duration of 1 revolution into 360 even periods. In this case, the encoder uses the previous revolution to map data collected to its appropriate crank angle. Using this method on a surging machine will cause problems. For machines with unstable/slow speeds, a shaft encoder is recommended as each degree is measured rather than deduced from the previous rotation. This gets rid of the limitation.

### **Checking Magnetic Pickup Signal**

There are a number of variables to take into consideration when setting up a magnetic pickup as a source of the speed signal for data analysis. This section will detail how to set up the magnetic pickup and verify its signal is conditioned correctly for use with Windrock equipment.

#### **I. Signal Polarity**

As mentioned under the theory section of this report, for best operation, a positive triggering signal should be applied to the analyzer. The polarity of the signal from the



magnetic pickup is dependent on whether the pickup is pointing at a pin or a hole, the manufacturer design of the magnetic pickup, how the cable connecting the pickup to the encoder is wired, and the hole/pin setting on the encoder. Due to the variety of possible combinations of these items, Windrock's encoders have the ability to invert the magnetic pickup signal prior to being applied to the circuit. This switch is marked "Hole-Pin" or "H-P" depending on the encoder type. An alternate way to think of this switch is that in one position, the signal from the magnetic pickup is inverted and in the other position the signal is not inverted.

Encoder Device	"Hole" Position	"Pin" Position
Shaft Encoder	Non-Inverting	Inverting
Multi-Event Encoder	Inverting	Non-Inverting

## II. Magnetic pickup gap size

In addition to signal polarity, signal amplitude (size) is critical to reliable data collection. The signal amplitude is directly related to the type of magnetic pickup used and the size of the gap between the magnetic pickup and the marker it is pointed at. The recommended gap is between 1/8" and 1/4" (2 - 4 1/2 turns out from touching the flywheel). Higher speeds on your machine will create a smaller range in the usable gap.

## III. Pin or Hole

Windrock's recommendation is to use a hole drilled in the flywheel because there is less risk of injury with this option. The recommended size hole is 1/4" wide x 1/4" deep. If it is difficult to get a good signal with the hole, a pin will usually result in a cleaner signal. If using a pin, it is important to not use a pointed pin. A pointed pin creates a signal more like a spike than a wave and can be difficult for the hardware to identify the event properly.

## IV. Checking Magnetic Pickup Signal

Oscilloscope mode, a Voltage Input Cable (A6019-00-06) and a magnetic pickup cable (A6015-00-06A/B) can be used to view the raw magnetic pickup signal on the analyzer. The voltage input is a six foot long cable with a BNC connector on one end with a Lemo connector on the other with a blue strain relief.

The following detail how to setup the 6320 to measure the magnetic pickup signal.

1. Screw the magnetic pickup cable onto the magnetic pickup
2. Connect the magnetic pickup cable into the voltage input cable using the supplied BNC barrel.
3. Plug the voltage input cable into channel 1 of the 6320.



4. It is important to check your cables and if you have more than 1 mag pickup cable, note which one you are using. Changing the cable may change your results as the cables can be wired internally as either inverting or non-inverting.



Figure 2 – Magnetic pickup cables

5. From the main analyzer menu, select “Data Collection Menu,” then select “special collection modes,” followed by “O-scope mode.” Change the setup to match the screen shot below. Depending on the operating speed of the machine being tested, adjustments will likely need to be made to the step size (increase step size until you can clearly see the event on the screen). The settings below are a good place to start.



Figure 3 – Changing the settings in the analyzer software



- After pressing the ENTER key, the magnetic pickup signal will be flashing on the screen. Press the “2” button to freeze the trace. Try to catch the once-per-turn event as shown in Figure 4. Pressing “2” again will toggle back to the live view.

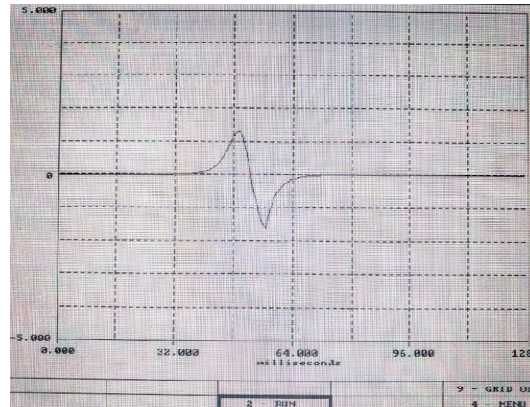


Figure 4 – Once-per-turn event capture

- With this O-Scope setup, each horizontal dashed line on the screen is 1 volt. (Figure 4 is approximately 2.5 volts peak-peak).
- While monitoring the signal, take care to look for any other events that could be causing false TDC events. Review installation as necessary.
- If you cannot get a clean signal using a hole as a target, you may need to have a pin installed.
- A magnet can also generate a more significant response from the pickup allowing for a wider gap. This can help remove noise from the signal as well.
- If your environment has a lot of electromagnetic interference and you are using a multi-event encoder, you may need to install a termination cap on your tooth count port.

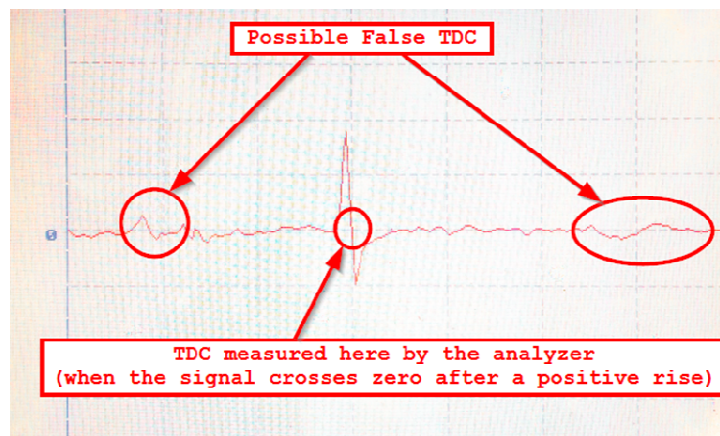


Figure 5 – Identifying false TDC events



Once you have verified whether you have a positive going signal or a negative going signal, we can add the encoder to the mix.

We have found the Hole/Pin label on the encoders to be a little confusing so please keep this in mind: the hole-pin switch is a toggle, these are not hard settings. Each piece of your magnetic pickup system has the ability to invert the signal.

**The end result needs to be a positive going signal after the encoder inverts or does not invert the signal in order for the analyzer to consistently read the center of the hole/pin.**

The labels on the multi-event encoder and the shaft encoder are opposites of each other. Using the table below, one can determine the appropriate setting for your encoder to make sure that your signal is delivered to the analyzer with a positive going signal.

If your signal was positive going in the O-scope mode test, then your encoder should be set to its non-inverting option

Encoder Device	“Hole” Position	“Pin” Position
Shaft Encoder	Non-Inverting	Inverting
Multi-Event Encoder	Inverting	Non-Inverting



Figure 6 – Multi-event Encoder



Figure 7 – Shaft Encoder



## Appendix

### Using Accelerometer Cable to view signal integrity.

We realize that you may not always have access to the low voltage input cable. Most kits have an accelerometer cable included (A6061-00-xx). Using this cable with the options below will allow you to verify the integrity of your signal, search for false triggers, etc.

#### However, you will not get a voltage level reading.

The accelerometer cable functions the same as the “A” mag pickup cable (A6015-00-06A). If you have a “B” cable (A6015-00-06B), you will have to note that the signal you see in the O-scope mode is actually an inverse of what the encoder will be receiving and hence you’ll have to use the opposite encoder setting from what this tutorial indicates.

Remember, this method may not help if you have an unlabeled or 3<sup>rd</sup> party magnetic pickup cable or if your pickup is emitting either too much or too little voltage.

```
————— O-scope Mode —————
RPM                > 0.000000
Step Size          > 640 usec
Trigger            > 0.000000
Count              > 200
Channel            > Channel 1
Input              > Vibration
Filter             > none
Trigger Mode       > Free Run
Upper Scale        > 1.500000
Lower Scale        > -1.500000

Finished           > Yes - hit enter

Sample length 128.00 msec
Sample rate 1562.50 Hz

Battery Unknown                               Oct 24 14:28:45 2016
```

Figure 8 – O-scope mode settings for using accelerometer cable with magnetic pickup



The signal using an accel cable in O-scope mode is positive or negative?	My Mag Pickup cable is A6015-00-06A or A6015-00-06B?	→	The signal coming into encoder is:		What kind of encoder am I using?	Therefore, the setting to use on my encoder to achieve a positive going signal is?
Positive	A6015-00-06A	Then...	Positive	&	Shaft	Hole (non-inverting on shaft)
Positive	A6015-00-06A	Then...	Positive	&	Multi-event	P (non-inverting on M.E.)
Negative	A6015-00-06A	Then...	Negative	&	Shaft	Pin (Inverting on shaft)
Negative	A6015-00-06A	Then...	Negative	&	Multi-event	H (inverting on M.E.)
Positive	A6015-00-06B	Then...	Negative	&	Shaft	Pin (inverting on shaft)
Positive	A6015-00-06B	Then...	Negative	&	Multi-event	H (inverting on M.E.)
Negative	A6015-00-06B	Then...	Positive	&	Shaft	Hole (non-inverting on shaft)
Negative	A6015-00-06B	Then...	Positive	&	Multi-Event	P (non-inverting on M.E.)

If you have additional questions about this topic or would like more information about other topics, please email [sales@windrock.com](mailto:sales@windrock.com).