Vehicle Measurement System (VMS)

Operation Manual

20 June 2017

Document Revision Data

Version	Date	Description
xx	19 Aug 2016	Release Notes
1.0	20 Sep 2016	Edited from Release notes
2.0	13 Feb 2017	Updated for RC-4 functionality
2.1	9 Mar 2017	Internal review edits (version #'s and other details)
3.0	1 Apr 2017	Major re-write to trim excess information
3.1	10 Apr 2017	Re-formatting
3.2	24 Apr 2017	Updates based on user feedback
3.3	20 June 2017	Corrections based on feedback from translation

CONTENTS

1 INTRODUCTION

This document covers the installation and operation of the Ford VCMM measurement tool and the VMS application. It is not intended to address operation of the product as a VCI device. For VCI operation, refer to the Ford IDS product documentation.

2 VCMM SOFTWARE INSTALLATION INSTRUCTIONS:

Prior to software installation make sure you have administrator privileges on the target PC.

2.1 INSTALL THE MEASUREMENT LIBRARY TO THE TARGET PC

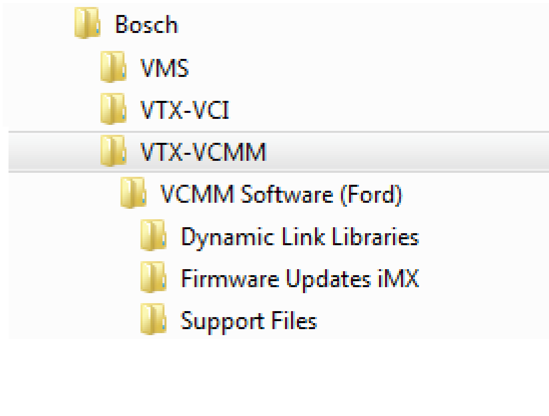
- Install the Measurement Library provided for this release of the Ford Platform Group. The setup is extracted to the target PC.
- User is prompted to proceed with installation.
- Installation proceeds. The VCMM Measurement Library is a 32-bit library, and is installed in the same folder structure as the platform group

2.2 PC HARDWARE REQUIREMENTS

- The VMS Application runs on a Windows 7, Windows 8, Windows 8.1 and Windows 10.
- A DirectX 11 compatible graphics card is required. You can determine the compatibility of the target PC with DirectX 11 by executing the application “dxdiag.exe”, found in the Windows System folder, on the target PC. In the “dxdiag.exe” application, click on the “Display” tab, and look for the “DDI Version” property. If the version property is 10.1 or greater, then the target PC is DirectX 11 compatible.
- The VMS Application uses approximately 86 megabytes of disk memory when installed. (This value does not include the requisite VCMM measurement library.)
- When executing, the VMS Application requires a minimum of 120 megabytes of CPU memory.
- For optimal graphics performance a minimum of 512MB of graphics memory is necessary.

2.3 INSTALLING THE VMS APPLICATION TO THE TARGET PC

- Execute the “setup.exe” provided for this release of the VMS Application. The setup is extracted to the target PC.
- The VMS Application is a 32-bit application, and is installed alongside other Bosch VCI and VCMM tools under the folder “Program Files (x86)/Bosch”:



2.4 UNINSTALLING THE VMS APPLICATION

The application may be uninstalled from the Windows Start Menu (Start→All Programs→VMS→Uninstall VMS), or using the Windows Add/Remove Programs utility.

3 OVERVIEW OF THE USER INTERFACE

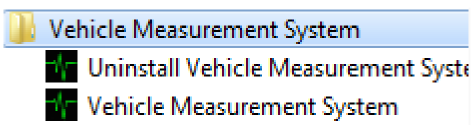
3.1 LAUNCHING THE APPLICATION

Windows Desktop

The application can be launched from the Windows desktop by double-clicking the icon shown below:

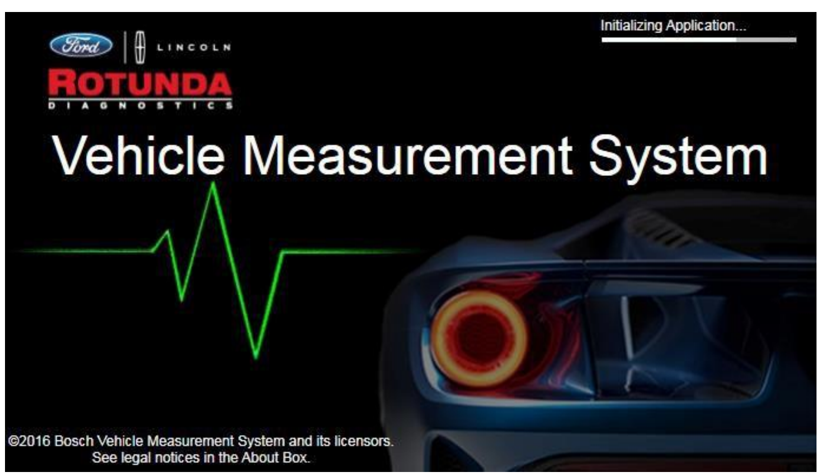
Windows Start Menu

The application is found in the Windows Start menu: Start→All Programs→Ford Motor Company→Vehicle Measurement System.



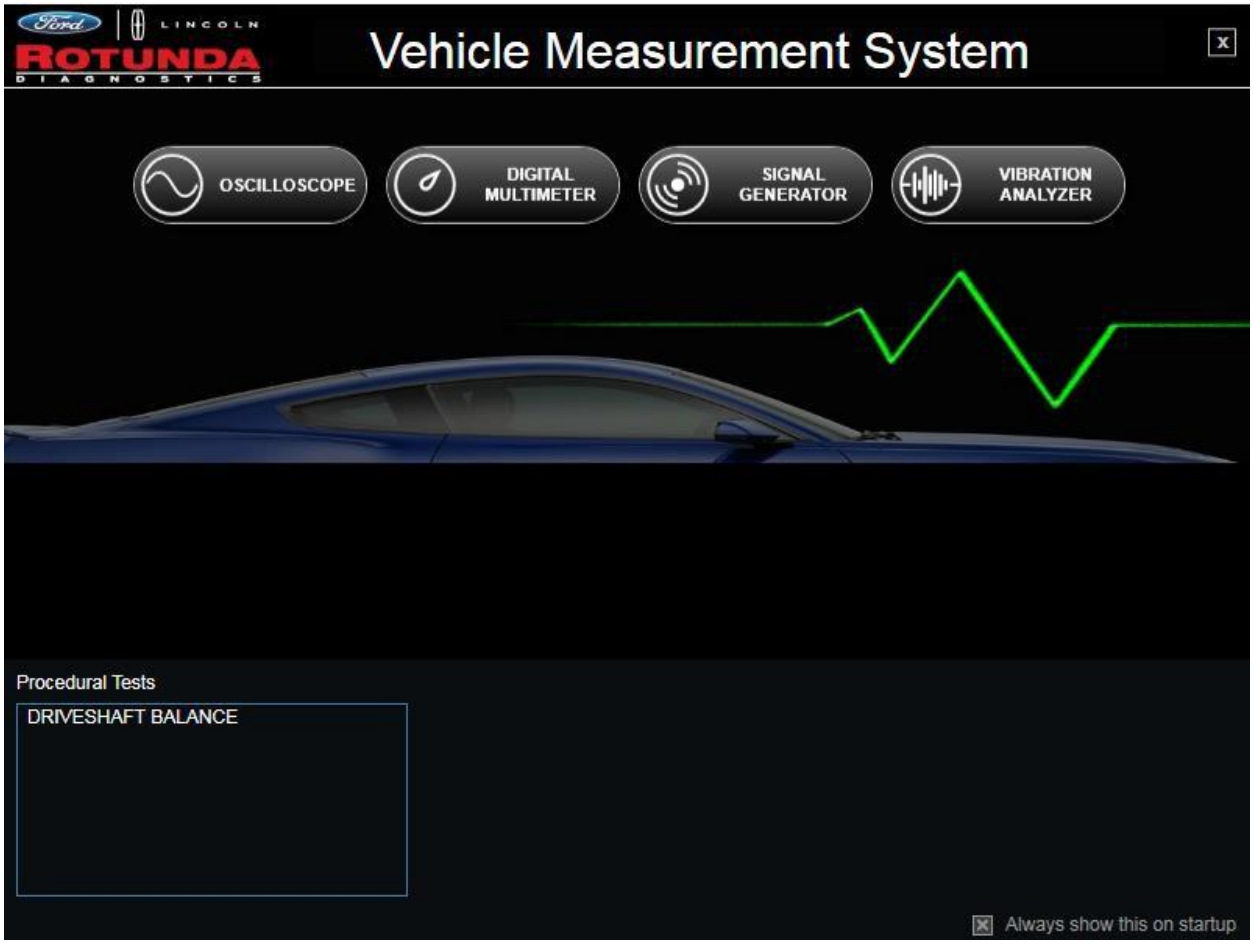
3.2 LOADING SCREEN

The following dialog is briefly displayed while the application loads and initializes.



3.3 Launcher Window

By default, VMS displays the "Launcher" window, shown below, each time the application is started. This window provides a centralized location for selection of available tools, saved files, and procedural tests.



3.3.1 Main Tools

Each of the four main tools – Oscilloscope, Multi-meter, Signal Generator, and Vibration Analyzer – can be activated by clicking the associated tool icon near the top of the window.

3.3.2 Procedural Tests

Procedural tests are VMS functions which lead the user through a sequence of steps to perform a specific diagnostic function. Only Driveshaft Balance is available in this release. Procedural tests are accessible through the Launcher Window as well as from the pull-down menu on the main display.

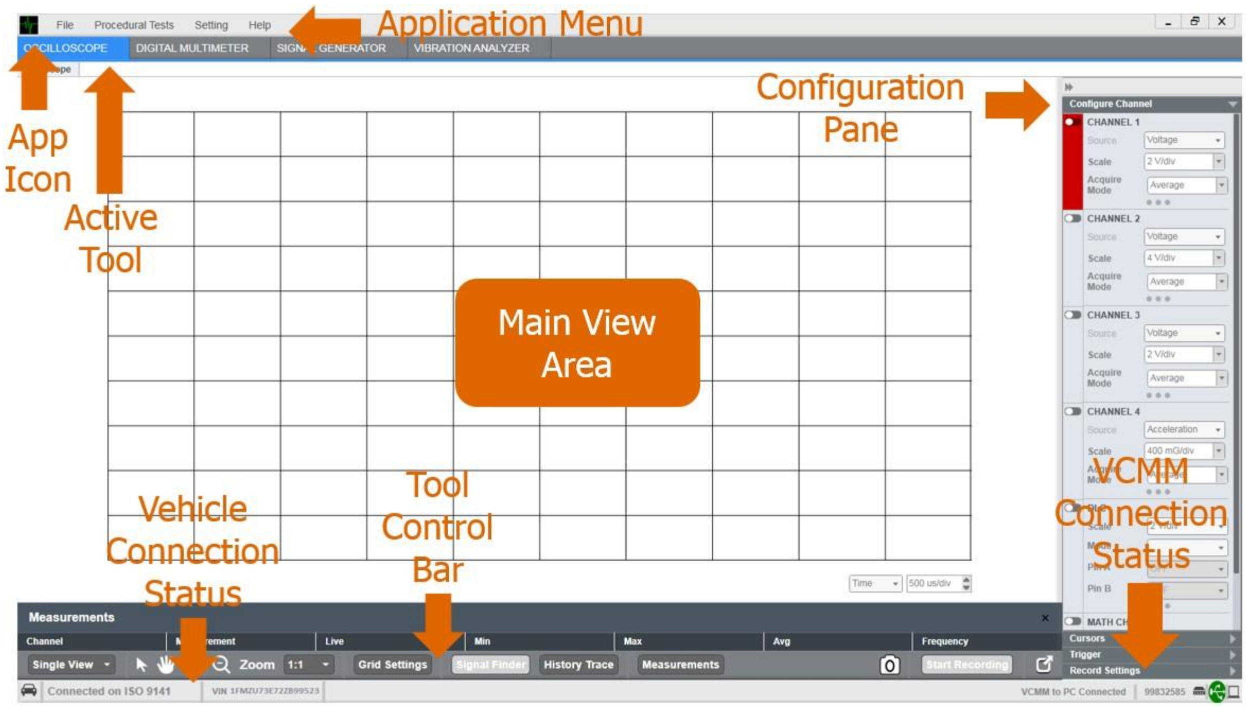
3.3.3 Show/Hide the Launcher Window

You can prevent the Launcher Window from appearing at application startup by unchecking the option "Always show this on startup" in the lower right corner of the Launcher Window.

3.3.4 Persistence

Settings for all tools will be saved when exiting the VMS. Upon re-entering VMS the last used settings will be restored in all tools.

3.4 MAIN SCREEN LAYOUT



3.5 CONNECTING TO A VCMM

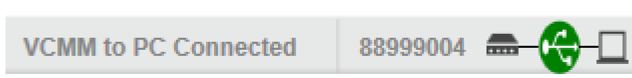
Measurement functions require a Ford VCMM to be connected to the PC on which is running the VMS application. USB, Ethernet, and wireless are supported methods of connection. Status of the VCMM connection is shown in the lower-right corner of the application.

3.5.1 VCMM Connection Status

VCMM connection status is shown in the right-most part of the Status Bar.

- When there is no VCMM connected, the status shows an "X". A prompt message "Please Connect VMM to PC" appears when the loss of connection is first detected by the application.

- When a connection with a VCMM exists, the status is "Connected", and the connection symbol reflects the method of connection. The serial number of the connected VCMM is shown.

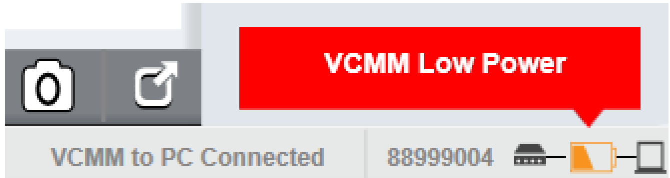


3.5.2 USB Connection

The VMS Application will automatically connect via USB. You can physically connect via USB either before or after starting the application, and the application will automatically establish the VCMM connection.

3.5.3 VCMM Low Power State

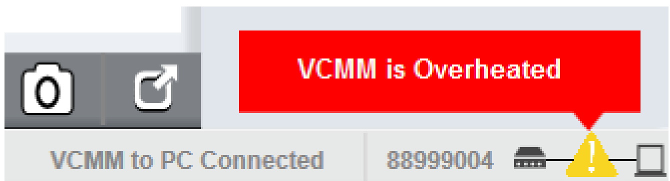
When external power is removed from the VCMM, the VCMM enters "low power" state, and acquisition of measurement data is no longer possible. When the VCMM is in low power state, VMS displays a warning message:



When external power is restored to the VCMM, the warning message is removed.

3.5.4 VCMM Overheated State

When the internal temperature of the VCMM exceeds maximum allowable operating temperature for the measurement subsystem, VMS displays a warning message:



When normal operating temperature is restored, the warning message is removed.

3.6 Vehicle Serial Communication

Serial communication between VMS and the vehicle is accomplished using the VCMM's communication interface and the SAE J1962 connector on the vehicle. Vehicle parameters for engine speed and vehicle speed are only used in the Vibration Analyzer tool.

Status of the serial communication connection is shown in the left-most portion of the VMS status bar, immediately to the right of the vehicle icon:

The serial connection status consists of two fields: the connection state, and the VIN read from the vehicle. The connection state field may display these states:

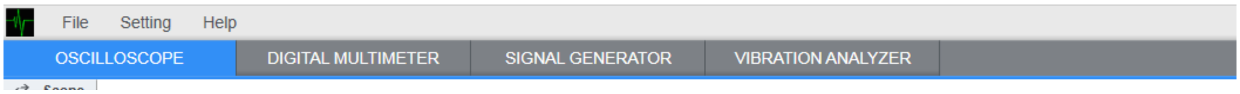
- "No Serial Connection" – No connection has been attempted. This is typically displayed when the VMS application has not connected to the VCMM.
- "Not Configured" – This indicates (a) serial communication is disabled.
- "Attempting J2534" – VMS is attempting to open the J2534 interface in the VCMM.
- "Attempting [protocol]" – VMS is attempting to connect to the vehicle using the indicated protocol.
- "Connected on [protocol]" – Serial communication is active using the indicated protocol.
- "Connection Failed" – All supported protocols were tested, but serial communication could not be established.

To the right of the connection state field is the VIN display area. The VIN shown here is the VIN read from the vehicle or, if no VIN could be read, the status “VIN Unknown”.

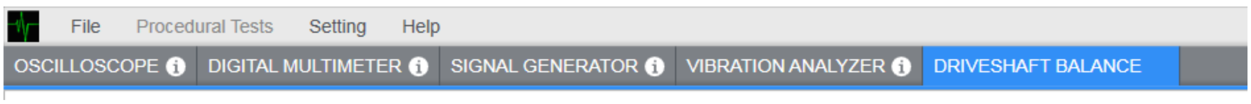
If serial communication cannot be established, or is lost, the application attempts to establish a connection every 10 seconds, testing the OBD II protocols in the order shown above.

3.7 Switching Tool Views

The current application release supports four main tools: Oscilloscope, Digital Multi-Meter, Signal Generator, and Vibration Analyzer. Each of the main tools has a permanent tab within the main view.



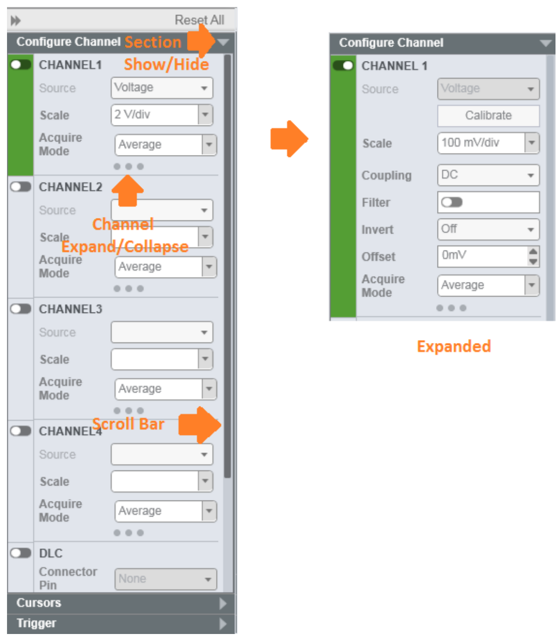
Procedural tests, such as DRIVESHAFT BALANCE are only displayed when active. When a procedural test is active, an additional tab is added to the right of the main tool tabs. Only one procedural test may be active at any one time.



3.8 Control Pane Operation (Scope and Meter Tools)

The Control Pane for the Meter and Scope tools consists of multiple channel and control subsections. There is also a scroll bar on the very right for access to hidden sections. Each channel section is partially open at all times so that key configuration settings are always visible. For example, in the Scope Configuration Pane, each channel state is shown in a section of the pane.

- A section can be shown or hidden entirely by clicking on the section visibility control (arrow icon).
- A channel section can be expanded to show hidden detail by clicking on the channel expander control (three dots):



3.8.1 Show / Hide Configuration Pane

The Configuration Pane can be hidden, so that the main viewing area is expanded to the full width of the application's window. The button for this feature is at the top of the Configuration Pane:

3.9 Full Screen Feature

The application can be sized to occupy the entire PC screen, and at the same time hide the Configuration Pane and tool tab controls. The button for this feature is located at the right-most side of the Tool Control Bar:

3.10 Application Version Information and Checking

The application's version information can be viewed by selecting the menu item "Help/About VMS". If connected to a VCMM, a dialog also shows version information for the VCMM.

3.11 Measurement Probes

3.11.1 Supported Probes

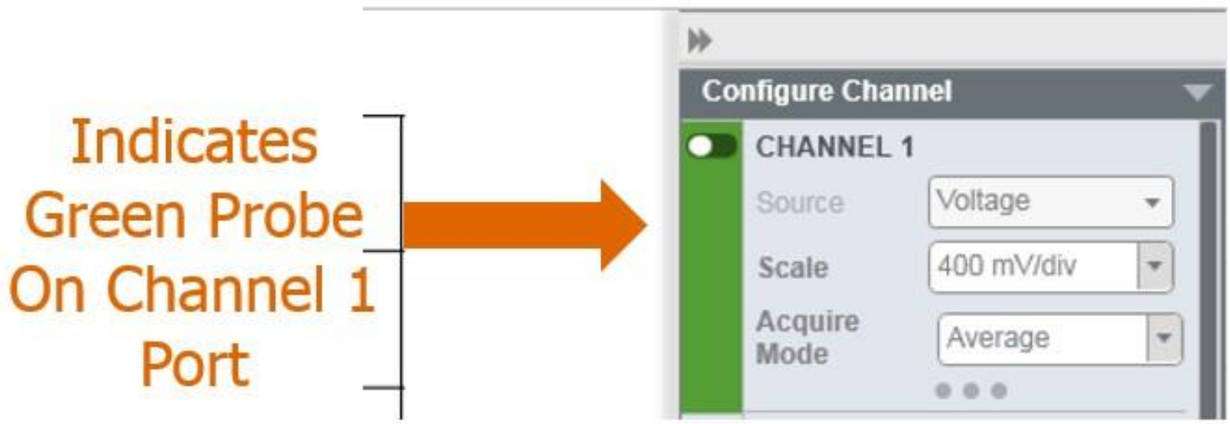
The VMS application supports various probe types for different types of measurement. In order to help identify what probe is plugged into which channel the control pane changes its header color to reflect the detected probe. Traces on the tools are also displayed in the indicated color. The supported probes and their color codes are indicated below:

Probe Type	Display Color	Measurement Range
Standard Lead – Red	Red	-60 .. +60 Volts
Standard Lead – Blue	Blue	-60 .. +60 Volts
Standard Lead – Yellow	Yellow	-60 .. +60 Volts
Standard Lead – Green	Green	-60 .. +60 Volts
Ignition Lead – Red	Red	-60 .. +60 Volts
Ignition Lead – Blue	Blue	-60 .. +60 Volts
Ignition Lead – Yellow	Yellow	-60 .. +60 Volts
Ignition Lead – Green	Green	-60 .. +60 Volts
Red Tick Probe	Red	-60 .. +60 Volts
Low Current	Black	-50 .. +50 Amps
High Current	Orange	-500 .. + 500 Amps
Pressure-Vacuum Transducer	Black	0 .. 500 psi
Accelerometer A	Blue	-4 G .. +4 G
Accelerometer B	Green	-4 G .. +4 G
Inductive Loop	Pink	0 .. 10 Volts
RTD Temperature Probe	Black	-80 C .. 309 C
BNC Adapter	Black	
DLC Channel	Orange	
Math Channel	Purple	

3.11.2 Probe Connection

In order for connected probes to be recognized by the application, the VCMM must be powered by an external power source, either the power adapter or vehicle DLC. USB power is not sufficient to drive the probes.

Probes may be connected to the VCMM channel ports before, or after, the application is started. The VMS application will indicate that it recognizes the presence of a probe by setting the color of the channel's On/Off button to the probe's assigned color. In this example, the green standard test lead is connected to channel 1. If the channel's On/Off button does not change to a probe color (as for channel 2, below), then the application does not recognize a probe on that channel's port.



4 OSCILLOSCOPE OPERATION

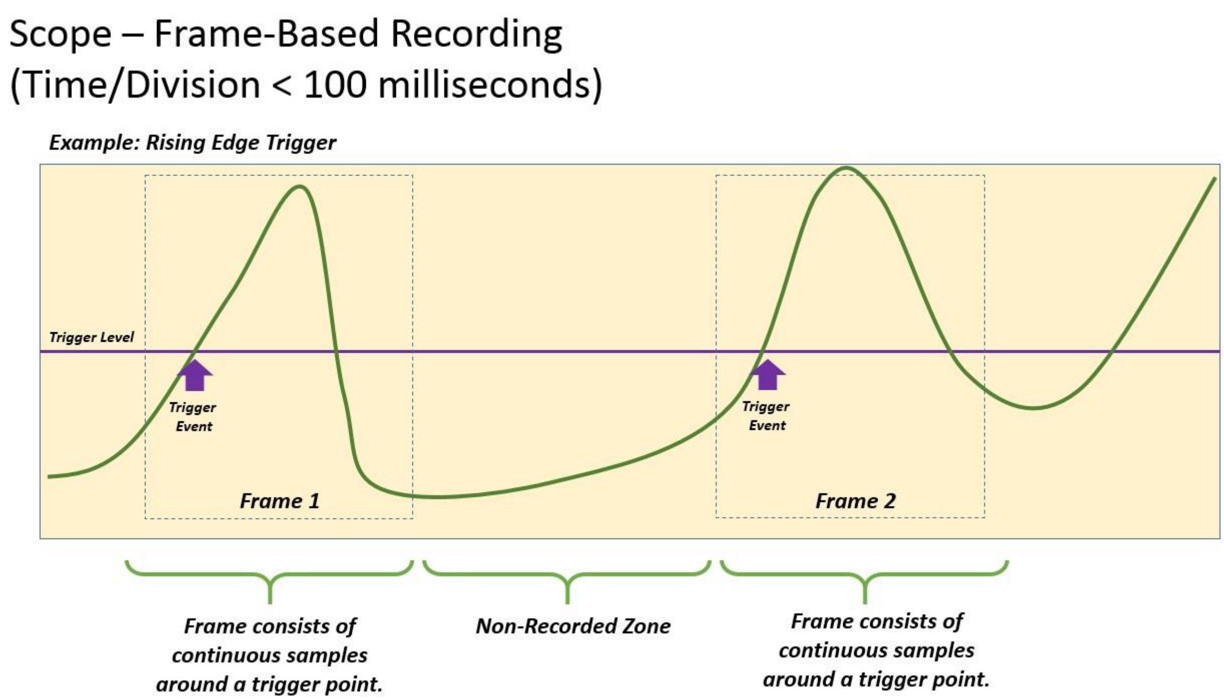
4.1 SCOPE ACQUISITION AND RECORDING MODES

VMS has three methods of acquiring and recording Scope data. The three methods are described in this section.

4.1.1 Frame-Based Data Acquisition

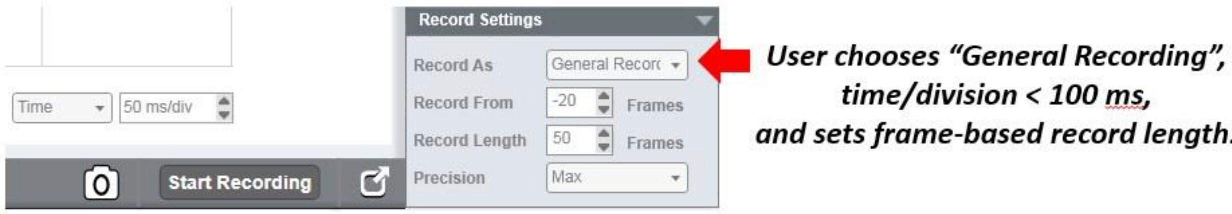
In the frame-based acquisition method, data samples are collected based on trigger events. This acquisition method is typically used when analyzing signals that contain periodic events.

- The user defines a trigger condition, and the VCMM collects samples for a specified amount of time before and after each trigger event. The data acquired for a trigger event is called a frame.
- Data samples between frames are not displayed and not recorded.
- The VMS application retrieves the acquired data from the VCMM on a frame-by-frame basis.
- The VMS application records the frames on the PC as they are retrieved from the VCMM.

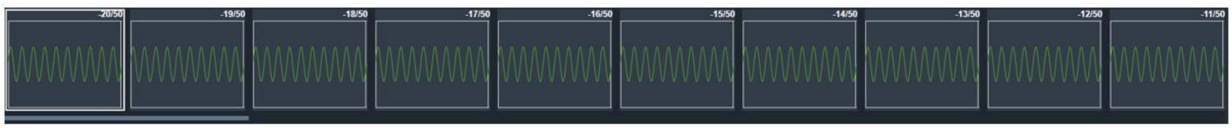


Frame-based acquisition is in effect when the user configures VMS in the following way:

- In the “Record Settings” section, the “Record As” option is set to “General Recording”.
- Either (a) the acquisition time scale is set to “Time”, and the time-per-division is less than 100 milliseconds per division; or (b) the acquisition time scale is set to “Angle”.



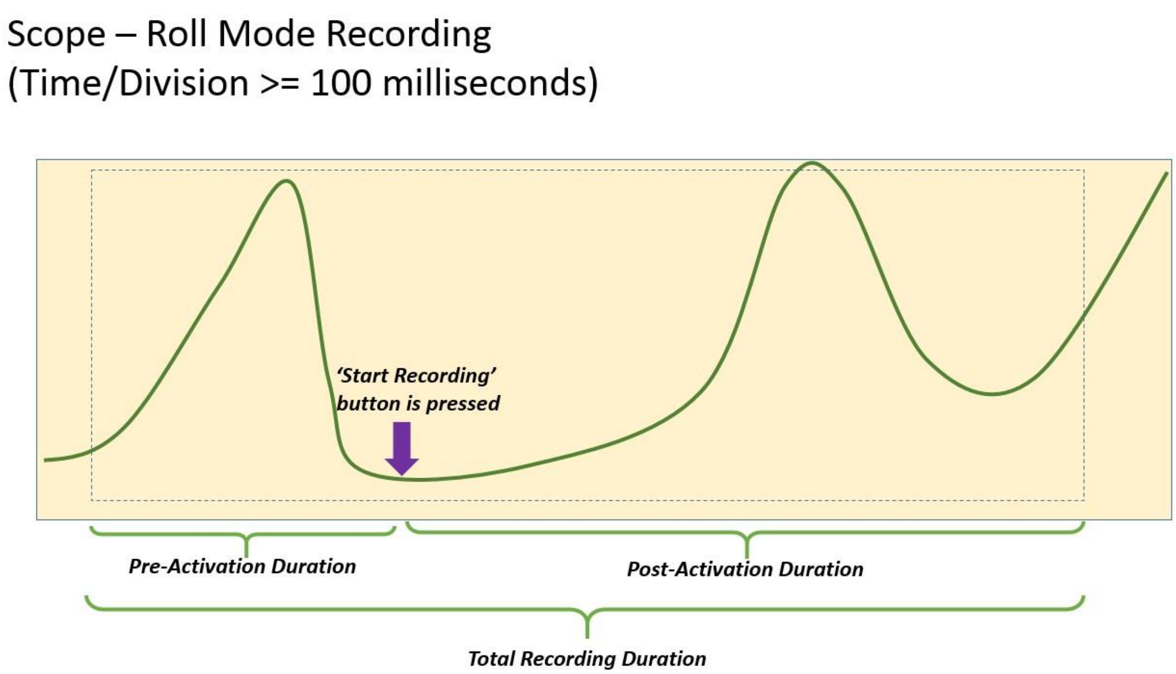
- The view and playback of data is on a frame-by-frame basis.



4.1.2 Roll-Mode Data Acquisition

In the roll mode-based acquisition method, there is no trigger involved. This acquisition method is typically used when analyzing a slow signal.

- Data is acquired at a fixed sample rate of 1,000 samples over the selected time range (10 times the user’s time/division setting).
- The VMS application retrieves the acquired data from the VCMM as samples, not frames.
- The VMS application records the samples on the PC as they are retrieved from the VCMM.

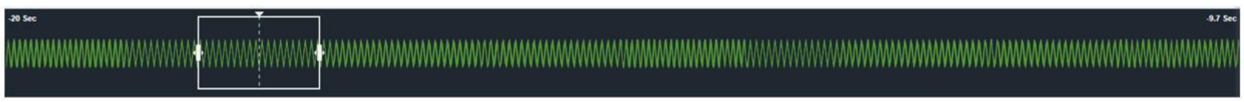


Roll-mode-based acquisition is in effect when the user configures VMS in the following way:

- In the “Record Settings” section, the “Record As” option is set to “General Recording”.
- The acquisition time scale is set to “Time”, and the time-per-division is greater than or equal to 100 milliseconds per division.

User chooses “General Recording”, time/division >= 100 ms, and sets time-based record length.

The view and playback of data is on a sample-by-sample basis:

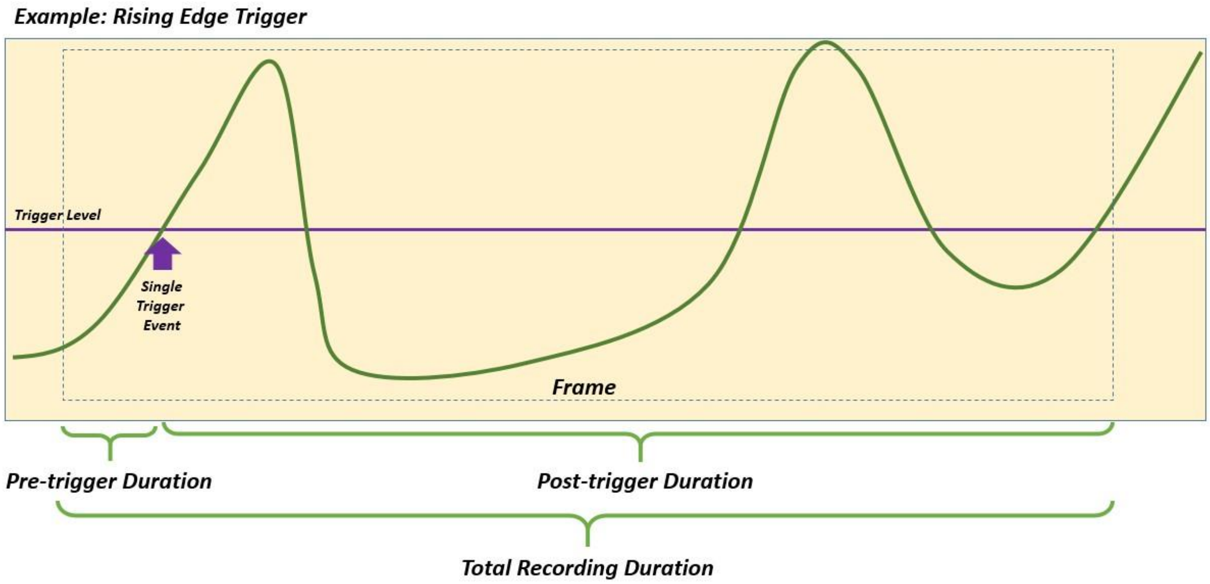


4.1.3 Continuous Data Acquisition

With the Continuous method of acquisition there is only a single trigger event. This method is typically used when analyzing an intermittent event. The Continuous method also allows the acquisition of samples at a fast rate, and without the risk of data loss due to the (relatively) slow bandwidth between the VCMM and PC. The Continuous method can acquire data without the loss of data that is seen between frames in the Frame method.

- The user defines a trigger condition, and the VCMM collects samples for a specified amount of time before and after the trigger event.
- Data is collected as samples, where the sample rate depends on the user’s selected time per division.
- The user defines the total duration to record, in seconds.
- The user also defines the amount of time to record before the trigger event. This means the total recording duration is divided into a pre-trigger period and a post-trigger period.
- Data is collected and stored within the VCMM as samples, and is uploaded to the VMS PC application after the recording has ended.
- During the acquisition process, data is displayed in the live Scope view, but the view may show only a subset of the acquired data.

Scope – Continuous Recording



Continuous data acquisition is in effect when the user configures VMS in the following way:

- In the “Record Settings” section, the “Record As” option is set to “Continuous Recording”.

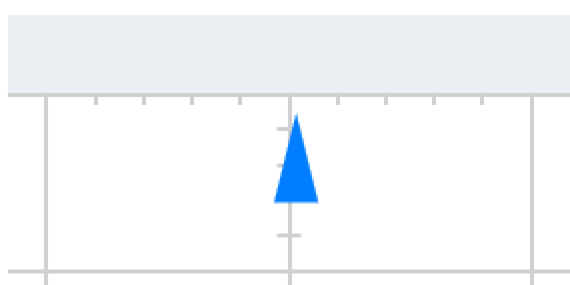
The view and playback of data is on a sample-by-sample basis.

4.2 Scope View Layout

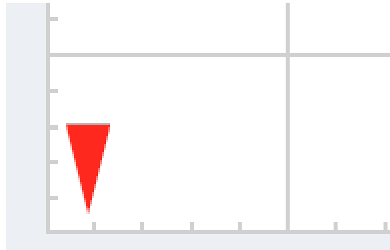
4.2.1 Special Plot Symbols

Additional symbols may be appear in the Scope view:

- If the channel trace is scrolled out of view, an arrow indicates the direction in which the trace has been scrolled. The arrow is drawn in the channel's color. If the trace is above the plot area, an up arrow is shown at the top of the plot:



- If the trace is below the plot area, a down arrow is shown at the bottom of the plot:



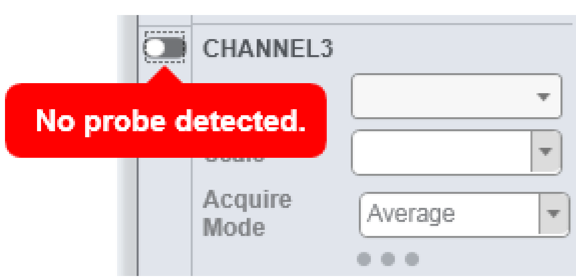
4.3 Standard Channel Configuration

- Ensure that a probe is connected to the channel, and that the application recognizes the probe. The channel section of the Configuration Pane will change color to show which probe is recognized.
- Turn the channel On using the channel's button/slider control.
- Data Source – This combo box displays only the data measurement types that are applicable to the connected probe. It is also possible to set the measurement type when no probe is connected, in which case any measurement type may be selected.
- Scale – Changes the Y-axis scale for the channel.
- Coupling – Select AC or DC probe coupling.
- Filter – Turns a 30 kHz filter On or Off.
- Invert Signal – Inverts the displayed line plot.
- Vertical Offset – Moves the entire channel trace up or down within the view. You can also drag the entire Y-axis up or down within the channel axis area using the mouse.
- Data Acquisition Mode – Switches between 'Average' mode and 'Min/Max' mode at the VCMM hardware level.

4.3.1 Channel Pop-ups

No Probe Detected

If you attempt to enable a channel on which no probe is connected, the following popup error is displayed:

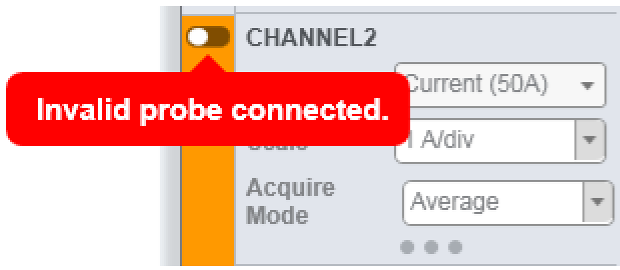


Invalid Probe Connected

You can configure a Scope channel even when there is no probe connected to the channel port. If you subsequently connect a probe that is inconsistent with the channel's configuration, and you then try to enable the channel, the popup error "Invalid probe connected" is displayed.

This error also occurs when (a) a Preset Configuration is effect, (b) the configuration calls for a specific probe on a channel, and (c) the wrong probe is connected on the channel.

In the example below, the user has selected the Source as "Current (50A)", but the user has connected an accelerometer probe to the channel. Since the accelerometer probe cannot be used to measure current, the probe is invalid in this case.

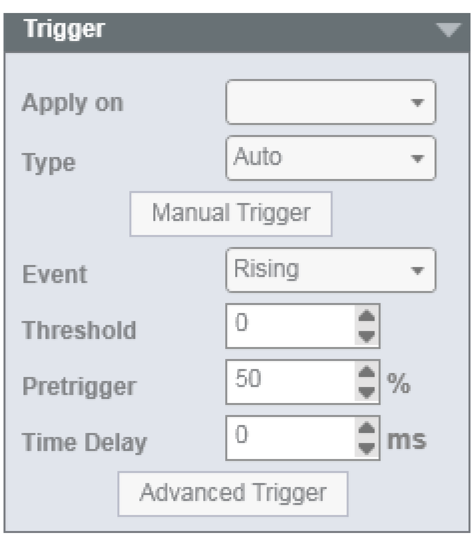


In response to this error, you can either connect a probe of the correct type, or you can change the channel's configuration.

4.4 Primary Triggers

The VMS frame capture system is controlled by a primary trigger configuration and, optionally, a secondary trigger configuration.

Expand the "Trigger" section of the Configuration Pane. Select the channel to use as the primary trigger source ("Apply On"), and other trigger settings. All settings can be changed while data acquisition is in progress.



4.4.1 Trigger Type

The following trigger types are supported:

- Normal – The frame acquisition system waits indefinitely for a trigger event to occur. The scope view will not update until the trigger condition is met.
- Auto - The frame acquisition system waits for a trigger event to occur, however, if a trigger does not occur within a short period of time, a frame is acquired. This means the system will trigger periodically even if the trigger condition is not met.

4.4.2 Primary Trigger Time Position

The time axis pre/post-trigger percentage can be set either by entering a percentage in the "Pretrigger" field, or by dragging the time axis trigger symbol T horizontally along the time axis to the desired position (left-most being 0% pre-trigger, and right-most being 100% pre-trigger).

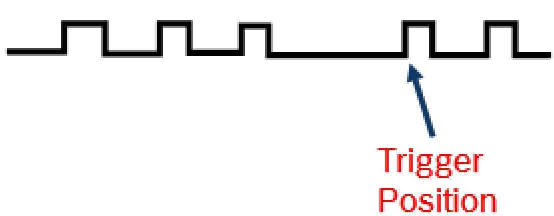
If you drag the trigger symbol close to the channel zero-level and then release the mouse, the symbol will 'snap' to the zero point. You can disable this snap-to-zero feature by holding down the CTRL key while dragging the trigger symbol.

4.4.3 Primary Trigger Event

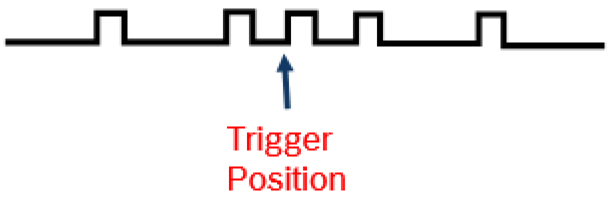
The primary trigger event defines the condition under which a frame of data samples is acquired by the VCMM. You use the "Event" combo box in the Trigger section to specify a primary trigger condition.

Each time the primary trigger condition is met, a frame of data is acquired. (Whether or not a frame is actually acquired also depends on the trigger "Type", described above.) The following primary trigger events are supported:

- Rising Edge Trigger - A Rising Edge trigger occurs when the trigger channel's signal moves up through the horizontal trigger level.
- Falling Edge Trigger - A Falling Edge trigger occurs when the trigger channel's signal moves down through the horizontal trigger level.
- Missing Pulse Trigger - A Missing Pulse trigger may be used when the signal on the trigger channel consists of a regular series of pulses. A Missing Pulse trigger event occurs, and a Scope frame is captured, when a pulse interval is detected that is at least twice the interval being tracked:



- Extra Pulse Trigger - An Extra Pulse trigger may be used when the signal on the trigger channel consists of a regular series of pulses. An Extra Pulse trigger event occurs, and a Scope frame is captured, when a pulse interval is detected that is one-half, or less, of the interval being tracked:



- High Pulse Longer Than – The high pulse longer than trigger event occurs when a positive going pulse exceeds a programmable threshold time.
- High Pulse Shorter Than – The high pulse shorter than trigger event occurs when a positive going pulse is less than a programmable threshold time.
- Low Pulse Longer Than – The low pulse longer than trigger event occurs when a negative going pulse exceeds a programmable threshold time.
- Low Pulse Shorter Than – The low pulse shorter than trigger event occurs when a negative going pulse is less than a programmable threshold time.

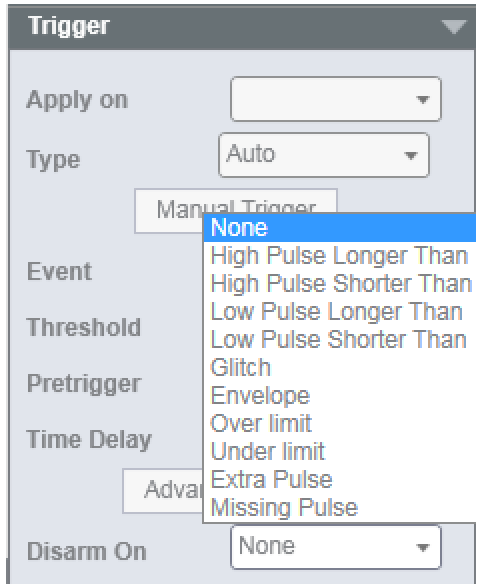
4.4.4 Primary Trigger Threshold

The trigger threshold can be set by either entering a numeric value in the "Threshold" field, or by dragging the Y-axis trigger symbol vertically to the desired level on the channel's Y-axis. On the Y-axis, the trigger symbol is color-coded to the channel selected as the trigger channel.

4.5 Secondary (Advanced) Triggers

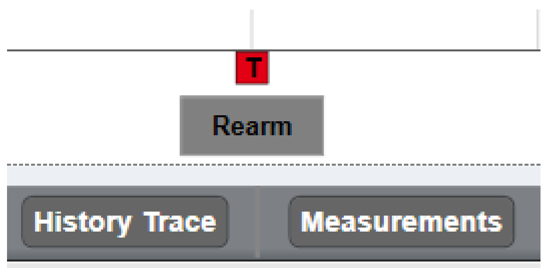
A secondary trigger is a set of conditions which, when met, causes the processing of primary triggers and inbound frames to be suspended and display the data captured when the secondary trigger was detected. In VMS, a secondary trigger is configured in the "Trigger" section of the Configuration Pane by first clicking the "Advanced Trigger" button. Clicking this button expands the Trigger section to display the "Disarm On" combo box. Choose the option which

you want to use as the secondary trigger event to disarm the processing of primary triggers. Depending on which option you choose, additional selections may be necessary.

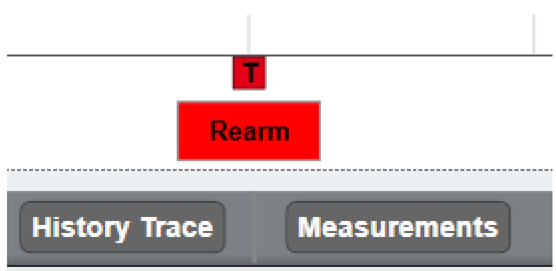


4.5.1 Secondary Trigger Operation

When a secondary trigger event occurs, VMS immediately suspends Scope data acquisition, and displays the scope frame in which the secondary trigger event was detected. In addition to suspending Scope data acquisition, VMS displays a button labeled "Rearm" below the channel plot area.



This button is in the grayed-out state (as shown above) until a secondary trigger event is detected. When a secondary trigger occurs, and data acquisition is suspended, the "Rearm" button becomes enabled:



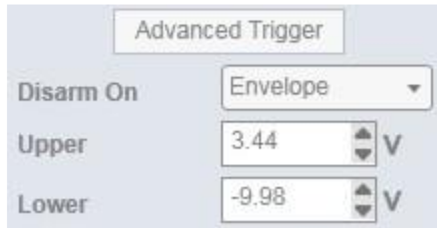
In order to restart data acquisition, you must clear the secondary trigger condition, and then click the "Rearm" button. Alternatively, you can set the "Disarm On" selection to "None".

If you click the "Rearm" button without clearing the secondary trigger condition, VMS immediately detects the condition again and suspends data acquisition.

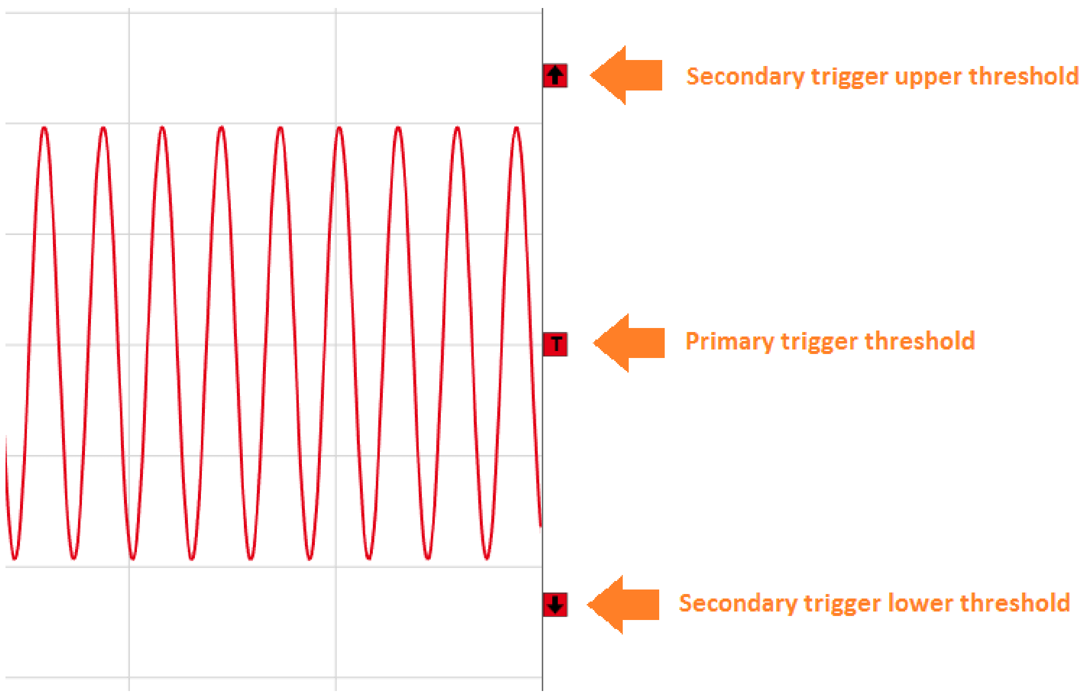
4.5.2 Secondary Trigger Thresholds

Some secondary triggers require you to specify one or two trigger thresholds. This is in addition to the primary trigger threshold. (The primary trigger threshold continues to be used as the trigger for periodic frame capture.) You can specify the secondary trigger threshold(s) in either of two ways:

(a) Enter numeric values into entry fields. The values you enter here are in the units of measure for the trigger channel:



(b) Move secondary trigger indicator(s), alongside the Y-axis of the plot area, to the desired threshold level(s):



4.5.3 Supported Secondary Trigger Events

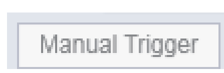
The following secondary trigger events are supported:

- Envelope Trigger - The Envelope trigger uses two secondary trigger thresholds, in addition to the primary trigger threshold. You must define a secondary trigger upper threshold, and a secondary trigger lower threshold. An Envelope trigger event occurs when the signal on the trigger channel either (a) rises above the upper limit, or (b) falls below the lower limit.
- Over Limit Trigger – The Over Limit trigger uses one secondary trigger threshold, in addition to the primary trigger threshold. You must define a secondary trigger upper threshold. An Over Limit trigger event occurs when the signal on the trigger channel rises above the upper limit.

- Under Limit Trigger – The Under Limit trigger uses one secondary trigger threshold, in addition to the primary trigger threshold. You must define a secondary trigger lower threshold. An Under Limit trigger event occurs when the signal on the trigger channel falls below the lower limit.
- Missing Pulse Trigger – The Missing Pulse trigger (described in paragraph 12.6.312.6.3, above) may be used as a secondary trigger. In this case, the acquisition of frames is suspended as soon as the first frame with a missing pulse is detected. The only threshold to be set is the primary trigger threshold.
- Extra Pulse Trigger – The Extra Pulse trigger (described in paragraph 12.6.312.6.3, above) may be used as a secondary trigger. In this case, the acquisition of frames is suspended as soon as the first frame with an extra pulse is detected. The only threshold to be set is the primary trigger threshold.
- Glitch - A Glitch trigger event occurs when the signal crosses above and below a user-defined trigger level, but does so within a period of time that is short relative to the overall frame length. You must specify the "short" time duration for the trigger condition.
- High Pulse Longer Than – The high pulse longer than trigger event occurs when a positive going pulse exceeds a programmable threshold time.
- High Pulse Shorter Than – The high pulse shorter than trigger event occurs when a positive going pulse is less than a programmable threshold time.
- Low Pulse Longer Than – The low pulse longer than trigger event occurs when a negative going pulse exceeds a programmable threshold time.
- Low Pulse Shorter Than – The low pulse shorter than trigger event occurs when a negative going pulse is less than a programmable threshold time.

4.6 MANUAL TRIGGER

While data is being acquired, you may force a trigger event at any time by clicking the "Manual Trigger" button in the Trigger section of the Configuration Pane.



4.6.1 Red Tick Probe Trigger

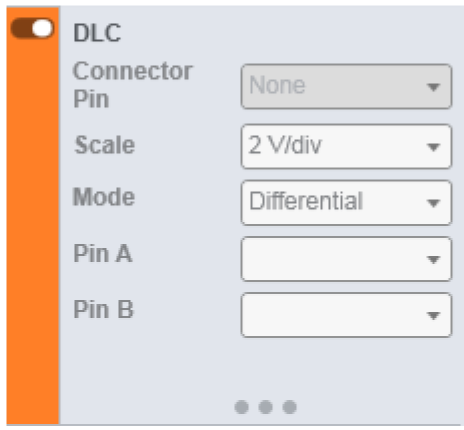
While Scope data is being acquired, you may force a trigger event at any time by pressing the button on the Red Tick probe.

4.7 DLC CHANNEL CONFIGURATION

The pins of the vehicle's Data Link Connector (DLC) may be used as a signal source for measurement data acquisition. This feature requires the VCMM's DLC connector to be connected to the vehicle's DLC.

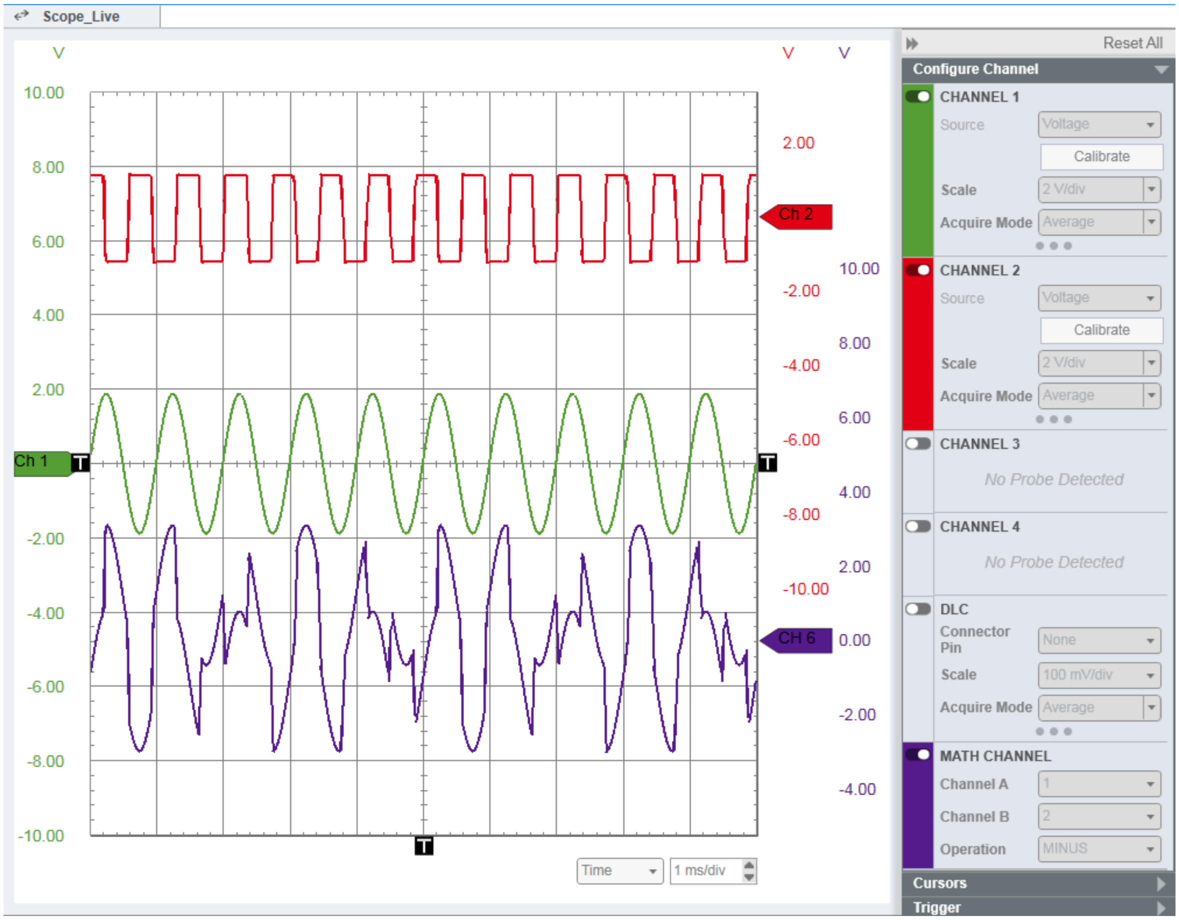
- Expand or scroll the "Configure Channel" section of the Configuration Pane until the "DLC" section of the pane is visible.

- Set up the mode:
    - Single ended – pin voltage referenced to ground
    - Added – adds the voltage of the two pins together
    - Differential – shows the difference between the pins – Note: this is the typical mode for CAN bus probing.
- Set up the pins(s) you wish to probe. The channel color will change to Orange which is the display color for the DLC channel once the channel configuration information is complete.
- Turn the DLC On by clicking the On/Off button/slider.



4.8 Math Channel

- Use the Math Channel section of the Configuration Pane to enable the Math feature. To begin Math channel configuration, leave the Math Channel's On/Off button in the "Off" state.
- The Math Channel feature requires two standard channels to be turned On and to be identically configured. Both input channels must be configured with the same scale, and both input channels must have the same Average/Min-Max setting.
- When both input channels are correctly configured, in the Math Channel section select one of the input channels as "Channel A", and the other input channel as "Channel B".
- Choose the math operation: Plus (A+B) or Minus (A-B).
- Switch the Math Channel On/Off button to "On". The Math Channel trace is added to the Scope display using the color purple:



- If you turn Off either of the input channels, the Math Channel is also turned Off.
- While the Math Channel is in operation, configuration of the input channels is disabled.

4.9 Time per Division

Set the time/division using the up/down arrow control in the Control Bar:

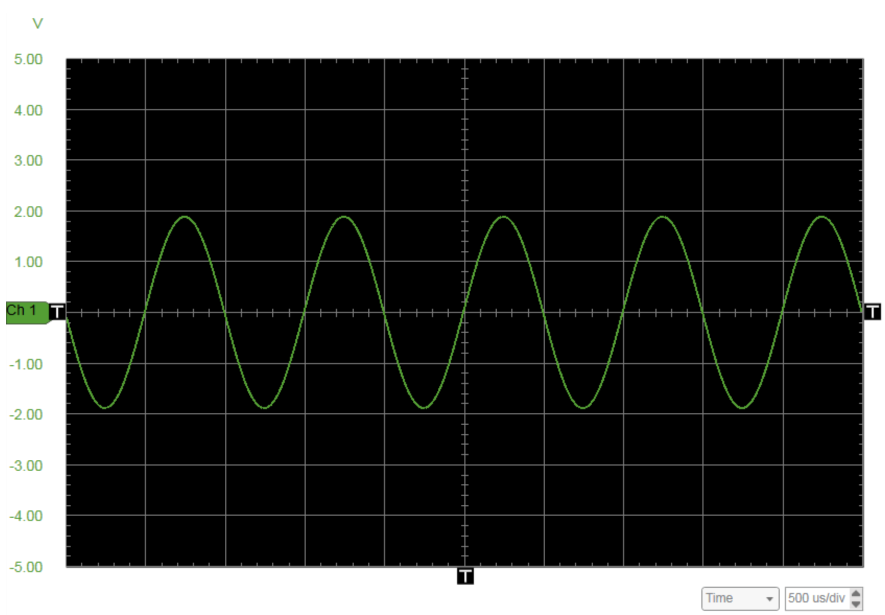
4.10 Grid Settings

Grid line settings are accessed using the Control Bar's "Grid Settings" button. The following features are available:

- Channel line thickness: 1, 2 or 3 pixel width options
- Grid line thickness: 1, 2 or 3 pixel width options
- Grid line color: Gray or black
- Grid background color: Changes the background of the entire plot area: White Grey, Black

Channel Line Thickness is enabled even when Grid setting is set to Off.

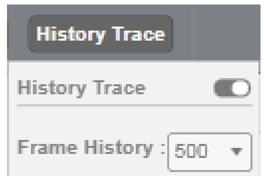
- Example of black background color:



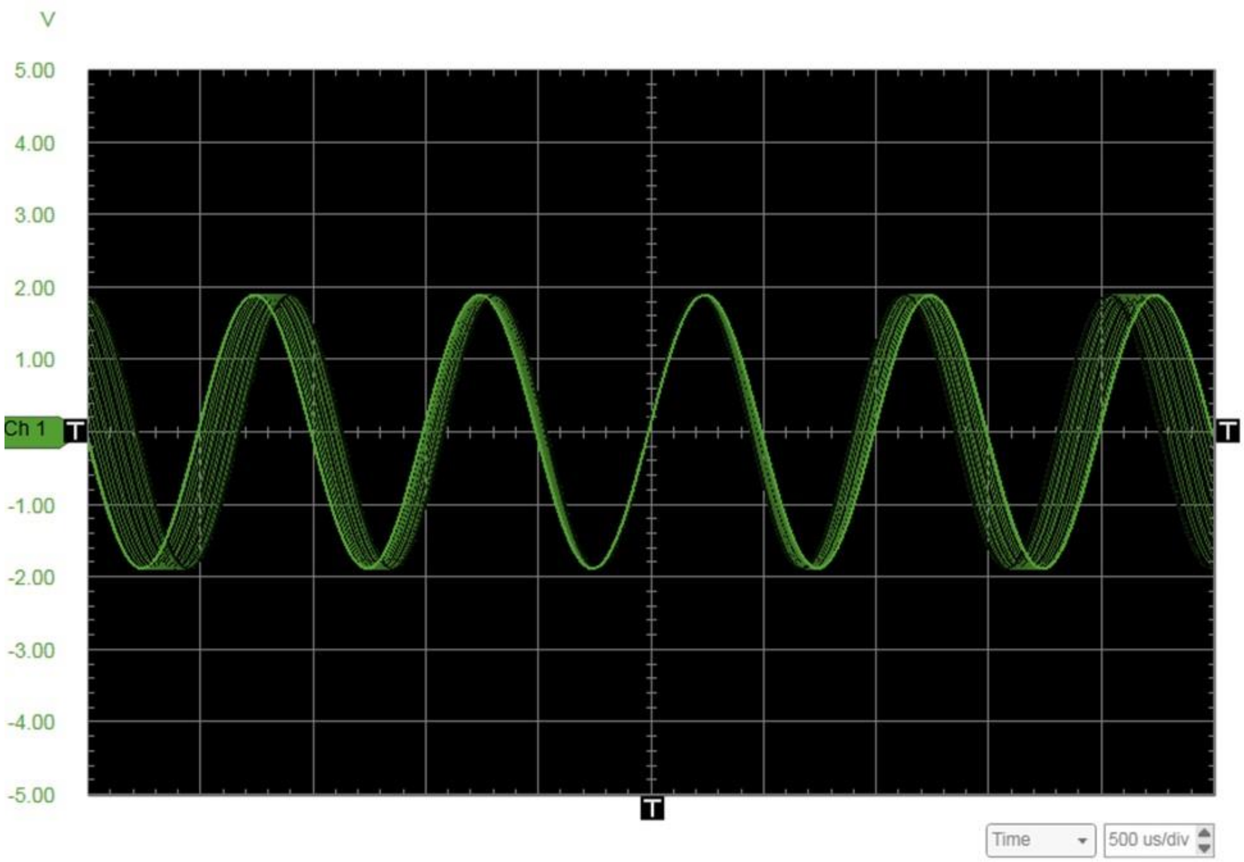
4.11 Trace History

The channel trace history feature is accessed using the Control Bar's "History Trace" button. This feature retains a history of channel traces, up to a specified maximum, and reduces the opacity of each trace as the trace ages.

- Click the On/Off button/slider to enable and disable the history feature.
- When the feature is On, set the maximum number of traces to retain. Selections are 20, 50, or 500.

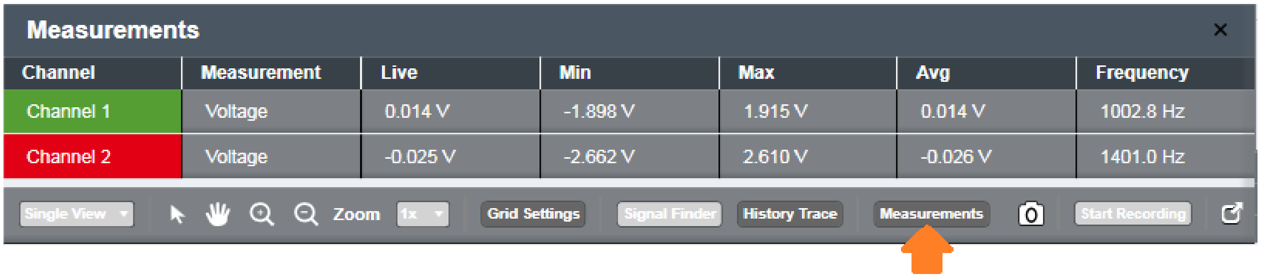


- Example of trace history:



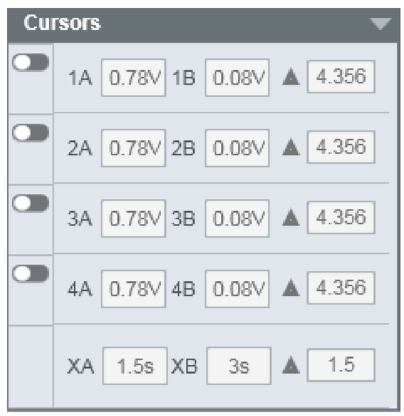
4.12 Measurement Pane

Digital readouts of Scope channel measurements can be viewed by clicking the “Measurements” button in the Control Bar.

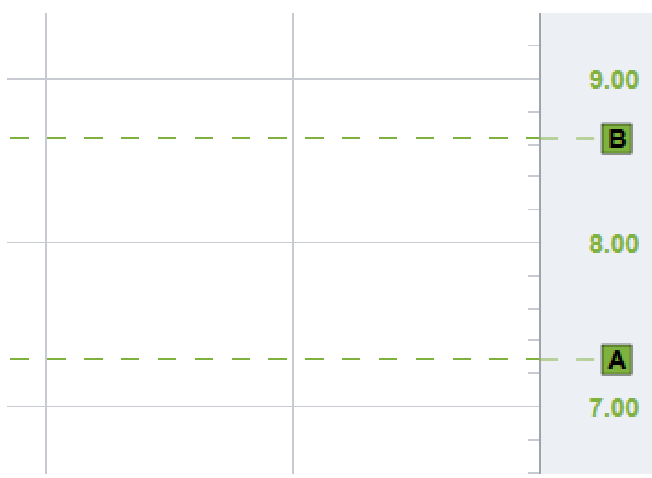


4.13 Cursors

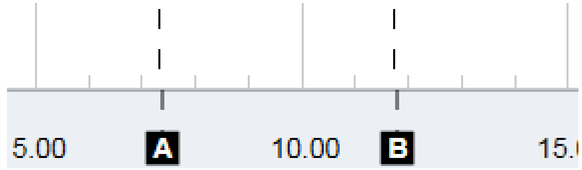
Expand the “Cursors” section of the Configuration Pane. Two cursors, labeled “A” and “B”, can be displayed for each channel. Click on a channel’s cursor On/Off button to turn cursors On and Off for the channel.



A channel’s cursors are displayed as horizontal dashed lines, extending to the channel axis, and drawn in the same color as the channel’s scope traces:



Vertical (X-axis) cursors are displayed in a similar manner, but are drawn in black, and apply to all channels:



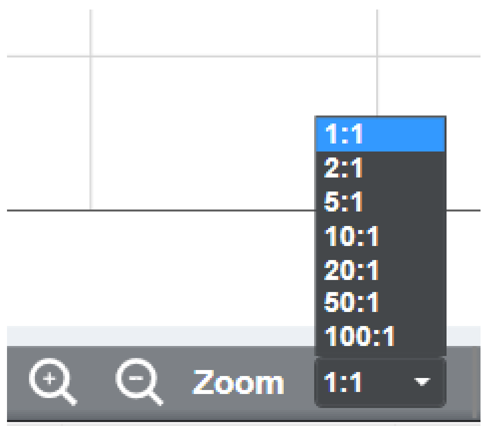
4.14 Zoom

The Zoom feature allows you to zoom-in on a subset of a scope frame without having to change the data acquisition configuration. Zoom is only available in the Scope tool, and only applies to the time axis (i.e. no vertical axis zoom).

4.14.1 Preset Zoom Factors

There are three ways to control the zoom factor:

- Choose the zoom factor using the zoom combo box.
- Use the zoom icons (+/-) in the Control Bar.
- Resize the viewport within the zoom mini-window.

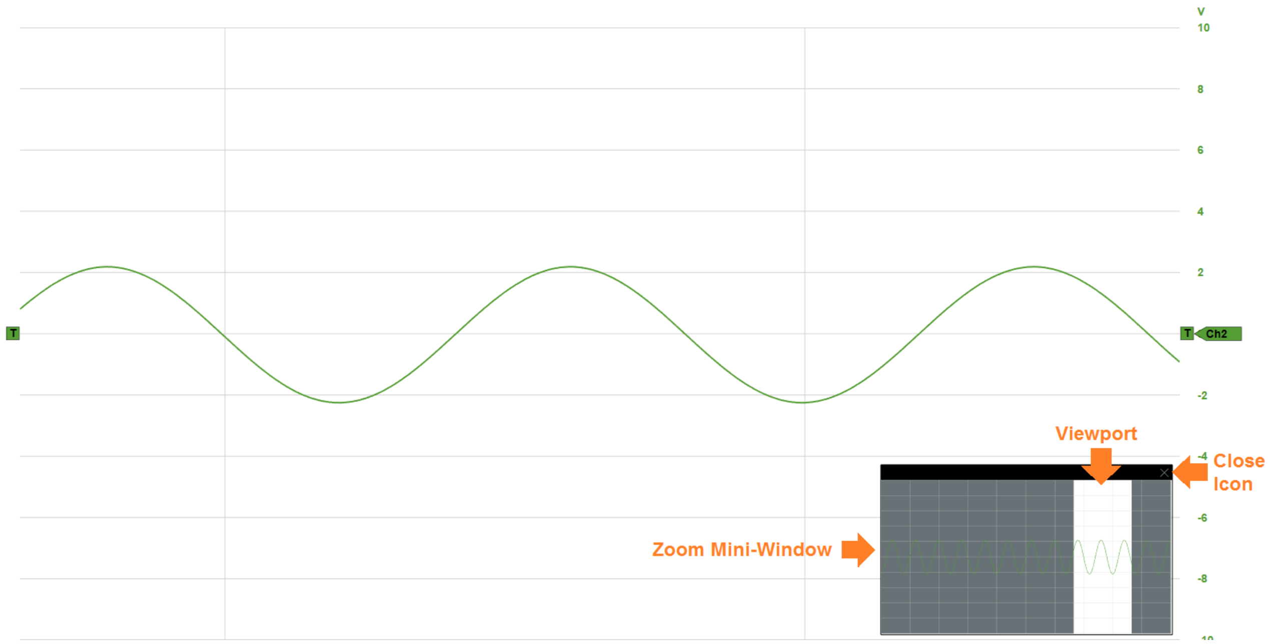


A zoom factor of 1:1 means no zoom. Each click of the "Plus" icon increases the zoom factor to the next higher zoom level: 2:1, 5:1, etc. Each click of the "Minus" icon decreases the zoom factor to the next lower zoom level, until no zoom (1:1) is reached.

You can turn Off zoom by setting the zoom factor to 1:1, or by clicking the "X" icon in the upper-right corner of the zoom mini-window.

4.14.2 Zoom Mini-Window

When zoom is enabled, the main plot area displays the zoomed portion (subset) of the frame. A "zoom mini-window" appears, and displays the channel traces and grid lines as they would appear if there were no zoom. Within the zoom mini-window is a viewport which indicates the portion of the frame that is the zoomed (main plot) area.



The location of the zoom mini-window within the plot area may be changed by placing the mouse over the “title bar” of the zoom mini-window, and then dragging the window to a new location within the plot area.

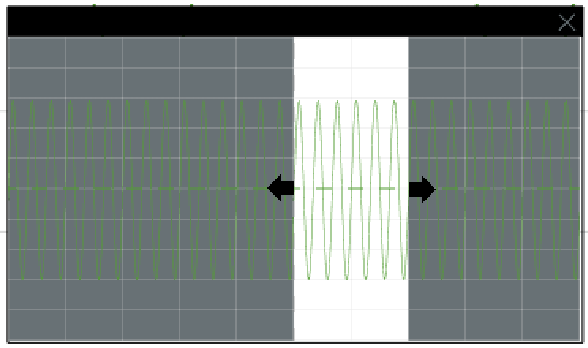
4.14.3 Dragging the Viewport

You can move the viewport to change the portion of the frame that is displayed in the plot area. Use the mouse to drag the viewport within the zoom mini-window. The content of the plot area changes in concert with the viewport. Change both the zoom factor and the zoom viewport to zero-in on a targeted portion of the frame.

At most zoom factors, the size of the viewport relative to the entire zoom mini-window correctly reflects the zoom factor. In other words, at a zoom factor of 2:1, the viewport width is one-half the zoom mini-window area. However, at the highest zoom factor, 100:1, the viewport would be so small as to be difficult to grab with the mouse; so the viewport is actually drawn a bit wider than the zoom factor indicates.

4.14.4 Expanding and Contracting the Viewport

The zoom can be individually adjusted in the X direction by horizontally expanding or contracting the viewport. Place the mouse over an edge of the viewport. The mouse cursor changes to one of the drag icons shown below. Drag the viewport edge to change the viewport dimensions.



4.14.5 Channel Graphics and Grid Lines

As you adjust the zoom factor and viewport, all visual elements associated with the active channels will adjust as well, so that the channel axis, cursors, and trigger thresholds maintain their relative positions.

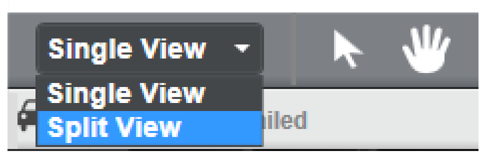
You can change the vertical offset of a channel while zooming (by dragging the channel's Y-axis, or setting the channel's Offset value). However, this will not affect grid lines, because grid lines are not associated with any specific channel.

4.14.6 Zoom and Channel Trace History

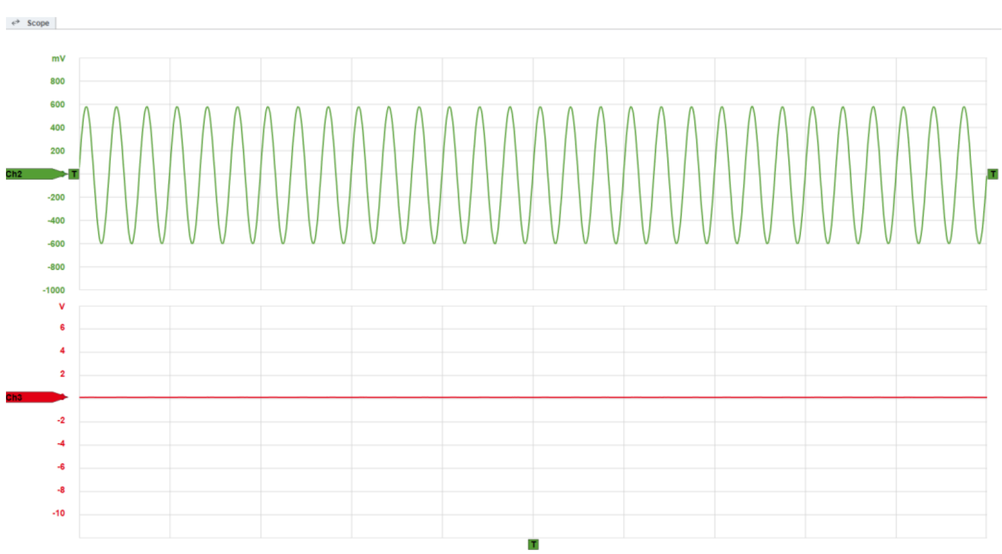
When zoom is enabled, channel trace history is shown in the main plot area (the zoomed area) only; not in the zoom mini-window.

4.15 Split Line Plots

When multiple channels are enabled, the Split Line option can be used to give each channel its own plot area.



The example below shows two channels in the Split View mode.



4.16 ANGLE DOMAIN

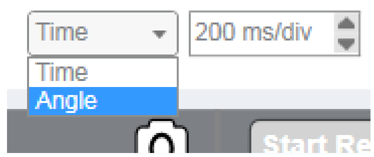
Angle domain allows the oscilloscope to display crank angle on the horizontal axis instead of time. In this mode the horizontal axis will display either 1 or 2 revolutions of the vehicle crankshaft. The display continue to track the angle even as engine RPM varies. Angle domain measurement can synchronize its horizontal axis to any repeating signal synchronized with engine rotation. This includes signals associated with either crankshaft rotation or camshaft rotation. Example signals include: crankshaft CKP, single pulse crankshaft position sensors, camshaft CMP, single injector activation, single spark plug firing, etc.

4.16.1 Probe Connections

- Connect a test lead (standard leads and ignition leads are allowed) between the appropriate indexing signal and one of the VCMM channel ports.
- Connect one or more other probes to other signal sources, depending on the problem to be diagnosed.

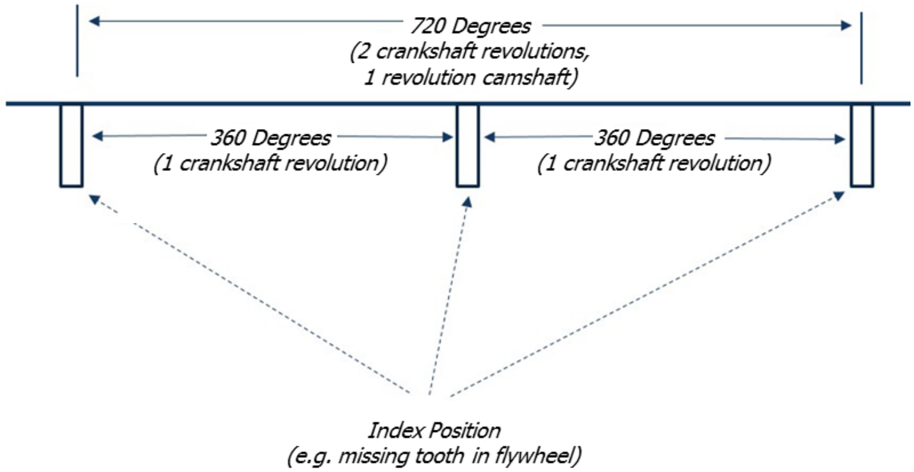
4.16.2 VMS Configuration

- In the Trigger section of the Configuration Pane, set the Trigger channel selection to the channel that is connected to the index signal.
- Connect one or more other probes to other signal sources, depending on the problem to be diagnosed.
- In the plot area, change the X-axis units from “Time” to “Angle”.

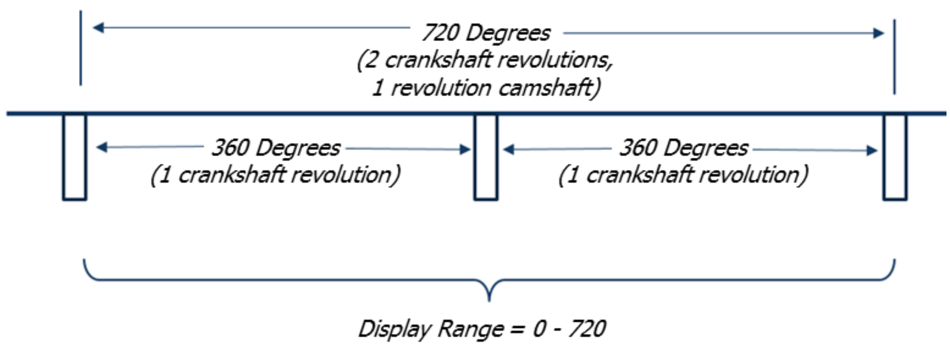


- When the Angle option is selected, two sub-options appear: Trigger Interval, and Display Range.

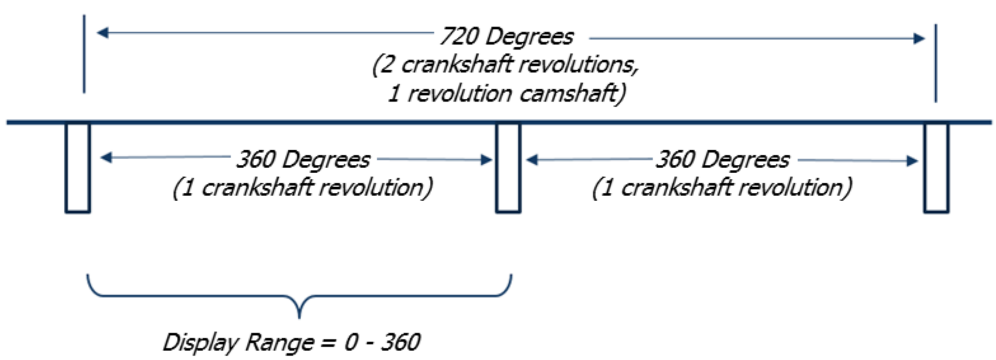
- The setting of “Trigger Interval” tells the system how often in the engine rotation cycle the trigger signal occurs.
  - Trigger Interval “360” – With this option, you are instructing the application that the trigger signal occurs each revolution of the engine. An example of this signal would be a crankshaft position sensor.
  - Trigger Interval “720” – With this option, you are instructing the application that the trigger signal occurs every other revolution of the engine. An example of this signal would be a camshaft position sensor, an injector firing signal, or a spark plug firing signal.



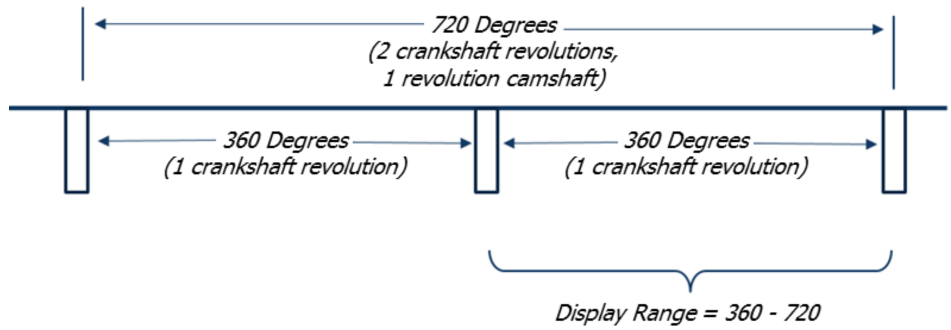
- The triggering system allows display of either one or 2 revolutions of the engine regardless of which trigger interval is selected.
- Display Range 0 – 720: This option instructs VMS to display a frame consisting of 720 degrees, or two revolutions:



- Display Range 0 – 360: This option instructs VMS to display the first 360 degrees of the 4-stroke cycle:



- Display Range 360 – 720: This option instructs VMS to display the second 360 degrees of the 4-stroke cycle:



4.17 SCOPE TOOL – FRAME-BASE RECORD AND PLAYBACK

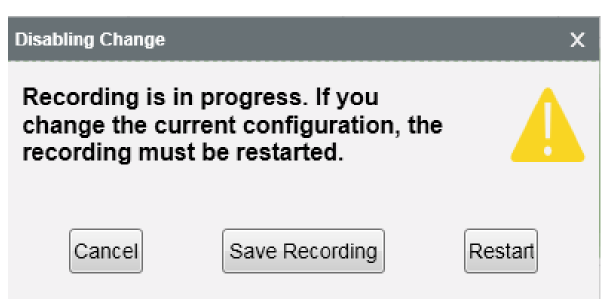
The Scope Record and Playback feature allows you to record Scope data, acquired in the frame-based method, save the data to a file, and replay the data within the VMS application.

4.17.1 Channel and Trigger Configuration

Before beginning a recording, set up all channels and the desired trigger as you wish them to be recorded. The following configuration settings must remain constant throughout the recording:

- Turning a channel On or Off
- Changing the following configuration properties of a channel: data source, hardware (vertical) scale, coupling, filter, or acquire mode (average vs. min/max)
- Changing the time per division
- For the DLC channel, changing the connector pin or hardware (vertical) scale
- Changing any aspect of the trigger setup, including the channel used as the trigger
- Changing the Off/On state or configuration of the Math Channel (since the Math channel can be used as a trigger)
- Changing the trigger configuration

If you make any of the above changes while recording is in progress, you will be prompted to save accumulated data:



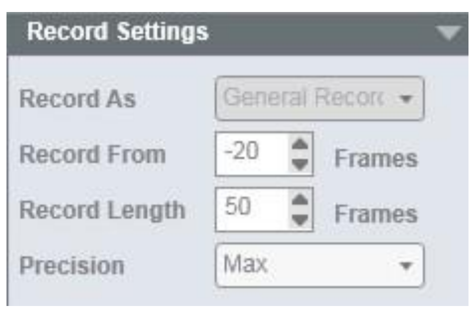
It is permissible to change the following configuration settings while recording, as they have no effect on the data that is stored:

- Connecting a probe to the VMM (but the associated channel remains Off)
- Changing the following configuration properties of a channel: invert, offset
- Enabling or disabling cursors
- Changing the position of a cursor
- Zooming
- Changing the thickness of scope traces
- Changing grid settings (On/Off or line thickness)
- Changing the scope view background color
- Enabling or disabling the history trace feature
- Enabling or disabling display of measurement data

4.17.2 Record Configuration

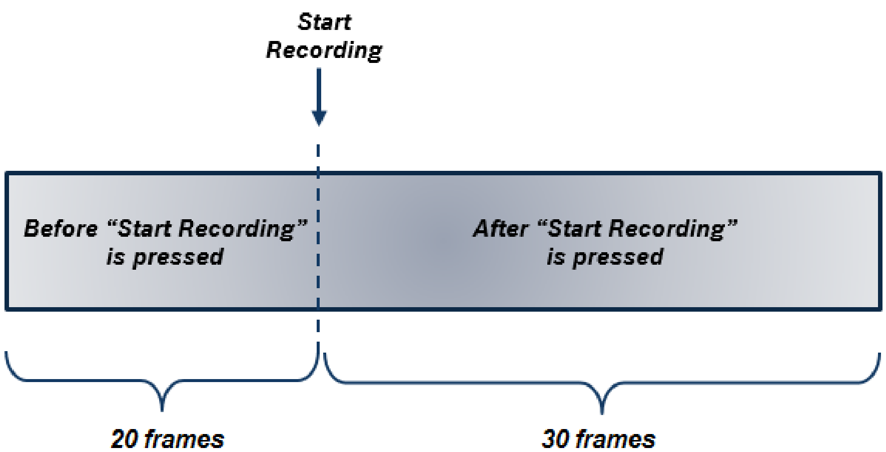
You use the “Record Settings” section of the Configuration Pane to specify how many frames (or seconds) you wish to record.

- When the time-per-division is less than 50 milliseconds or less per division, VMS operates in Frame Mode, meaning individual frames are acquired and displayed. The Record Settings will then show “Frames” as the unit of recording.
- At a time-per-division of 100 milliseconds or more per division, VMS operates in Sample Mode, meaning individual samples are recorded over time. The Record Settings will then show “Seconds” as the unit of recording.



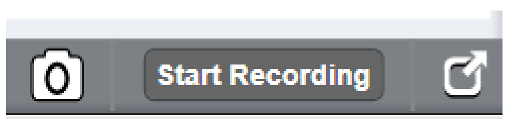
- Set the “Record Length” field to the maximum number of frames/seconds you wish to record. There is no restriction on the length, and it is possible to record for hours. Of course, the amount of disk space can be substantial, in the megabytes for thousands of frames/seconds recorded.

- The start of a recording is relative to when you click the “Start Recording” button. You use the “Record From” field to specify how much of the record length is to be cached before you press the button. The remainder of the Record Length is allocated to the period after you press the button. For example, in the scenario shown above (Record From = -20 frames, Record Length = 50 frames), the recorded file will contain 20 frames of data acquired before the “Start Recording” button is pressed, and 30 frames of data after the button is pressed. This is illustrated below.



4.17.3 Start Recording

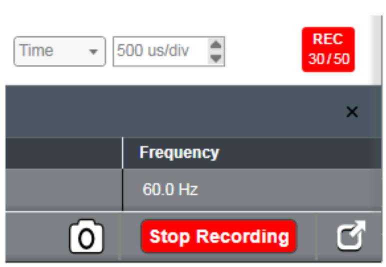
When you have completed configuration of the Record feature, click the “Start Recording” button in the toolbar to start the accumulation of acquisition data into the “after” portion of the recording file. Until you click “Start Recording”, VMS will maintain the most recent “before” data in a recording buffer. Then, when you click “Start Recording”, the “after” data will be appended to the “before” data to create the complete recording.



Note that you can click the Start button at any time and, depending on the configured value of “Record From”, VMS may not be able to acquire all “before” data at the Start time. Therefore, it is possible that the resulting record file may contain less “before” data than configured.

4.17.4 Recording Status

While recording is in progress, VMS displays the recording status as a count of frames relative to the total record length. In this example, VMS has recorded 61 of the configured 200 frames.



4.17.5 Stop Recording (Automatic)

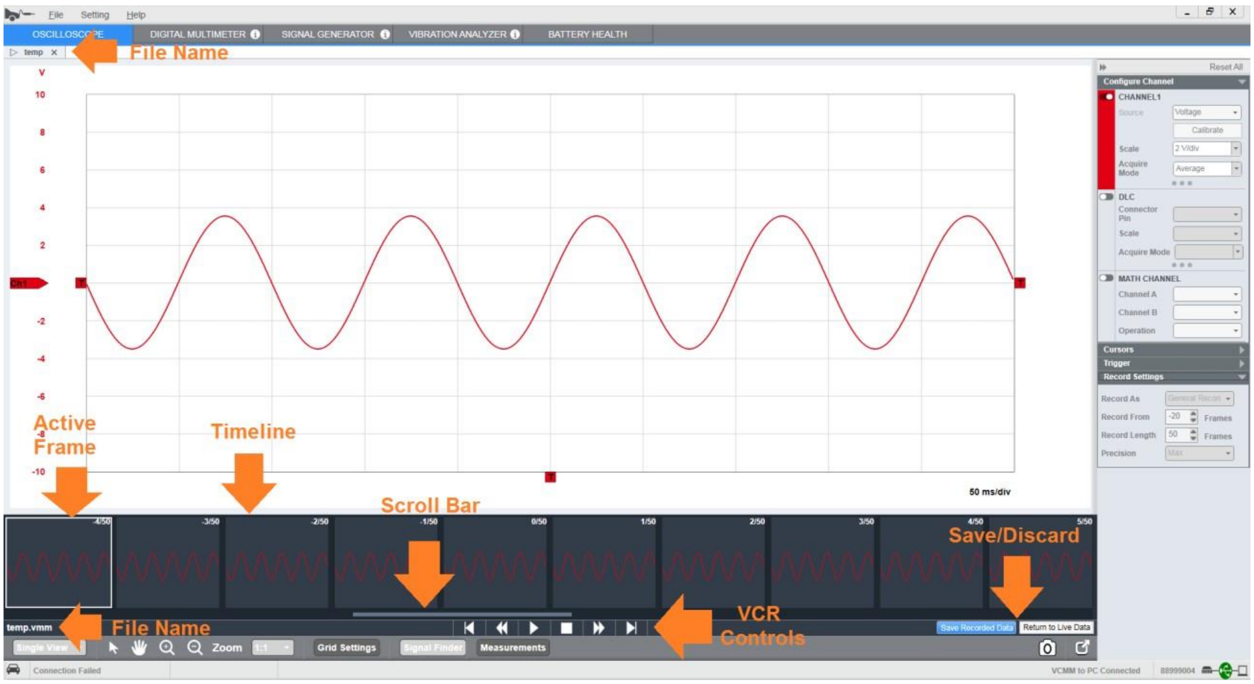
Recording stops automatically when the number of frames in the 'after' portion of the Record Length has been acquired.

4.17.6 Stop Recording (Manual)

When you click the "Start Recording" button, the button changes to a red color, and the label becomes "Stop Recording" You may terminate a recording at any time by clicking the "Stop Recording" button.

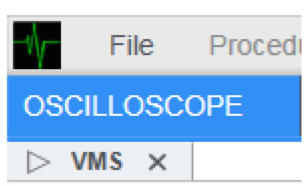
4.17.7 Frame Based Playback

Playback View Layout

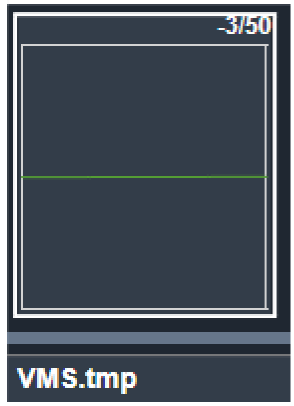


Review Mode

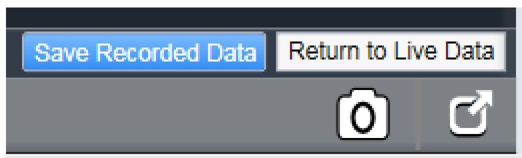
When a recording ends, the recorded data is stored in a temporary file. VMS creates a tab, labeled "VMS", in which to load the data for review. The new tab replaces the live data view during the review phase.



The file name "VMS" also appears below the timeline:



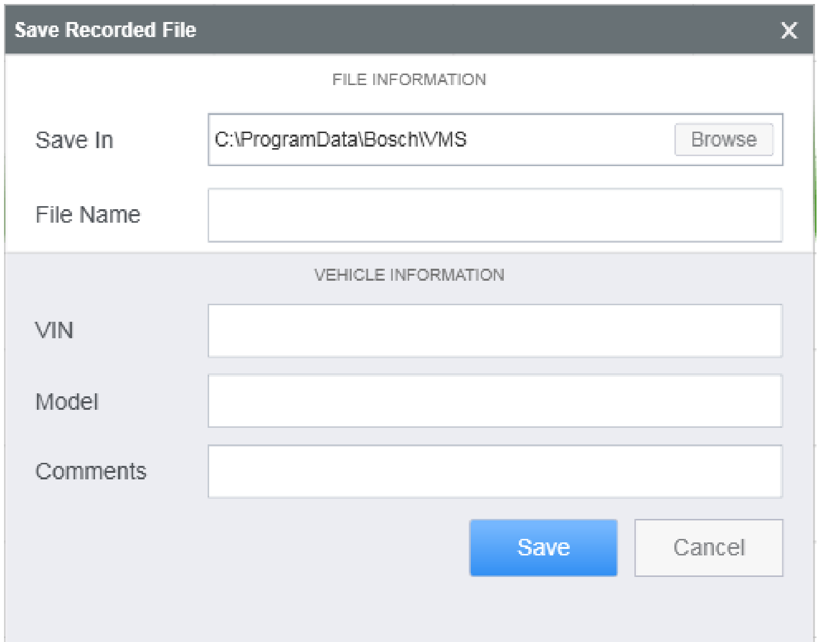
At this point, you may review the recorded data, and make a decision whether or not to save the data permanently. If you wish to discard the collected data, click the "Return to Live Data" button found in the lower-right corner of the view. This closes the temporary tab and restores the live view. The collected data is discarded.



Another way to discard a temporary recording is to click the "X" in the VMS tab.

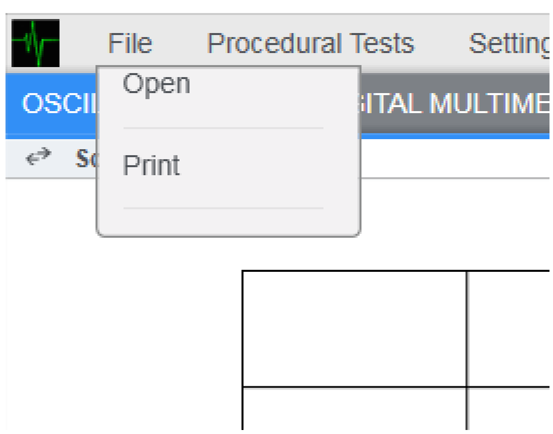
4.17.8 Saving Recorded Data Permanently

If you wish to save the collected data permanently, click the "Save Recorded Data" button. You are then prompted with the Save Recorded File dialog, where you may choose the directory and file name in which to store the data. (Note: VIN, Model, and Comment fields are not saved in the current release.) The file extension for VMS record files is "vmm".



4.17.9 Opening a Saved File

To open the saved file, choose the menu option File/Open.



The standard File/Open dialog appears. Choose the "vmm" file you wish to open. A new tab is created, and the selected file is loaded into a playback view in the new tab. The name of the file is shown in the tab and in the control bar.

4.17.10 Playback Timeline

A frame mode recording displays individual frames. A timeline is shown at the bottom of the view, in which a subset of the recorded frames appears as a set of “mini-images”. Each mini-image displays a sequence number in the upper-right corner. The sequence number indicates where the frame exists in the recording.

Three mini-images are shown in the example below. This timeline was created with a Record Setting of “Record From” = 20, and a “Record Length” = 50. The frame with the white border is the active frame, which is shown in full resolution in the main view. The sequence number of this frame is -20/50. The value of -20 means the frame was recorded 20 frames before the “Start Recording” button was pressed. The value of 50 means a total of 50 frames were recorded.

The frame with sequence number 0/50 is the frame recorded immediately after the “Start Recording” button was pressed.

The last frame in the timeline has the sequence number 29/50. This is because there was a total of 50 frames recorded, 20 of which were in the “before” period, and 30 of which were in the “after” period. The 20 “before” frames are numbered -20..-1, and the 30 “after” frames are numbered 0..29.

4.17.11 VCR Controls

 Moves the active frame to the first frame in the file.

 Moves the active frame once to the left in the timeline.

 Repeatedly displays frames one after the other in forward sequence.

 Stops repeated frame display.

 Moves the active frame once to the right in the timeline.

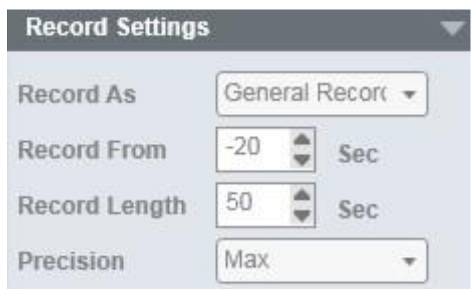
 Moves the active frame to the last frame in the file.

4.18 SCOPE TOOL – ROLL MODE-BASED RECORD AND PLAYBACK

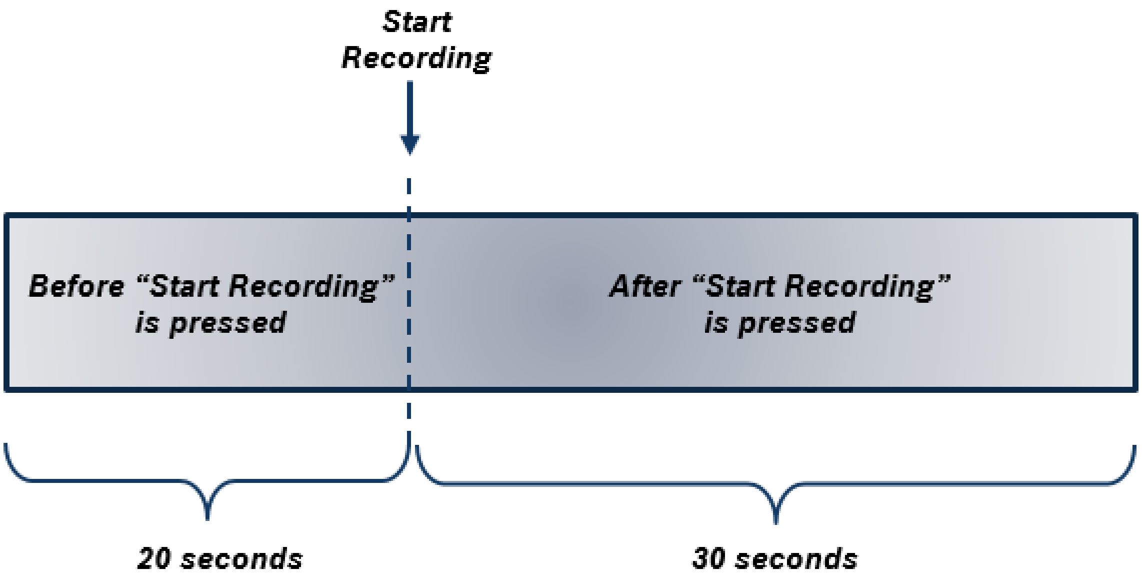
When the time-per-division is 100 milliseconds or more per division, VMS operates in Roll Mode, meaning data is recorded and displayed based on time. There are no triggers or frames, and a channel's data is displayed as a continuous signal trace. Record and playback in Roll Mode is very similar to the Frame-based method. This section describes the differences for record and playback between the Frame and Roll modes.

4.18.1 Record Configuration

The Record Settings section of the Configuration Pane will show "Sec" (seconds) as the unit of recording.



The 'before' and 'after' recording periods are in seconds, instead of frames.



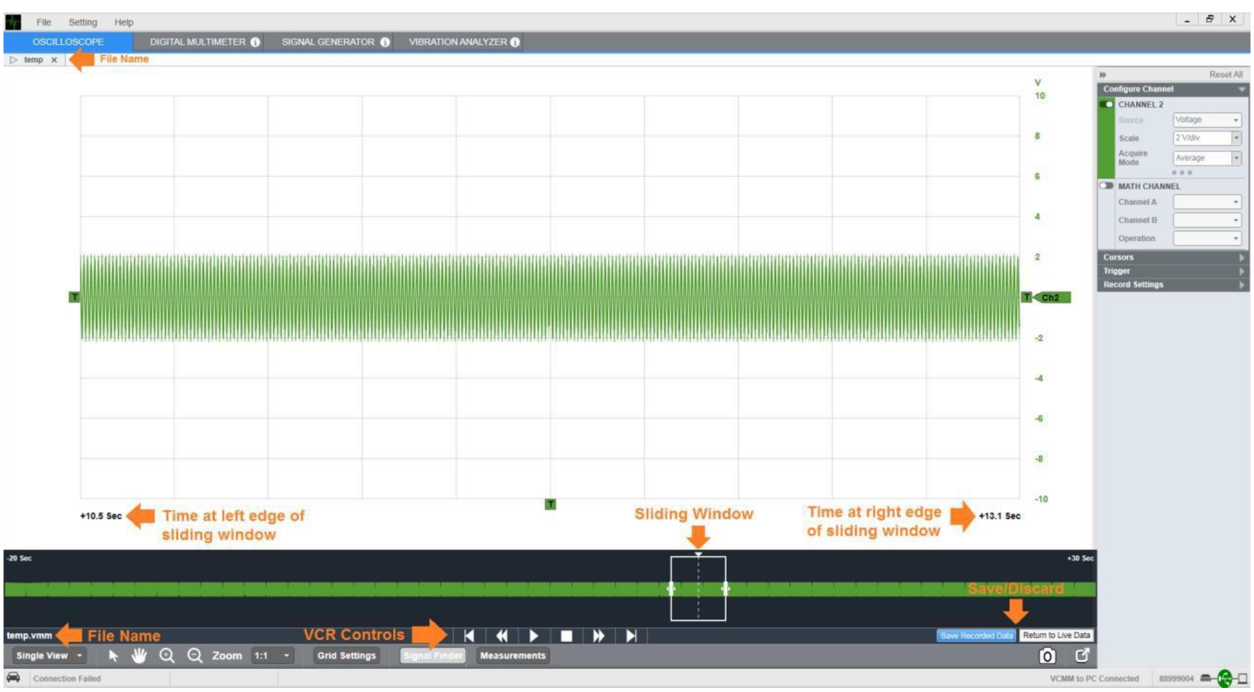
4.18.2 Recording Status

VMS displays the recording status as the number of accumulated seconds relative to the total record length.

4.18.3 Stop Recording (Automatic)

Recording stops automatically when the number of seconds in the 'after' portion of the Record Length has been acquired.

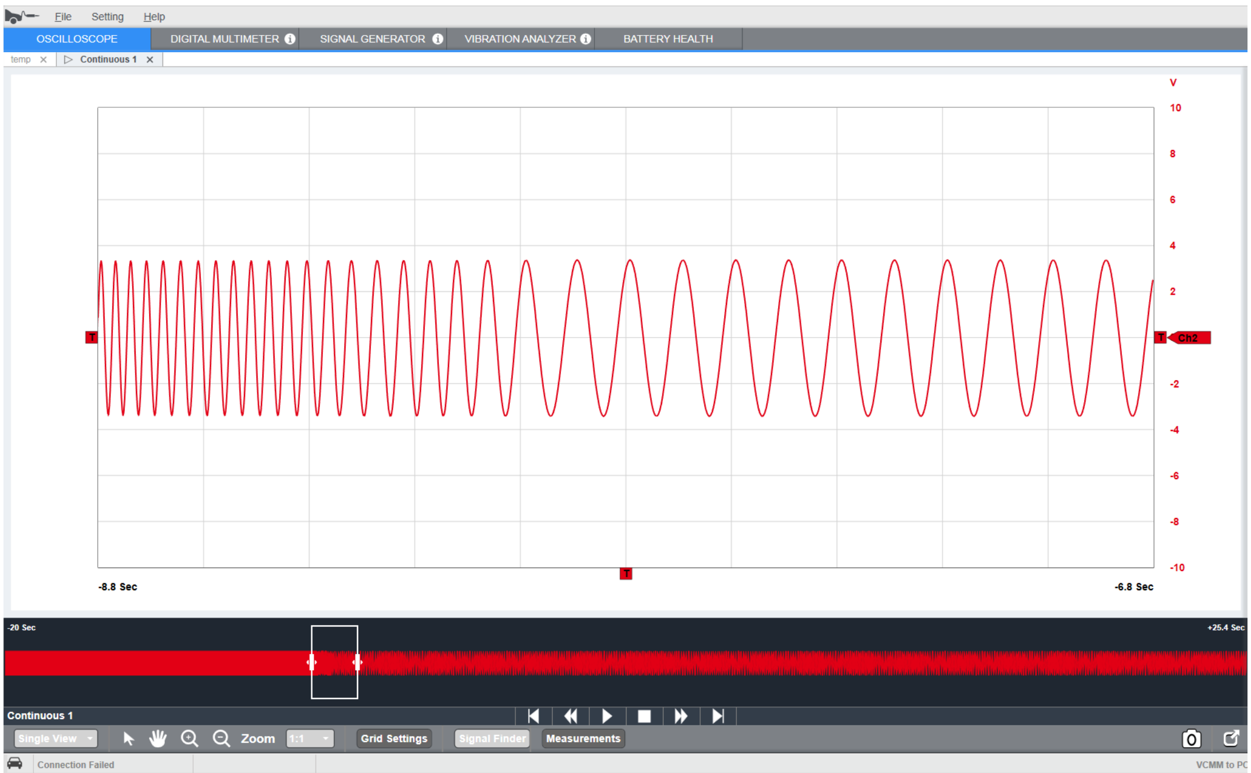
4.18.4 Playback View Layout



4.18.5 Playback Timeline

A time-based recording has a continuous timeline that shows the entire recording, regardless of the recording length. Within the timeline is a sliding window, shown as a white rectangle. The range of data encompassed by the sliding window is displayed within the main plot area.

The width of the sliding window may be expanded or contracted by grabbing the "handles" at the sides of the sliding window and dragging with the mouse. Contracting the sliding window is equivalent to zooming in on the timeline, and expanding is equivalent to zooming out. Below is an example of zooming in on a small part of the timeline. You can also drag the entire sliding window left or right to view segments of the timeline.



4.18.6 VCR Controls

 Moves the sliding window to the start of the timeline.

 Moves the sliding window left within the timeline by the width of the sliding window.

 Moves the sliding window continuously forward in the timeline.

 Stops continuous play.

 Moves the sliding window right within the timeline by the width of the sliding window.

 Moves the sliding window to the end of the timeline.

4.19 Scope Tool – Continuous Record and Playback

Unlike the Frame and Roll Mode methods of acquisition, Continuous Mode records all samples within the VCMM, as the data is acquired. Recorded data is uploaded to the VMS Client Application only when the recording is complete. This approach allows the acquisition of samples at a fast rate, and without the risk of data loss due to the relatively slow bandwidth between the VCMM and PC. The downside of this approach is that the amount of data that can be saved in a single recording is limited by the available memory in the VCMM.

The steps involved in configuring, acquiring, and playing back a Continuous mode recording are these:

a. Configure and enable one or more channels.

b. Choose “Continuous Recording” in the Record Settings section of the Configuration Pane. Set the recording duration.

c. Configure a trigger for the event of interest.

d. Click the “Start Recording” button to begin recording in the VCMM.

e. While acquisition is in progress, channel data is displayed in a roll-mode type display. The samples displayed are typically a small subset of the data being acquired.

f. Recording ends, either automatically, or by you clicking the “Stop Recording” button.

g. Collected data is uploaded from the VCMM to the PC. This can be a lengthy process, depending on the amount of data collected.

h. A playback view is created in which to view the collected data, and all collected data is loaded into the playback timeline. This can also be a lengthy process, depending on the amount of data collected.

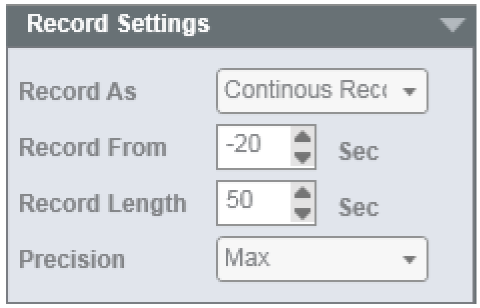
i. Data is displayed using a continuous-type timeline. Browse the data using the sliding window.

j. Save the data to a permanent file. Control then returns to the live view, where another recording may be initiated.

4.19.1 Record Configuration

Configure the recording to capture data before and/or after the trigger event. Record Settings for Continuous Mode consists of these configuration items:

- Record As – Set this to “Continuous Recording”.
- Record From – Set this to the number of seconds of data to retain before the trigger event. (This is always entered as a negative number, signifying ‘before’ the trigger.) This value must not be greater than the Record Length value.
- Record Length – Set this to the total number of seconds of data to record. By definition, the number of seconds to record after the trigger event equals “Record Length” minus the value of “Record From”.
- Precision – Not currently used.



4.19.2 Trigger Configuration

Continuous recording mode is typically used when analyzing an intermittent event. Configure the trigger to occur at the event of interest. Any one trigger event may be selected, including those normally found only in the Advanced Trigger list.

Since only one trigger event is possible in Continuous mode, the following trigger options have no meaning, and are not displayed in the Trigger section of the Configuration Pane, when Continuous mode is selected:

- You can only configure the primary trigger.
- The “auto” type of triggering does not apply. Triggering is always on the basis of “normal”, meaning the acquisition system will wait indefinitely for a trigger event.
- The pre-trigger duration is specified in the “Record Settings” section.
- “Time delay” has no meaning in Continuous mode.

Note that the acquisition system is in the “normal” mode at this point, which means the system will not acquire data, nor update channel traces, unless there is a trigger event on the trigger channel.

4.19.3 Data Capture Buffer in the VCMM

A key element of the Continuous Recording Mode feature is the caching of acquisition data in the VCMM. Caching of data in the VCMM is necessary, because the bandwidth between the VCMM and PC is not sufficient, for some configurations, to handle the amount of data acquired in real time. This data cache is called the “Data Capture Buffer”.

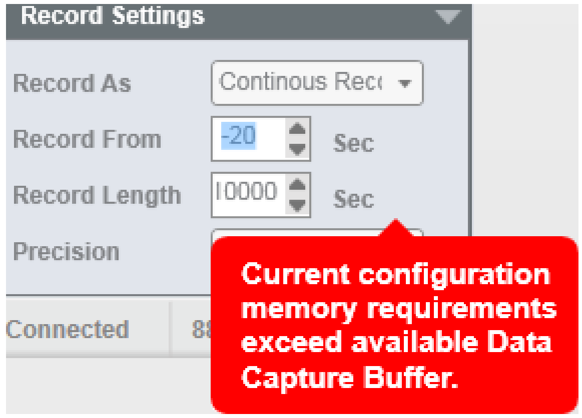
During the pre-trigger period, the VCMM acquires data and stores it into a Data Capture Buffer. During the pre-trigger phase, the VCMM only retains data for the configured duration of the pre-trigger phase. Data is disposed of as it ages beyond the length of the pre-trigger period.

When the trigger event occurs, data recorded during the pre-trigger phase is retained in the Data Capture Buffer, and the VCMM begins appending post-trigger data to the Data Capture Buffer.

4.19.4 Limited Recording Time

Since the data buffer in the VCMM has a maximum size, there is a limit on the recording duration. The size of the buffer is sufficient to store a 30-second recording, with four channels, at the highest supported sampling rate. The maximum possible recording duration depends on the number of channels enabled, and the time per division chosen by the user. With only a single channel enabled and a low sampling rate, the maximum recording duration may extend to hours.

As you configure the channels, time axis, and recording duration, VMS will (in the background) compute the amount of memory required to hold the associated data. If the memory requirement exceeds the VCMM's available memory, a red-error-popup will be displayed:



Recording cannot be started while this condition exists. You must change the configuration to bring VCMM memory requirements within limit. You can turn off channels, change the time per division, or reduce the Record From and/or Record Length values.

4.19.5 Start Recording

Recording of data in the VCMM does not begin until you click the "Start Recording" button. When you have completed configuration of the channels, trigger, and Record Settings, click the "Start Recording" button. The button changes to "Stop Recording", and the VCMM immediately begins accumulating the "pre-trigger" portion of the recording duration. The system also begins checking for the configured trigger condition. This means the trigger event could occur before the all configured pre-trigger data can be acquired. In fact, the trigger could be detected immediately upon clicking the "Start Recording" button, in which case no pre-trigger data would be stored.

4.19.6 Data Acquisition and Recording Status

While data is being acquired in the VCMM, a portion of the acquired data is sent to the VMS Client Application on the PC, and this data is plotted as a roll mode-type channel plot.

While data is being acquired in the VCMM, the number of seconds recorded and the total duration are displayed adjacent to the time per division field. In the example below, 7 seconds out of a total of 20 seconds have been collected. Until the trigger event is detected, the first value is zero.

While recording is in progress, you can use the "Manual Trigger" button to force a trigger event.

4.19.7 Stop Recording (Automatic)

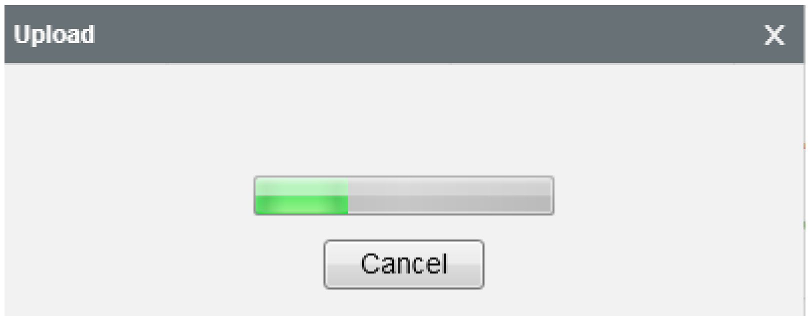
The recording ends automatically when data for the entire post-trigger time period has been acquired in the VCMM.

4.19.8 Stop Recording (Manual)

You can stop the recording at any time by clicking the “Stop Recording” button.

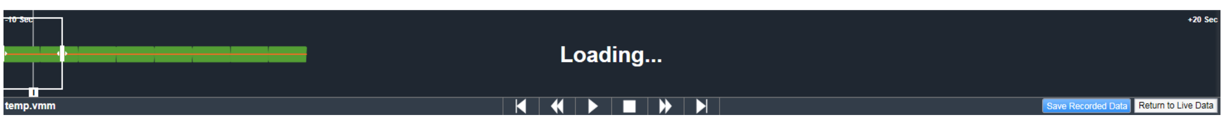
4.19.9 Data Upload

When data acquisition is complete, the application begins uploading the acquired data from the VCMM to the PC. This may be a lengthy process, depending on the amount of data acquired. A dialog is displayed showing progress of the upload.



4.19.10 Continuous Playback

When upload of acquired data to the PC is complete, a temporary playback window is opened in which to display the data. Playback is in the form of a continuous timeline, similar to the Roll Mode. All acquired data is loaded into the timeline, and this can be a lengthy process. While the timeline is being loaded, a status message “Loading…” is displayed in the timeline area, and the timeline can be seen to progress from left to right.

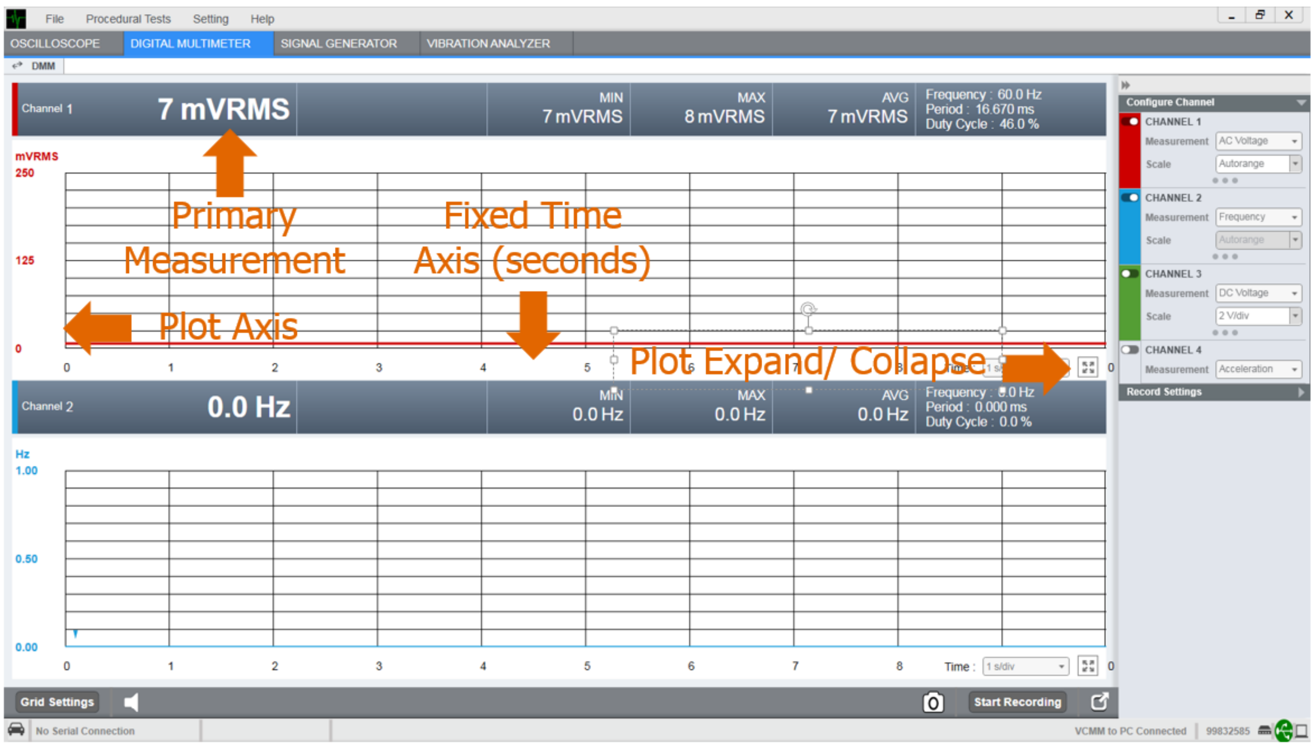


Once the timeline is completely loaded, the playback function works identically to that of the Roll Mode method. Refer to paragraph 12.23.

5 MULTI-METER OPERATION

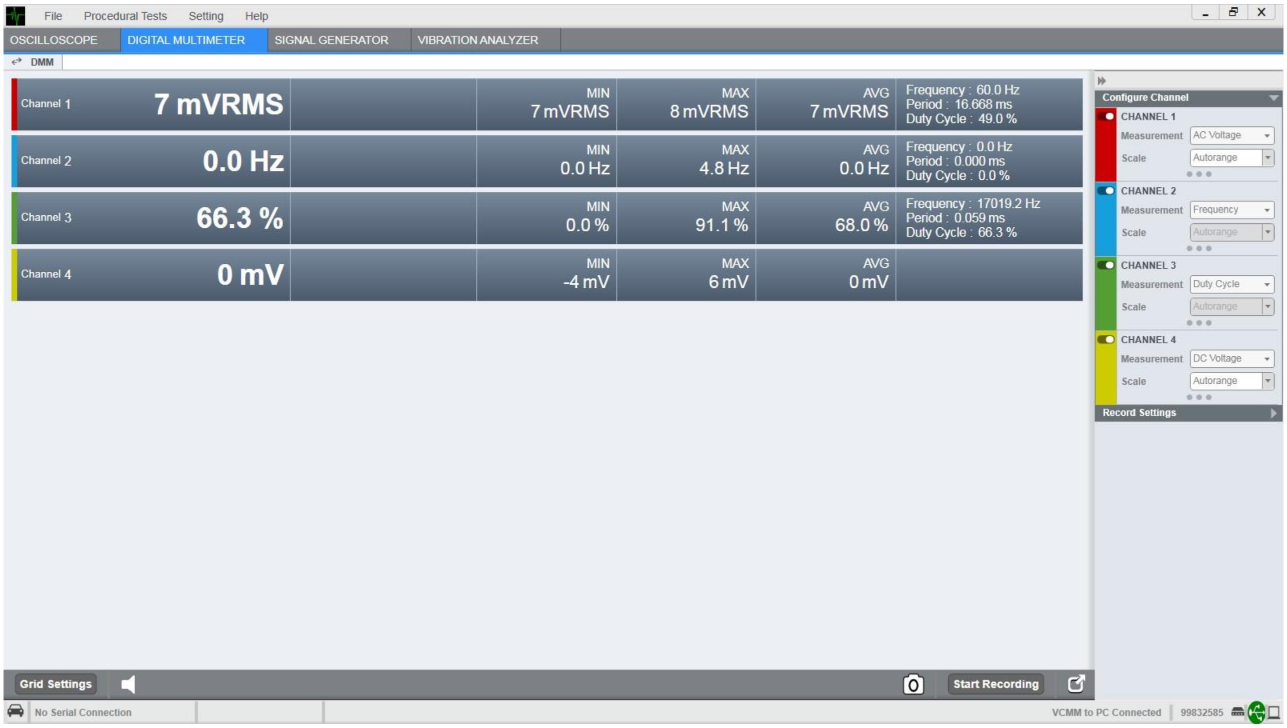
5.1 MULTI-METER VIEW LAYOUT

- Primary measurement and derived measurements (min, max, etc) correspond to the selected measurement type in the Configuration Pane. Line plot always shows the underlying signal.
- Channel color-coding is the same as in Scope view.
- Time axis is fixed (does not scroll).
- Plot expand feature expands only the selected plot.
- Grid settings are the same as in Scope view.



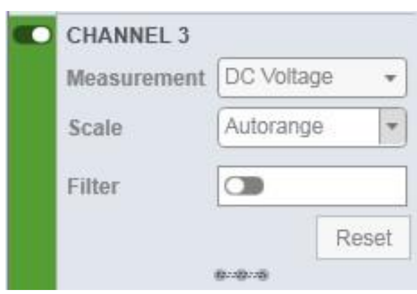
5.1.1 Viewing Three or More Active Channels

When three or more channels are On in the Multi-Meter view, the view shows only the digital readouts. To view line plots, you must reduce the number of active channels to one or two.



5.2 Meter Channel Configuration

- Select measurement type.
- Select either Auto Range or a specific range.
- Turn filter On or Off.
- Reset button clears the line plot, and restarts minimum, maximum, and average values.

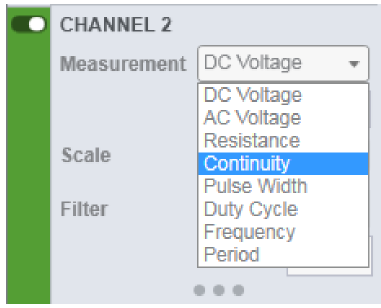


Meter channels may be configured even when there is no probe connected. The operation in this case is the same as for the Scope tool.

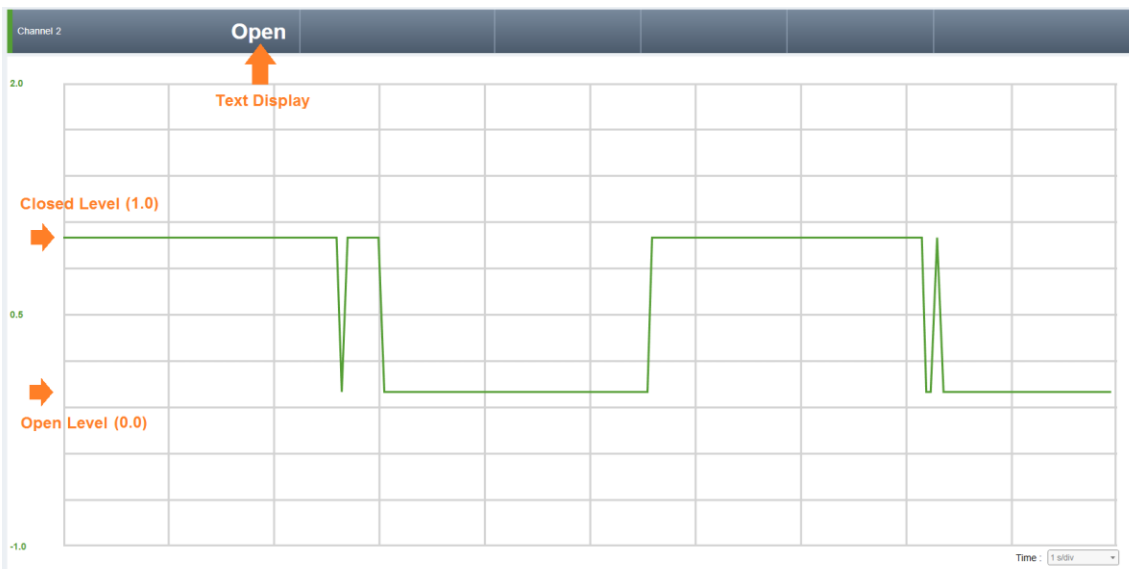
5.3 Continuity Testing

Continuity testing is used to determine whether a low impedance exists two points in an electrical circuit. A circuit is said to be “closed” when an impedance less than 10 ohms exists, and “open” when impedance is greater than 10 ohms.

- Select a channel to be used for continuity testing, and set the channel’s Measurement type to “Continuity”:



- Connect a standard test lead to the channel's port.
- Remove the test lead from the circuit to be tested.
- Enable the channel.
- Connect the endpoints of the test lead across the circuit to be tested.
- The Meter text and line plot display indicate whether the circuit is open or closed. In the line plot, the continuity value is plotted at a level of 0.0 for the open state, and 1.0 for the closed state.



- When the circuit is closed, VMS generates a tone through the PC's sound system. Tone generation can be enabled and disabled by clicking the speaker icon in the Control Bar.

 Indicates the tone generator is enabled, but the circuit is open.

 Indicates the tone generator is enabled, and the circuit is closed.

 Indicates the tone generator is disabled. Click again to re-enable tone generation.

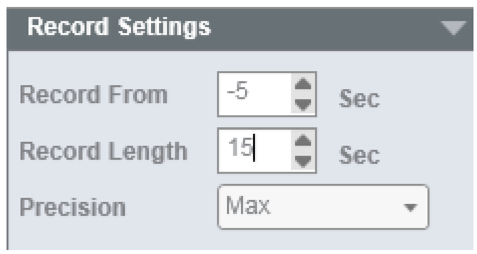
- In the current VMS release, it is not permitted to perform continuity testing while simultaneously making non-continuity type measurements.
- It is possible to perform continuity testing on multiple channels simultaneously.

5.4 Meter Record and Playback

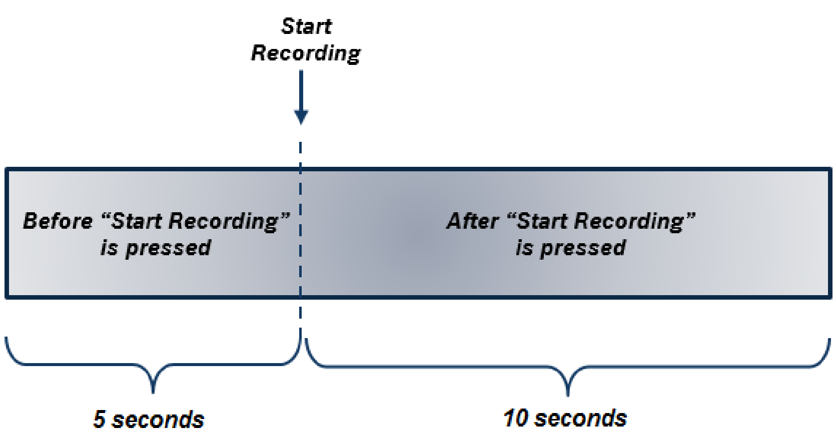
5.4.1 Record Configuration

You use the “Record Settings” section of the Configuration Pane to specify how many seconds of Meter data you wish to record.

- Set the “Record Length” field to the maximum number of seconds you wish to record. There is no restriction on the length, and it is possible to record for hours. Of course, the amount of disk space can be substantial, in the neighborhood of hundreds of megabytes for multiple hours of recording.



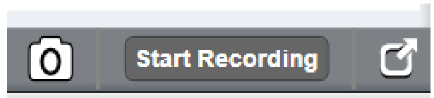
- The start of a recording is relative to when you click the “Start Recording” button. You use the “Record From” field to specify how much of the record length is to be acquired before you press the button. The remainder of the Record Length is allocated to the period after you press the button. For example, in the scenario shown above (Record From = -5 seconds, Record Length = 15 seconds), the recorded file will contain 5 seconds of data acquired before the “Start Recording” button is pressed, and 10 seconds of data after the button is pressed. (The “Record From” field is always entered as a negative number.) This is illustrated below:



- Precision – Not currently used.

5.4.2 Start Recording

When you have completed configuration of the Record feature, click the “Start Recording” button in the toolbar to start the accumulation of acquisition data into the “after” portion of the recording file. Until you click “Start Recording”, VMS will maintain the most recent “before” data in a recording buffer. Then, when you click “Start Recording”, the “after” data will be appended to the “before” data to create the complete recording.



Note that you can click the Start button at any time and, depending on the configured value of “Record From”, VMS may not have been able to acquire all “before” at the Start time. Therefore, it is possible that the resulting record file may contain less “before” data than configured.

5.4.3 Recording Status

While recording is in progress, VMS displays the recording status as the number of seconds accumulated relative to the total record length. In this example, VMS has recorded 7 of the configured 15 seconds.

5.4.4 Stop Recording (Automatic)

Recording stops automatically when the number of seconds in the ‘after’ portion of the Record Length has been acquired.

5.4.5 Stop Recording (Manual)

When you click the “Start Recording” button, the button changes to a red color, and the label becomes “Stop Recording” You may terminate a recording at any time by clicking the “Stop Recording” button.

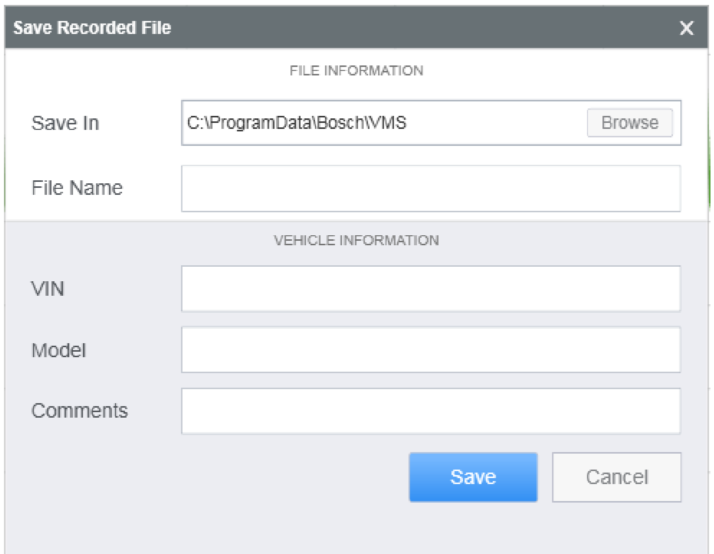
5.4.6 Playback Layout

5.4.6.1 *View Mode*

When a recording ends, the recorded data is stored in a temporary file. VMS creates a tab, labeled "temp", in which to load the data for review. The new tab replaces the live data view during the review phase.

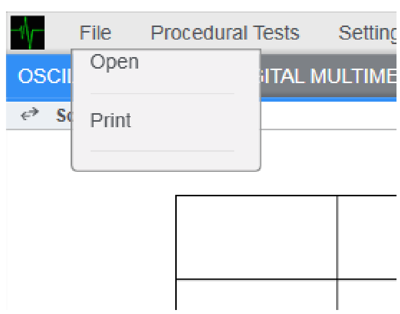
5.4.6.2 *Saving Recorded Data Permanently*

If you wish to save the collected data permanently, click the "Save Recorded Data" button. You are then prompted with the Save Recorded File dialog, where you may choose the directory and file name in which to store the data. (Note: VIN, Model, and Comment fields are not saved in the current release.) The file extension for VMS record files is "vmm".



5.4.6.3 *Opening a Saved File*

To open the saved file, choose the menu option File/Open.



The standard File/Open dialog appears. Choose the "vmm" file you wish to open. A new tab is created, and the selected file is loaded into a playback view in the new tab. The name of the file is shown in the tab and in the control bar.

5.4.6.4 Playback Timeline

A Meter recording has a continuous timeline that shows the entire recording, regardless of the recording length. Within the timeline is a sliding window, shown as a white rectangle. The range of data encompassed by the sliding window is displayed within the main plot area.

The width of the sliding window may be expanded or contracted by grabbing the “handles” at the sides of the sliding window and dragging with the mouse. Contracting the sliding window is equivalent to zooming in on the timeline, and expanding is equivalent to zooming out. Below is an example of zooming in on a small part of the timeline. You can also drag the entire sliding window left or right to view segments of the timeline.

5.4.6.5 VCR Controls

 Moves the sliding window to the start of the timeline.

 Moves the sliding window left within the timeline by the width of the sliding window.

 Moves the sliding window continuously forward in the timeline.

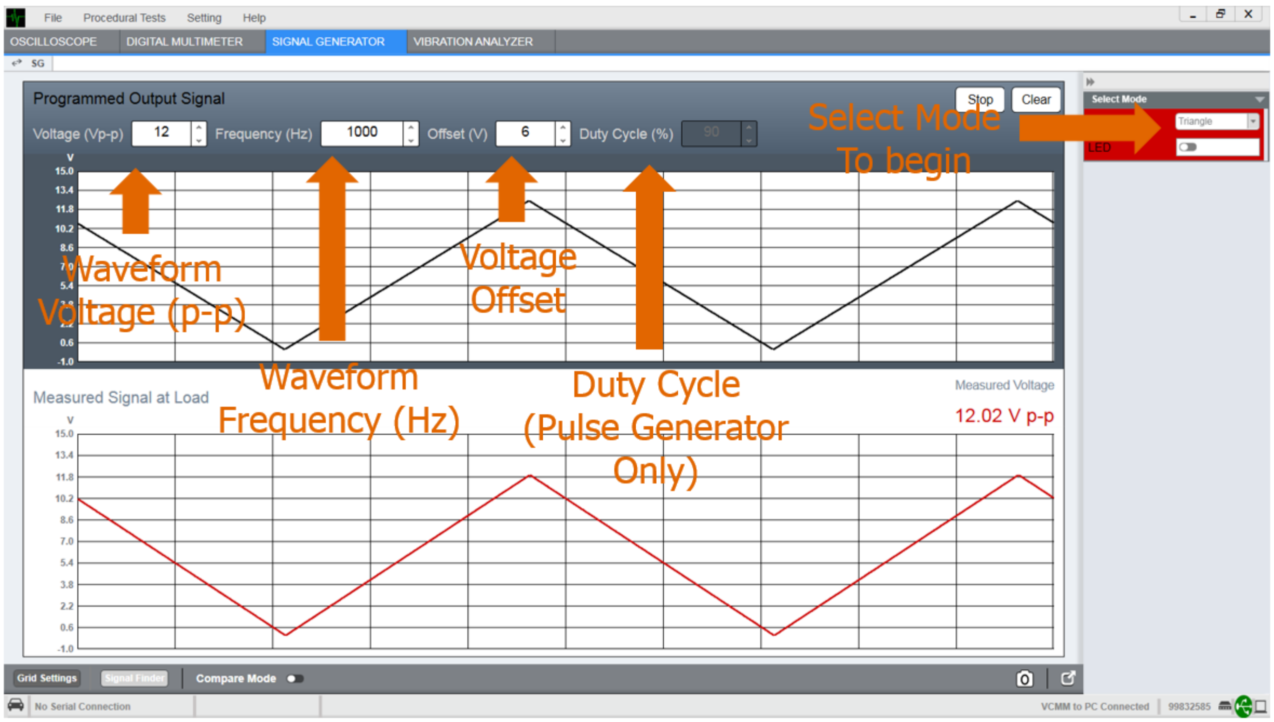
 Stops continuous play.

 Moves the sliding window right within the timeline by the width of the sliding window.

 Moves the sliding window to the end of the timeline.

6 SIGNAL GENERATOR OPERATION

6.1 SIGNAL GENERATOR VIEW LAYOUT



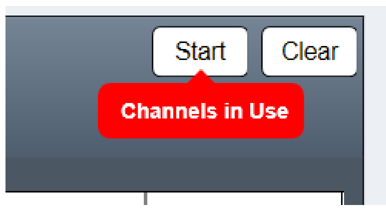
6.2 SIGNAL GENERATOR LIMITATIONS

- The VCMM is hard-wired to generate the output signal on the channel 1 port.
- Channel 2 displays Programmed Output Signal for comparison.
- The Signal Generator cannot generate a negative voltage.
- The Signal Generator has a maximum output of 30 V.

6.3 SIGNAL GENERATOR OPERATION

- CAUTION: A voltage will be generated on the channel 1 port when this tool is started. Before starting this function, ensure the probe connected on channel 1 is not in contact with another circuit.
- NOTE: To prevent damage to the VCMM, the tool will measure the open circuit voltage on port 1 before connecting the signal generator output. If the measured voltage exceeds ±30V the signal generator will not be enabled. This test results in a short delay between the time the signal is activated and the time it appears on the output pin.
- Ensure a standard test lead is connected to the channel 1 port.

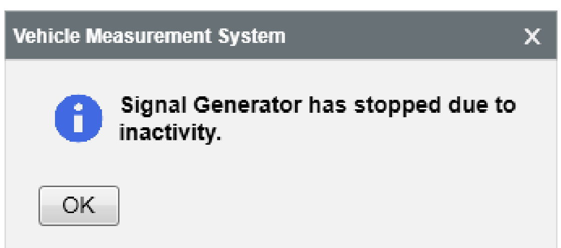
- Select a mode (waveform).
- Select non-zero values for Voltage, and for Frequency and Duty Cycle as applicable. Use the up/down arrows, or type a value into the input field. Fractional values (e.g. 1.5) are permitted.
- Voltage is specified as peak-to-peak for waveform modes, or DC voltage for the Voltage mode. In most signal generators waveforms are nominally centered about the zero voltage level. However, since the Signal Generator is not capable of outputting a negative voltage, the signal generator will default to an offset of ½ the programmed output signal's amplitude. To override the default offset adjust the Offset value. Set the offset to a more positive value to shift the nominal waveform up, or a more negative value to shift the waveform down.
- If the waveform type is Pulse Generator, set the Duty Cycle in the range 1 – 99%.
- After setting the desired configuration, click the "Start" button. The button turns to "Stop", and output signal appears on channel 1. Note: If channel 1 or 2 is in use by another tool the signal generator will not start. In this case the message below will appear:



- You may change the output configuration while output is in progress.

6.3.1 TIMEOUT

After 10 minute of inactivity the signal generator will turn itself off. This is to prevent inadvertent damage to components being probed in a subsequent test session. If the signal generator needs to turn itself off the following message will be displayed:



This message box can appear on top of signal generator, oscilloscope, or multi-meter tools.

7 PARALLEL OPERATION OF TOOLS

7.1 General Description

It is possible to transition between Oscilloscope, Multi-meter, and Signal Generator tools. A typical use case for this feature would be to set up a signal generator, then transition to the oscilloscope tool to view the generated signal along with other signal you wish to measure. There is no sharing of settings between the vibration analyzer and other tools. Characteristics of this feature include:

- The user may switch among the tools and test procedures without the necessity of disabling a channel in the tool of origin.
- When moving between the Scope and Meter tools, user changes to a channel's configuration are carried over from the tool of origin to the destination tool.
- Under special conditions, configuration of the Signal Generator tool will be automatically carried over to the Scope and Meter tools, but only for configuring the output channel and loopback channels in Scope/Meter. This is intended to ease the user's effort in configuration the destination tool to display the output channel and loopback channels using the same configuration as in Signal Generator. (The user will typically want to display these channels in the same way as shown in Signal Generator.)

7.2 Defaults

The signal generator reserves the use of channels 1 and 2. When transitioning between signal generator and other tools these channel usages cannot be changed. The signal output will always appear on channel 1 and the programmed signal will always appear on channel 2. These channels cannot be repurposed for other operations when the signal generator is active.

When switching between the signal generator tool and the scope or meter tools the initial setting of the scope or meter will be defaulted to voltage and time base settings that best display the signal being generated. If voltage scale or time base settings in either of these tools are subsequently changed VMS will remember the new settings on tool changes.

When changing between oscilloscope and meter tools coupling and voltage settings are retained to the greatest extent possible. Features include:

- Channels may be enabled in each tool. A channel's enabled/disabled state is carried over as the user moves between the tools.
- Changes to configuration of the channels, including measurement type, channel range, and AC/DC coupling can be made at any time. Changes to these settings are carried over from origin to destination tool.
- Changes to acquire mode (average, min/max) of each channel in the scope tool can be made. These changes have no effect on the meter tool.
- The Changes to time base in the scope have no effect on the acquisition of meter data.

- The meter tool offers an auto-range feature, but the scope function does not. If the auto-range is selected for a channel in meter, this option does not affect the range shown in the scope tool. Similarly, when switching from scope to meter (with auto-range previously selected in meter), the range selection in scope has no effect on auto-range in meter.
- The configuration of the low-pass filter in scope or meter will not be shared between scope and meter. Each tool will retain independent filter settings. This is because the filters have different purposes for scope and meter.
- When navigating away from the meter tool, any channel that is configured in meter for continuity will be no longer active. Audible indication of continuity is turned Off.
- If application needs to automatically terminate signal generator output, and where the user subsequently returns to the signal generator tool, the signal generation will remain disabled. The user may re-start the signal output, but VMS will not do so automatically

7.3 RECORDING IMPLICATIONS

- After a recording has commenced, switching tools is not permitted. This is indicated by the lock symbol on the other tools in the tool pane. The lock symbols are shown below:

- Recording in scope or meter is permitted while signal generation is enabled. If signal generation is enabled in the signal generator tool, and the user then navigates to the scope or meter tool, the user will be permitted to start a recording. However, any subsequent attempt by the user to switch to signal generator will be a “breaking” change.

8 RED TICK PROBE OPERATION

The VCMM features a Red Tick probe. This probe is able to be used for all measurement and signal generation functions. In addition, the probe features a button as well as an LED.

8.1 LED OPERATION

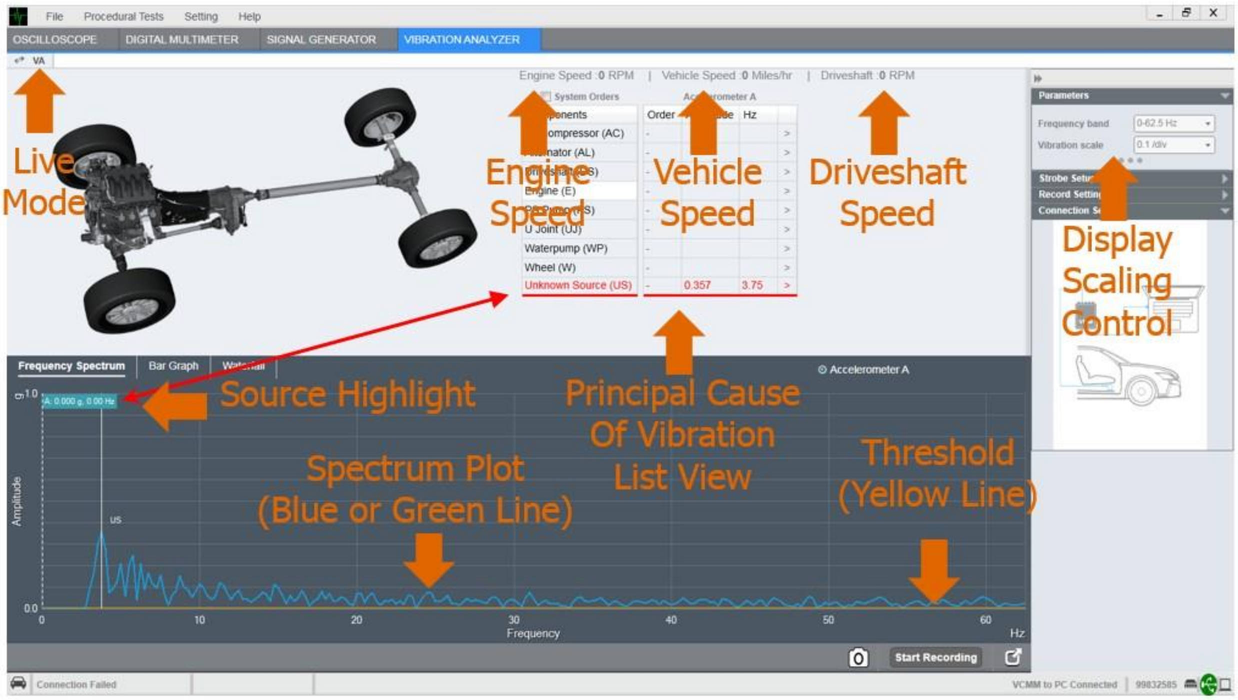
The purpose of the LED is to illuminate the area of the unit under test that you wish to probe. This is a convenience feature since probe areas on a vehicle are often poorly lit. If a Red Tick Probe is detected on any measurement channel an LED control button will appear in the channel control pane. The LED can be activated and de-activated using this control. The appearance of the control is shown below:

8.2 TRIGGER BUTTON OPERATION

The Red Tick Probe also features a trigger button. This can be used to activate a recording (when armed) or to manually trigger the scope.

9 VIBRATION ANALYZER OPERATION

9.1 VIBRATION ANALYZER VIEW LAYOUT



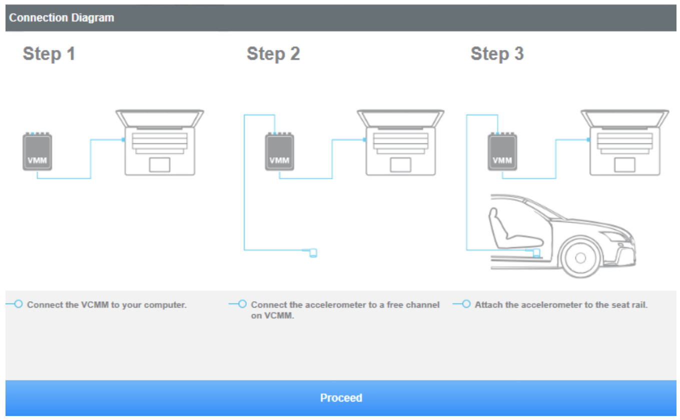
9.2 VIBRATION ANALYZER OPERATION

9.2.1 Setting up the Vibration Analysis Tool

- Connect at least one accelerometer to one of the four standard channels. (If no accelerometer is connected, Vibration Analyzer tool can be selected, but the tool will not display a trace in the frequency spectrum line plot.)
- Click on the Vibration Analyzer tab. The Vibration Analyzer automatically connects to a maximum of two channels with accelerometer probes. (There is no On/Off switch for accelerometer channels in the tool.)
- To exit the Vibration Analyzer tool, simply click on another tool tab. The Vibration Analyzer automatically disconnects from any channel with an accelerometer probe.

9.2.1.1 *Connection Diagram – 1 Accelerometer*

Upon entering the Vibration Analyzer tool, you are presented with the connection diagram dialog shown below. This is the first screen you will view when the Vibration Analysis tool is initialized from either IDS or from the VMS launch screen.



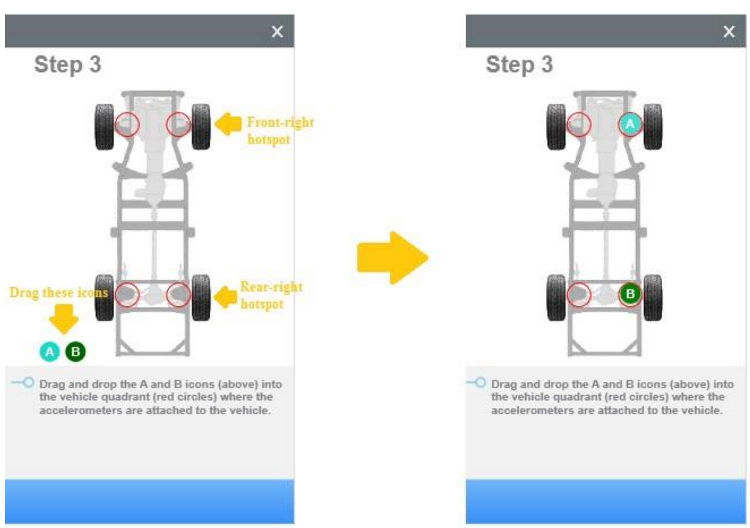
This connection diagram will guide you step-by-step to make the needed connections.

- Click on "Proceed" (blue bar at bottom) to continue to the next view in the workflow.
- You may cancel the workflow by closing the Connection Diagram using the "X" button in the upper-right corner. This cancels "Live mode" Vibration Analysis and presents just an empty view. To get back to the Vibration Analysis workflow, you must click on another tool (Scope, Meter, or Signal Generator), and then click back on the Vibration Analyzer tool tab.

9.2.1.2 *Connection Diagram – 2 Accelerometers*

When using two accelerometers in the analysis, Step 3 in the Connection diagram changes to a top-view Chassis diagram, which presents four "hotspots" displayed as Red circles next to each Wheel. You must use the icons and hotspots in the Vehicle's top-view chassis image to identify, to VMS, the location of the accelerometers on the vehicle. (See diagram below.) You will notice that accelerometer 'A' & 'B' icons flash until both icons are dragged and dropped onto hotspots.

You may place the accelerometers either on the "Front and Rear" or "Left and Right" configurations, but not diagonally. Once the locations are confirmed, you can click on the Proceed button.



9.2.2 Vehicle Information Entry

After clicking "Proceed" in the Connection Diagram dialog, you are presented with the Vehicle Information Entry dialog.

If you launch "Vibration Analyzer" tool from IDS, then the vehicle information will be filled out with data coming in from IDS, and transferred to VMS. If you initiate the vibration analyzer tool from VMS (launcher or tool bar), then you must manually enter this information.

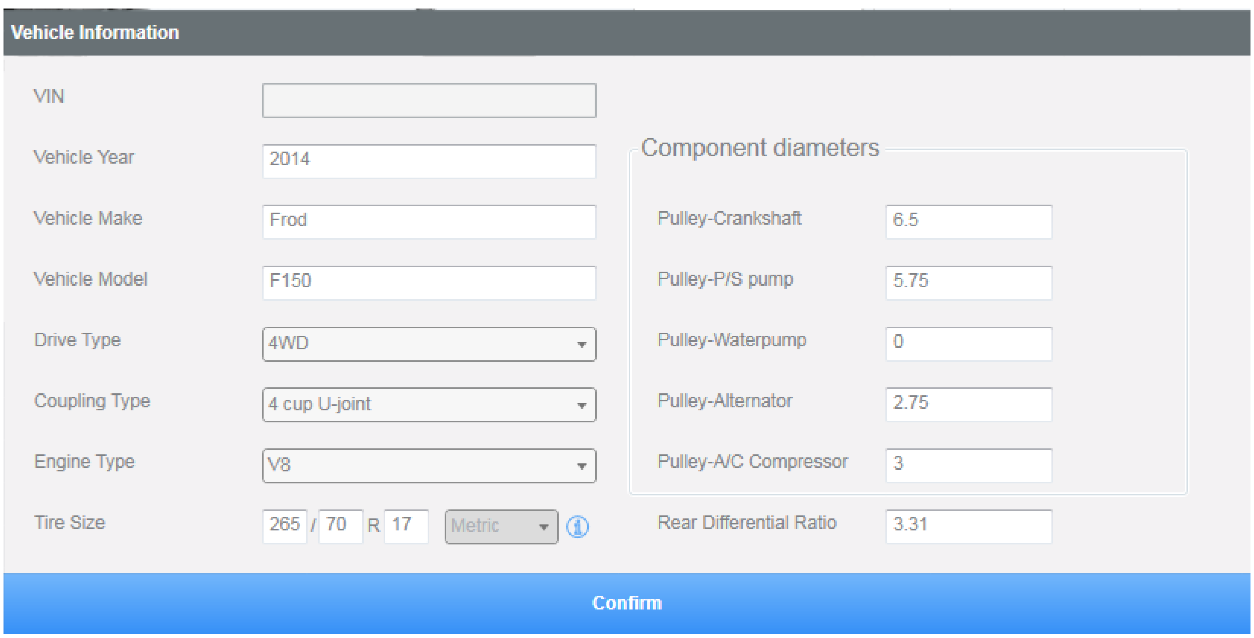
You must select, or enter, the following data items:

- Drive type
- Engine type
- Tire units (only Metric unit type is supported in the current release)
- Tire size
- Rear differential ratio is required if Drive Type is not FWD

Other entry fields are optional. VIN and Vehicle name fields are not editable.

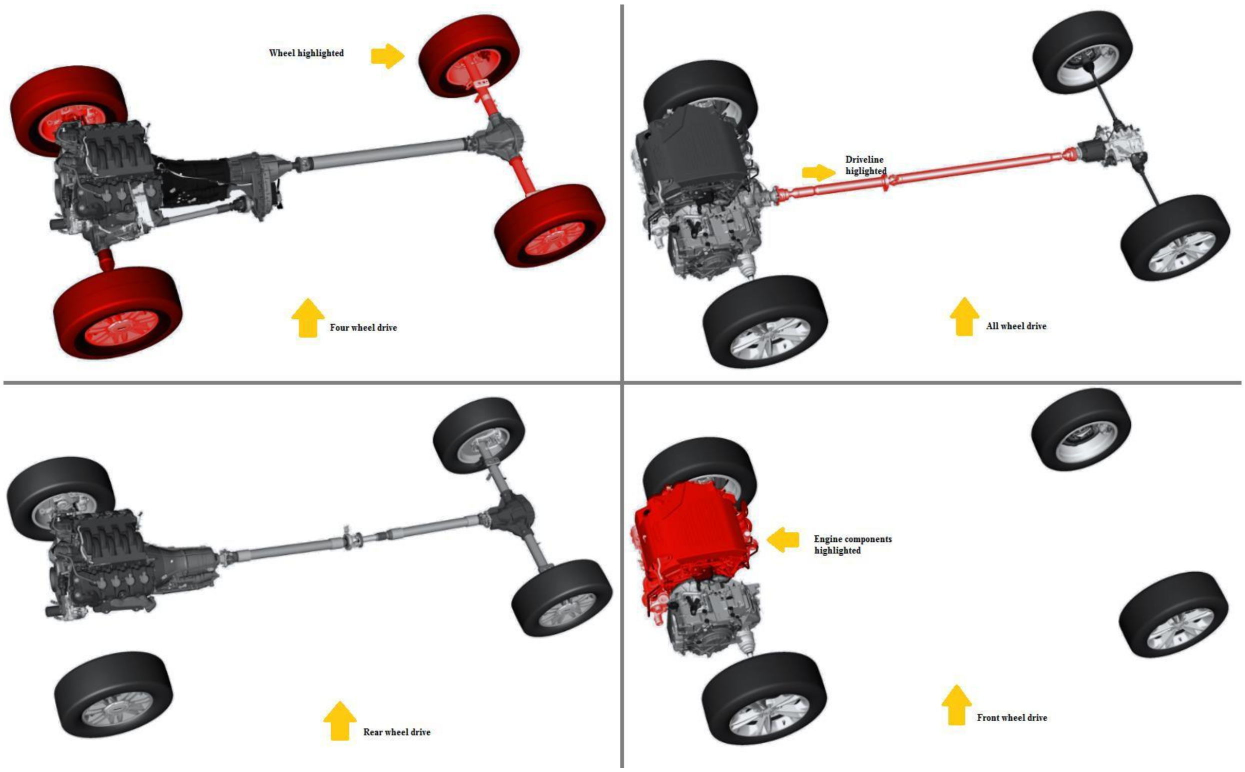
You have two choices at this point:

- Click "Confirm" after making all entries to continue to the next view in the workflow.
- You may cancel the workflow by closing the Vehicle Information dialog using the "X" button in the upper-right corner. This cancels "Live mode" Vibration Analysis and presents just an empty view. To get back to the Vibration Analysis workflow, you will have to switch to another tool (Scope, Meter, or Signal Generator), and then click back to the Vibration Analyzer tool.



9.3 CHASSIS DIAGRAMS

Based on the type of Drive selected, the main Vibration view will show a corresponding Chassis diagram for – Front Wheel drive, All Wheel drive, Four Wheel drive and Rear Wheel drive images. Vibration sources – Wheels, Engine and Driveline - are highlighted in Red when they are evaluated as source of vibration.



Based on the number of accelerometers connected, the wheels are highlighted in different possible combinations:

- All four Wheels are highlighted in red when only one of the Accelerometers A or B is connected and Wheel is the principal source of Vibration.
- Only the two Front or the two Rear Wheels are highlighted in red, when both A and B Accelerometers are connected and one of them is on the Front end and the other is on the Rear end of the vehicle.
- Only the two Left or the two Right Wheels are highlighted in red, when both A and B Accelerometers are connected and one of them is on the Right side and the other is on the Left side of the vehicle.

When the Wheel is the principal source of Vibration, you can use both A and B accelerometers simultaneously to isolate vibration to a specific side, by connecting them on the Front, Rear, Left or Right.

9.4 Data Analysis View

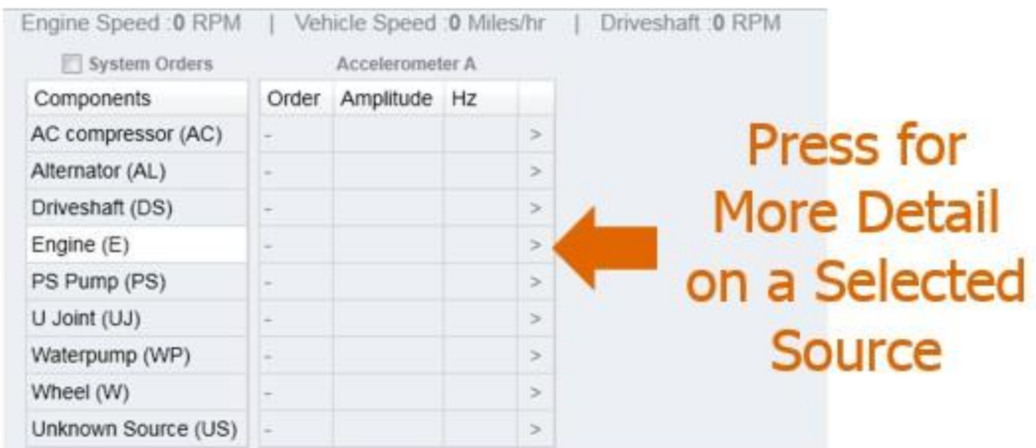
After clicking “Confirm” in the Vehicle Information Entry dialog, the main Vibration Analyzer view is displayed. This is the view in which you can view the waveform in live mode in one of the three display modes – Frequency Spectrum, Bar Chart, and Waterfall.

9.4.1 Principle Component Table

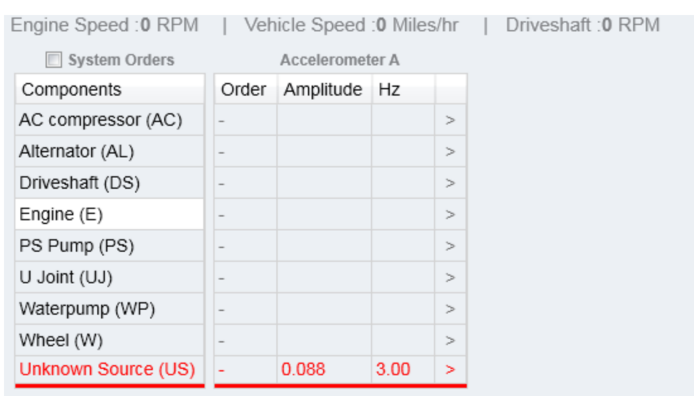
The tabular view shows the list of possible sources of vibration. For each source of vibration, its G values and orders of vibration are displayed.

These values dynamically change in the live mode. The highest sources of vibration are highlighted in red. At the top of the Component table, you will also see the current Engine Speed in RPM, and Vehicle Speed in MPH.

Further details about each source can be viewed by clicking on each row.



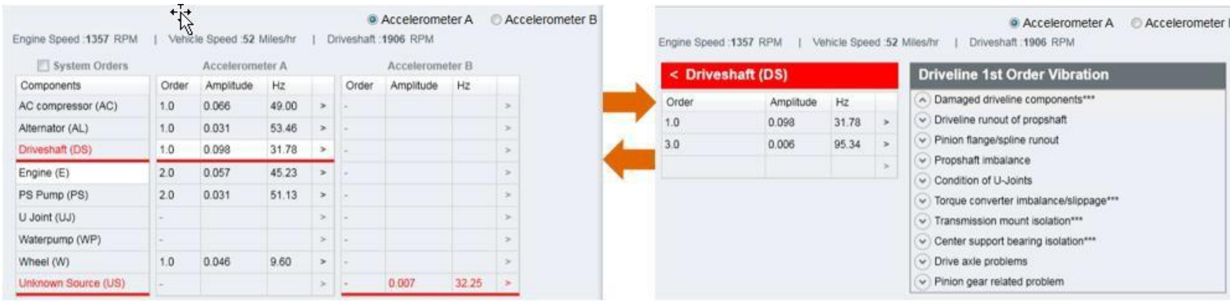
Unknown Source” is shown as a vibrating component in Principal Component Display list view when there is no Serial Communication available to correlate, OR when none of the eight components, listed above, match the Vibrating Frequency. The screenshot below illustrates the “no serial data” scenario.



If one of the components, is contributing a high vibration, then in the tabular view, you can click on the particular row to look at the other orders of vibration from that component and also see the recommended procedures.

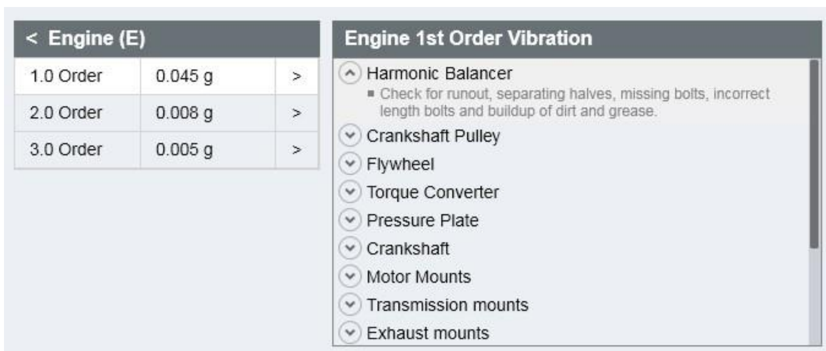
The detailed component view will show the top three amplitudes and corresponding orders for that source.

The illustration below shows a detailed view for Driveshaft. You can return to the Principal component view by clicking on the “<” button on the header.

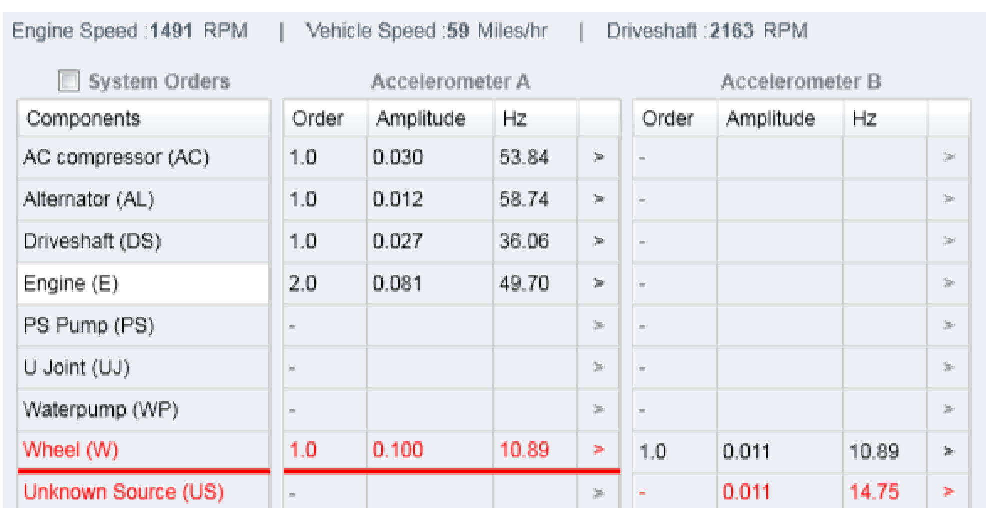


When you click on one of the rows shown in this detailed view, a detailed explanation of probable “Causes” of vibration is shown on the right. The text shown is specific to the selected component and selected order.

Below is an illustration for Engine 1.0 order causes.



When two accelerometers are connected, the view will display component data from both, as illustrated below. A component is highlighted in red when either accelerometer evaluates that component as a source of vibration. In the illustration below, Accelerometer A shows Wheel as the source of vibration, while Wheel on Accelerometer B is not a vibration source.



9.4.2 Frequency Spectrum Display

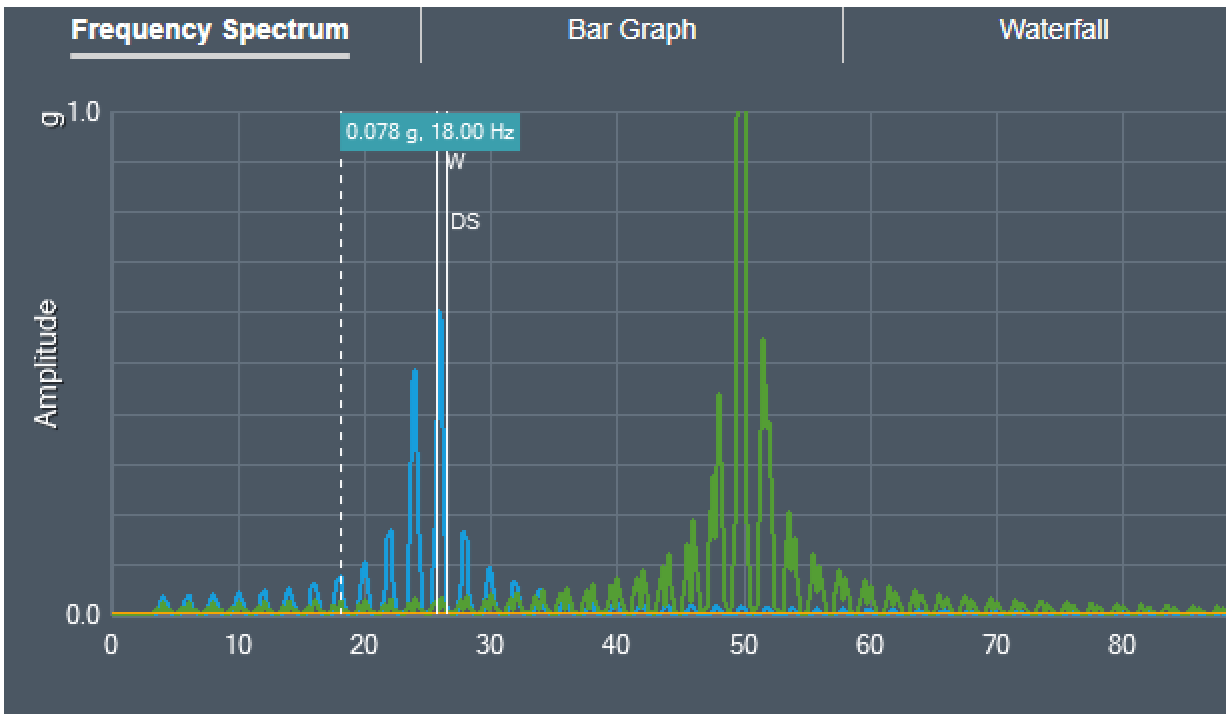
Upon entering live mode view, the Vibration Analyzer tool will start acquiring Accelerometer data at 8,192 samples per second. Vibration Analyzer requires a set of 32,768 samples from the Accelerometer input to evaluate a full (0 - 1,000Hz) spectrum at 0.25Hz resolution. As a result, the tool requires four seconds for initial data acquisition; during this initial period no frequency data will be displayed.

After this initial analysis, the spectrum output will be displayed in the Frequency Spectrum line plot in the lower half of the view. This Frequency Spectrum will continuously update at a rate of twice per second.

The yellow line in the Frequency Spectrum depicts the threshold G, which is automatically set by the tool to 0.005G. Vibrations below this threshold limit are not analyzed by the tool.

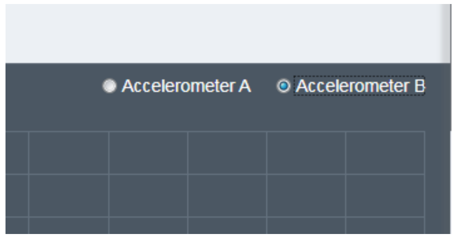
The vertical solid white lines in the frequency spectrum graph are "Markers" denoting the highest sources of vibration corresponding to the frequency. The illustration below shows markers for W (Wheel), and DS (Driveshaft).

The frequency spectrum plot is displayed in blue for Probe A, and in Green for Probe B. The illustration below shows when both Probe A and B are connected.

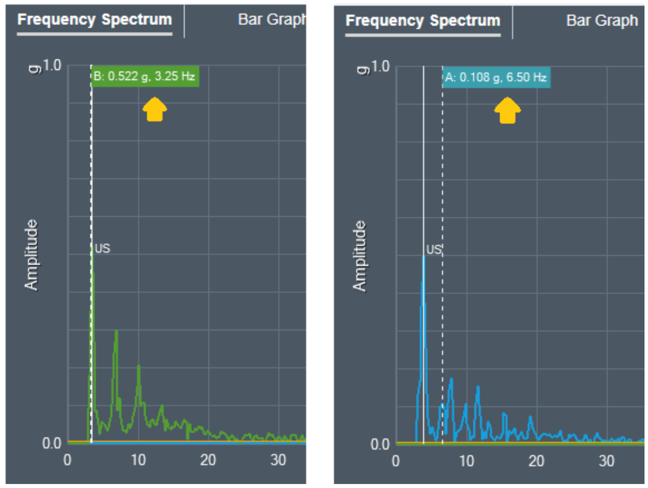


A marker line, the dotted white line in the Frequency Spectrum graph, can be dragged with the mouse left button press over the spectrum plot. The blue label shows the frequency and amplitude values at a point on the spectrum. The marker label will be shown in green for Accelerometer B and in blue for Accelerometer A. You can switch between the two accelerometers using the radio button on the top right corner of the Frequency Spectrum.

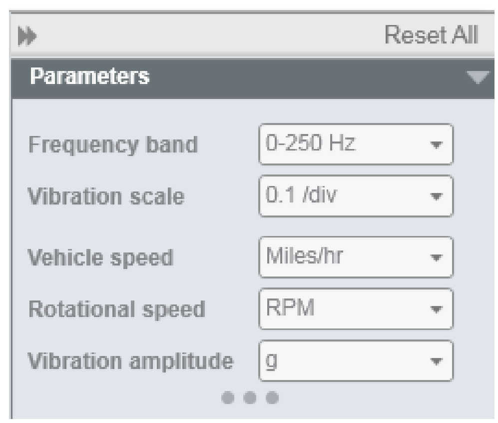
When only one accelerometer is connected. i.e. either A or B, the radio button for the connected accelerometer is automatically selected and the other accelerometer, which is not connected, is not displayed.



The illustration below shows Accelerometer B's value at the peak – 0.522 G at 3.25 Hz; and Accelerometer A's value at the peak – 0.108 G at 6.50 Hz.



9.4.3 Data Analysis Display Controls

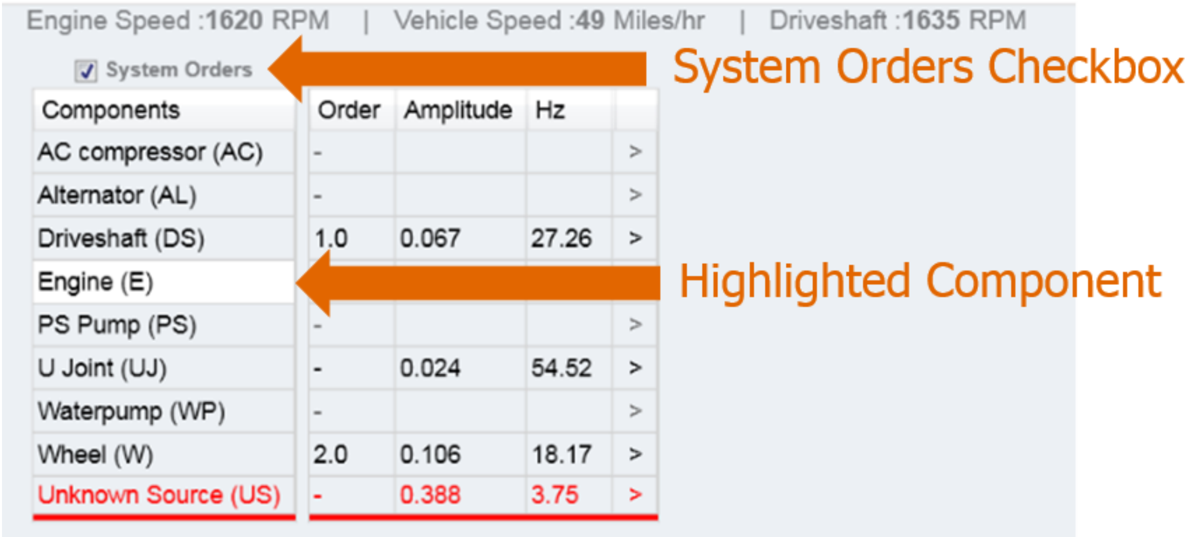


By default, the Frequency Spectrum will be displayed for 0 – 250Hz on the X-Axis range, and 0.01 G/division on the Y-Axis scale. You can change the X-Axis range by selecting a different Frequency Band from the drop-down list located in the "Parameters" control pane. You can change the Y-Axis scale by selecting a different Vibration Scale from the drop-down.

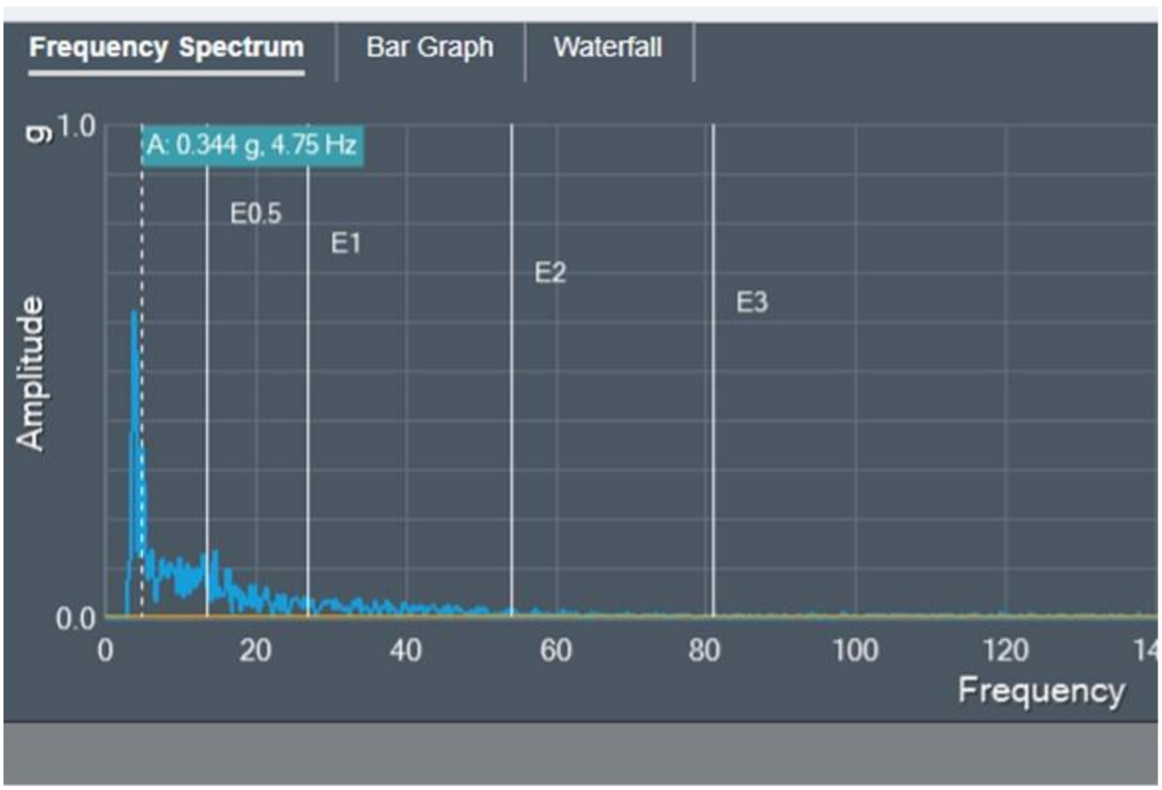
By default the Units for:

- Vehicle speed is miles/hour; you can change it to Km/hr.
- Rotational speed is RPM; you can change it to Hz.
- Vibrational amplitude is G; you can change it to meters per second, per second.

Highlighting of different orders of vibration of a particular component can be accomplished in the frequency spectrum display. This is done by highlighting the desired component in the principal cause window and clicking on the "System Orders" checkbox as shown below.



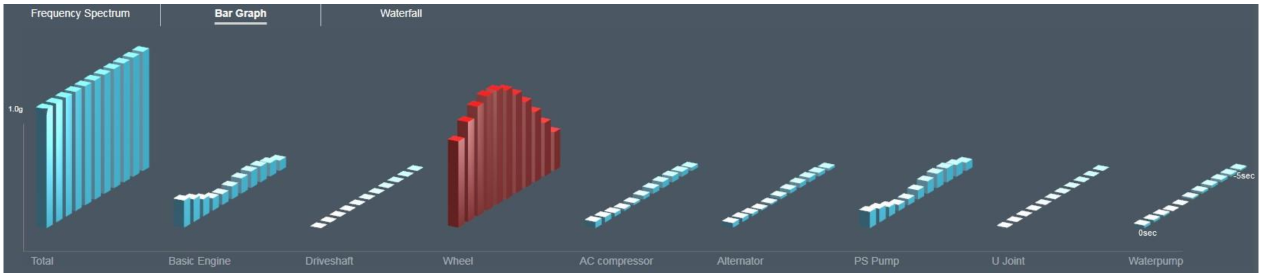
Once system orders are selected on a component the frequency spectrum display will add markers for each relevant order of the component. The marker will track the component as the rotational velocity of that component changes. The image below show system orders for the engine.



9.4.4 Bar chart

In the bar graph display mode, vibration amplitude is displayed in bars representing the major vehicle systems tested: engine, driveshaft, wheels/tires, power steering pump, A/C compressor, alternator, and total energy. Eleven continuous cycles or frames are displayed for analysis.

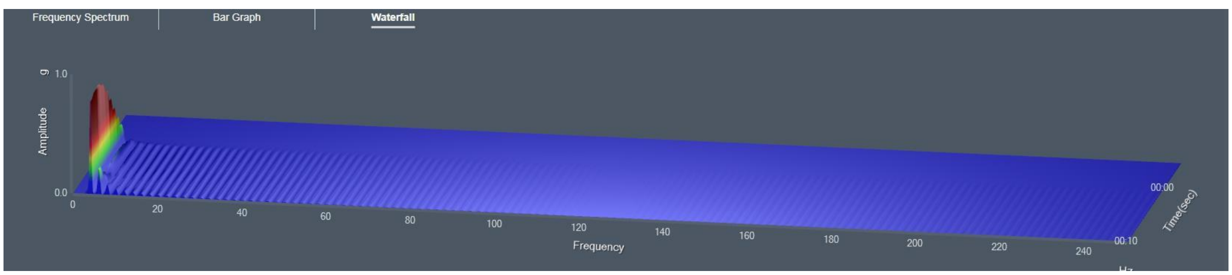
The most recent cycle is shown in the foreground of the bar chart display. The illustration below shows Wheel as the source of vibration.



9.4.5 Waterfall chart

In the Waterfall display, vibration amplitude vs. vibration frequency is plotted over time in a 3D graph. The waterfall display is often useful for analyzing vibrations that do not vary frequency with the rotating elements on the vehicle.

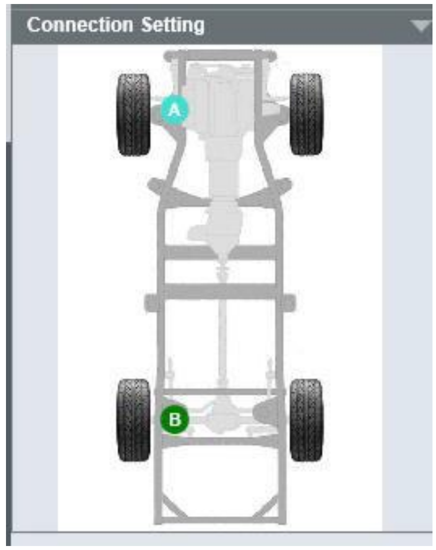
Amplitude is also shown in various colors - Blue (low), Green (lower middle), Yellow (upper middle) and Red (high).



Note: The waterfall display function makes heavy use of the PC's graphic memory. If you are having issues with the waterfall display please check your PC's graphics card memory. It should be greater than 512MB for proper operation.

9.5 CONNECTION SETTING PANEL

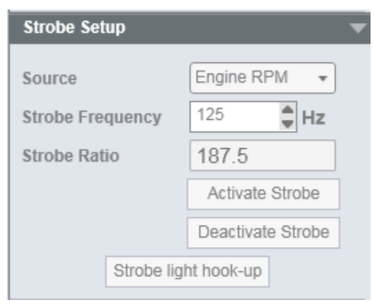
When two Accelerometers are connected, you can click on the Connection setting panel to change the A and B Accelerometer locations without restarting Vibration Analyzer.



9.6 STROBE LIGHT

The strobe light provides a strobe synchronous with vibration in order to help isolate the source of the vibration. In order to use this feature, you must connect an Induction Loop probe on VCMM channel 1.

When an Induction Loop probe is connected, a Strobe line in red will be displayed on the Frequency spectrum and the Strobe setup configuration will be enabled with Engine RPM as the default source.

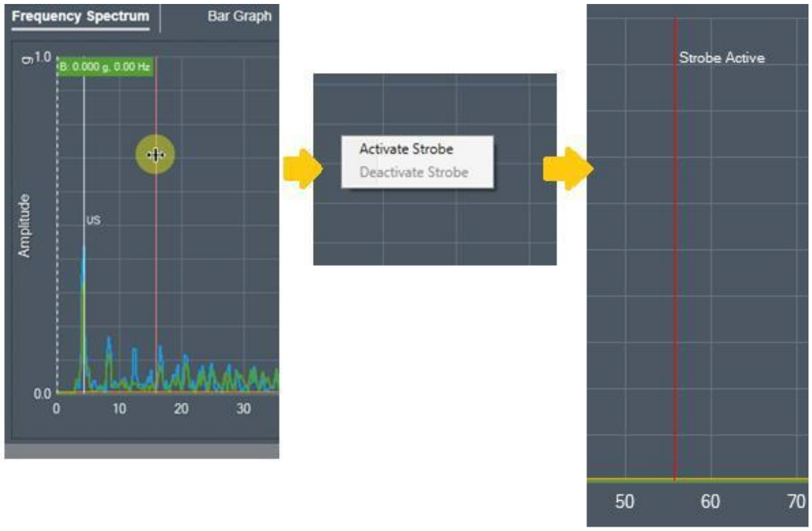


From the Source drop down, you can change the selection to Engine RPM, Vehicle Speed or Manual.

When the source selection is either Engine RPM or Vehicle speed, the strobe frequency is continuously updated to match the changes in engine rpm or vehicle speed. The Vehicle speed selection will match the strobe frequency to the any multiple of rpm of the wheel. The RPM selection will match the strobe frequency to the any multiple of rpm of the engine.

To change the preset frequency, you can either drag the strobe line on the Frequency spectrum, or change the frequency manually in the Strobe setup. To activate Strobe, use the right-click option on the Frequency spectrum, or click on the “Activate Strobe” button on the Strobe setup panel. Changes to strobe frequency or strobe ratio can only be made when strobe is deactivated. Once activated the selections cannot be adjusted until strobe is in deactivated mode.

A label “Strobe active” appears on the frequency spectrum once the strobe light is activated.

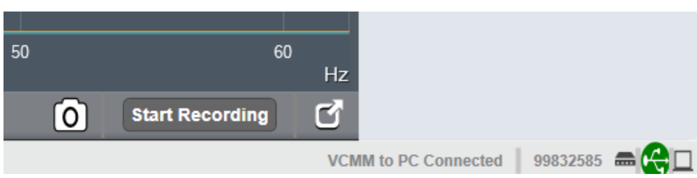


The next steps are done on the vehicle. The objective is to match the strobe frequency to the frequency of the vibration source.

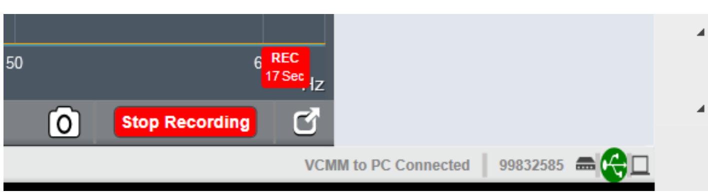
You can deactivate the Strobe light either by using the right-click option or clicking on the Deactivate strobe button.

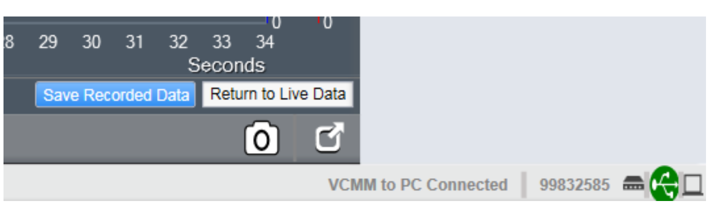
9.7 Recording

The vibration analyzer supports recording of test drive sessions. To start a recording from the live display mode press the “Start Recording” Button.



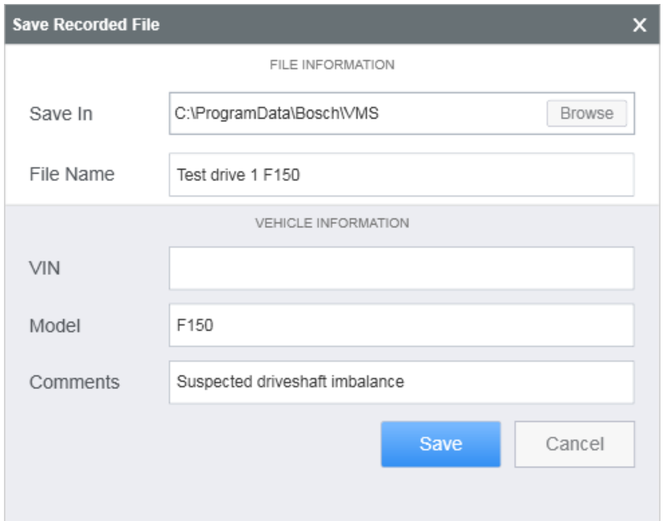
When you have captured sufficient data press the “Stop Recording” button.





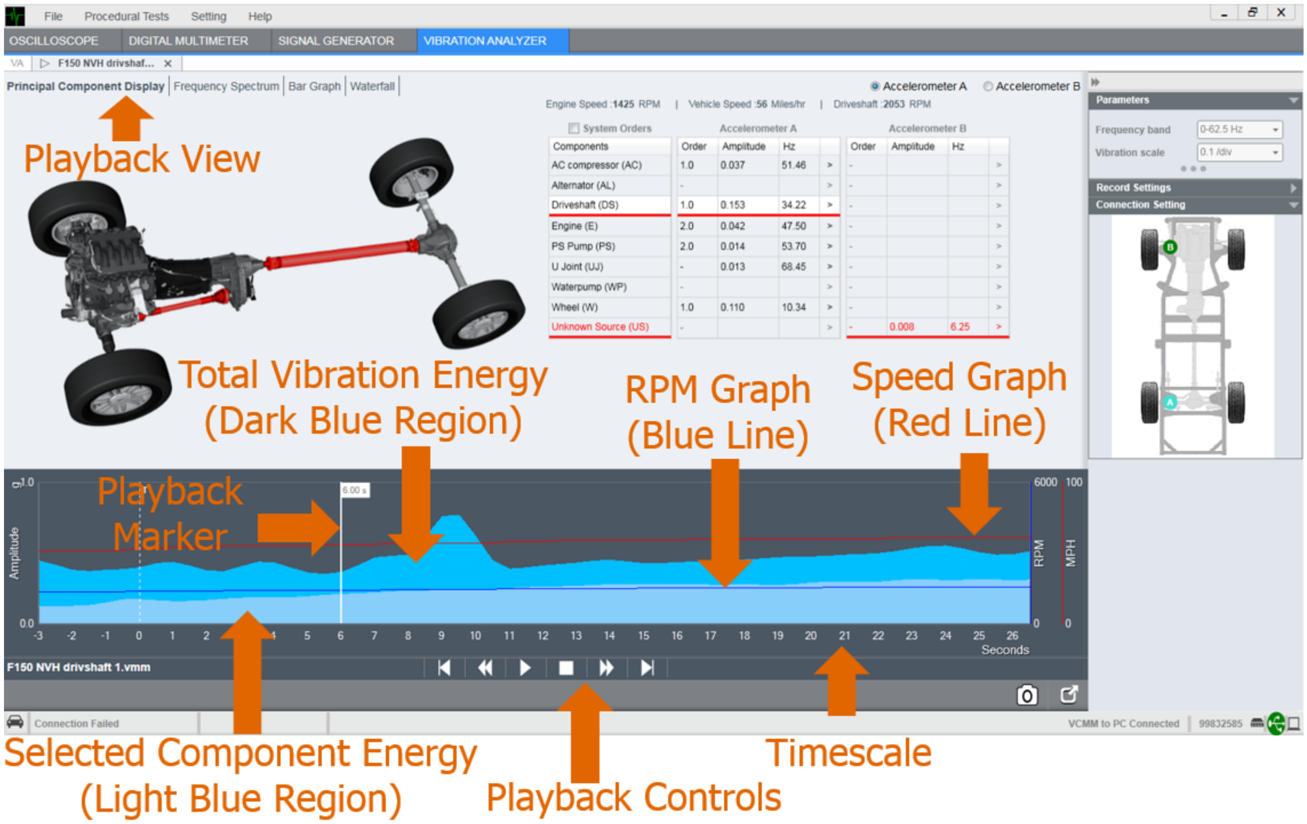
You will be presented with a view of your recorded data. You may save the data or return to live mode.

If you choose to save your test drive data a dialog box will appear asking you for file name information as well as allowing you to enter information about the test drive. The dialog box is shown below:



9.8 Playback

When playing back a recorded file the lower portion of the screen becomes a timeline of the recording. Aspects or the timeline are shown in the diagram below:



Aspects of the timeline portion of the playback screen that differ from the live data mode include:

- Total Vibration Energy – The region in dark blue on the lower part of the display represents the total vibration energy being picked up as a function of time in the recording.
- Selected Component Energy – The region in light blue on the lower part of the display represents the vibration energy attributable to a selected vibration source as a function of time in the recording. The component source is selected by clicking on the desired component in the principal component portion of the display.
- RPM Graph – RPM as a function of time is graphed as a solid blue line superimposed on the shaded area of the timeline.
- Speed Graph – Vehicle speed as a function of time is graphed as a solid red line superimposed on the shaded area of the timeline.
- Timescale – The timescale shows the time after start of recording as measured in seconds.
- Playback Marker – the playback marker shows the position within the recording where the current displayed data was acquired.
- Playback controls – The playback controls in vibration analyzer work in the same manner as those in the other VMS tools. They are as follows:

 Moves the active frame to the first frame in the file.

 Moves the active frame once to the left in the timeline.

 Displays frames one after the other in forward sequence.

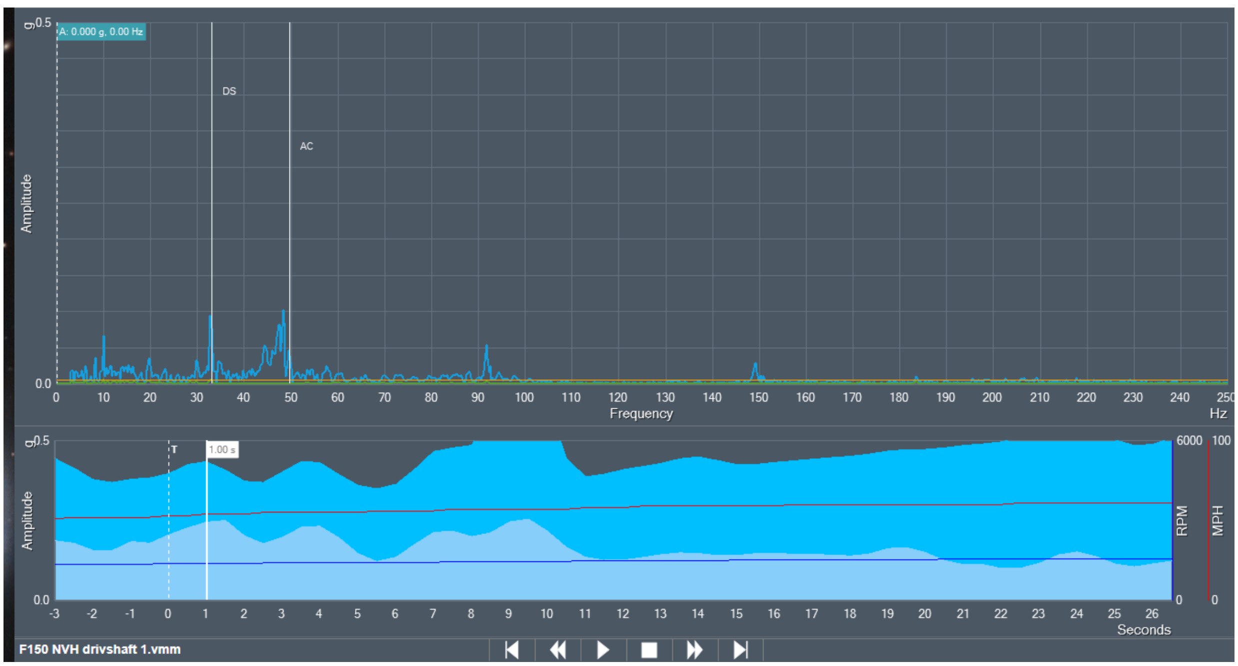
 Stops repeated frame display.

 Moves the active frame once to the right in the timeline.

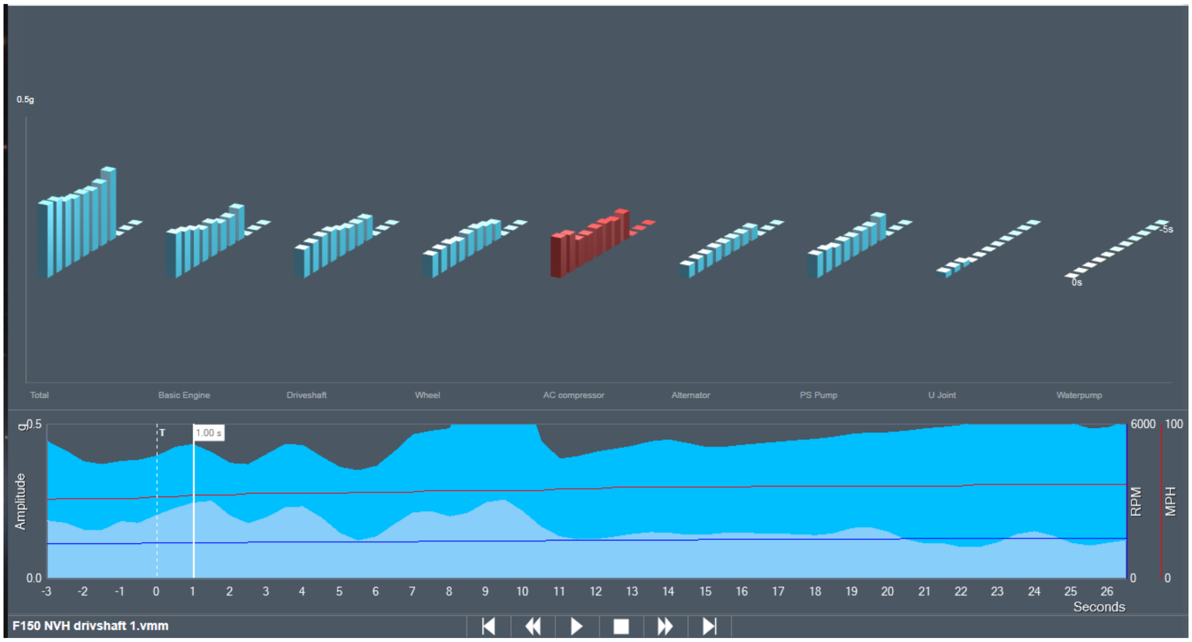
 Moves the active frame to the last frame in the file.

- Playback View – During playback the data view can be toggled between Principal Component Display, Frequency Spectrum Display, Bar Graph Display, and Waterfall Display. When toggling between the data display modes the timeline display remains on the lower part of the screen while the data view in the upper part of the screen changes. Examples of the different playback views are shown below:

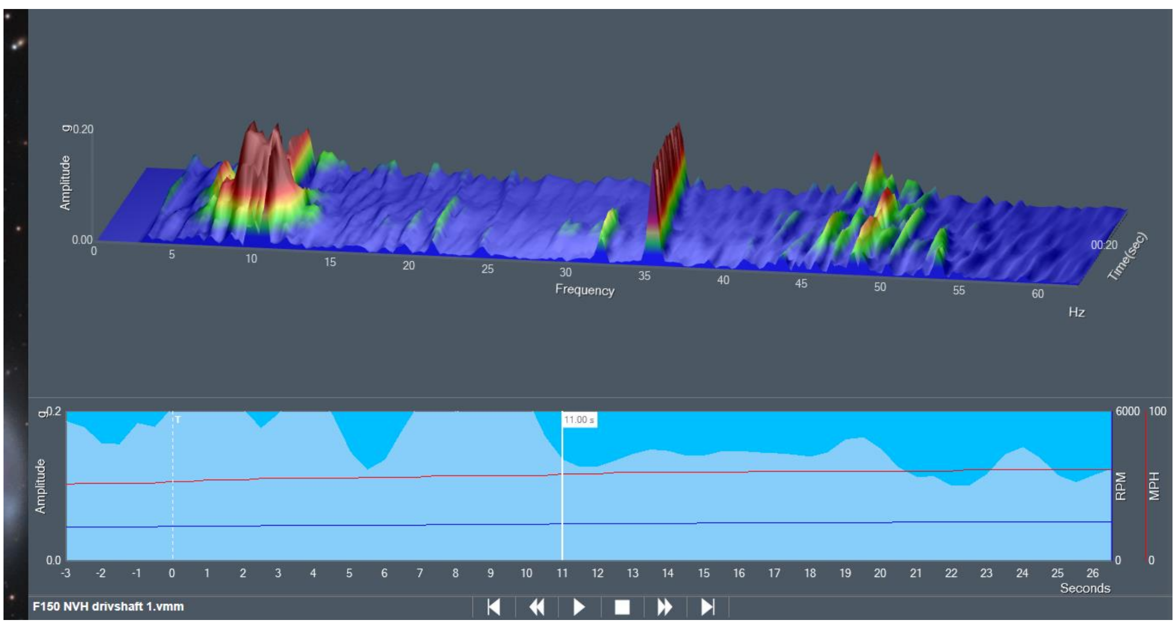
    - Frequency Spectrum Display



- Bar Graph Display



- Waterfall Display



10 DRIVESHAFT BALANCE PROCEDURAL TEST

10.1 SUMMARY OF FEATURES

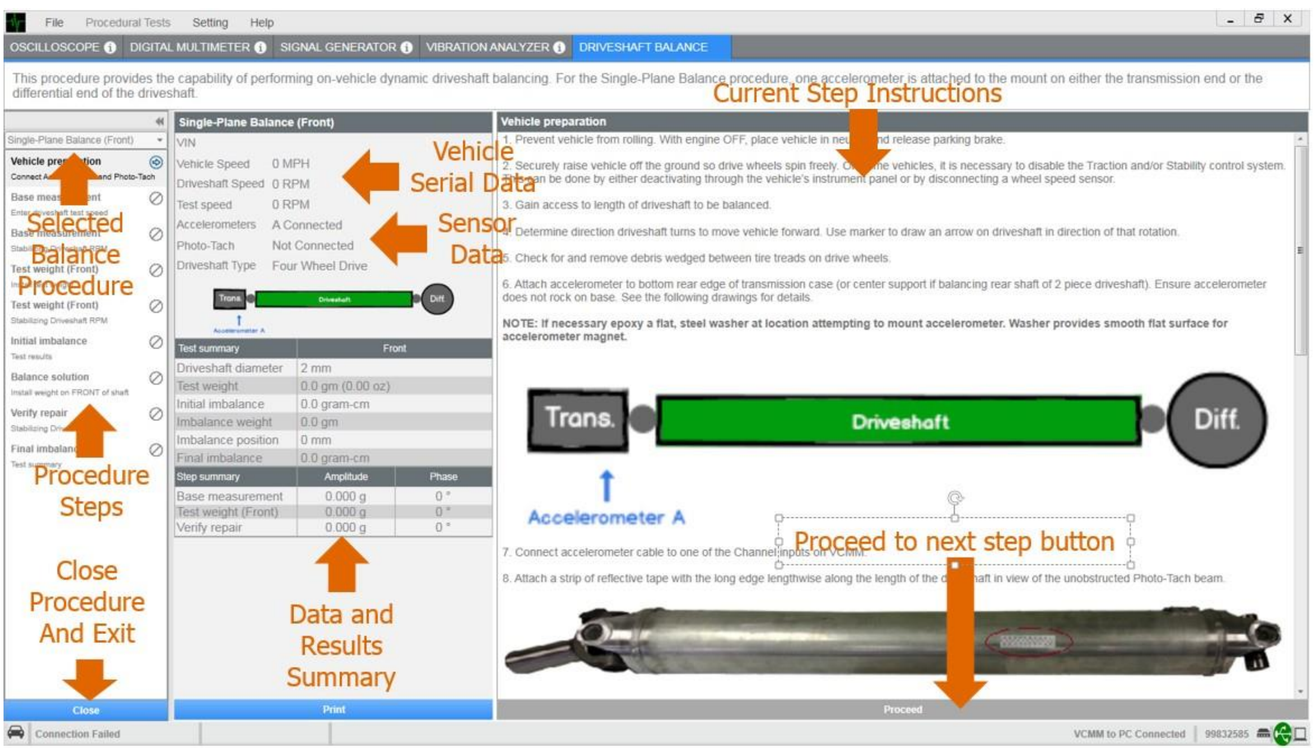
The Driveshaft Balance test included with the current release has this functionality:

- Provides three workflows for driveshaft balance analysis:
    - Single-plane (front or rear)
    - Dual-plane
    - Dual hose clamp (front or rear)
- Accepts accelerometer input from one or two accelerometer probes.
- Accepts photo tachometer (photo-tach) input probe and converts photo-tach signal to driveshaft's rotational speed.
- Integrates accelerometer data, driveshaft speed, and photo-tach data to compute imbalances on the driveshaft and provides solution to correct the imbalance.

10.1.1 Functional Limitations

- Driveshaft Balance cannot be performed on a Front-Wheel Drive (FWD) vehicle.

10.2 DRIVESHAFT BALANCE VIEW LAYOUT



10.3 Operation

10.3.1 Entering and Exiting the Driveshaft Balance Test

- To enter the Driveshaft Balance test from Scope or Meter click "Driveshaft Balance" from "Procedural Tests" menu. Driveshaft Balance can also be accessed from the launcher window.
- To enter the Driveshaft Balance test from Signal Generator, set the waveform mode to Off, and then click "Driveshaft Balance" from "Procedural Tests" menu. In the Launcher Window, click "Drive Shaft Balance" in the list of Procedural Tests.
- To enter the Driveshaft Balance test from the Vibration Analyzer tool, click "Driveshaft Balance" from "Procedural Tests" menu. In the Launcher Window, click "Drive Shaft Balance" in the list of Procedural Tests.
- Connect at least one accelerometer and a photo-tach probe to any of the four standard channels. (If no accelerometer or no photo-tach is connected, the Proceed button on the first step "Vehicle Information" will remain disabled.)
- Once Driveshaft Balance test is launched, it automatically connects to a maximum of two channels with accelerometer probes and to the photo-tach. (There is no On/Off switch for channels in this test.)
- To exit the Driveshaft Balance test, click the blue "Close" button on the bottom-left corner of the view. If the Driveshaft Balance test is in the middle of a test procedure, you must first "Abort" the procedure, and then click "Close". The test automatically disconnects from all connected channels.

10.3.2 Theory of Driveshaft Balance

During balancing tests, the driveshaft is run at a balancing speed specified by the driveshaft manufacturer and/or above the point of resonance/vibration.

The accelerometer signals are sampled and then filtered to isolate the fundamental of the vibration frequency (i.e. the frequency of revolution of the driveshaft). The amplitudes of the filtered vibration signals are then measured, as are the phase angles between the photo-tach reference and the peaks of the vibration signals. The center frequency of the band-pass filter is dynamically adjusted so that the filter matches the current value of the driveshaft RPM.

For the single-plane driveshaft balancing procedure, this process is repeated three times:

- *As a "Baseline" test with the driveshaft unmodified to measure the inherent imbalance.*
- *Again with a known "test weight" added to the driveshaft to measure the change due to a known perturbation value.*
- *A third time after the balance weight has been added to verify the balance weight was installed at the correct location and has resolved the inherent imbalance.*

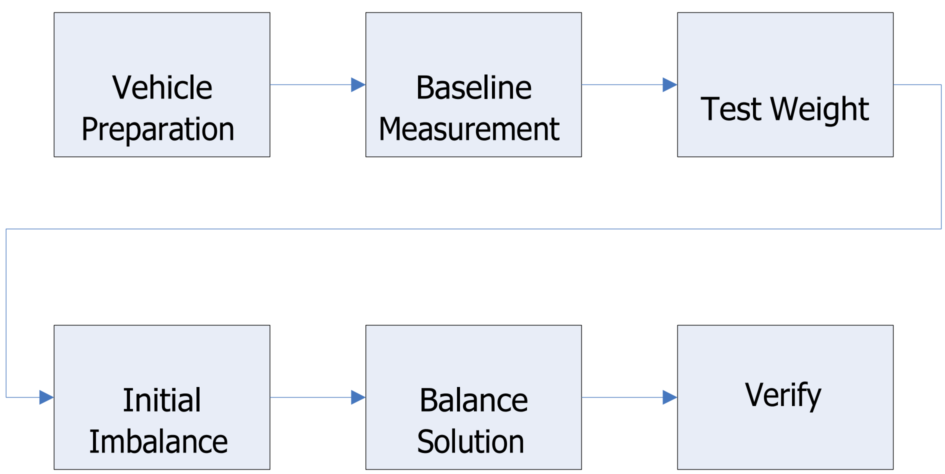
The driveshaft is run at the same speed in all cases, and the amplitudes of the filtered vibration signals are measured as well as the phase angles. Based on the analysis of the initial baseline measurements, and of the effects of adding a test weight, the Driveshaft Balance tool computes the size and position of a weight required to balance any vibrations that were present at the start of the test.

The two-plane driveshaft balancing procedure is an extension of the single-plane case. Two accelerometers are used, one on the mount at each end of the driveshaft (instead of one that is used for the single-plane case). If a half shaft is being balanced, the accelerometers are positioned on the mounts for each end of the half shaft. A baseline test is run without any test weights. Then a test weight is added to one end of the driveshaft, and the measurements are repeated. The test weight is then moved to the other end of the driveshaft, and a third set of measurements is made. The vibration data is analyzed, and the balancing weight positions are determined relative to the positions of the test weights. After the balancing weights are attached, a fourth test run is made in order to verify the repair.

The Driveshaft Balance test lets you perform either single-plane (most common) or two-plane dynamic driveshaft balancing procedures.

For single-plane driveshaft balancing, one accelerometer is attached to the mount on either the transmission extension (tail-shaft) housing or the differential end (pinion housing) of the driveshaft. For two-plane balancing, two accelerometers are attached to the mounts at either end of the driveshaft where there is a non-rotating surface. In both cases, for measuring imbalances on the front of the driveshaft, accelerometer A should be connected; and for measuring imbalances on the rear of the driveshaft, accelerometer B should be connected.

A photo-tachometer is used to measure the driveshaft position relative to an imbalance and to measure the rotational speed of the driveshaft during a balance procedure. The photo-tach is attached to an articulating arm with a magnetic base. The magnetic base is mounted to a non-rotating surface situated so that it can illuminate a piece of reflective tape placed on the driveshaft. The reflective tape is attached at any location on the driveshaft other than where it will interfere with installation of balance and/or test weights.



10.3.3 Driveline Balancing Tips

Several factors may contribute to a high residual imbalance, including improperly following the procedure. This section outlines potential causes of a poor balancing result.

10.3.3.1 Driveline Resonance

If the target speed is on or near the driveline natural frequency, a resonance condition occurs where the vibration energy changes dramatically as the driveline RPM varies. This results in a high residual imbalance that might be even higher than the baseline.

There are two ways to determine if the selected target RPM is on or near the driveline natural frequency:

1. Characterize the vehicle by plotting the first order driveline energy with respect to the driveline RPM using the Vibration Analyzer tool.
2. Monitor the energies shown on the screen while sustaining the target speed. If the energies vary more than 20% while in the target zone, the vibration is either load dependent or the target speed is on or near the driveline natural frequency.

An ideal target speed is a speed at which the first order driveline energy is high and stable within ±25 RPM.

10.4 VEHICLE INFORMATION ENTRY

After entering the test, you are presented with the Vehicle Information Entry dialog.

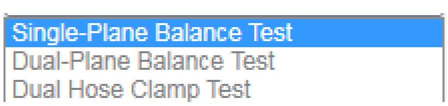
If you launch “Driveshaft Balance” test from IDS, then the vehicle information may be filled out with data coming in from IDS, and transferred to VMS. If you initiate the Driveshaft Balance tool from VMS (launcher or tool bar), then you must manually enter this information.

You must select, or enter, the following vehicle information:

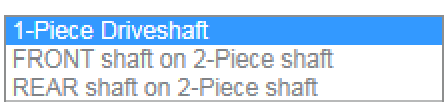
- Drive type (note FWD does not contain a driveshaft, hence cannot be selected).
- Driveshaft type
- Tire units (only Metric unit type is supported in the current release)
- Tire size
- Rear differential ratio is required

You must then select, or enter, the following Vehicle information:

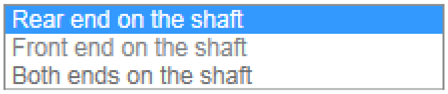
- Driveshaft Balance test type: Single-Plane, Dual-Plane or Dual hose clamp



- Test driveshaft type: One-piece shaft, front of the two-piece shaft, or rear of the two-piece shaft



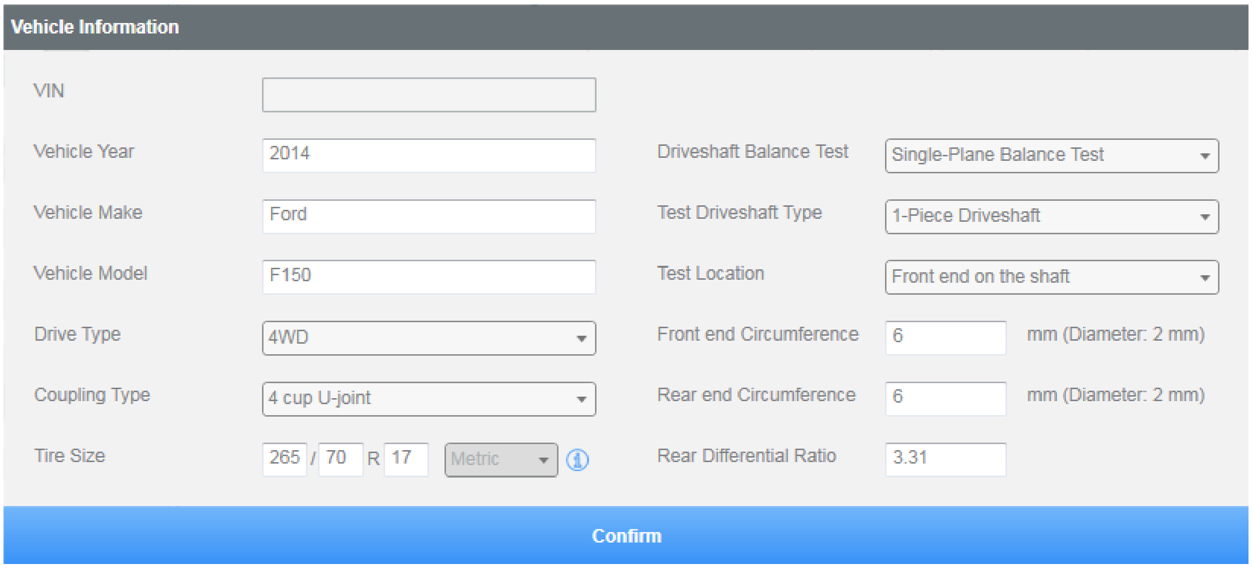
- Test location: Front-end or rear-end of the shaft. For Dual-Plane, “Both ends of the shaft” is the only possible location option.



- Circumference sizes of the front and rear of the shaft being balanced. Enter the circumference measurements of the drive shaft where the test weights and rebalance solution weights are expected to be installed using the kit supplier measuring tape.

Other entry fields are optional. VIN and vehicle name fields are not editable.

Click "Confirm" to start selected driveshaft procedure.



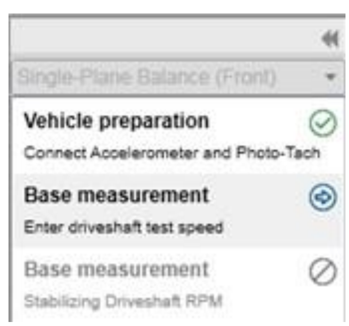
Once confirmed, if you want to change the driveshaft balance procedure type or other configuration items in this Vehicle information dialog, then you must close the driveshaft balance tool by clicking on the "Close" button and then re-launch the driveshaft balance tool.

Following completion of a driveshaft balance procedure, if you want to restart a driveshaft test, you must close the driveshaft balance tool and re-launch it.

10.5 List of Steps and Corresponding States

For a selected Driveshaft Balance procedure, the list of steps are displayed in the left-side panel. Each step shows a title and a short description. There is also a small icon next to each step, which indicates the state of the step:

- Step actively running – blue arrow icon
- Step ran successfully – green checkmark icon
- Step not ready to run – grey stop icon



Follow the steps as outlined in the guided procedure to perform the selected balance procedure.

10.6 Single Plane Driveshaft Balance

10.6.1 Step 1: Vehicle Preparation.

Vehicle preparation

1. Prevent vehicle from rolling. With engine OFF, place vehicle in neutral and release parking brake.

2. Securely raise vehicle off the ground so drive wheels spin freely. On some vehicles, it is necessary to disable the Traction and/or Stability control system. This can be done by either deactivating through the vehicle's instrument panel or by disconnecting a wheel speed sensor.

3. Gain access to length of driveshaft to be balanced.

4. Determine direction driveshaft turns to move vehicle forward. Use marker to draw an arrow on driveshaft in direction of that rotation.

5. Check for and remove debris wedged between tire treads on drive wheels.

6. Attach accelerometer to bottom rear edge of transmission case (or center support if balancing rear shaft of 2 piece driveshaft). Ensure accelerometer does not rock on base. See the following drawings for details.

NOTE: If necessary epoxy a flat, steel washer at location attempting to mount accelerometer. Washer provides smooth flat surface for accelerometer magnet.

7. Connect accelerometer cable to one of the Channel inputs on VCMM.

8. Attach a strip of reflective tape with the long edge lengthwise along the length of the driveshaft in view of the unobstructed Photo-Tach beam.

9. Connect Photo-Tach cable to the Photo-Tach sensor and then to one of the Channel inputs on VCMM.

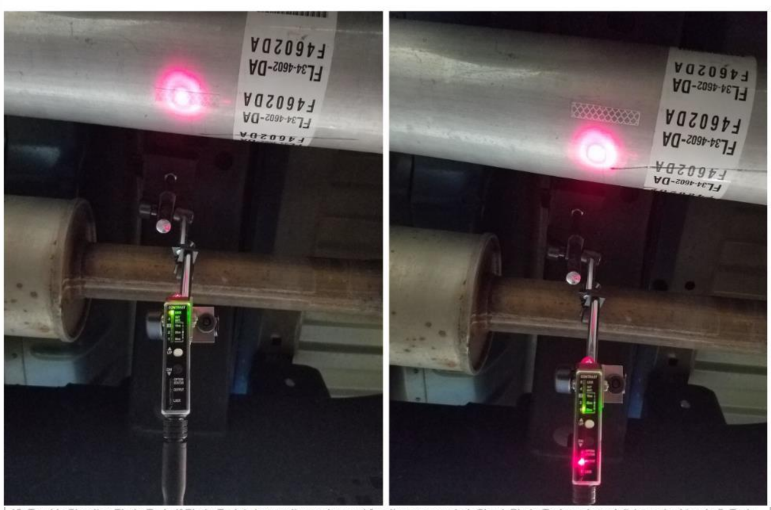
10. Position the Photo-Tach sensor 6 to 10 inches (15 to 25 millimeters) from the driveshaft using the magnetic base supplied in the kit. Aim the Photo-Tach beam to view the driveshaft and reflective tape at a 10-30 deg angle.

IMPORTANT NOTE: Accelerometers and Photo-Tach MUST remain in the same location for the entire test procedure. Changes in the position of these components will cause erroneous results.

11. Setting the Photo-Tach: It is critical to set the Photo-Tach to the contrast between the driveshaft surface and reflective tape.

* **Steel or Painted Driveshafts.** With the Photo-Tach beam OFF of the reflective tape, press and hold the BLACK DN button on the Photo-Tach until the Contrast LEDs cycle and release.
* **Aluminum Driveshafts.** With the Photo-Tach beam ON the reflective tape, press and hold the WHITE UP button on the Photo-Tach until the Contrast LEDs cycle and release.

12. Verify Photo-Tach Operation: Move the reflective tape into view to test the setup by rotating driveshaft. Rotate the shaft to pass the reflective tape through Photo-Tach beam. The green contrast LED indicators on the Photo-Tach should move through the entire contrast scale. If the LEDs on the contrast scale are less than 5 bars of deviation, then adjust the beam angle and retest.



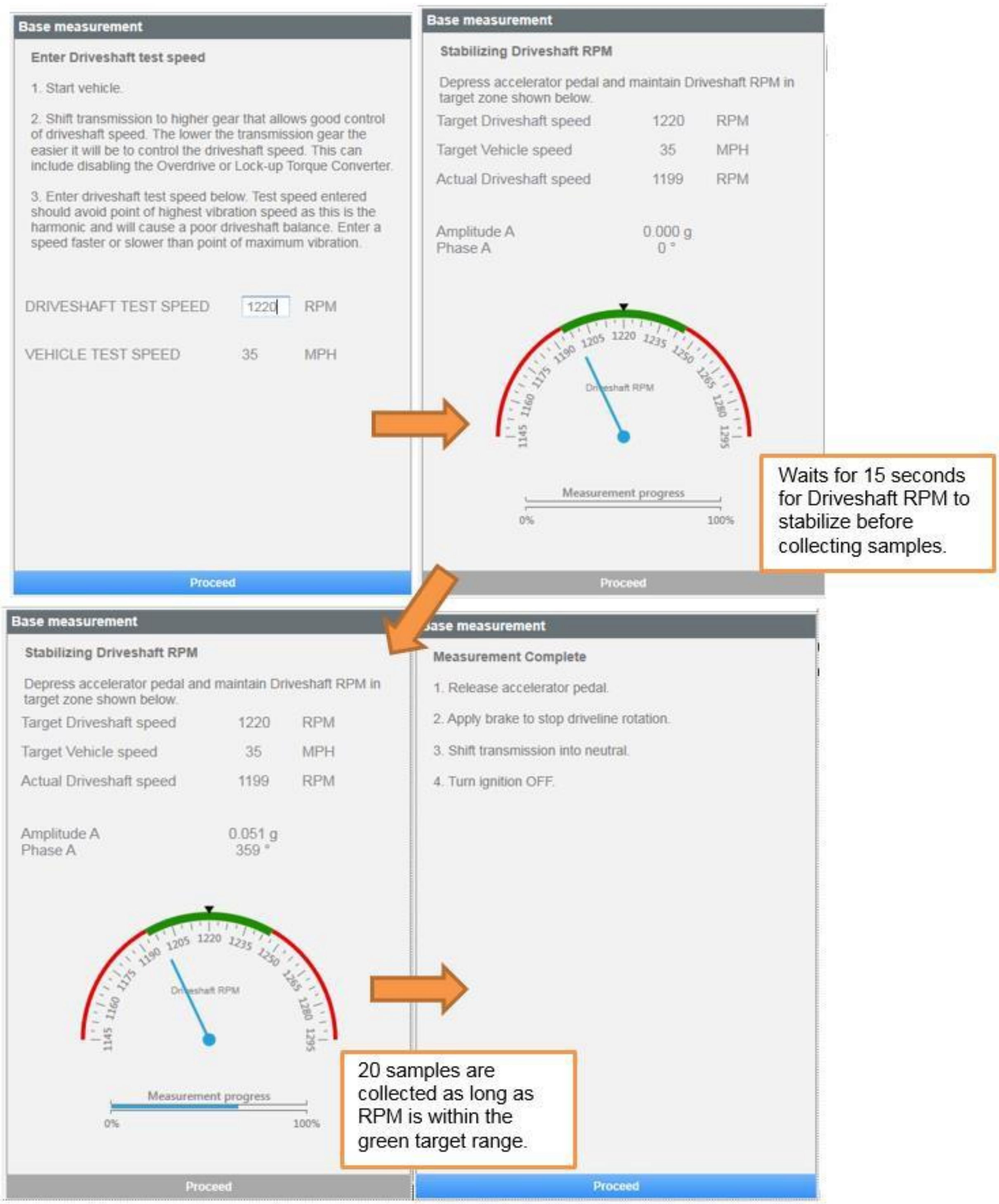
13. Trouble Shooting Photo-Tach: If Photo-Tach is inoperative or does not function as expected. Check Photo-Tach angle and distance to driveshaft. Tach should not be installed perfectly perpendicular to driveshaft surface. Aluminum driveshaft reflectivity my cause abnormal response. Having Photo-Tach at slight angle will reduce aluminum shaft glare.

For additional Photo-tach support and information, click the link to the Mark Eye® Pro tm instruction manual. (http://www.ttco.com/userfiles/files/070-0156_MarkEye-Pro-Instructions.pdf)

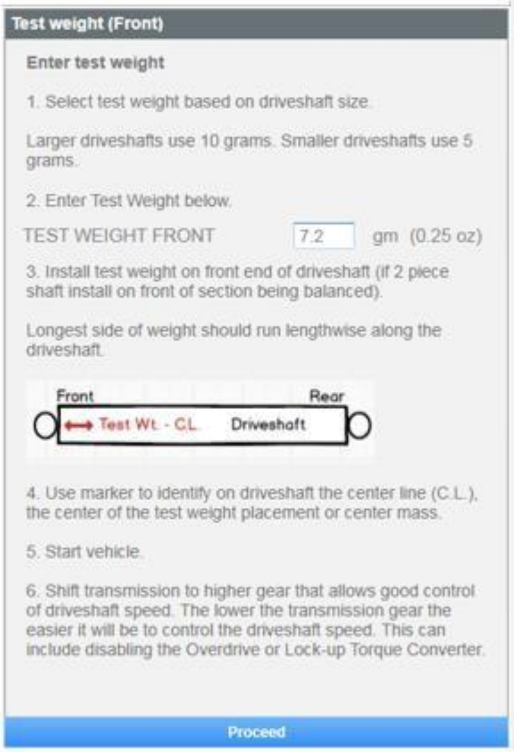
14. Ensure all cables are routed to avoid contact with moving parts and exhaust.

Proceed

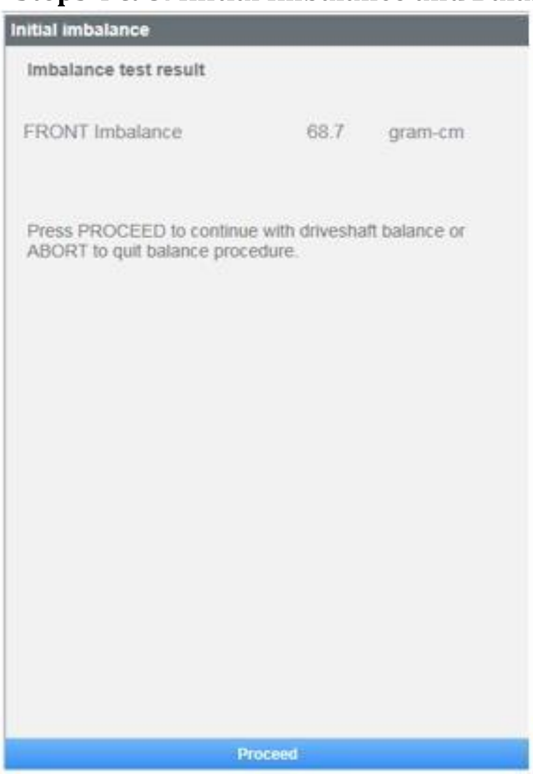
10.6.2 Step 2: Base Measurement

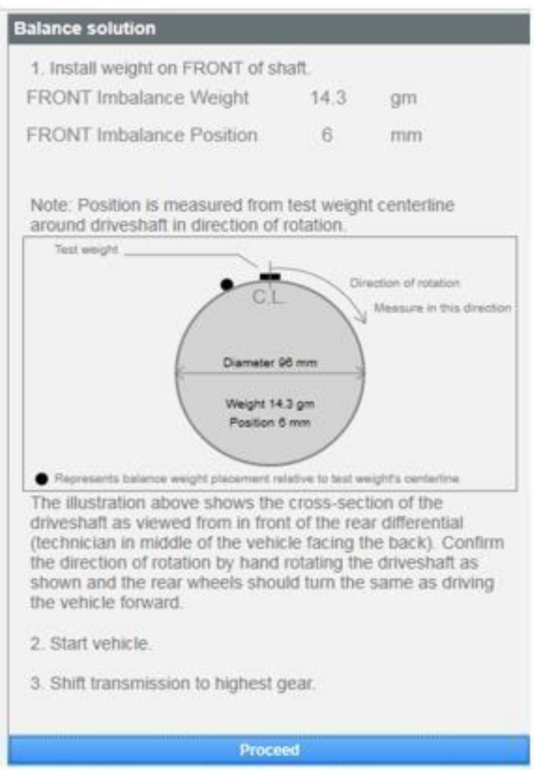


10.6.3 Step 3: Test Weight Measurement



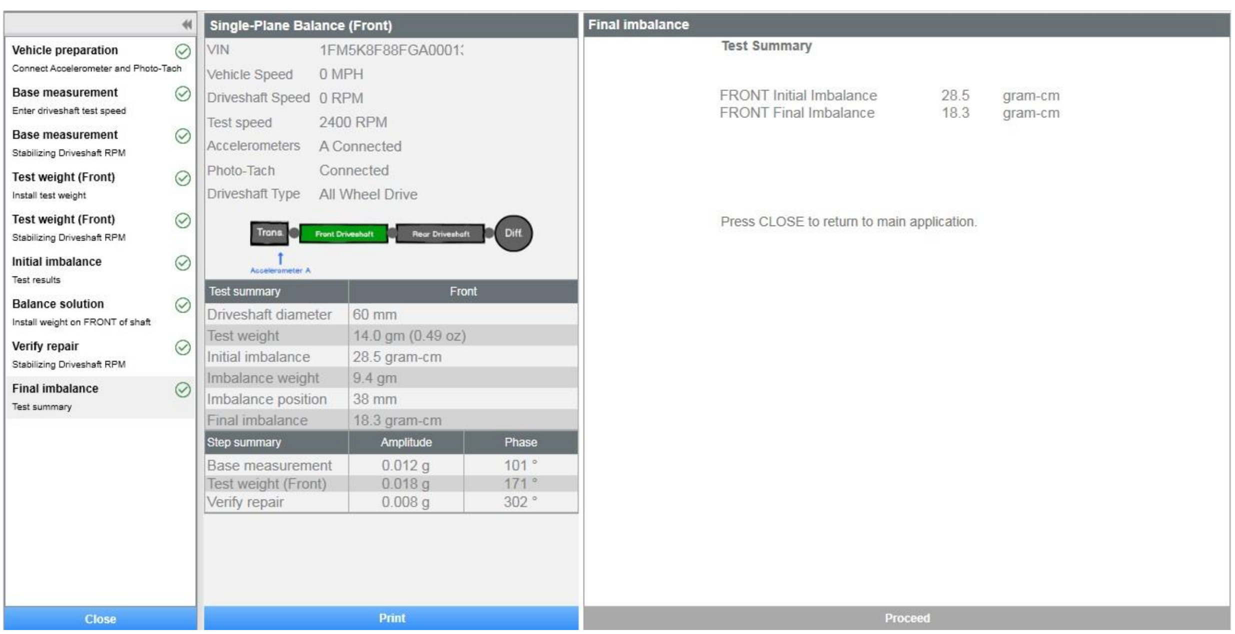
10.6.4 Steps 4 & 5: Initial Imbalance and Balance Solution





10.6.5 Step 6: Verify Repair

10.6.6 Final Test Summary



10.7 DUAL PLANE DRIVESHAFT BALANCE

10.7.1 Step 1: Vehicle Preparation

Vehicle preparation

1. Prevent vehicle from rolling. With engine OFF, place vehicle in neutral and release parking brake.

2. Securely raise vehicle off the ground so drive wheels spin freely. On some vehicles, it is necessary to disable the Traction and/or Stability control system. This can be done by either deactivating through the vehicle's instrument panel or by disconnecting a wheel speed sensor.

3. Gain access to length of driveshaft to be balanced.

4. Determine direction driveshaft turns to move vehicle forward. Use marker to draw an arrow on driveshaft in direction of that rotation.

5. Check for and remove debris wedged between tire treads on drive wheels.

6. Attach accelerometer to bottom rear edge of transmission case (or center support if balancing rear shaft of 2 piece driveshaft). Ensure accelerometer does not rock on base. See the following drawings for details.

NOTE: If necessary epoxy a flat, steel washer at location attempting to mount accelerometer. Washer provides smooth flat surface for accelerometer magnet.

7. Connect accelerometer cable to one of the Channel inputs on VCMM.

8. Attach a strip of reflective tape with the long edge lengthwise along the length of the driveshaft in view of the unobstructed Photo-Tach beam.

9. Connect Photo-Tach cable to the Photo-Tach sensor and then to one of the Channel inputs on VCMM.

10. Position the Photo-Tach sensor 6 to 10 inches (15 to 25 millimeters) from the driveshaft using the magnetic base supplied in the kit. Aim the Photo-Tach beam to view the driveshaft and reflective tape at a 10-30 deg angle.

IMPORTANT NOTE: Accelerometers and Photo-Tach MUST remain in the same location for the entire test procedure. Changes in the position of these components will cause erroneous results.

11. Setting the Photo-Tach: It is critical to set the Photo-Tach to the contrast between the driveshaft surface and reflective tape.

* **Steel or Painted Driveshafts.** With the Photo-Tach beam OFF of the reflective tape, press and hold the BLACK DN button on the Photo-Tach until the Contrast LEDs cycle and release.
* **Aluminum Driveshafts.** With the Photo-Tach beam ON the reflective tape, press and hold the WHITE UP button on the Photo-Tach until the Contrast LEDs cycle and release.

12. Verify Photo-Tach Operation: Move the reflective tape into view to test the setup by rotating driveshaft. Rotate the shaft to pass the reflective tape through Photo-Tach beam. The green contrast LED indicators on the Photo-Tach should move through the entire contrast scale. If the LEDs on the contrast scale are less than 5 bars of deviation, then adjust the beam angle and retest.

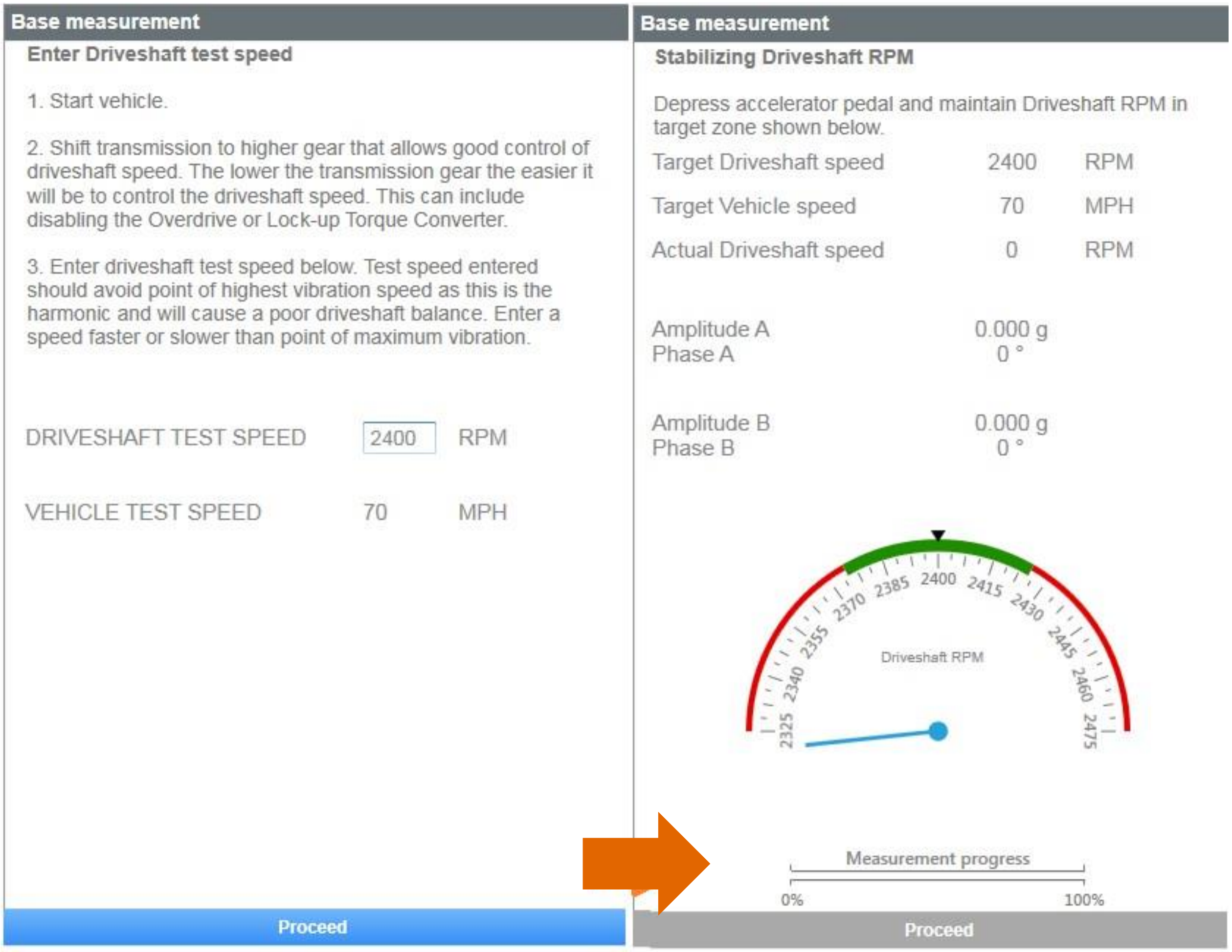
13. Trouble Shooting Photo-Tach: If Photo-Tach is inoperative or does not function as expected. Check Photo-Tach angle and distance to driveshaft. Tach should not be installed perfectly perpendicular to driveshaft surface. Aluminum driveshaft reflectivity my cause abnormal response. Having Photo-Tach at slight angle will reduce aluminum shaft glare.

For additional Photo-tach support and information, click the link to the Mark Eye® Pro tm instruction manual. (http://www.ttco.com/userfiles/files/070-0156_MarkEye-Pro-Instructions.pdf)

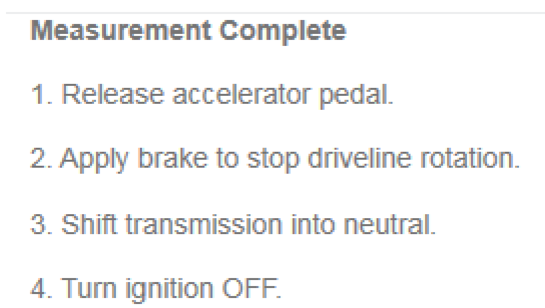
14. Ensure all cables are routed to avoid contact with moving parts and exhaust.

Proceed

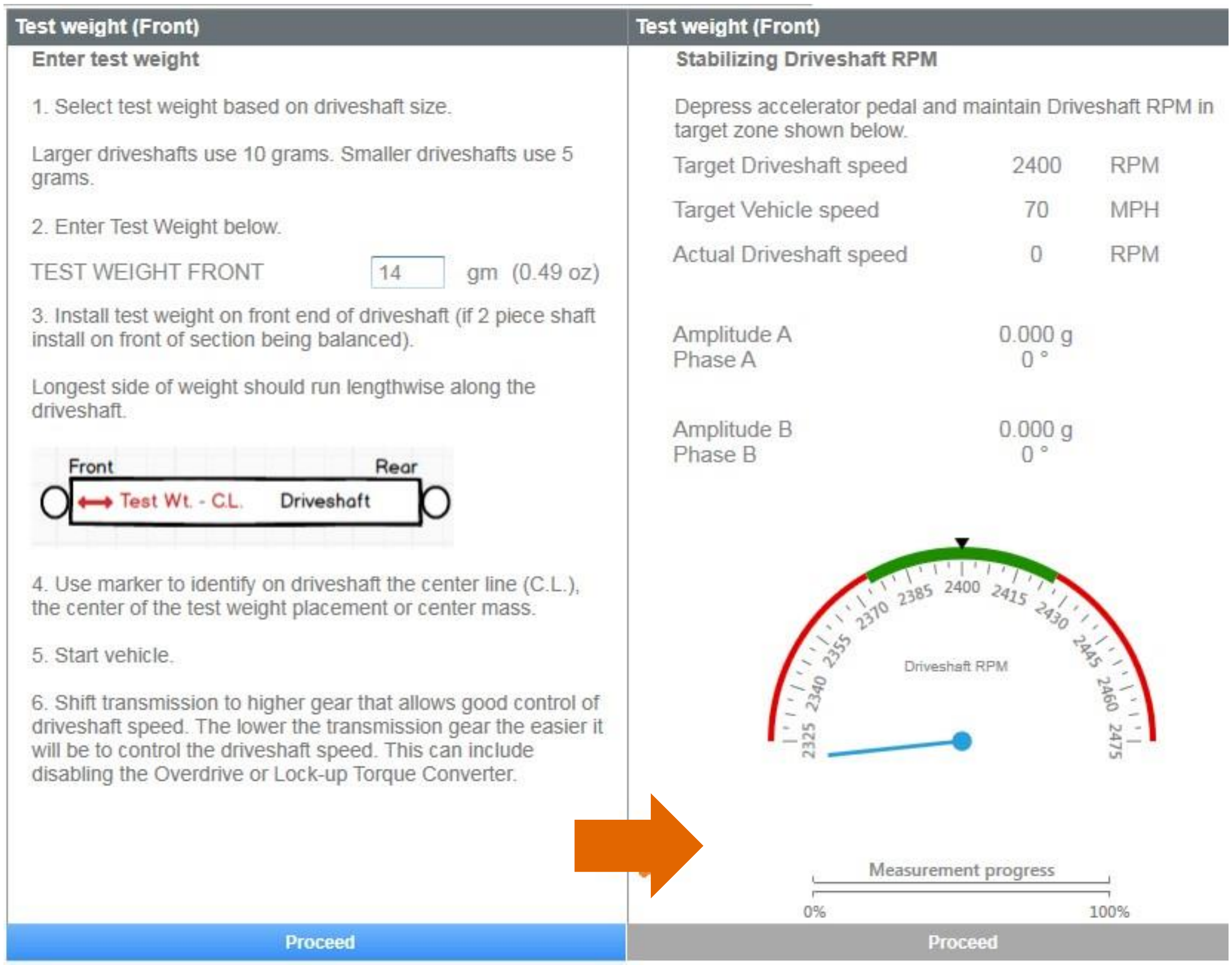
10.7.2 Step 2: Base Measurement



Once Base Measurement is complete, follow these instructions and click Proceed.



10.7.3 Step 3: Test Weight Measurement (Front)

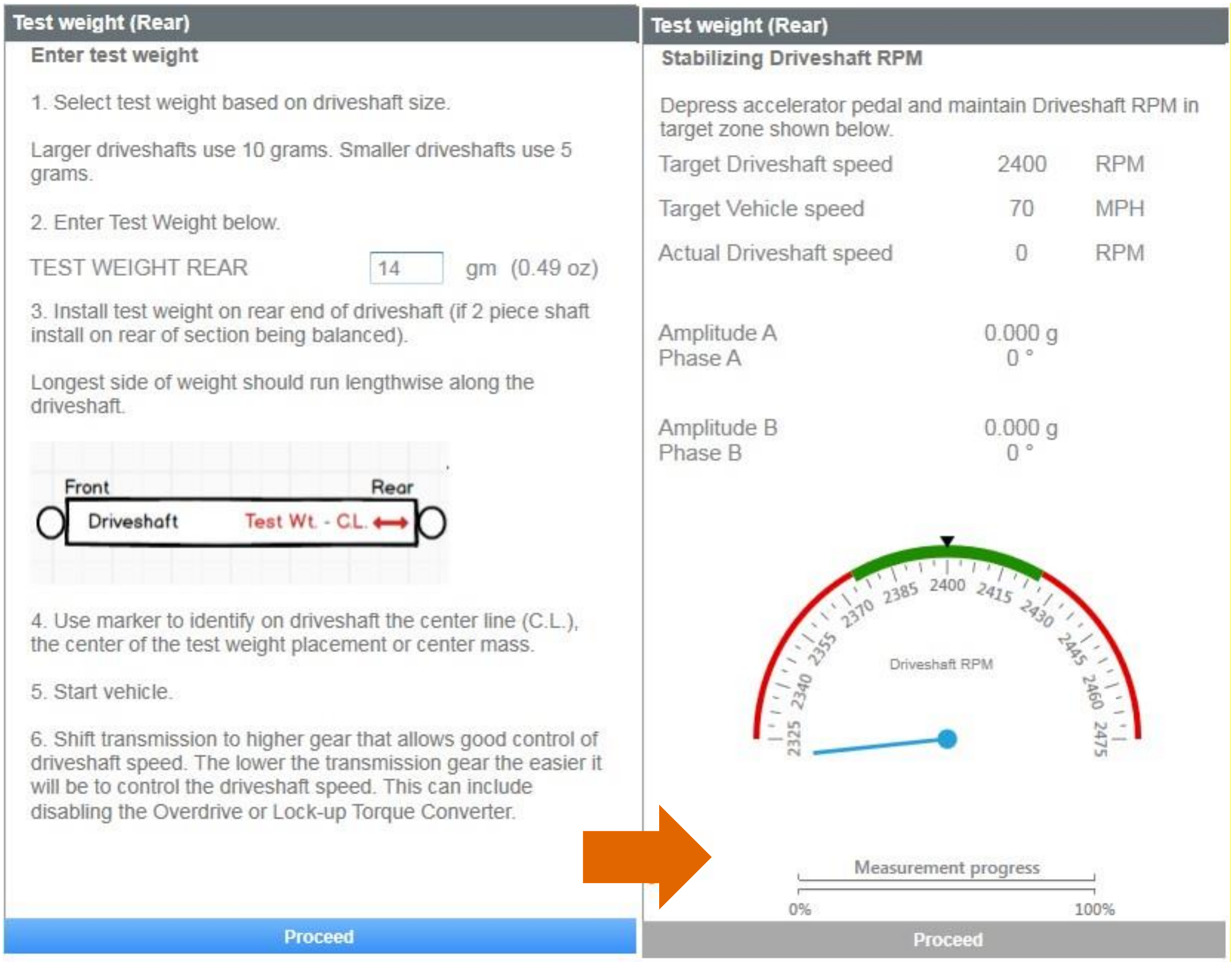


Once Test Weight (Front) measurement is complete, follow these instructions and click Proceed.

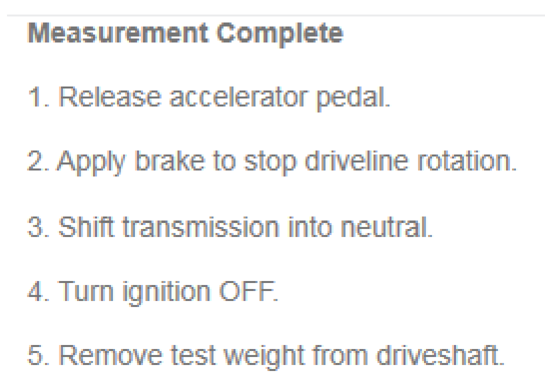
Measurement Complete

1. Release accelerator pedal.
2. Apply brake to stop driveline rotation.
3. Shift transmission into neutral.
4. Turn ignition OFF.
5. Remove test weight from driveshaft.

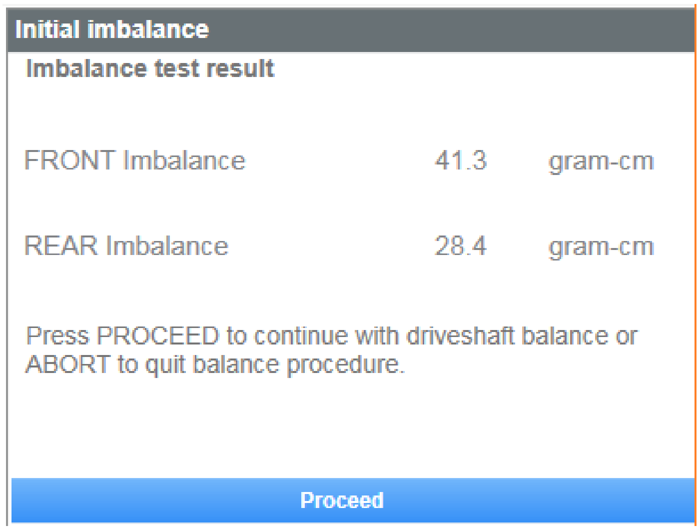
10.7.4 Step 4: Test Weight Measurement (Rear)



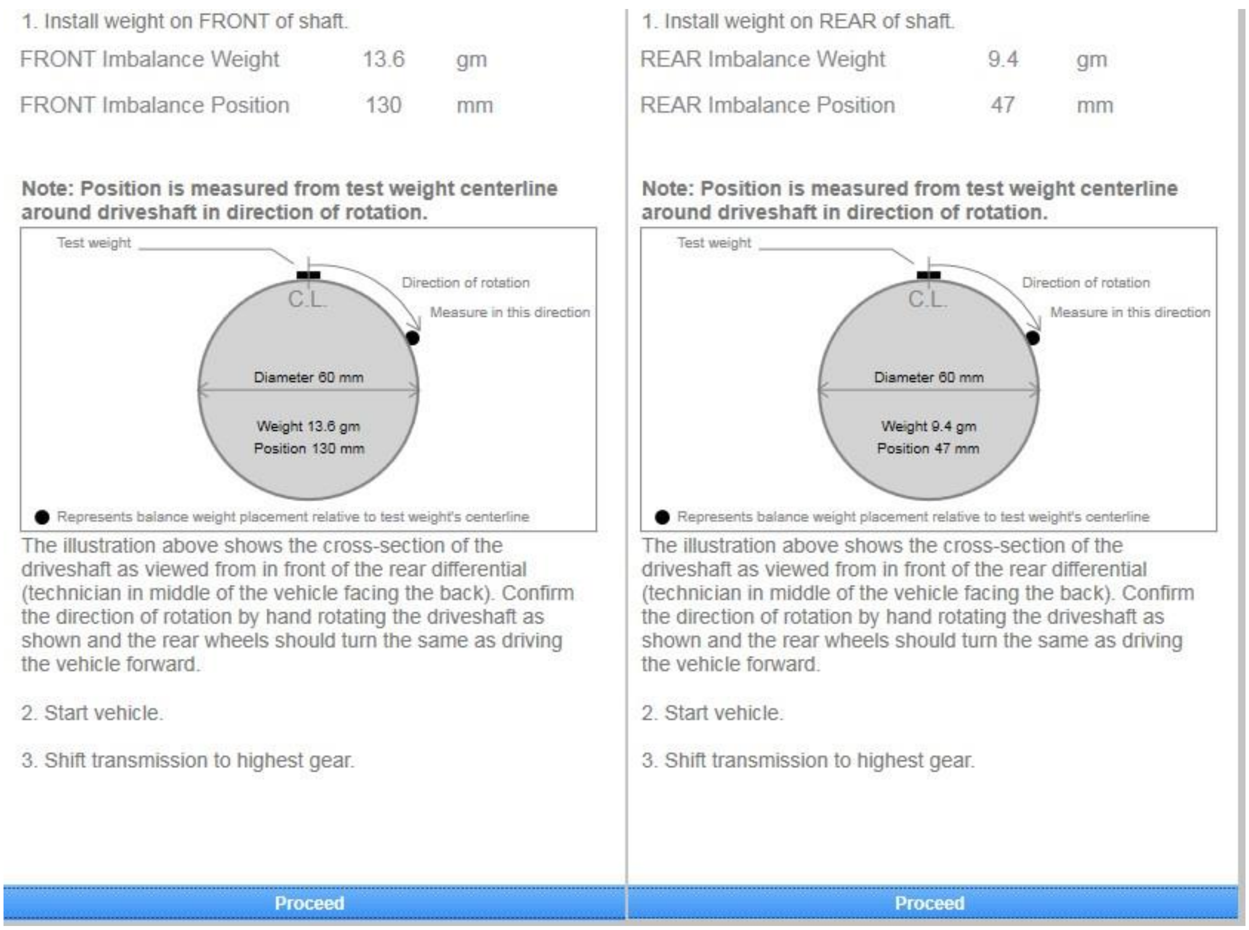
Once Test Weight (Rear) measurement is complete, follow these instructions and click Proceed.



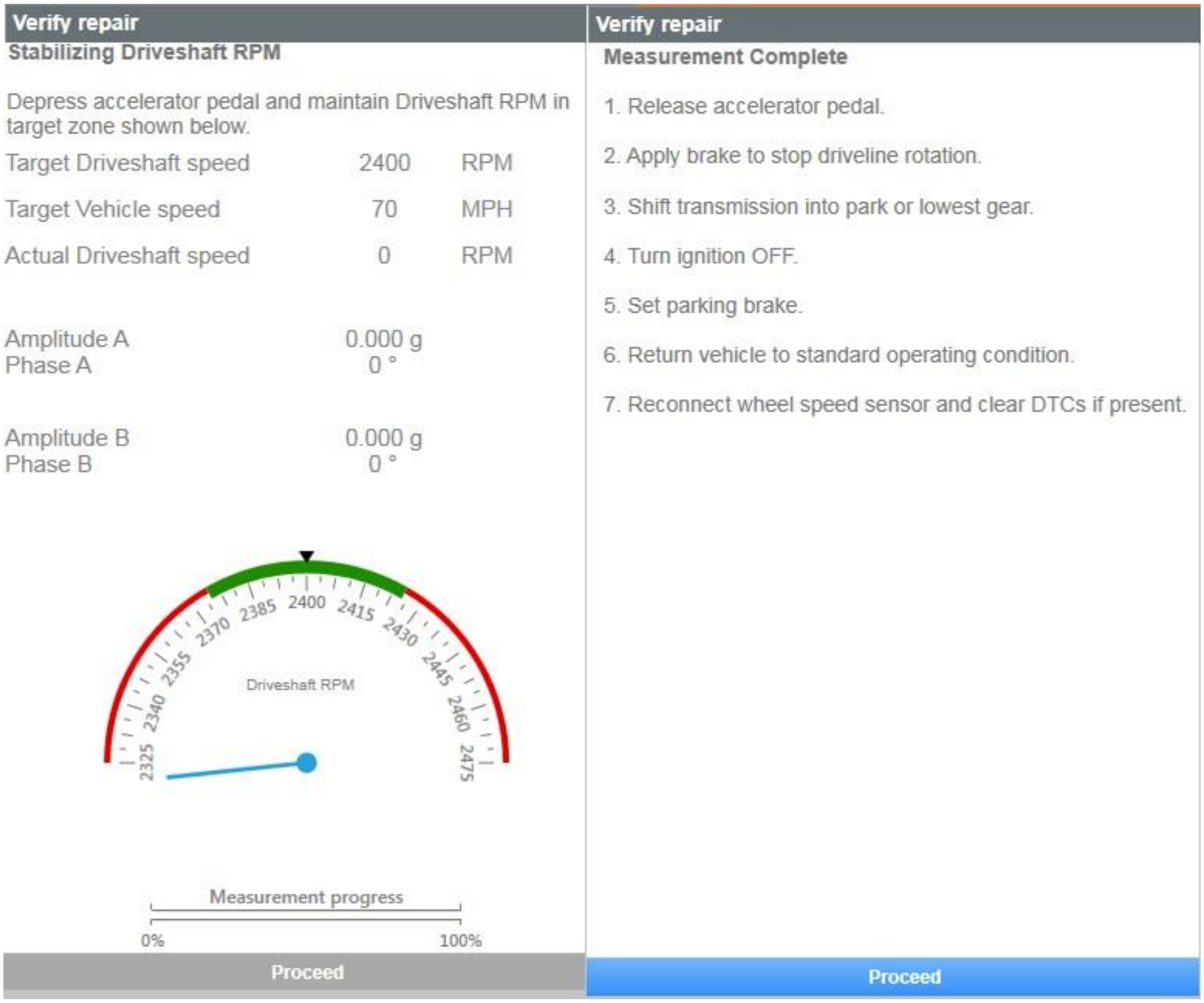
10.7.5 Step 5: Initial Imbalance & Install solutions (Front and Rear)



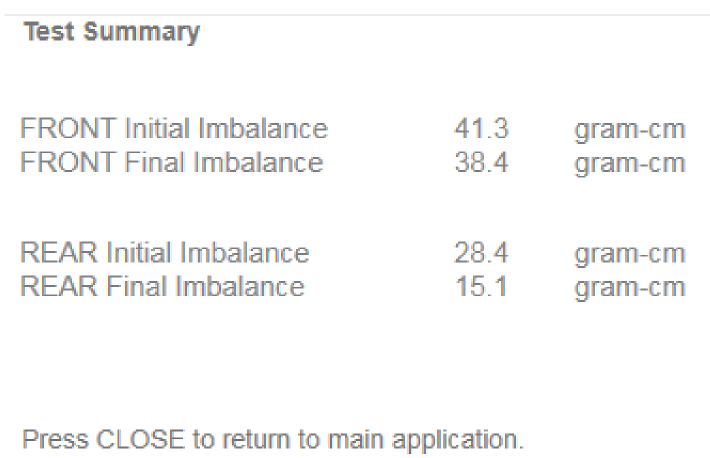
Click Proceed and follow the install instructions in the next two screens for BOTH Front and Rear:



10.7.6 Step 6: Verify Repair



10.7.7 Step 7: Test Summary



10.8 DUAL HOSE CLAMP BALANCE

The 'Dual Hose Clamp Balance' method uses standard stainless steel hose clamps. The screw of the hose clamps provides the counterweight for the imbalanced driveshaft. The most common, and generally recommended, place to perform the balancing is at the rear differential.

Vehicle Preparation and Base Measurement steps are similar to Single-Plane Balance procedure.

Installation of a 'Test Weight' is next. In this procedure, the test weight in simply one stainless steel hose clamp. It is installed near the end of the driveshaft, near the accelerometer.

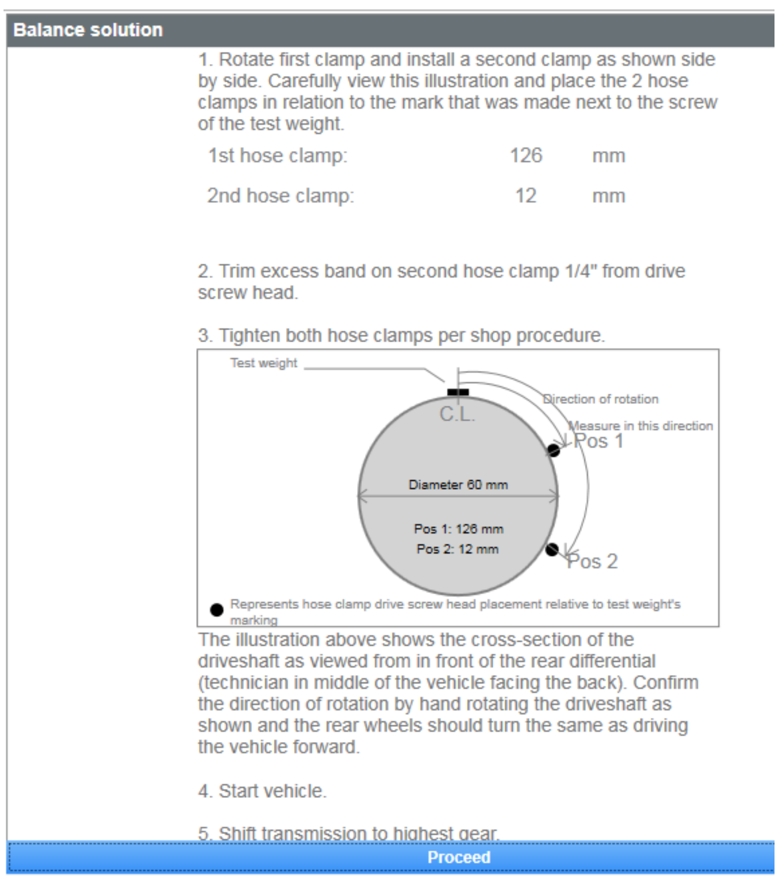
If the driveshaft is tapered, use the narrower portion, usually near the U-joint.

The hose clamp can be installed in any position relative to the reflective tape; it won't matter to the balance process.

Put a mark on the driveshaft indicating the center of the screw on the test weight hose clamp. You will need to measure from this point later in the procedure.

In the "Initial Imbalance" phase, the balance procedure displays the amount, in grams-cm, of the driveline's imbalance. If the initial imbalance is less than 7.0 grams-cm, there probably is no need to continue the driveshaft balance procedure, as this is a very small amount of imbalance.

Carefully view this next screen as it will show the precise placement of the two hose clamps in relation to the mark that was made next to the screw of the test weight.

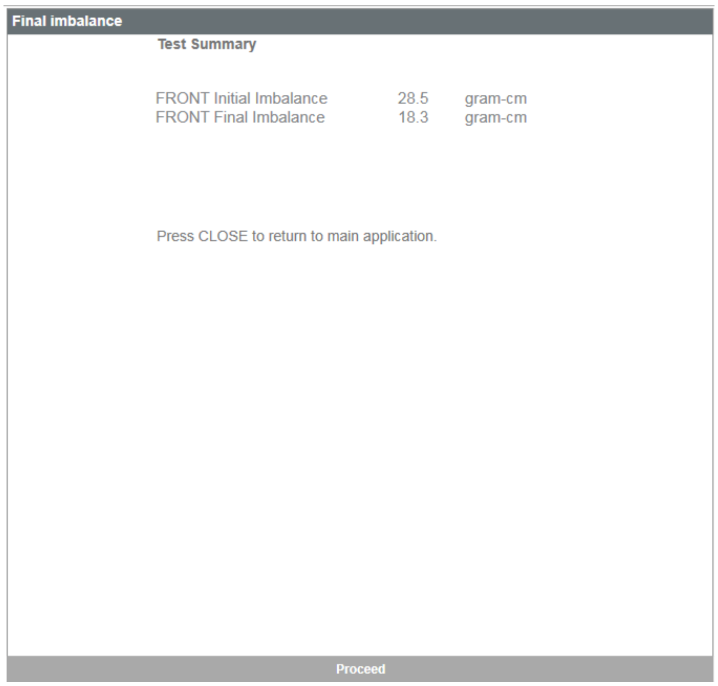


In the direction of rotation, measure and mark the two locations (distances) from the mark by the test weight clamp. These two marks will be where the two hose clamp screws will be located.

First loosen and rotate the test weight clamp to one of the new marks, and install the second hose clamp on the second mark. Remove any extra clamp band, if more than ¼" inches is protruding.

On the following screens, you will spin the driveline a third and final time to verify the effectiveness of the balance.

The final screen shows the "before" and "after" of the driveline balancing. There will always be some amount of imbalance indicated - the goal is to minimize it.



11 HARDCOPY PRINT

Hardcopy print is supported in the Scope, Meter, Signal Generator, Vibration Analyzer, Driveshaft Balance, and Battery Health. For the Scope and Meter tools, both the live and playback views can be printed.

11.1 PRINT CONTENT

11.1.1 View Content

The portion of the view that is printed includes the line plots and value text fields. The Configuration Pane, Control Pane, and other non-data elements are excluded.

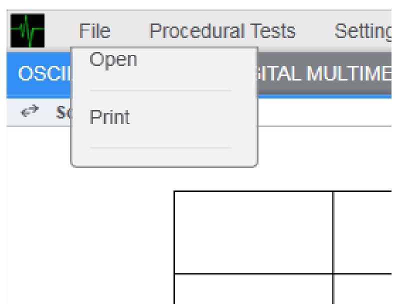
11.1.2 Standard Header

Each hardcopy image will contain standard text at the top of the image. The header contains the VIN, vehicle description, and date/time when printed.

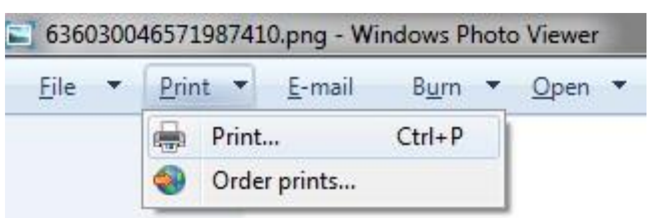
11.2 PRINT STEPS

VMS makes use of Windows Photo Viewer to support the print feature. When a view is printed, Photo Viewer is opened, and an image of the view is loaded into Photo Viewer. At that point, the user can use any of the Photo Viewer options to print, copy, email, etc the image.

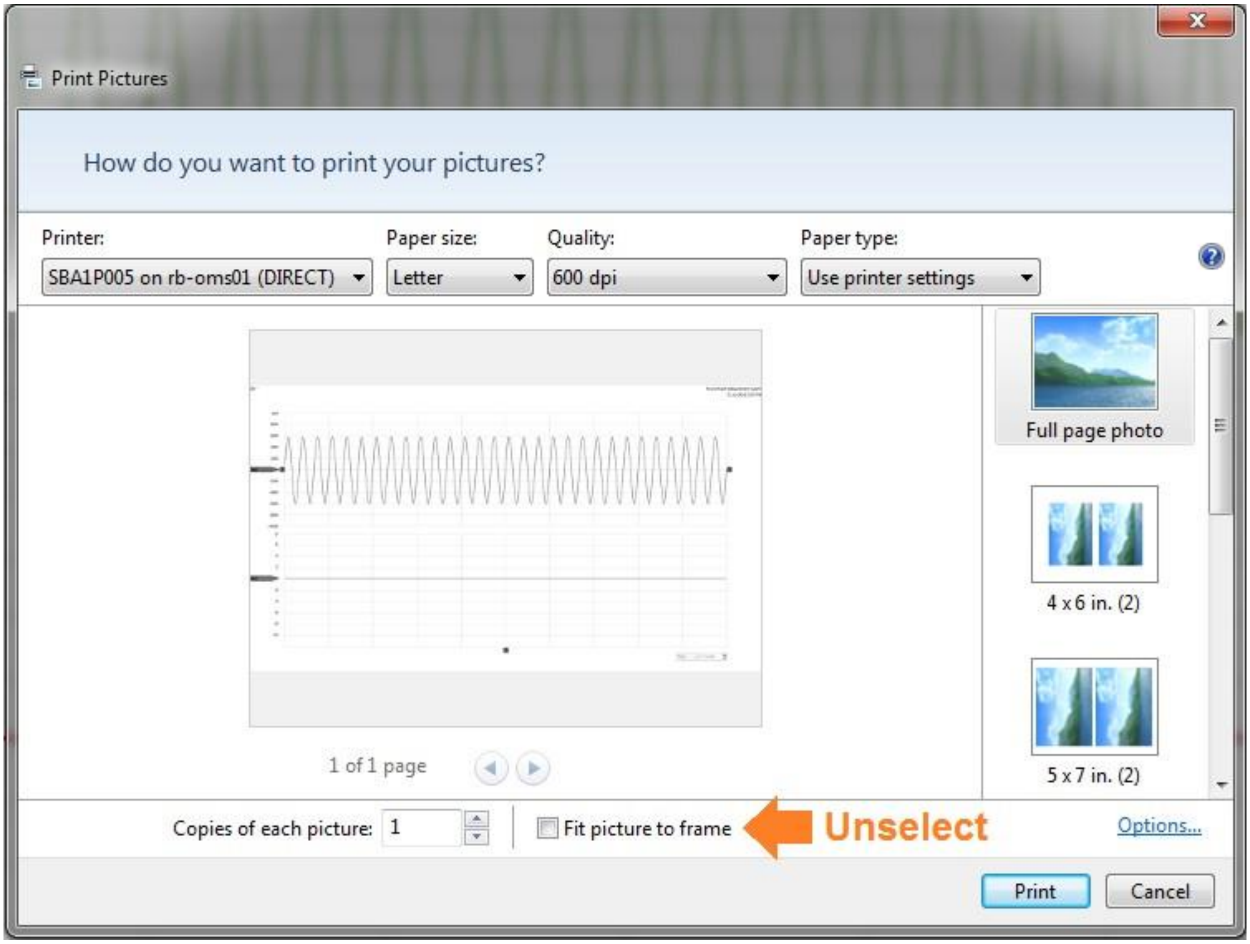
- In VMS, select the menu item File/Print.



- An image of the view is opened in Photo Viewer.
- In Photo Viewer, select the Print menu item.



- The print dialog is displayed.
- Unselect the “Fit picture to frame” option.

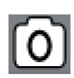


- Select printer and other options.
- Click “Print”.

Note that if you have an application other than Windows Photo Viewer selected in Windows as your default image viewing application, your preferred application will be launched instead of Photo Viewer.

12 COPY TO CLIPBOARD

Copy-to-Clipboard is supported in the Scope, Meter, Signal Generator, Vibration Analyzer, Driveshaft Balance, and Battery Health. For the Scope and Meter tools, this feature is available for both the live and playback views.

- Click the copy-to-clipboard button in the Control Bar: 
- Switch to the target application, and do a paste.

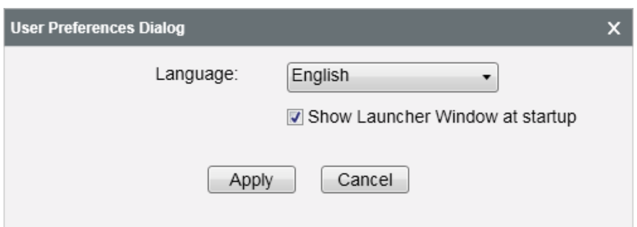
13 LANGUAGE SUPPORT

The following languages are supported in VMS.

Arabic	Finnish	Italian	Russian
Czech	French	Korean	Spanish (Mexico)
Chinese (Simplified)	French (Canada)	Norwegian	Spanish (Spain)
Chinese (Traditional)	German	Polish	Swedish
Danish	Greek	Portuguese (Brazil)	Turkish
Dutch	Hebrew	Portuguese (Portugal)	Thai
English	Hungarian	Romanian	Vietnamese

The active language can be changed at any time. Select the menu item “Settings/User Preferences”.

The User Preferences Dialog is displayed. Choose the target language from the Language combo box, and click “Apply”.



14 TROUBLESHOOTING COMMON PROBLEMS

14.1 VCMM Disconnect

If the VMS loses communication with the VCMM,, the VMS application process may not terminate, leaving an orphan process in the Windows task list.

The actions to take in this case are:

- Kill the VMS application process (VSM.exe) using Windows Task Manager.
- Reboot the VCMM by disconnecting all power (USB and external).
- Reconnect external power and the USB cable to the PC.
- Ensure external power is on for the VCMM.
- Connect probes to the VCMM channel ports.
- Start the VMS Application.