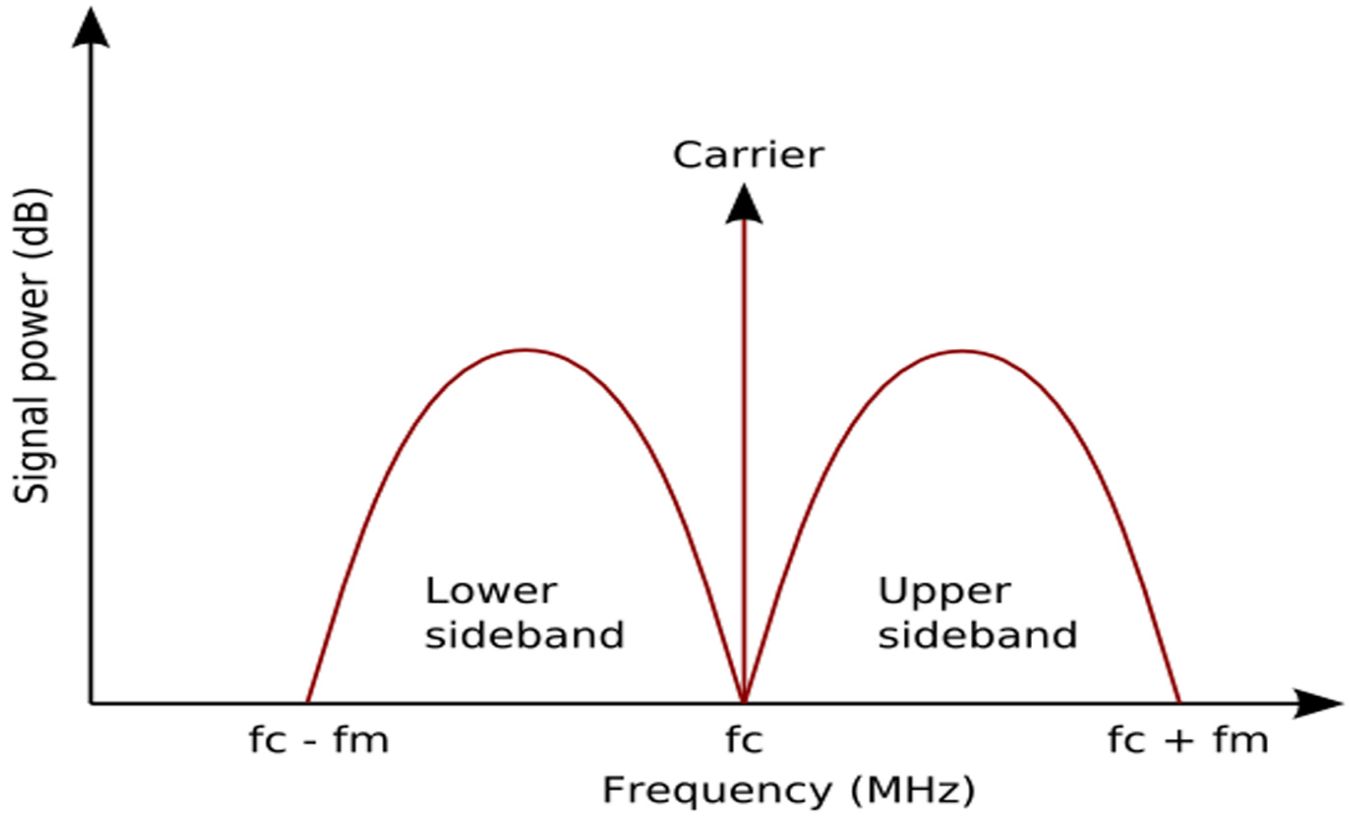
VIBRATION SPECTRAL ANALYSIS

Practical Applications of Sidebands



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Vibration Spectral Analysis:
Practical Applications of Sidebands

by Jude Iyinbor, CEng.

Introduction

What pictures do sidebands paint when they show up in vibration spectral plots? This will largely depend on the pattern of occurrence. In this review, we consider a list of common faults and what the sidebands generated look like.

Fault Recognition via Sidebands

In vibration analysis, sidebands are generated in many cases by the following types of issues:

- Bearing related issues
- Gear related Issues
- Electrically related issues

Bearing Related Issues

When rolling element bearings deteriorate through a fault on the inner raceways, outer raceways, or even the Cage, there is sometimes the presence of sidebands in the spectral plot due to modulation of the running speed – 1x rpm (modulating frequency) around the bearing tones (center frequency). If as an illustration, there is a defect on the inner raceway (identified by the presence of Ball Pass Frequency Inner race – BPFI), this defect will move in and out of the bearing load zone at each rotation of the shaft (1x rpm). This results in amplitude modulation (fluctuations in amplitude) with a constant frequency as the amplitude level rises and falls as it goes in and out of the load zone. There could also be some harmonics due to the impacts felt every time the inner race defect is in the load zone. See figure 1 for pictorial representation of what can be seen in some cases with BPFI faults in the frequency domain.

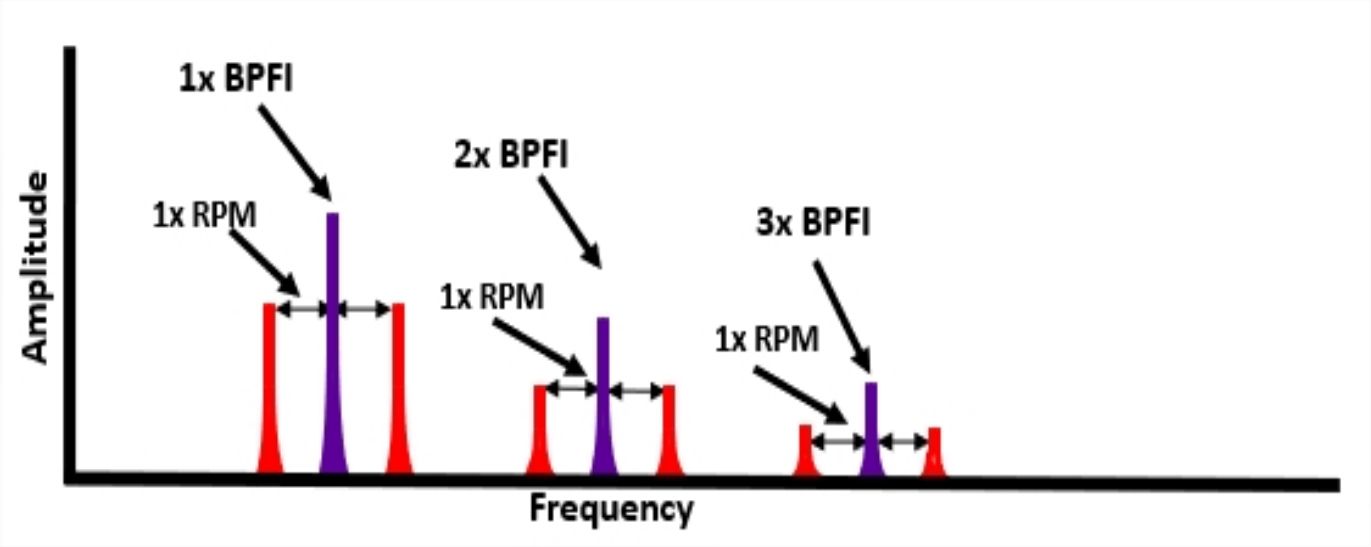

Figure 1: Harmonics of Ball Pass Frequency Inner race (BPFI) with sidebands of 1x RPM depicting bearing related issues

Gear Related Issues

When Gears rotate and mesh together, there are usually activities found at the Gear Mesh Frequency (GMF). If a tooth was worn or damaged on the Pinion, it means that there will be a rising and falling of vibration as this damaged tooth comes into meshing activity. This will occur at each rotation of the Pinion shaft with the damaged tooth (1x rpm of Pinion shaft). This causes amplitude modulation of the running speed of the Pinion shaft around the Gear Mesh Frequency. Any slight changes in speed may also cause frequency modulation. See figure 2.

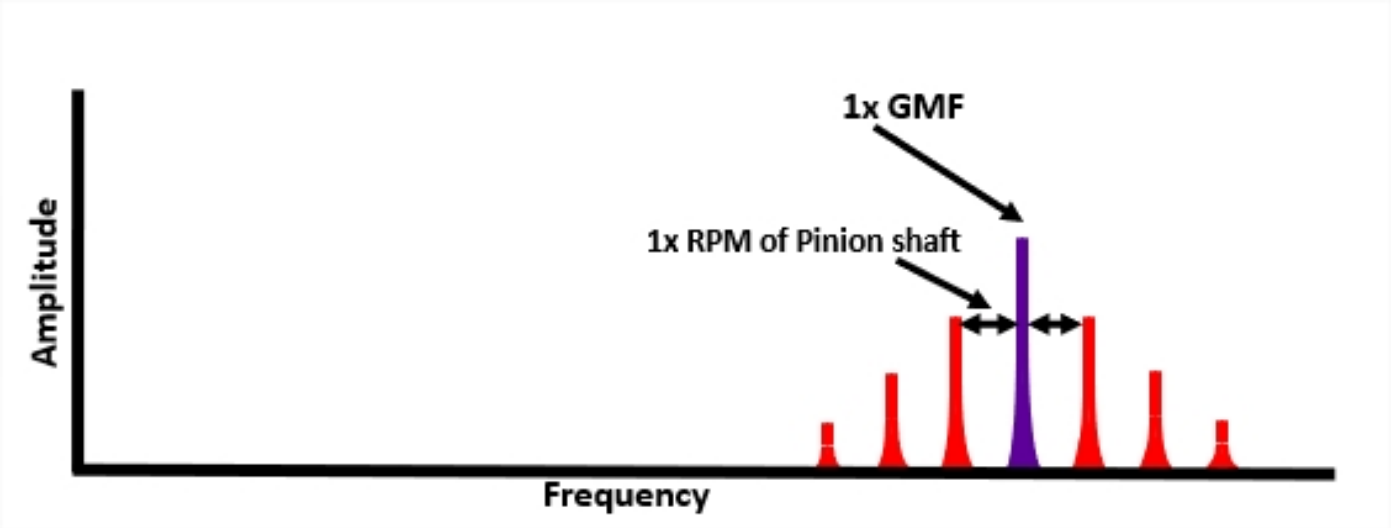

Figure 2: 1x Gear Mesh Frequency with sidebands of 1x rpm of pinion shaft depicting issues related to the Pinion Gear

Electrically Related Issues

For electric motors, modulation can happen due to broken or damaged Rotor bars. Rotor eccentricity can also show up as modulated signal with side bands in the frequency domain. In the case of damaged rotor bar, the fluctuation in amplitude is usually due to the slip that is generated around 1x rpm and its harmonics as the broken rotor bar goes in and out of the magnetic field causing a rise and fall in vibration amplitude levels. This slip is seen as Pole Pass Frequency (Number of Poles x Slip Frequency). The Pole Pass Frequency (F_P) modulates around the 1x RPM and its harmonics are seen in the lower frequency range. Most times it is possible to also see a visual individual presence of Pole Pass Frequency in the Low Frequency range (see figure 3). For loose or open Rotor bar, Twice Electrical Line Frequency (2xLF) modulates around Rotor Bar Passing Frequency (RBPF = Number of Rotor Bars x 1x RPM) in the high frequency zone.

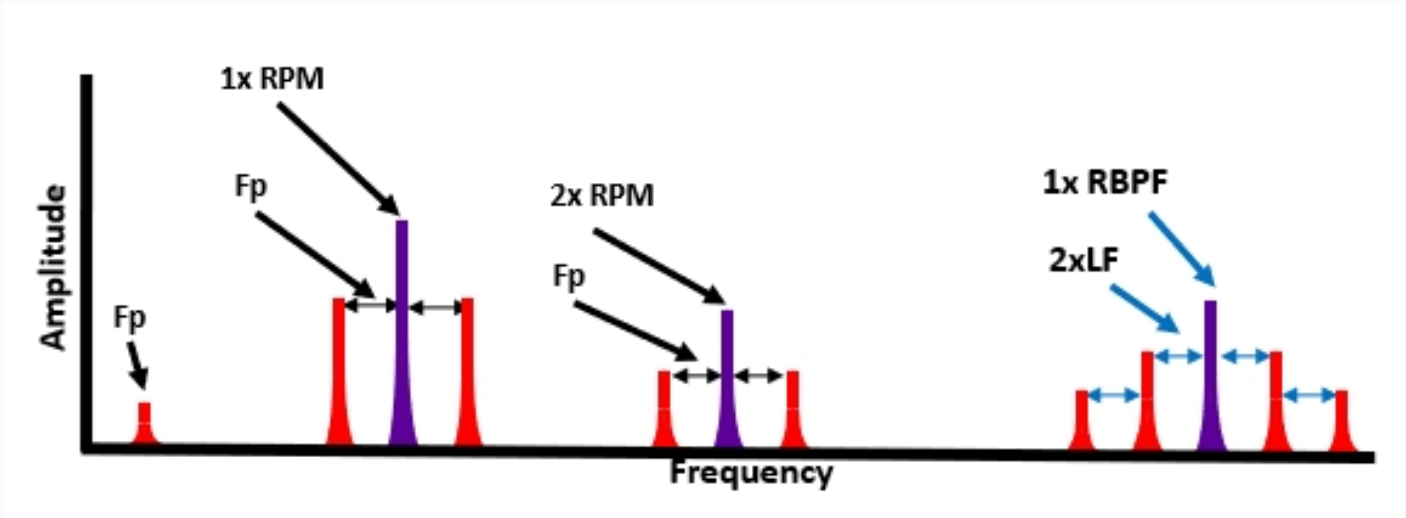

Figure 3: 1x RPM with sidebands of F_p and its harmonics coupled with 1x RBPF with sidebands of 2x LF depicting Electrically related issues with respect to damaged and loose Rotor Bar

Brain Teasers: Check your Comprehension

Q1: Which one of the following faults cannot easily be recognized through sidebands? (A): Gear Related Issues (B): Bearing problems (C): Oil Whirl

Q2: In Electric Motors, modulation can occur due to which of the following (A): Broken Rotor Bar (B): Loose connection (C): Dirt Buil up

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