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Title: Determine Wheel Speed or Driveline Vibration using a Smart Phone and Free VibSensor Application

Applies To: All Chassis

CHANGE LOG

Please refer to the change log text box below for recent changes to this article:

11/22/2017 - Added Wheel End Vibration Example and Updated Component Speed Calculator with 2nd Order
10/24/2017 - Initial Article Release

DESCRIPTION

The use of a Smart Phone (Android or iPhone) application to identify a Wheel Speed or Driveline Vibration.

SYMPTOM(s)

Noticeable chassis vibration that can be validated during a test drive at a specific speed or speed range.

SPECIAL TOOL(s) / SOFTWARE

Most modern Smart Phones have a built in 3 axis accelerometer that is capable of recording vehicle vibrations from 1 - 50Hz

VibSensor Smart Phone Application is availalbe for both Android (4.1 or later) and Apple iPhone (IOs 6.0 or later) (No Cost - Free)

Application	Android - Google Play	Apple - iPhone
VibSensor Now Instruments and Software, Inc.	Link to Google Play	Link to iTunes

Application Operation and Setup

WARNING:

Vehicle driver should follow all safe driving practices and laws . Do not operate your smart phone while driving. If needed utilize a second person to operate the phone as a passenger during the test drive.

Phone setup before test drive :

1. The phone with the installed application should lay flat on a hard flat surface in the cab of the truck .Either the Dash or Floor will work for most vibrations.
2. Always place the phone flat with the top of the phone facing forward (toward windshield) Figure 1 and Figure 2

Figure 1: Phone on Dashboard

Phone must be laying flat with the top of the phone facing forward (toward windshield)

Figure 2: Phone Stick Dash Pad

If the surface will not retain the phone during a test drive you should use a phone Sticky Dash Pad or other rubber mat as shown.

VibSensor application setup before test drive :

1. Open the VibSensor application . Figure 3
2. Test the phone and application on this screen by tapping the phone in all three directions and the X, Y and Z axis colored dots will change according to the velocity and direction of the tapping. Figure 3
   X Axis = Left and Right
   Y Axis = Forward and Backwards
   Z Axis = Up and Down
3. Tap on Acquire at the bottom of the Main Screen Figure 3
4. On the Acquire main screen tap the Title field and enter the VIN and details of the vibration such as speed that the vibration peaks. Figure 4
5. Leave both the Delay at 0:00 Minutes and the Duration at 01:00 Minutes Figure 4
6. The Start button at the bottom will start the recording . Only record during the test drive and while the vibration is occurring. Figure 4

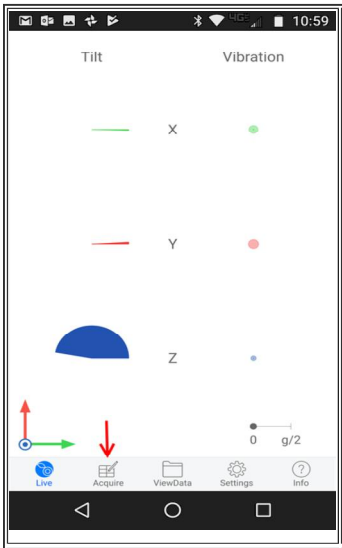


Figure 3: Main Screen

You can test the phone and application on this screen by tapping the phone in all three directions and the X, Y and Z axis colored dots will change according to the velocity and direction of the tapping.

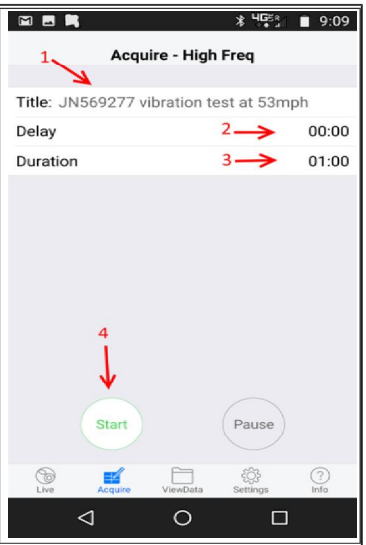


Figure 4: Acquire Screen

1. Tap the Title field and enter a valid name for this test
2. Delay - Leave this at Default of 0.00
3. Duration - Leave this at 1:00 minute
4. Click the Start Button to record during the vibration and test drive.

Using VibSensor application during a test drive :

1. Test drive the vehicle on a flat smooth road if possible.
2. Verify that the vibration can be felt . Document the speed that the vibration begins, peaks and possibly ends .
3. Example would be a vibration that begins at 45MPH and peaks at 52MPH and ends at 60MPH.
4. Drive the vehicle at a steady speed where the vibration peaks and have a passenger tap the Start button #4 on the VibSensor Acquire Screen . Figure 5.
5. Continue driving at this steady speed until the 1.00 minute timer stops the recording .
6. The test file will automatically save when the recording stops .
7. You can take multiple recordings by following the same steps above.

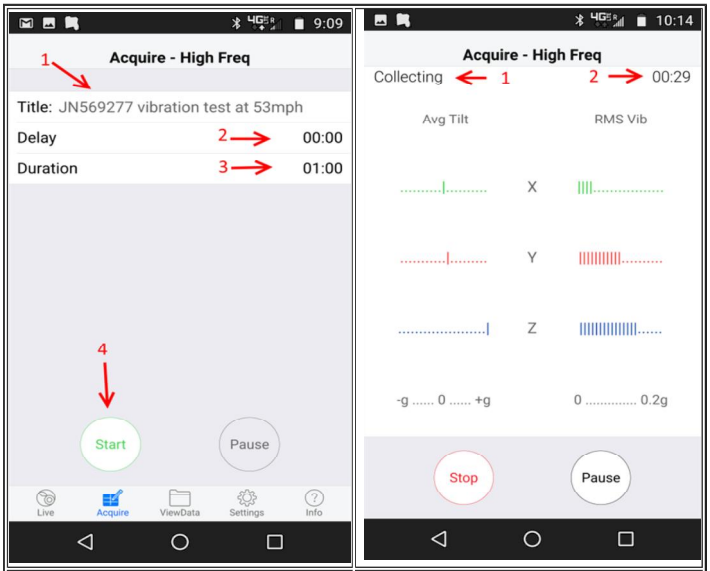


Figure 5: Acquire Screen

4. Tap Start to begin recording

Figure 6: Acquire Recording

1. Mode - Collecting
2. Recording time

Reviewing the data recorded using VibSensor Application :

1. Tap the ViewData button at the bottom of the screen. Figure 7
2. The recordings are grouped by Date. Figure 7 Tap the date to expand.
3. Recordings on this screen are listed by time of day. Tap the recording to open. Figure 8

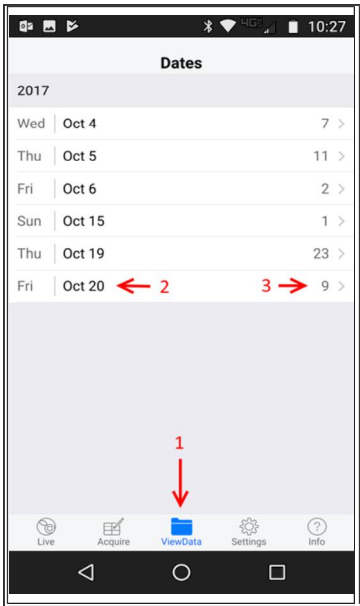


Figure 7:View Data Screen / Date

1.Tap View Data Button
2. Grouped recording by date .
3. Number of recordings on this date. Tap to expand

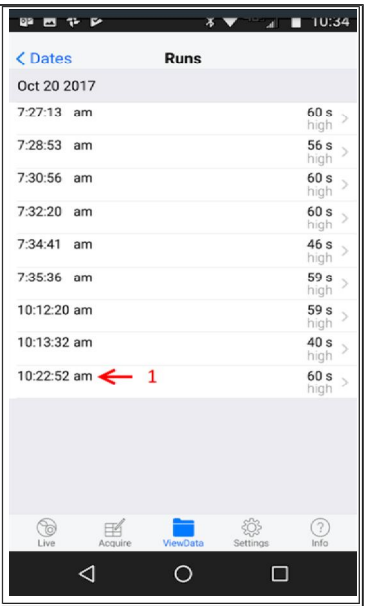


Figure 8: View Data Screen / Time

1. Tap Time to analyze recording

Analyzing the data recorded using VibSensor Application :

1. As shown below there are several examples of recorded vibrations.
2. The Resonances section will be used to compare the dominant Vibration in Hz against the Component Speed Calculator below this section.
3. 1st Sample below Figure 9 has the 3 Axis Resonances (vibrations)
4. The first number in the Axis is the primary most dominant (power density) vibration for that specific axis
5. The number in the ( ) is the calculated power density (A numeric scale of the amount of power or vibration magnitude . The higher the number the greater the vibration magnitude)
6. The second number is the second most dominant (power density) vibration for that specific axis . We will **not** use the second number for comparison.
7. Find the highest power density (magnitude) number and axis and compare this reading in Hz to the Component Speed Calculator below this section.

Reading from Example below : Z Axis has the dominant vibration of 28 Hz power density of (12).
X: 0.19 Hz (1.7), 28 Hz (1.2)
Y: 28 Hz (2.3), 7.6 Hz (0.16)
Z: 28 Hz (12), 46 Hz(0.57)

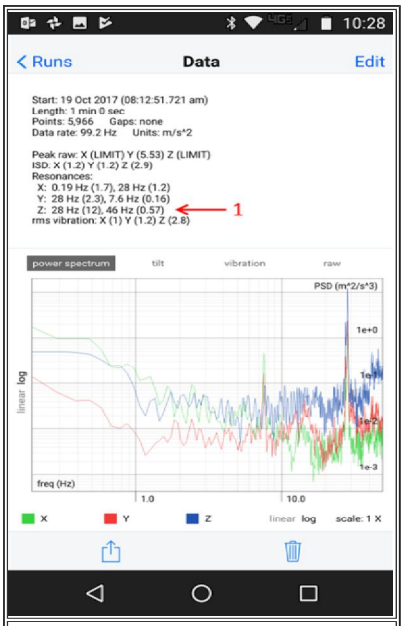


Figure #9: Example Data Analyzed

1: Z Axis has the dominent vibration of 28 Hz power density of (12).

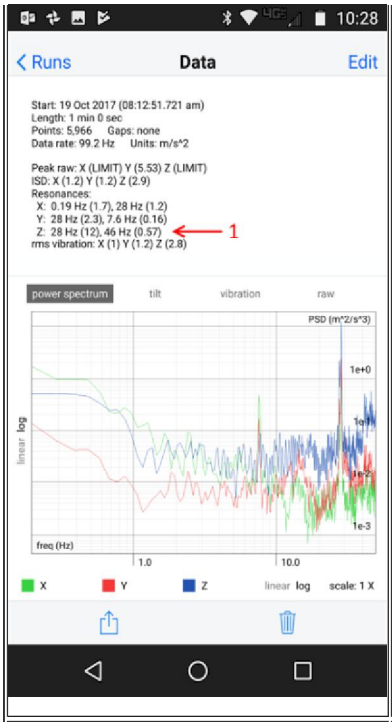
Comparing vibration recorded values with the Component Speed Calculator.

1st Order Vibrations:

1. First (1st) order vibration is a vibration of a spinning component with One shake per revolution of the component .
2. Second(2nd) order vibration is a vibration of a spinning component with Two shakes per revolution of the component .

Order	Component	Description /Possible Solutions	Speed/ Frequency
1st	Driveline (Prop shafts)	One shake per revolution of a component turning the speed of the prop shafts. Check for out-of-round or out-balance drive shafts, worn u-joints or flanges, loose output and input flanges and shafts.	50 - 65 MPH 26- 31 Hz
1st	Wheel End (Tires)	One shake per revolution of the tire/wheel assembly. Check for out-of-round tires and rims or out-of-balance tires, rims, brake drums or hubs.	50 - 65 MPH 6 - 9 Hz
2nd	Driveline (Prop shafts)	Two shakes per revolution of a component turning the speed of the prop shafts. Check for correct U-joint working angles and worn u-joints	50 - 65 MPH 52-62Hz
2nd	Wheel End (Tires)	Two shakes per revolution of the tire/wheel assembly. Check for out-of-round tires and rims or out-of-balance tires, rims, brake drums or hubs.	50 - 65 MPH 12 - 18 Hz

Examples:



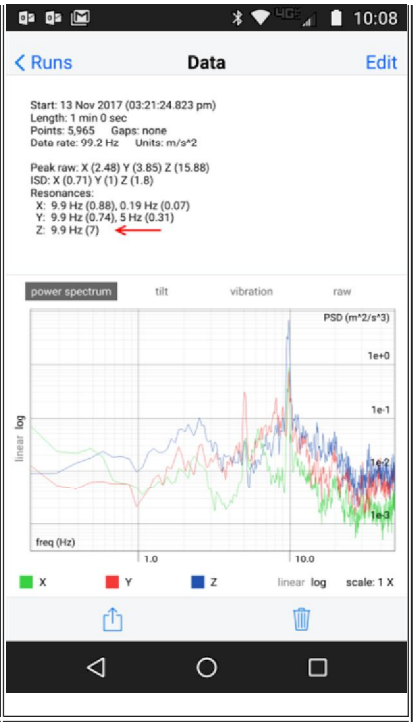


Figure #10: Example 1 Data Analyzed	Figure #11: Example 2 Data Analyzed
1: Z Axis has the dominent vibration of 28 Hz power density of (12).	1: Z Axis has the dominent vibration of 9.9 Hz power density of (7).

Example 1 Analysis:

1. Using the recording in Example 1 - Figure 10 there is a dominant vibration at 28Hz on the Z Axis with a Power Density of (12) .
2. This vibration peaked at 54 MPH during the road test.
3. Enter the following in the Calculator below

Min Vehicle Speed MPH = 50
Max Vehicle Speed MPH = 60
Rear Axle Ratio = 3.70
Rear Tire Revs/Mile = 502

1. Compare the Recorded Dominant Vibration of 28 Hz to the Driveline1st Order column .
2. Look for the matching vehicle speed and vibration in Hz.
3. At 54 MPH the calculated Driveline 1st Order is at 27.86Hz which matches (+ or - 0.5 Hz) the recorded value of 28Hz .
4. This is the source of this 1st order Driveline Vibration. Driveline Balance or Runout is the most probable cause.

Example 2 Analysis:

1. Using the recording in Example 2 - Figure 11 there is a dominant vibration at 9.9Hz on the Z Axis with a Power Density of (7) .
2. This vibration peaked at 68 MPH during the road test .
3. Enter the following in the Calculator below

Min Vehicle Speed MPH = 60
Max Vehicle Speed MPH = 70
Rear Axle Ratio = 3.08
Rear Tire Revs/Mile = 518

1. Look for the matching vehicle speed and vibration in Hz.
2. At 68 MPH the calculated Wheel End 1st Order is at 9.78Hz which matches (+ or - 0.5 Hz) the recorded value of 9.9Hz .
3. This is the Source of this 1st order Wheel End /Tire Vibration. Wheel End/ Tire Balance or Runout is the most probable cause.

Tire/Wheel end and Driveline Component Speed Calculator

1. Obtain the vehicle Rear Axle Ratio from the Service Portal > Vehicle Information Page> Details. (Make sure to include a decimal point: example - 3.55)
2. Obtain the Rear Tire Revolutions per Mile (Revs/Mile) from the Sales Data Component book by tire model and size or use the calculator and chart in IK2600052
3. Enter the min/max vehicle speed in MPH of the recorded vehicle vibration, the rear axle ratio and the rear tire revs/mile.
4. Click the calculate button to display the Tire/Wheel End and Driveline 1st Order Speed in Hz. Yellow Columns or the 2nd Order in the Green Columns
5. Compare the Dominant Vibration from recorded vibration in Hz to the calculated component speed in Hz below to determine the component that is generating the vibration.

IK2600052 Title: Calculating Pulses Per Mile - includes online calculator
CT400 Sales Data Components Sales Data Tire Only Book

1st Order = One shake per one revolution of component.
2nd Order = Two shakes per one revolution of component.

Minimum Vehicle Speed	
Maximum Vehicle Speed	
Rear Axle Ratio	Use Decimal Point Example 2.93
Rear Tire Revs/Mile	

Calculate using MPH

	Tire /Wheel End			Driveline /Prop Shafts		
Vehicle Speed (MPH)	**Wheel End Speed (RPM)**	**Wheel End 1st Order (Hz)**	**Wheel End 2nd Order (Hz)**	**Driveline Speed (RPM)**	**Driveline 1st Order (Hz)**	**Driveline 2nd Order (Hz)**

WARRANTY INFORMATION

Warranty Claim Coding:
Refer to the Warranty Coding Manual for Group and Noun Codes.

Standard Repair Time(s):
Refer to the SRT Manual for Repair Times

OTHER RESOURCES

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