Less noise • More sound

Application Note

Vibration Analysis with RAPID-TEST

RAPID-TEST in combination with NTI's vibration sensor allows analyzing vibrating devices such as the vibration motor of mobile phones. The system measures the vibration frequency (RPM), amplitude or accelaration (m/s² or g) to check for correct operation.
This document provides information about the required components, system setup and programming for such a test.

Contents

1 Introduction

Mobile phones normally comprise a vibration alert as standard feature. During production, this device is typically tested with a simple current measurement. Unfortunately, this test only allows proving the presence of the device, but not its proper operation.

Consequently, a simple, fast and thorough verification of the vibration alert is required. RAPID-TEST in combination with the vibration sensor from NTI represent an ideal solution to this demand.

2 Vibration sensor

2.1 Description

NTI's vibration sensor perfectly meets the typical requirements of a mobile phone vibration test. It needs only a slight contact to the DUT surface and accurately picks up vibrations between 5 Hz and 20 kHz.

2.2 Technical specifications

Type	C-DYN
Sensitivity *	20 mV/g ±20%
Impedance	1500 Ohm
Bandwidth	5 Hz – 20 kHz
Temp. range	–30 to +70 °C
Power supply	not required
Dimensions	∅ 22 mm x 9 mm
Weight	8 g
Cable, connector	*custom defined*

**: calibrated sensors available upon request*

Fig. 1 Vibration sensor with custom-specific cable & connector

3 Sensor mounting

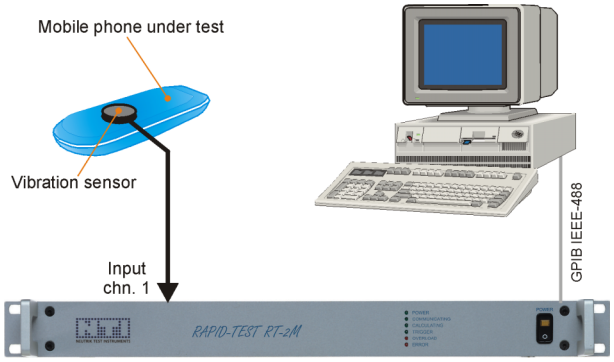

Fig. 2 Test setup

The vibration sensor is made up of a circular PCB and a blue silicone cylinder that comprises a moving mass. Mounting the sensor to the test fixture can be done in two ways.

A) Contacting: hold the sensor with an elastic fixture (e.g. a spring) that presses the PCB to the device under test (DUT). As an option, you can insert a thin piece of hard rubber between the PCB and the DUT. In any case, the blue silicone cylinder must be allowed to move freely.

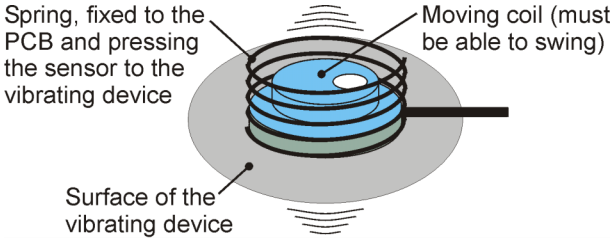

Fig. 3 Connecting mounting

B) Non-contacting: mount the sensor firmly into the test jig so that the blue silicone cylinder points towards the DUT without touching it. Make sure that the distance from the DUT to the sensor is as short as possible.

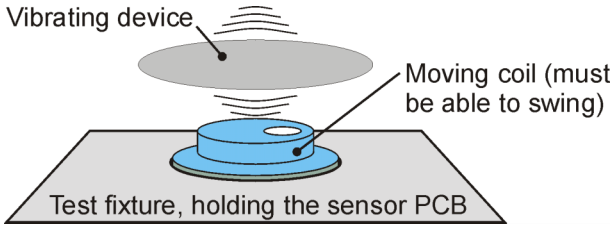

Fig. 4 Non-connecting mounting

Both mounting methods require optimum damping of parasitic vibrations.

4 Application example

4.1 Basic setup

Figure 4 shows a typical vibration alert test setup with RT-Eval, NTI's free evaluation software for RAPID-TEST.

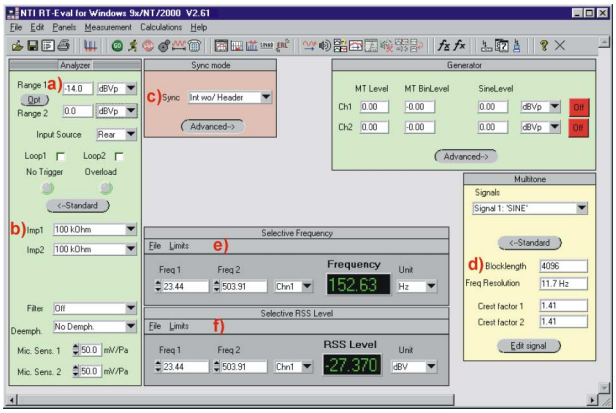

Fig. 5 RT-Eval settings

Analyzer settings

a) *Input range = –14 dBVp*. This value typically matches the signal amplitude if the sensor is in direct touch with a mobile phone. Raise the input range in case of an overload – decrease it if the signal level is too low.

b) *Input impedance = 100 kOhm*.

c) *Sync mode = Int w/o Header*. In this mode, the measurement must be initiated when the the DUT is vibrating – with the advantage of being independent of external „noise". As an alternative, it is possible to let RAPID-TEST automatically trigger to an active vibration in the *Sync mode = Threshold*. However, this approach requires a careful adjustment of the input range, threshold level and delay and is less robust against false triggering due to external vibrations (refer to the RAPID-TEST user manual).

d) *Multitone blocklength = 4096*. This setting results in a signal acquisition duration of ~340 ms.

Measurement panels

e) Selective Frequency: 20 Hz – 500 Hz

f) Selective RSS Level: 20 Hz – 500 Hz

The selective frequency measurement is only supported by RT-2M or RT-2X, but not by RT-1M.

Test execution

Activate the vibration alert and click on the „GO“ button to start the test.

Related commands

A listing with the RAPID-TEST remote control commands representing the aforementioned setup and measurements are filed in the appendix.

4.2 Acceleration, RPM

Alternatively to the level and frequency measurement, the system also supports the acquisition of processed results, for instance:

- Acceleration, expressed in m/s² or in g
- RPM (revolutions per minute)

NTI provides an application file for RT-Eval („Vibration_AccelarationRPM.app“) with the corresponding setup as free download on its homepage: www.nt-instruments.com

Acceleration

The acceleration measurement is based on the level result and the sensitivity of the sensor. The sensitivity of the NTI sensor typically is 20 mV/g with an accuracy of ±20%, which is sufficient for most industrial applications (alternatively, calibrated sensors are available from NTI upon request).
The formulas below describe the calculation of the acceleration (RMS) results:

$$Acceleration\,[m/s^2] = \frac{U_{RSS\_Selective}\,[V]*1000*9.81\,[m/s^2]}{S_{Sensor}\,[mV/g]}$$

$$Acceleration\,[g] = \frac{U_{RSS\_Selective}\,[V]*1000}{S_{Sensor}\,[mV/g]}$$

Equation 1 Acceleration calculation

whereby:
$U_{RSS\_Selective}$ = RSS level measurement result
S_{Sensor} = sensitivity of the sensor
1 g = 9.81 m/s²

RPM

Calculation of the RPM result is pretty simple:

$$RPM = f_{Sensor}\,[Hz]*60\,[s]$$

Equation 2 RPM calculation

whereby:
f_{Sensor} = frequency measurement result

APPENDIX

Program example

The program example below summarizes the system set-up as described in chapter 4.1. The program is written in „C“ language and was created automatically by the RT-Eval Code Generator (RAPID-TEST control commands in quotation marks).

- Make sure that the channel-specific settings correspond to the wiring of the test stand (i.e. vibration sensor connected to input channel 1).
- The measurement starts as soon as command "`MTONe:OUTPut:STARt`" is sent to the unit. Therefore, the vibration alert must be activated prior to this command.
- RAPID-TEST returns the measurement results upon each query command (e.g. "`MEASUREMENT1:SELECTIVERSS? 2 43`").

Limit test

The control PC has to check the measurement results against user-defined reference limits for the PASSED / FAILED decision.

- The detected frequency has to be within a user-defined band around the nominal frequency of the vibration alert.

Example: $f_{nom.}$ = 200 Hz

$\Rightarrow f_{min.}$ = 150 Hz, $f_{max.}$ = 250 Hz

- The sensor level (i.e. signal energy of the vibration alert) must be higher than a user-defined threshold.

Example: $RSS_{nom.}$ = -27 dBV

$\Rightarrow RSS_{min.}$ = -35 dBV

```
! REM  *************** MTONE INITIALIZATION (ACTIVE SIGNAL) ***************
SendToRT "OUTPUT:MTONE:PAR 1,'SINE',4096,1,1,44,44,0.000E00,0.000E00"

! REM  *************** INPUT SETTINGS ***************
SendToRT "INPUT1:RANGE -14.00 dBVp"
SendToRT "INPUT1:LINK OFF"
SendToRT "INPUT:SYNC INTNOHEADER"
SendToRT "INPUT:SWFILTER OFF"
SendToRT "INPUT:DEEMPHASIS OFF"
SendToRT "INPUT1:IMPEDANCE 100k"

! REM  *************** MTONE SETTINGS ***************
SendToRT "OUTPUT:MTONE:ACTIVE 1"

! REM  --------------- MEASUREMENT PART ---------------
! REM  Activate the vibration alert of the device under test
SendToRT "OUTPUT:MTONE:START"
! REM  Stop the vibration alert of the device under test

! REM  *************** MEASUREMENT SELECTIVE RSS ***************
SendToRT "MEASUREMENT1:SELECTIVERSS:UNIT DBV"
SendToRT "MEASUREMENT1:SELECTIVERSS? 2 43"
ReadFromRT
! REM  Parse the result string & check the results

! REM  *************** MEASUREMENT SELECTIVE FREQUENCY ***************
SendToRT "MEASUREMENT1:FREQUENCY:SELECTIVE? 2 43"
ReadFromRT
! REM  Parse the result string & check the results

! REM  *************** ERROR QUERY ***************
SendToRT "SYSTEM:ERRORS?"
ReadFromRT
! REM  Interpret the returned error messages
```