Shaft Voltage Tester
Handheld Digital Oscilloscope

AEGIS-OSC-9200

Shaft Voltage Testing Guide

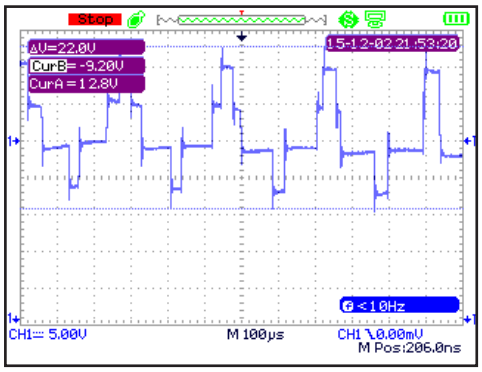
Electro Static Technology™
An ITW Company

Examples of Shaft Voltage Readings

High Peak to Peak common mode voltage –

Typically 20 to 120 volts peak to peak (10 to 60 volts peak). The waveform image shows the capacitive coupled common mode voltage on the shaft of the motor. The "six-step" waveform is the result of the 3 phases of pulses from the VFD. The timing of the pulse width modulation (PWM) pulses to the motor from the drive determines what the waveform looks like. Sometimes it will look like a square wave.

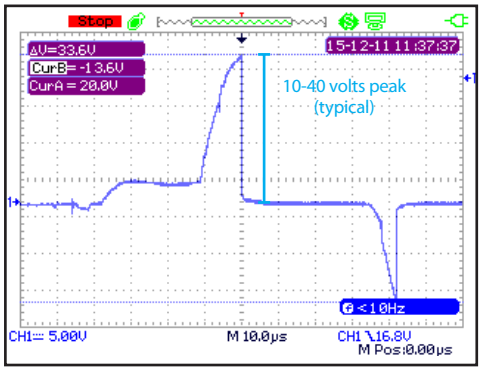
This six-step or square wave is what is seen when there is no bearing discharge and the peak to peak shaft voltage is at its maximum level. The voltage level may eventually overcome the dielectric in non-isolated bearings and begin discharging.



High amplitude EDM discharge pattern –

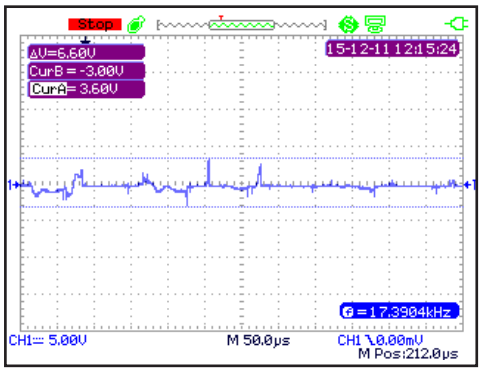
Typically EDM discharges can occur from 20 to 80 volts peak to peak (10 to 40 volts peak) depending on the motor, the type of bearing, the age of the bearing, and other factors. The waveform image shows an increase in voltage on the shaft and then a sharp vertical line indicating a voltage discharge. This can occur thousands of times in a second, based on the carrier frequency of the drive. The sharp vertical discharge at the trailing edge of the voltage is an ultra high frequency dv/dt with a typical "discharge frequency" of 1 to 125 MHz (based on testing results in many applications).

Reference: NEMA MG1 Section 31.4.4.3



Low amplitude voltage discharge pattern –

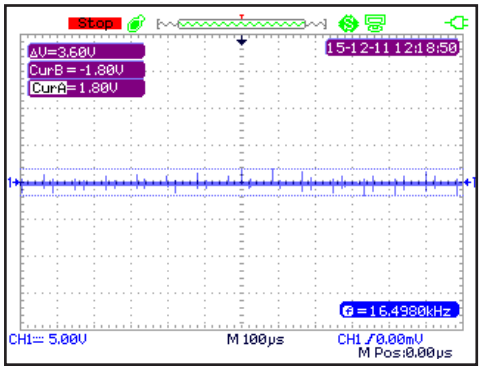
Typically the voltages are 4 to 15 volts peak to peak (2 to 8 volts peak). The waveform image shows a more continuous discharge pattern with lower dv/dt frequencies. The lower voltage may be due to greater current flow in the bearings which is the result of the bearing lubrication becoming conductive or could be a function of the motor's drive, speed, loading or other factors. As discharges occur in the bearings, the lubrication is contaminated with carbon and metal particles. The lower impedance to the shaft voltages results in lower peak to peak voltages. This condition is usually found in motors that have been in operation for many months or years.



Peak to Peak voltage with AEGIS® ring installed –

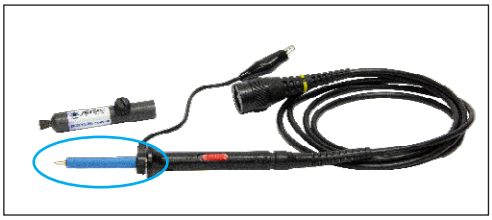
With the AEGIS® ring installed, a bare steel shaft will typically show shaft voltages of 2 to 10 volts peak to peak (1 to 5 volts peak) depending on the power of the motor, ground noise, the conductivity of the shaft and other factors. The voltage readings may be decreased further with the application of AEGIS® Colloidal Silver Shaft Coating which allows for higher shaft surface conductivity and a more efficient electron transfer to the conductive micro fiber tips.

The waveform image shows the low peak to peak waveform of a motor with the AEGIS® SGR ring installed and discharging the shaft voltages normally.

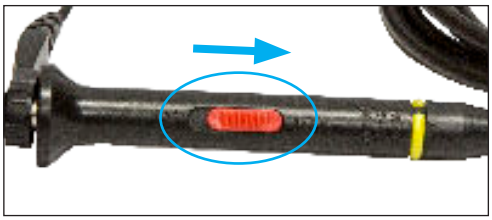


AEGIS® SVP Tip Installation

AEGIS® Shaft Voltage Testing Probe PP510

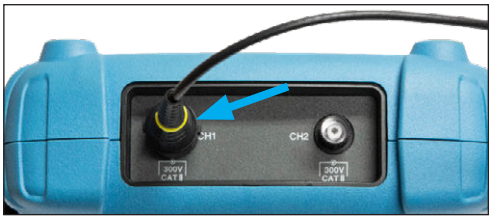


1. The probe has an insulated sleeve over the tip. Do not remove this cover.



2. Set the probe to 10X.

3. Secure the probe tip using the thumb screw. Be careful not to over-tighten.



4. Connect the probe to Channel 1 (CH 1).

Note: The AEGIS-OSC-9200 comes with one SVP probe tip already installed

Default Settings for Shaft Voltage Testing

1. Press **Default**
2. Press **Default** again to confirm

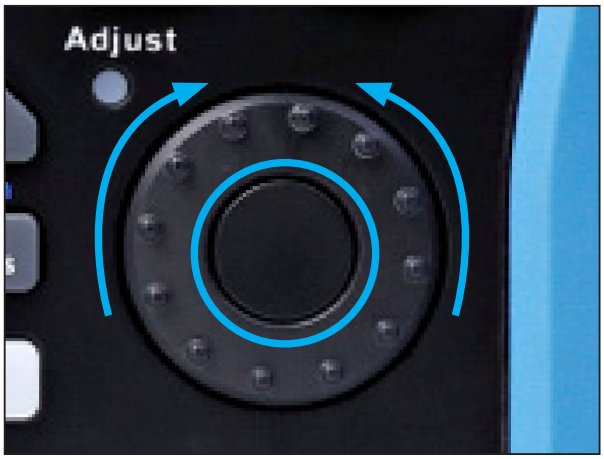
Default parameters include:

- DC Coupling
- 10:1 (10X) in both channels
- 5 V/div voltage scale
- 50 µs/div time scale

For the full list of factory settings, see the user manual included on the flash drive

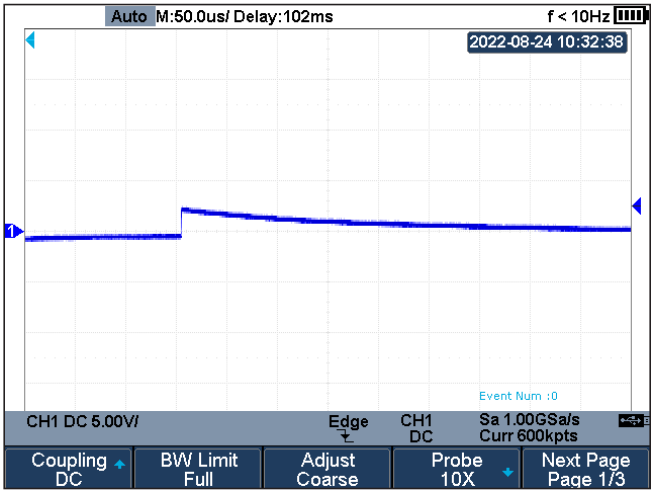
Using the Dial

When using the menu buttons (**CH1, Cursors, Measure**, etc.) you choose and select options using the scope's dial. Move between options by turning the dial, and make your selection by pressing the button in the middle of the dial.

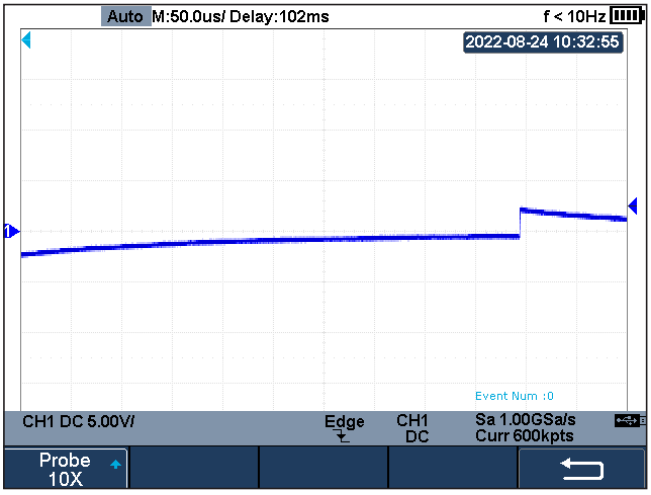


10:1 Attenuation

The Default settings include 10:1 attenuation on Channel I. If you somehow overwrite those settings and need to set them manually:

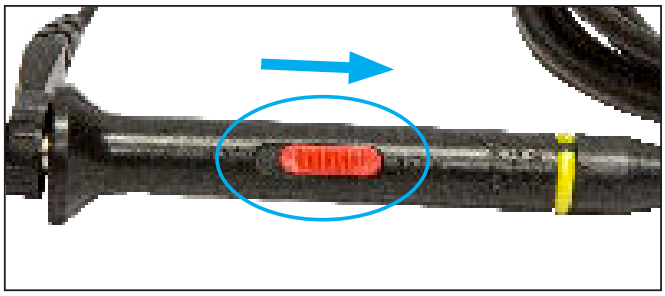


Press **CH1** to bring up the CH1 menu on Page 1/3. (If a different page pops up, press **F5** to cycle back to Page 1/3). Press **F4 Probe**



Press **F1** and use the dial to choose 10X. Then press **F5** to go back.

Press **Menu** to collapse the CH1 menu.



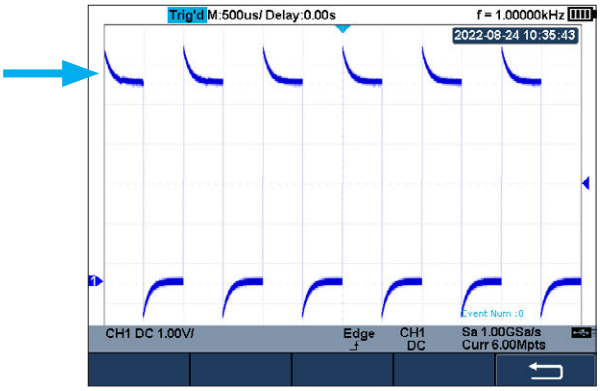
Make sure the probe is also set to 10X

Tuning the Probe (Compensation)

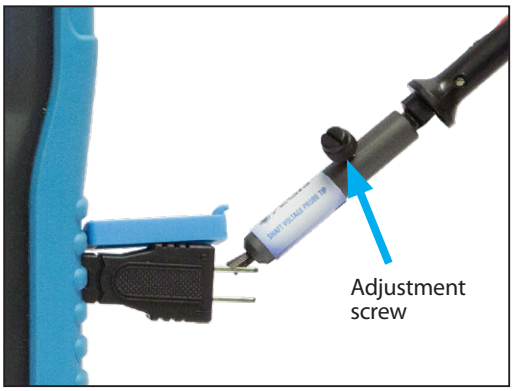
Now the scope is set up to fine-tune the probe. The AEGIS-OSC-9200 includes two prongs (under the right-side flap) that generate a square wave to help you fine-tune the probe's compensation for maximum accuracy.

This calibration must be done the first time a new probe is used, and should be checked periodically to ensure accurate waveform measurements.

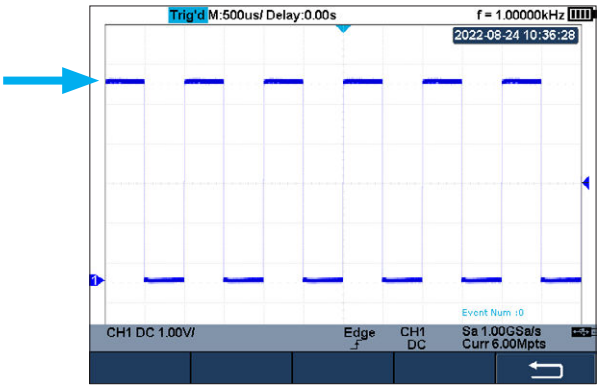
1. Clamp the probe ground lead to the lower prong (labelled ⊥) and touch the SVP Tip to the upper prong ("Cal").



2. Press **AUTO**. The scope will display a train of approximately square waves of amplitude about 6V and frequency 1 kHz.

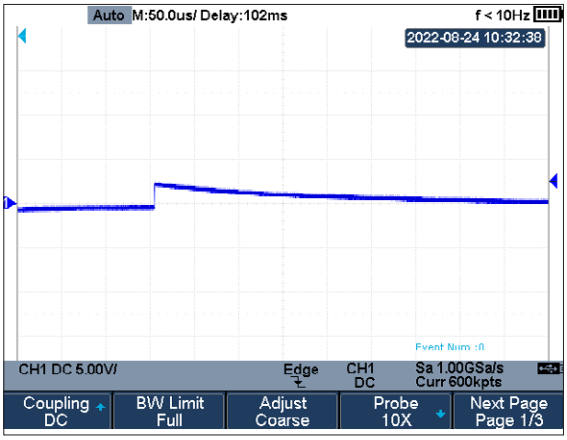


3. The plastic envelope the probe came in includes a small plastic screwdriver. Use it to adjust the screw in the probe until the waves are displayed with square edges. The probe is now ready to use.



4. Pressing **AUTO** changed the scope's voltage and time scales from the Default values. Press Default twice more to restore them.

Menus and the MENU Button

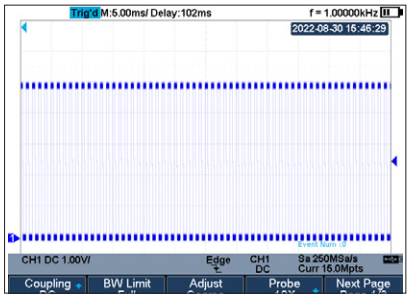


Here is the **CH1** menu. On this and all menus, you select an item by pushing the F key **(F1-F5)** beneath it.

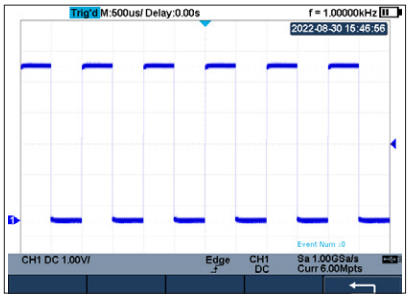
Pressing **MENU** hides the current menu, and pressing **MENU** again opens it back up.

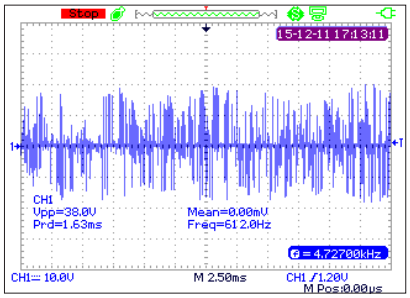
Generally, the **MENU** button opens (or closes) the last menu viewed.

Auto Button



When viewing a waveform, pressing **AUTO** resizes the voltage and time scales to fit the waveform.



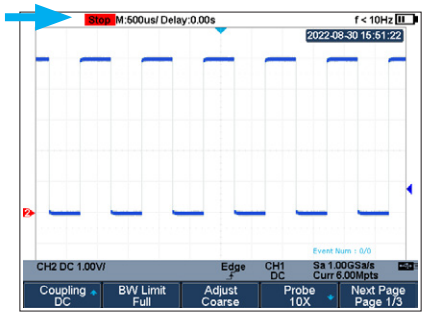


Caution: Shaft voltages are highly random so using **AUTO** may give too large a timescale. This can be adjusted. See Setting Time Period below.

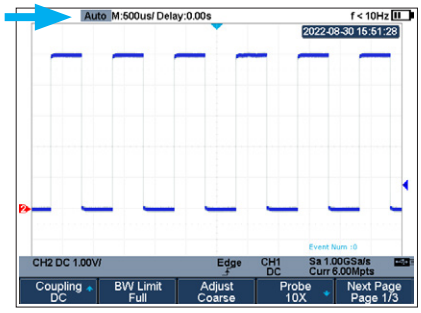
Note: Noise from the VFD may also cause CH2 to be displayed - even if no probe is plugged into the CH2 BNC. If this occurs, press **CH2** until the red trace disappears, and find Vpp using **Measure** or **Cursors**.

Run/Stop Button

While making measurements, **RUN/STOP** freezes the screen. When stopped, the word STOP will appear in the upper left of the screen.



This enables you to analyze the waveform more easily and save if desired.



Pressing **RUN/STOP** again resumes measurement. The message in the upper left will change to "Trig'd" or "Auto".

Setting Voltage Amplitude (V/div)

An EDM discharge pattern will show a climb in voltage and then a sharp vertical line. The sharp vertical line shows the moment of discharge to ground.

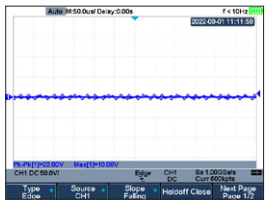
The **Default** settings are a good starting point, but you will likely need to adjust time and voltage scales up or down to get a good image of a discharge.

You control the vertical scale of the displayed signal by adjusting the **volts per division (V/div)**. The entire signal, from peak to peak, should all be displayed on the screen. 5V is a good place to start, and then adjust up or down based on the conditions. The setting selected in volts per division is shown in the lower left of the screen.

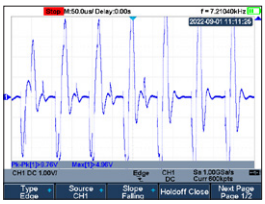
Press "V" to decrease vertical sensitivity (shorter waveforms)

Press "mV" to increase vertical sensitivity (taller waveforms)

Amplitude will need to be adjusted according to the conditions.
Set V/div to show complete wave from top peak to bottom peak.



In this example the amplitude is too small. Press **mV** to shrink the scale and show more detail.



In this example the amplitude is too large. Press **V** to enlarge the scale and show the whole waveform.

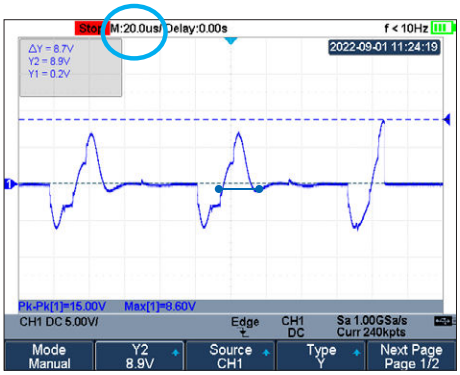
Setting Time Period (s/div)

Control the horizontal scale of the displayed signal by adjusting the time scale. Default is 50 µs (microseconds)/div. You can then adjust the time based on the conditions. The selected seconds per division setting is shown at the bottom center of the screen. The EDM waveforms are best displayed at a setting of 50 µs/div or less. Adjust the time setting to show the desired waveform.

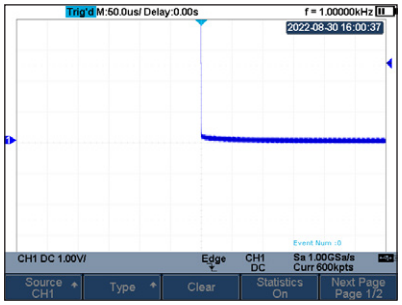
Press "ns" to increase horizontal sensitivity (wider waveforms)

Press "s" to decrease horizontal sensitivity (narrower waveforms)

The image at right has a timescale of 20 µs/div. It clearly shows a rise in voltage and an abrupt, sharp discharge (third peak).

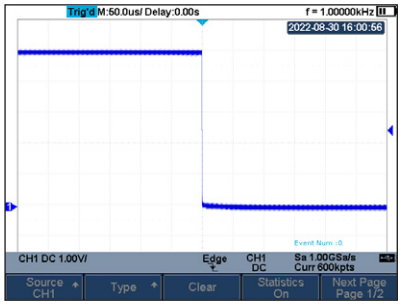


Adjusting Waveform Position



Some waveforms may display too high or low on the screen. This often happens when using the **Measure** function.

Waveforms' onscreen position can be adjusted by offsetting the voltage.



The up arrow moves the waveform higher onscreen and the down arrow moves it lower. The current offset level is indicated by the blue 1 and arrow at the extreme left of the screen.

The time can also be offset. The arrows under similarly move waveforms left and right.

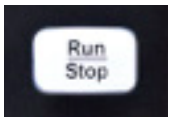
Screen Capture: Saving Images to Flash Drive

Plug in a USB flash drive. A message will pop up: "USB flash drive detected."

1. Push Print. This automatically captures the screen and saves it to the flash drive. You can view the images on any computer with a USB port when you're finished making images.

Screen capture may be done either while actively collecting data or while collection is paused:

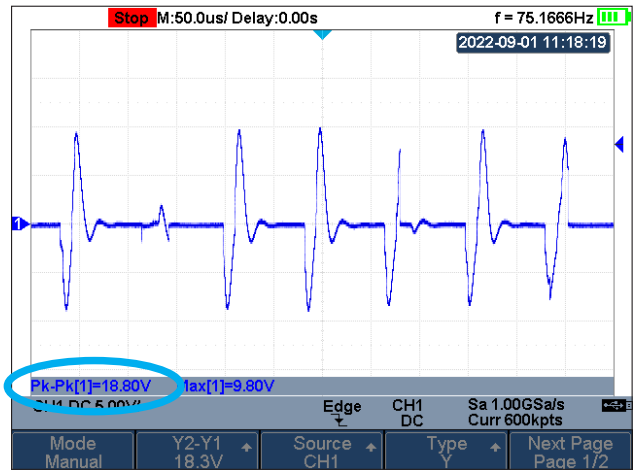
1. Press **RUN/STOP** to pause the screen. Voltage & time scales can be changed while screen is paused.

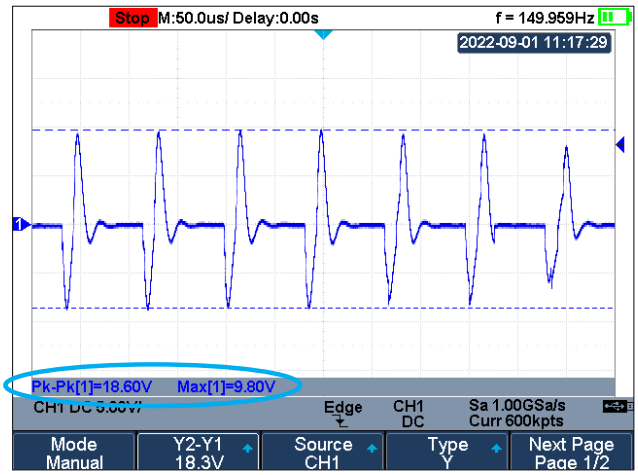


2. Pressing **RUN/STOP** will resume data collection

Peak to Peak Voltage (Vpp) with Measure

The AEGIS-OSC-9200 offers two main methods to measure peak to peak voltage (Vpp): **Measure**, and **Cursor**.





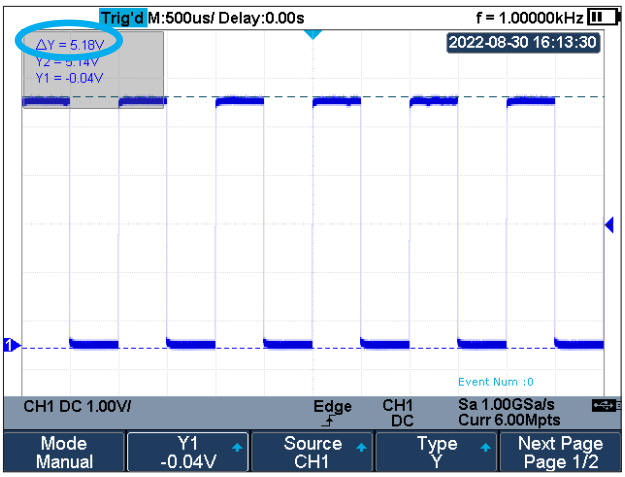
Press **Measure** and make sure Source = CH1.

Press **F2** for Type. This brings up a list of all available properties to Measure (Peak-Peak is first). You can select up to four measurements with the dial. You can also choose to display statistics onscreen.

Press **F2** again to collapse the Type menu.

The measurements you selected are displayed at the bottom of the screen, along with statistics for each (if selected).

Peak to Peak Voltage with Cursors



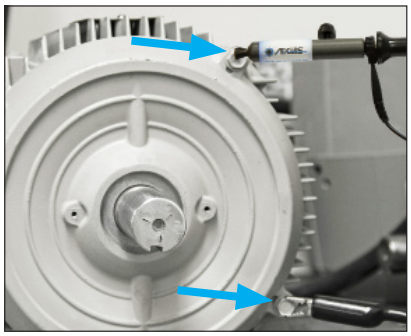
Press Cursors and make sure Type is Y or XY. If not, press **F4** and use the dial to change it to Y.

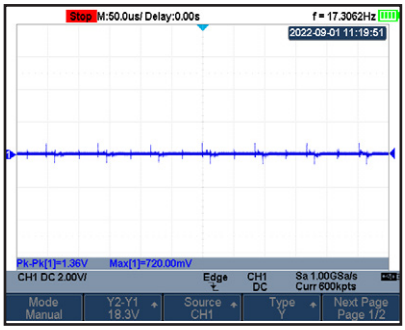
Press **F1** for Mode and then select Manual.

The selected cursor (Y1/Y2) is listed over **F2**. Move it up or down using the dial, and then press **F2** and switch to the other cursor, and position it.

The difference between the cursors is displayed at top left. DY = Y2 – Y1, so position the Y2 cursor at the top of the waveform, and Y1 at the bottom.

Taking the Measurements: EMI

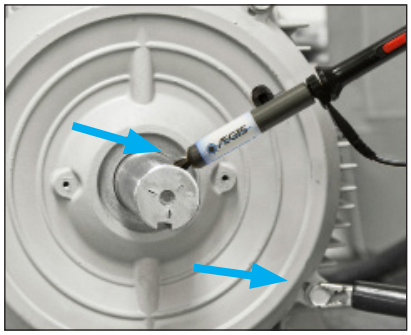


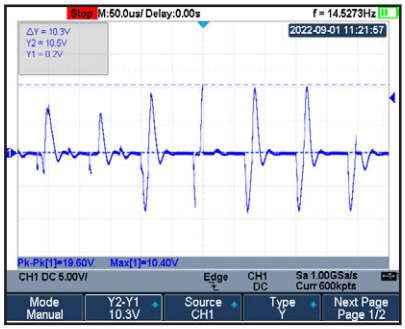


Ground Reference Reading: EMI

1. The reading displays ground noise or EMI being produced by the motor/drive system. This electrical noise may be present before and after installing the AEGIS® ring.
2. Find 2 bare metal points on the motor. They must be unpainted (or have the paint scraped off) and conductive.
3. Place the AEGIS® SVP on one of the points and the probe grounding clip on the other point.
4. Measurements will vary depending on the motor size and conditions.

Taking the Measurements: Shaft Voltage





Shaft Voltage Reading

1. Shaft must be clean & free of any coatings, paint, or other nonconductive material.
2. Secure the probe in place with magnetic base.
3. Align SVP tip on shaft end or side ensuring continuous contact. Avoid the shaft's keyway if possible.
4. Place oscilloscope grounding lead on bare metal of motor .
5. If this test is to be used in a report, save an image to a flash drive.

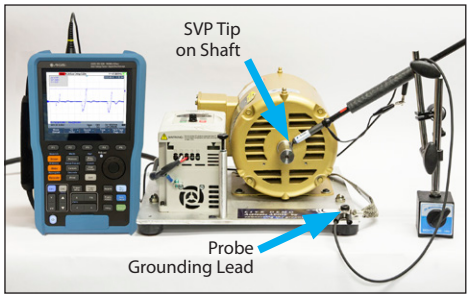
⚠ Follow all safety precautions when working with rotating equipment.

Measurements Using the AEGIS® Grounding Simulator™

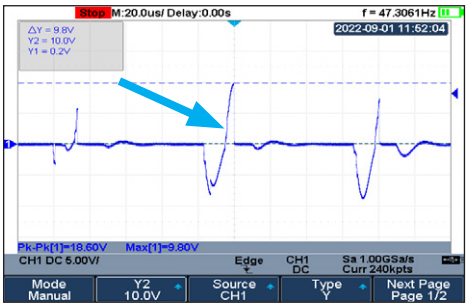
The AEGIS® Grounding Simulator™ can be used to simulate how the shaft voltages will change after an AEGIS® Ring is installed. It is a quick way of showing a "Before & After" but since only a small amount of conductive microfibers are touching the shaft the shaft voltage may be higher than when the circumferential AEGIS® Ring is installed.

1. Take the Shaft Voltage Reading without Shaft Grounding
2. Take the Shaft Voltage Reading with the AEGIS® Grounding Simulator™

First Take the Shaft Voltage Reading without Shaft Grounding



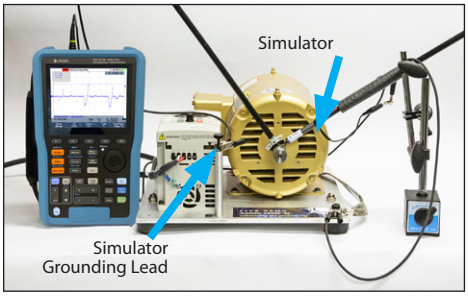
1. Shaft must be clean & free of any coatings, paint, or other nonconductive material.
2. Secure the probe in place with magnetic base.
3. Align AEGIS® SVP™ on shaft end or side ensuring continuous contact. Avoid keyway if possible.
4. Place probe grounding lead on bare metal of motor ensuring conductive path to ground.
5. Save the image, as described on page 7.



The voltage measurement of 9.8V peak using cursors is an example of the voltage discharging through the bearings without AEGIS® shaft grounding.

⚠ Follow all safety precautions when working with rotating equipment.

Next Take the Shaft Voltage Reading with the Grounding Simulator™ Touching the Shaft



1. Maintain the same setup as above.
2. Place the AEGIS® Grounding Simulator™ grounding lead on bare metal of motor.
3. Place the Simulator against the shaft to simulate the AEGIS® Shaft Grounding Ring.
4. Save an image as above.

The voltage measurement of 0.6V peak to peak is an example of the voltage discharging through the AEGIS® Grounding Simulator to ground. The AEGIS® Shaft Grounding Ring will perform equally or better.

⚠ Follow all safety precautions when working with rotating equipment.