ROHM's KX132-1211 & KX134-1211 Accelerometers for Industrial Applications

ROHM Semiconductor USA

Industry 4.0

The Fourth Industrial Revolution is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. (Source)

1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Cyber Physical Systems

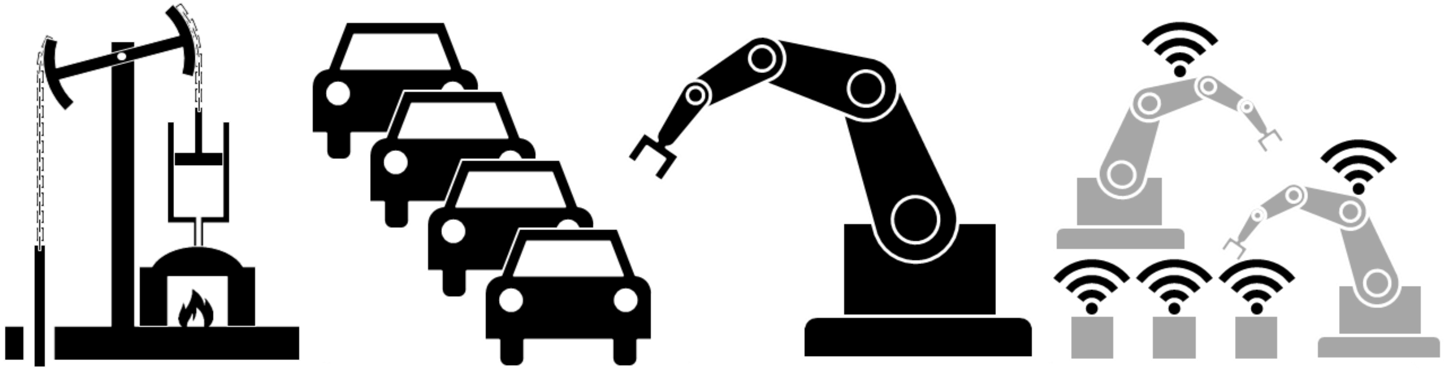


Image Credit: *Christoph Roser at AllAboutLean.com*

Top Trends for Industry 4.0

- Predictive Maintenance
- Smart Sensors
- Smart Factory
- 3D Printing

Industry Leaders – Industrial IoT & Machine Health Monitoring

ROHM SEMICONDUCTOR

Shoreline IoT

Parker

REGAL®

NIKOLA LABS

EMERSON.

BANNER

WAITES

FLUKE®

GOULDS PUMPS

ERBESSD INSTRUMENTS®

TRACKONOMY™

Industrial IoT – Market/Application Examples

Industrial Pumps
$62B('19)

Vibration Detection

Industrial Motors
$33B('17)

300M Motors ('19)

Vibration Detection

Industrial IoT

Predictive Maintenance

Industrial Fans
$6.5B('20)

Vibration Detection

Utility Poles

Vibration Detection

Angle Measurement

Wind Turbines
>300K turbines ('19)

Vibration Detection

System Doors
>200M doors by AA

Motion & Vibration Detection

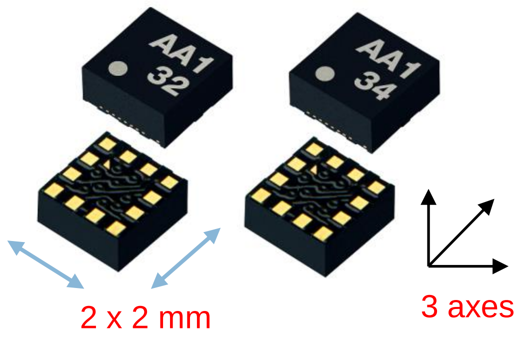
KX132-1211 & KX134-1211 Accelerometers Key Features

Key Features

- Operating Temperature -40C to +105C
- Fast Sampling Rate (ODR up to 25.6kHz)
- Wide Signal Bandwidth & g-Range (KX134)
- Advanced Data Path (Vibration Detection Engine)
- Low Standby Current (0.5 µA)
- Low Operating Power (from 0.53 µA)

Package

- 2 x 2 x 0.9 mm
- LGA 12-pin



Description	Unit	KX132 & KX134
Package	mm	2 x 2 x 0.9
Digital I/F	-	SPI / I2C
VDD	V	1.7 - 3.6
Standby Current Low Power Current [1] High Perf. Current [1]	µA	0.5 0.53 – 34 148 – 239
Buffer Memory (FIFO)	Byte	512

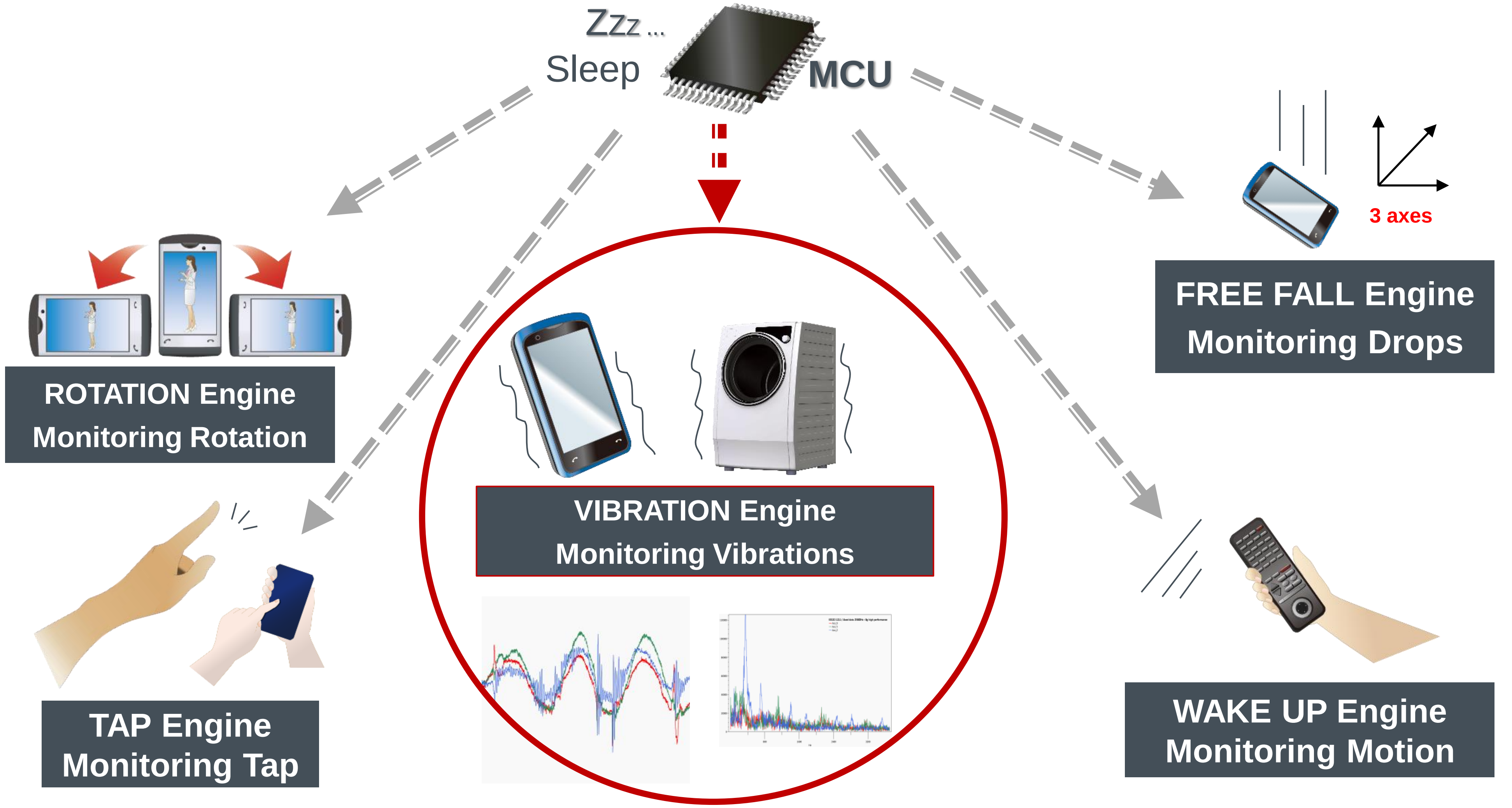
Description	Unit	KX132	KX134
G-Range	g	±2, 4, 8, 16	±8, 16, 32, 64
0g Offset	mg	±25	±75
Sensitivity [*2]	counts/g	2048 (16g)	512 (64g)
Signal Bandwidth (-3dB)	Hz	4200 (x,y) 2900 (z)	8200 (x) 8500 (y) 5600 (z)

[1] Current varies with e.g., Power mode, ODR, the average filter control settings and VDD.

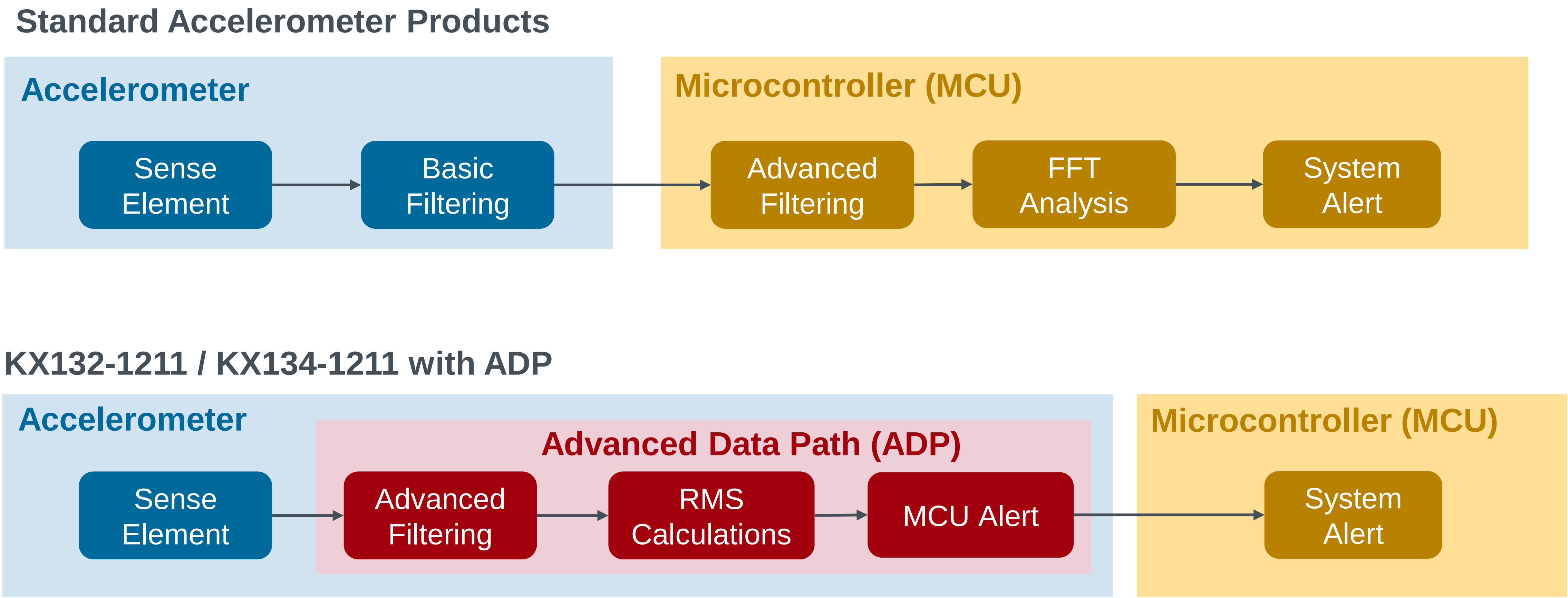
[2] Sensitivity varies with G-Range.

KX132-1211 & KX134-1211 Embedded Functions (Digital Engines)

Embedded functions can monitor application conditions while MCU is asleep

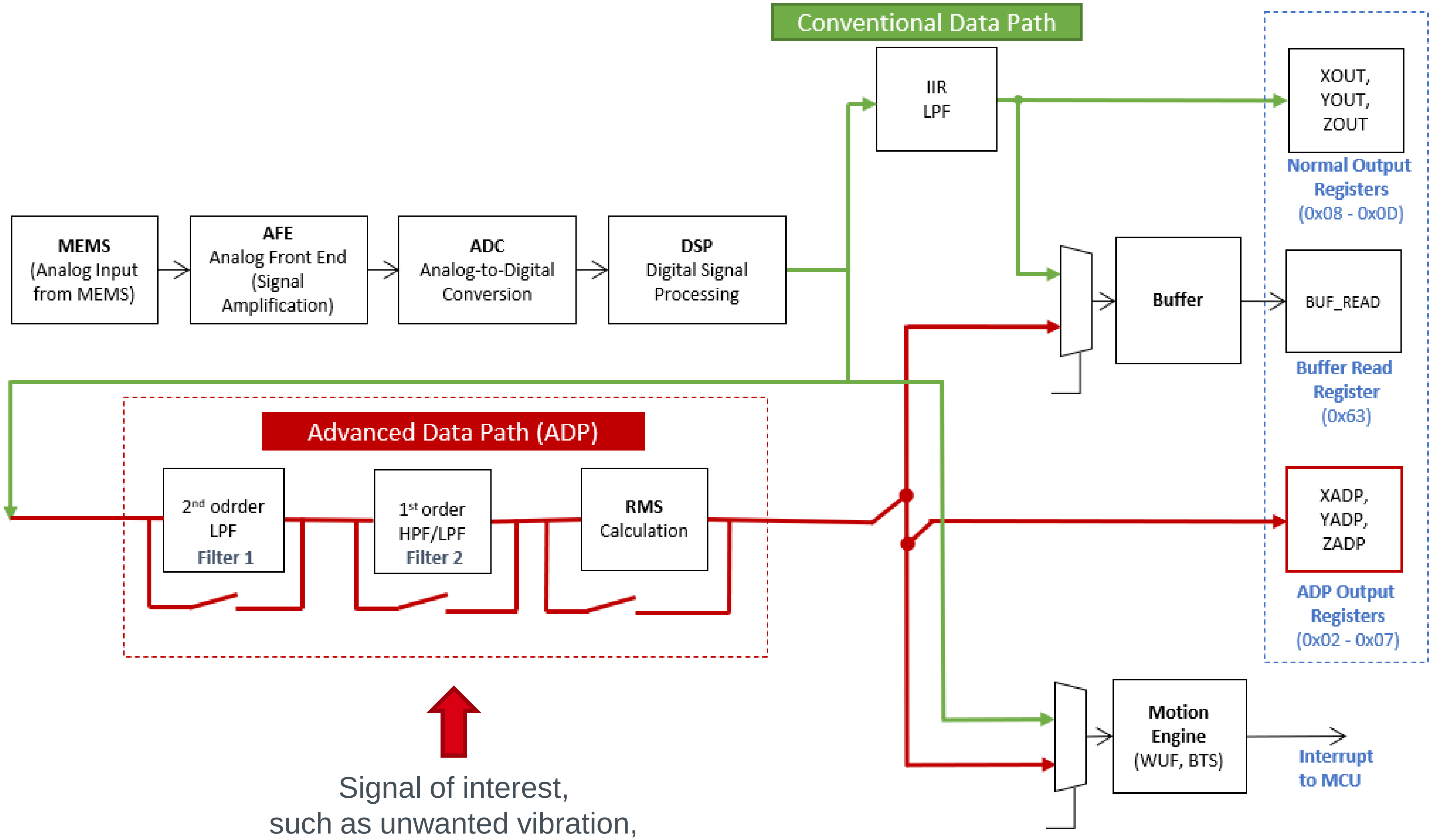


KX132-1211 & KX134-1211 Accelerometers Solution Advantage



Take Away Message: KX132-1211 & KX134-1211 are designed to perform vibration analysis at a fraction of power compared to a microcontroller to perform a similar task!

Advanced Data Path – Look Under the Hood



Signal of interest,
such as unwanted vibration,
is identified here

Application Examples – Machine Health Monitoring

Key Considerations

- There are many sources for motor failures. Some of the common ones are listed in the table on the right.
- Each failure mode can be identified by detecting a vibration at a certain frequency.

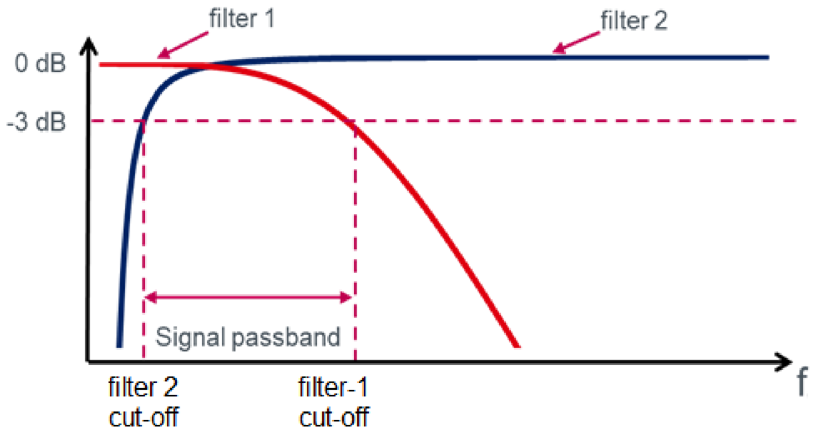
Vibration Sources Identification Guide

CAUSE	FREQUENCY	AMPLITUDE	PHASE	COMMENTS
Unbalance	1 x RPM	Highest in Radial Direction- Proportional to Unbalance	Single Mark (Steady)	A common cause of vibration.
Defective Anti-Friction Bearings	Very High-Often From 10 to 100 x RPM	Use Velocity	Unstable	Velocity readings are highest at defective bearing. As failure approaches, the amplitude of the velocity signal will increase and its frequency will decrease. Cage frequency is approximately 0.6 x RPM x number elements.
Misalignment of Coupling or Bearing	1, 2 or 3 x RPM	High Axial Axial 50% or more of Radial	Often 2, Sometimes 1 or 3	Use phase analysis to determine relative movement of machine or bearings. Use a dial indicator if possible. Often diagnosed as a bent shaft. Can be caused by misalignment of V belts.
Sleeve Bearing	1 x RPM	Not Large Use Displacement Mode Up to 6000 CPM	Single Reference Mark	May appear to be unbalanced. Shaft and bearing amplitude should be taken. If shaft vibration is larger than the bearing, vibration amplitude indicates clearance.
Bent Shaft	1 or 2 x RPM	High Axial	1 or 2	Similar to misalignment. Use phase analysis.
Defective Gears	High No. Gear Teeth x RPM	Radial	Unsteady	Use velocity measurement. Often affected by misalignment. Generally accompanied by side band frequency. Pitting, scuffing and fractures are often caused by torsional vibrations. Frequency sometimes as high as 1 million CPM or more.
Mechanical Looseness	2 x RPM Sometimes 1 x RPM	Proportional to Looseness	1 or 2	Check movement of mounting bolts in relation to the machine base. Difference between base and machine indicates amount of looseness.
Defective Drive Belts	1 or 2 x Belt Speed	Erratic	Use Strobe to Freeze Belt in OSC Mode	Calculate the belt RPM using: $\text{Belt RPM} = \frac{\text{Pulley Diameter x 3.141}}{\text{Belt Length}} \text{ x Pulley RPM}$ Look for cracks, hard spots, soft spots or lumps. Loose belt. Changes with belt tension.

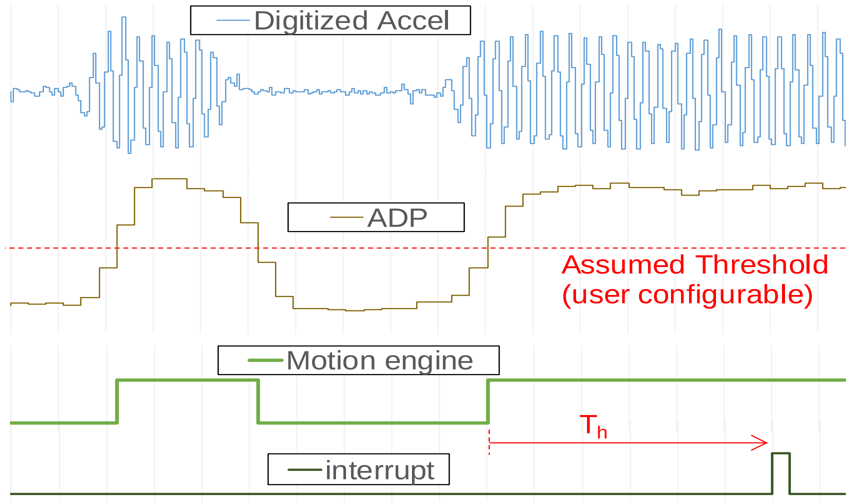
Source: https://www.vibescorp.ca/learn-about/basic-understanding-of-machinery-vibration/

Approach

- **Step 1:** The Advanced Data Path in KX132-1211 and KX134-1211 can be dynamically configured to detect only the frequencies of the interest through setup of an internal low-pass and high-pass filters as a band-pass filter. Thus, only the signals of interests (e.g., failures), will be detected, and the rest will be ignored. This allows a more robust detection with fewer false negatives.

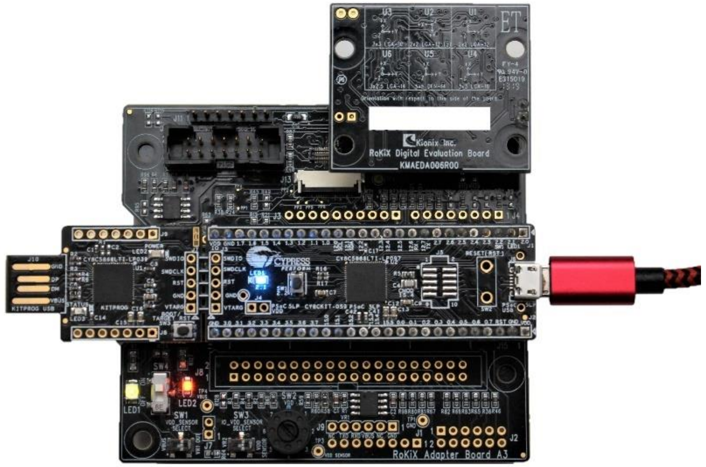


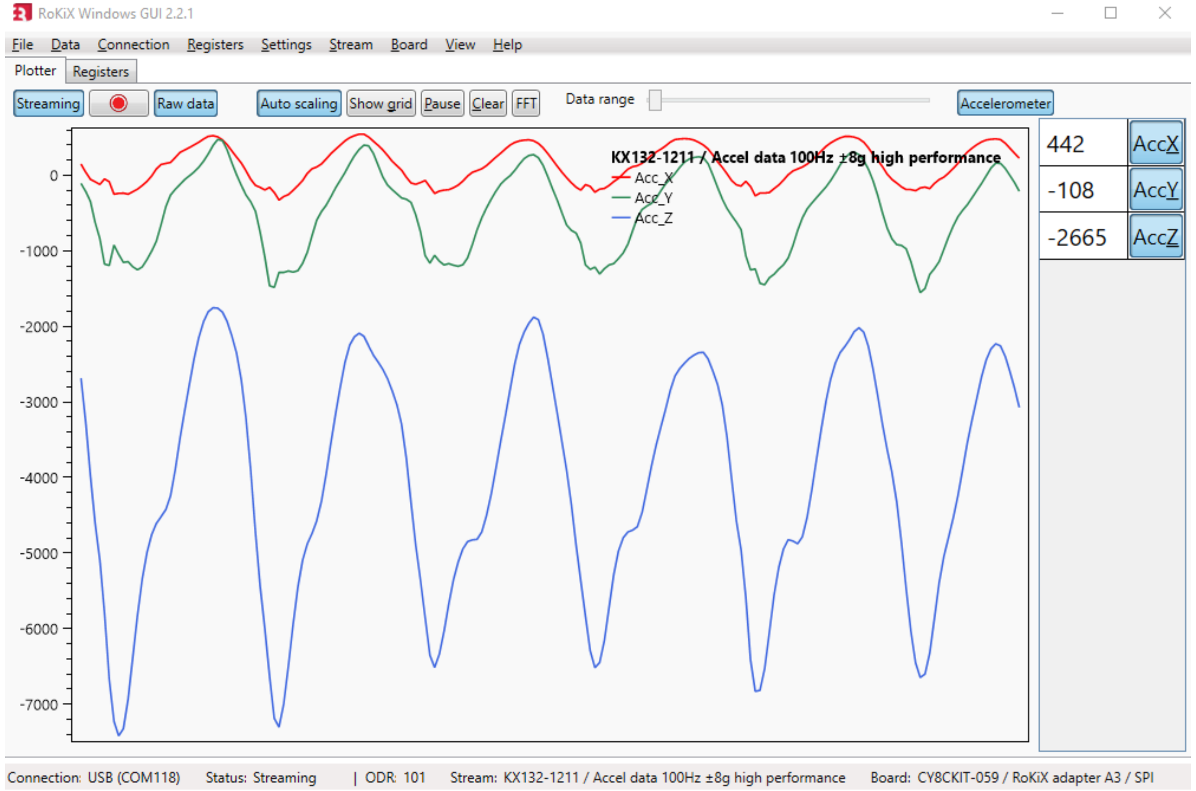
Step 2 (optional): To estimate the amplitude of the vibration, the input signal can be routed via a configurable RMS engine where as many as 2 to 256 samples can be averaged. The resulting signal amplitude (and duration) can be used to compare against a configurable threshold to confirm if it exceeds it or not.



Evaluation & Development Supporting Tools

Description	ROHM P/N
KX132-1211 Evaluation Board	**KX132-1211-EVK-001**
KX134-1211 Evaluation Board	**KX134-1211-EVK-001**
RoKiX Development Kit	**RKX-EVK-001**





Evaluation Board

Easy to use evaluation board with all the signals accessible through the 14-pin header

Development Kit

Complete offering of the software, hardware, and firmware used for device evaluation purpose

RoKiX Windows GUI

Easy to use device evaluation software with graphical user interface supporting real time data display in time and frequency domains, configuration of all registers, test of digital engines, logging the data, and much more

Thank you!

ROHM
SEMICONDUCTOR

ROHM Semiconductor U.S.A., LLC