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| **Countries:** | AUSTRALIA, BAHAMAS, BOLIVIA, BELIZE, CANADA, CHILE, COLOMBIA, COSTA RICA, DOMINICAN REPUBLIC, ECUADOR, EL SALVADOR, TRINIDAD AND TOBAGO, UNITED STATES, URUGUAY, VENEZUELA, MEXICO, ARUBA, NICARAGUA, PERU, PUERTO RICO, Curaçao, GUATEMALA, GUYANA, HAITI, HONDURAS, JAMAICA, PANAMA, SOUTH AFRICA | **Document ID:** | IK0600020 |
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| **Viewed:** | 2087 | | |

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**Title: Determine Wheel Speed or Driveline Vibration using a Smart Phone or tablet and a vibration analysis app.**

**Applies To: All Chassis**

## CHANGE LOG

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

05/16/2018- Emphasized need to length of recording
03/05/2018- Added NVH App by Vibrate Software Inc. and some vibration terminology
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) or tablet to diagnose a vibration caused by wheel end or driveline

## Definitions:

- Hertz (Hz)- The number of time the frequency repeats itself in one second. By determining the speed of the vibration (hz) you can determine which component is generating the vibration. By knowing the speeds of the wheel ends and drive shaft you can match those frequencies to that of the vibration frequency

- Vibration Order- the number of times a waveform (a shake) repeats itself during one revolution of a component.
  - **Driveline** example: A driveline in a vehicle normally produces a 1st or 2nd order vibration (but the amplitude of the vibration is too low to be felt by the driver). The driveline 1st order vibration produces 1 pulse (or shake) per revolution. A 2nd order vibration produces 2 pulses (or shakes) per revolution of the shaft
  - **Tire** example: A tire with high runout in one spot will generate a 1st order vibration. If more than one tire has high runout then a 2nd order or 3rd order vibration can exist because the high spot contacts the road at different times.

- Amplitude- Also known as G-force. The higher the amplitude the harsher the vibration feels to the driver.

## SYMPTOM(s)

Abnormal vehicle vibration that can be validated during a test drive at a specific speed or speed range.

## SPECIAL TOOL(s) / SOFTWARE

Most modern Smart Phones & some tablets have a internal 3 axis accelerometer that is capable of recording vehicle vibrations from 1 - 50Hz

- "VibSensor" Smart Phone or Tablet Application is available for both Android ( 4.1 or later) and Apple iPhone ( IOs 6.0 or later) ( No Cost - Free) **INSTRUCTIONS START HERE**
- "NVH" App by Vibration Software Inc. is also available. This app requires the device have GPS (does not need cell service). Cost is $400.00 and is easy to use and very accurate. It has **several advantages** over the free "VibSensor" app. **INSTRUCTIONS START HERE**

## "Vibsensor" app instructions (free)

| Application | Android - Google Play | Apple - iPhone |
|---|---|---|
| VibSensor<br>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 or tablet while driving. Utilize a second person to operate the device during the test drive.**

**Phone / Tablet setup before test drive :**

1. The phone / tablet with the installed application should lay flat on a hard flat surface in the cab of the vehicle. Place device on the floor next to the seat (for most vibrations).
   - If you can feel the vibration but the vibration is not shown in the App recording then try placing the phone / tablet on the dash and repeating the test.
2. Always place the device flat with the top facing forward (toward windshield). Placing a bag of rice on top of the device will hold it steady during the road test. Figures 1-4


**Figure 1:**

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


**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.

**Figure 3: Device on the cab floor**

Device must be laying flat with the top of the facing forward (toward the hood)


**Figure 4: Device on the cab floor with bag of rice on top**

A bag of rice placed on top of the device will hold it tight to the floor.

**VibSensor application setup before test drive :**

1. Open the VibSensor application .
2. Test the device 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 5
   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 5
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 6
5. Leave both the Delay at 0:00 Minutes and the Duration at 01:00 Minutes Figure 6
   - **Recordings that are only a few seconds long are often not accurate**.
6. The Start button at the bottom will start the recording . Only record during the test drive and while the vibration is occurring. Figure 6

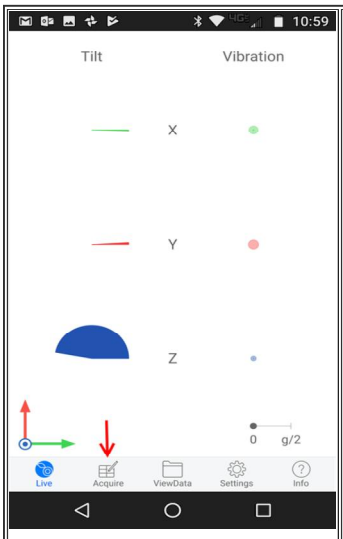


**Figure 5: Main Screen**

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

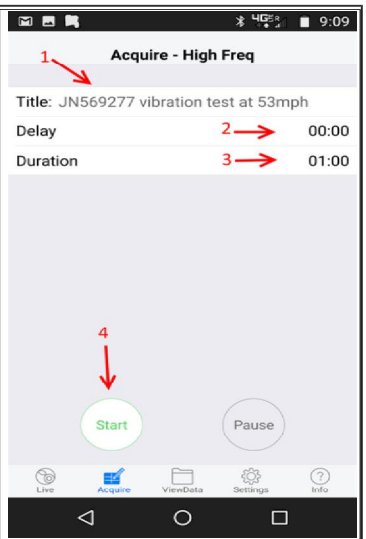


**Figure 6: Acquire Screen**

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.  Note the section of the road and landmarks so that you can repeat the test on the same stretch of road.
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 7.
5. Continue driving at this steady speed until the 1.00 minute timer stops the recording.
    - **Recordings that are only a few seconds long are often not accurate**
6. The test file will automatically save when the recording stops .
7. You can take multiple recordings by following the same steps above.

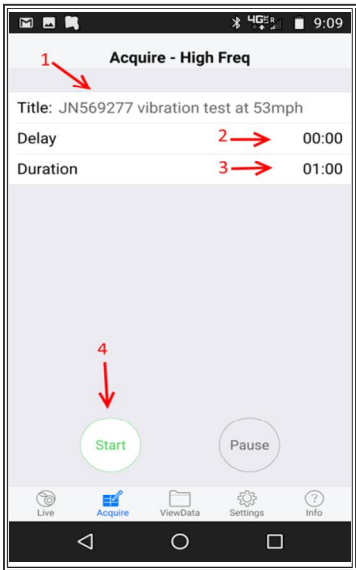


**Figure 7: Acquire Screen**

4. Tap Start to begin recording

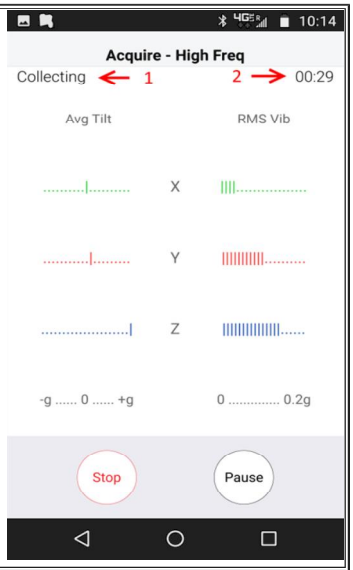


**Figure 8: Acquire Recording**

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 9
2. The recordings are grouped by Date. Figure 9 Tap the date to expand.
3. Recordings on this screen are listed by time of day. Tap the recording to open. Figure 10

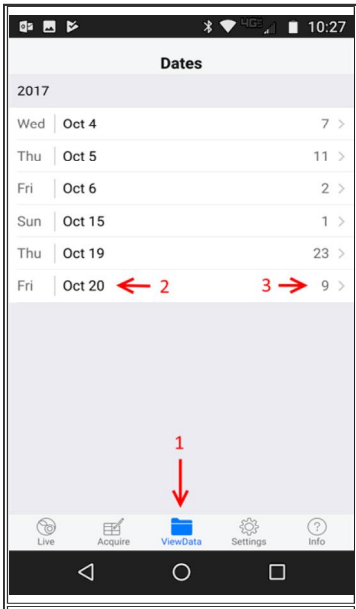


**Figure 9:View Data Screen / Date**

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

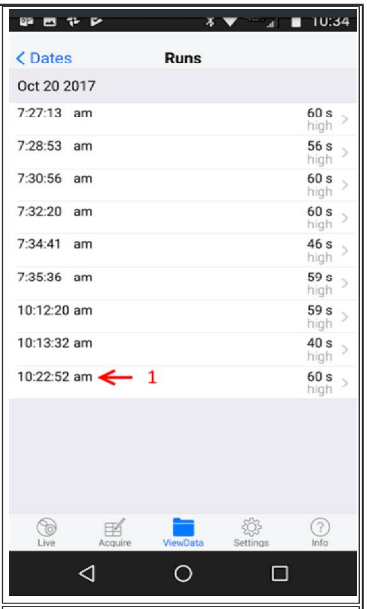


**Figure 10: View Data Screen / Time**

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 11 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)

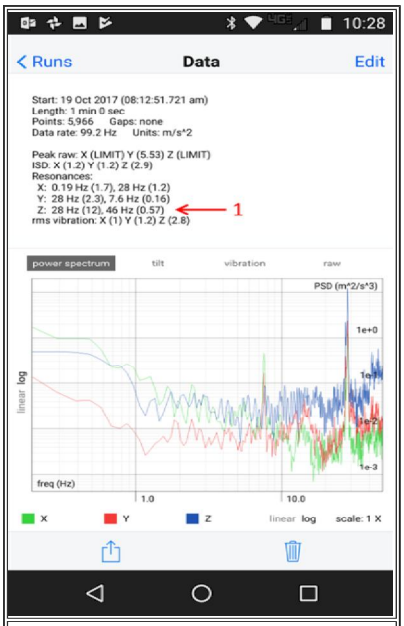


**Figure #11: Example Data Analyzed**

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

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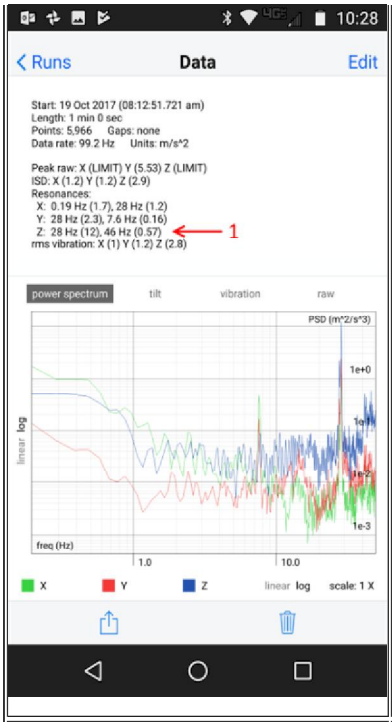
**Comparing vibration recorded values with the Component Speed Calculator.**

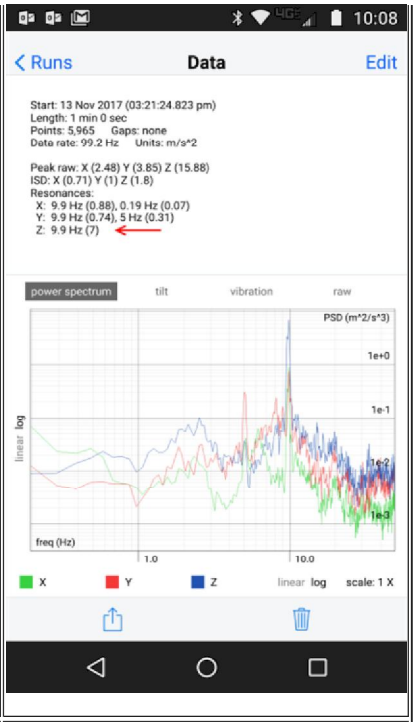
1st Order Vibrations:

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 #12: Example 1 Data Analyzed | Figure #13: 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 12 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 imbalance or driveline high runout is the most probable cause.

**Example 2 Analysis:**

1. Using the recording in Example 2 - Figure 13 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 imbalance or tire/wheel runout is the most probable cause.

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## 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)** |
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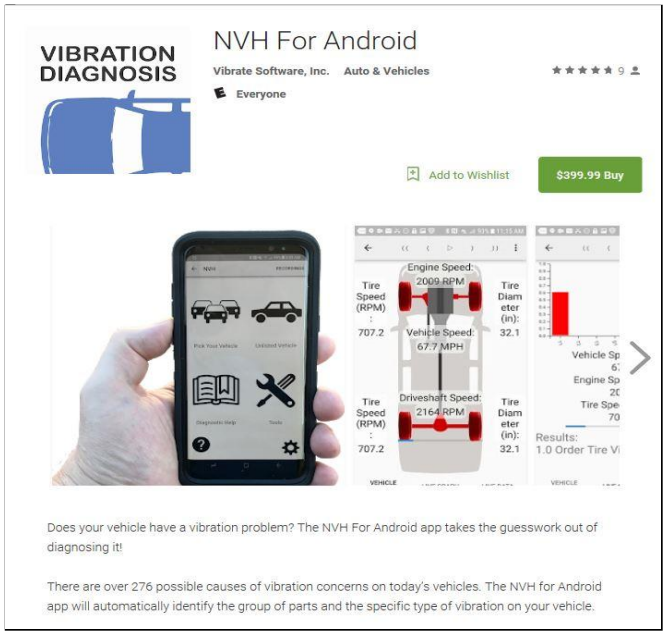
## "NVH" app instructions (approx. $400.00)




| Application | Android - Google Play | Apple - iPhone |
|---|---|---|
| VIBRATION DIAGNOSIS NVH For Android Vibrate Software, Inc. Auto & Vehicles Everyone | Link to Google Play | Link to iTunes |

- "NVH by Vibrate Software Inc." appication has been tested by Navistar on Apple devices (with GPS) and on the Samsung Galaxy Tab E Lite 7" screen. Model SM-T113NYKAXAR. As of March 2018 this tablet was approx. $100.00 USD.

**Application Operation and Setup**

| WARNING: |
| --- |
| **Vehicle driver should follow all safe driving practices and laws . Do not operate the phone / tablet while driving.** |

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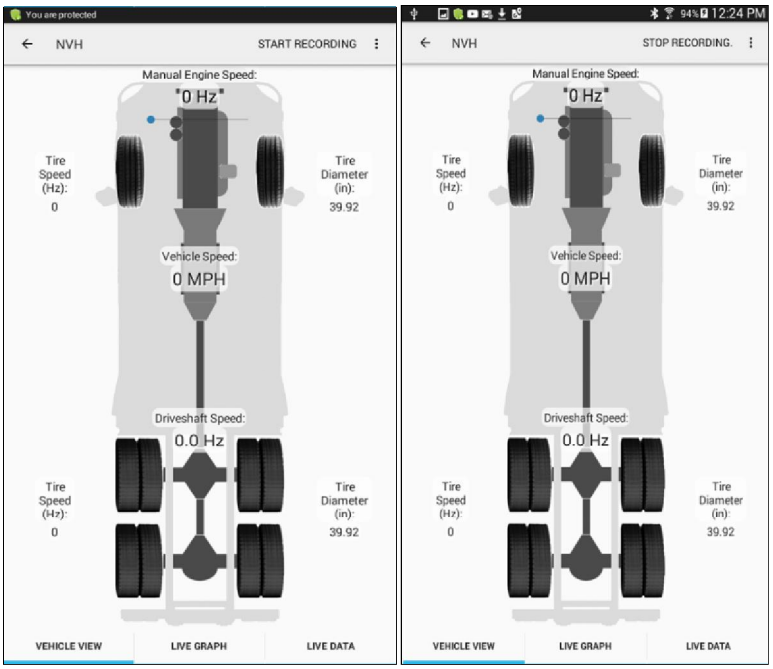
**Phone / Tablet setup:**

1. Read the instructions and tutorial that comes with the App. The App developer has several YouTube videos that are also helpful. **HERE**
2. Enter the required information into the App such as axle ratio, tire size, etc. Enter the last 8 of the VIN as the vehicle name. This will make replaying recordings and attaching recordings to Case Files easier.
3. The phone / tablet with the NVH application should lay flat on a hard flat surface in the cab of the vehicle. **Place device on the floor next to the seat (for most vibrations).**
   - If you can feel the vibration but the vibration is not shown in the App recording then try placing the phone / tablet on the dash and repeating the test.
4. Placing a bag of rice on top of the device will hold it steady during the road test.
   -

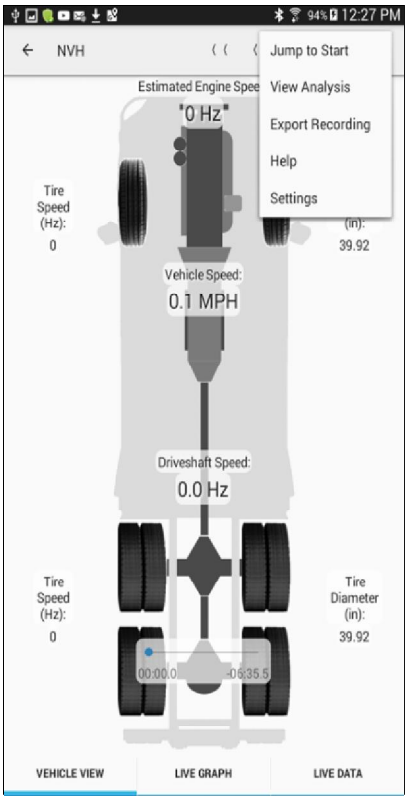
|  |  |
| --- | --- |
| **Device on the cab floor** | **Device on the cab floor with bag of rice on top** |
| Device must be laying flat with the top of the facing forward (toward the hood) | A bag of rice placed on top of the device will hold it tight to the floor. |

5. Start the recording before you begin the test drive.
   - The app will record until you stop it and in the Analysis it will show you the vehicle speeds (in 10 MPH increments) and the level of vibrations it detected
6. **Start** and **Stop** recording by touching the top right corner of the screen
   -

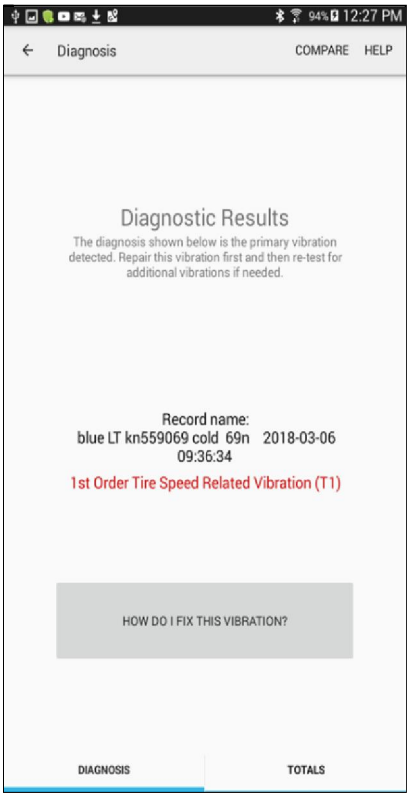



7. Name your recording with the VIN (if not already done) and any comments. Then **Save**
   - 

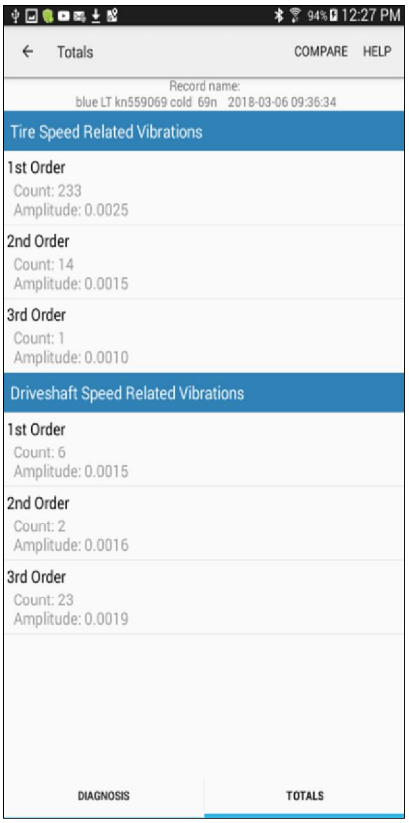
8. Complete your test drive. Note the speed that the vibration occurs and drive this speed for a total of 1 minute or so (its ok if you are at high or lower speeds at times). Spend 15-30 seconds at speeds higher and lower than the speed of the vibration. Then select "Stop Recording"
9. Select **View Analysis**
   -



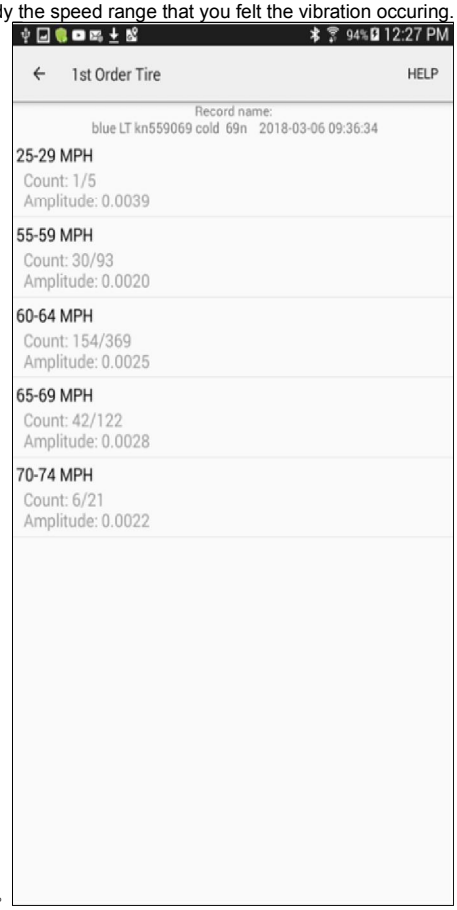

10. Review the result. Select TOTALS at the bottom right of the screen




11. Select the Vibration that has the highest "Count" and "Amplitude". This is 1st Order Tire Speed in the case below.



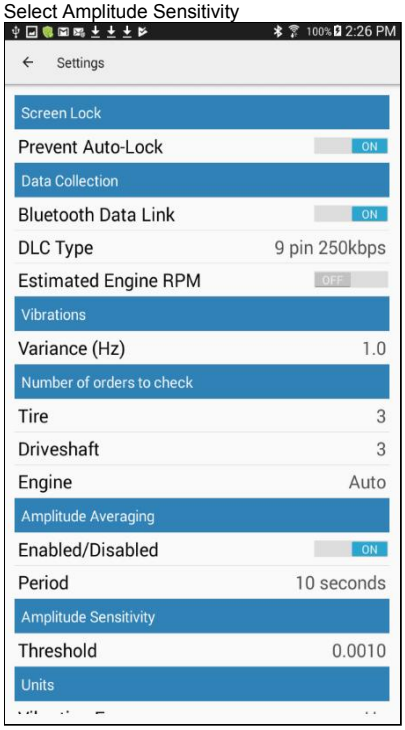

12. Study the speed range that you felt the vibration occuring. "Count" is how often the vibration was sensed.



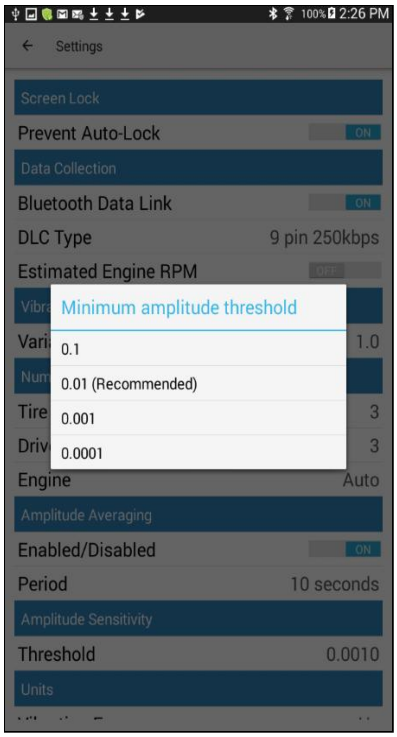

13. If during the test drive you feel the complaint (and recorded it) but the App screen states "no vibration detected" then increase the sensitivity of the App. above its default setting.
    - This improves the accuracy of your diagnosis BUT at this higher sensitivity even a vehicle with a NORMAL RIDE may show a vibration issue with the App.

- Select Settings (the gear icon on the bottom right corner)


- Select Amplitude Sensitivity




- Set Amplitude Sensitivity to **.001**




14. Navigate to "Recordings" in the App and view your recording again. The App will now interpet the recording with the higher Amplitude sensitivity setting.
15. After determining the source of the vibration follow the appropriate manual or the iKnow articles below to solve the complaint

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## WARRANTY INFORMATION

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

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

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## OTHER RESOURCES

IK1700017 LT vibration at highway speeds

IK0300008 Vibration Troubleshooting (vehicle not moving)

IK1400005 Driveline Information Center and Troubleshooting Procedures

Master Service Information Site

Free web-based vibration diagnostics training is offered at Meritor's "The BullPen" website. Course AP3410 "Drivetrain Vibration Diagnostics"

Hide Details

Feedback Information

Viewed: 2086
Helpful: 26
Not Helpful: 0

No Feedback Found