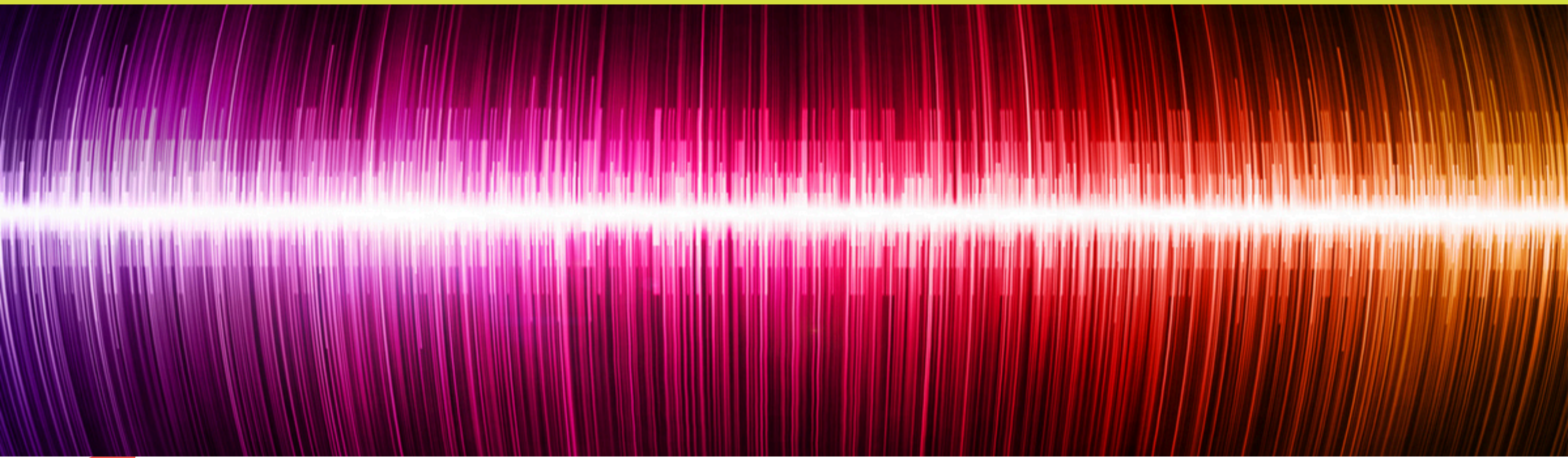
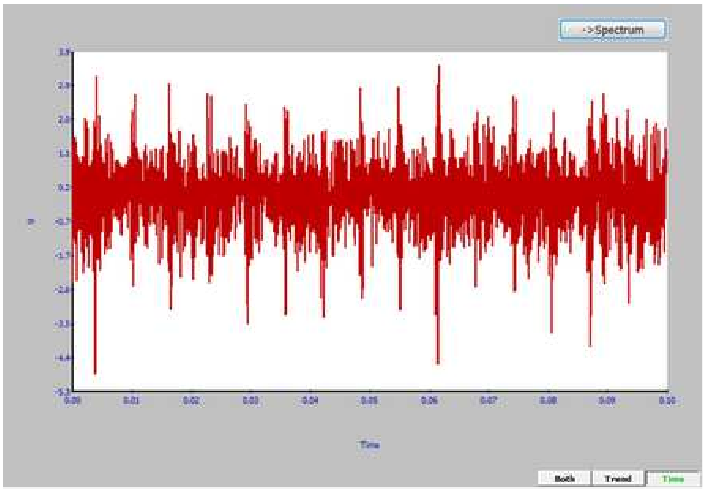
What is

Envelope demodulation

and how does it detect bearing faults?



If we look at the vibration time waveform from a damaged bearing, as detected by a vibration sensor (accelerometer) for instance, it will typically look like this>>>



The numerous high amplitude “spikes” are caused by the damaged bearing parts knocking against each other. Because the bearing noise spikes are of very short time duration, they produce high frequency components in the resulting vibration frequency spectrum. Consequently, examining the high frequency content of a vibration waveform is a very good indication of bearing wear. This is precisely what is done when the bearing noise is calculated in Bearing Damage Units (BDU).

The waveform is firstly high pass filtered to remove any low frequency run-speed vibration signals and then the magnitude of the resulting signal is calculated to determine the bearing wear.

A reading of 100 BDU corresponds to 1g RMS (average) high frequency vibration and is pretty much indicative of a worn or damaged bearing. In other words, it may be helpful to think of the BDU figure as being very roughly equivalent to “percentage” bearing wear.

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However, an even better measure of bearing wear can be achieved by looking at the Envelope Demodulated vibration waveform (DeMod). Although complex to explain mathematically, DeMod is relatively easy to implement on a high-end vibration analyser.

Such devices used to be prohibitively expensive, but not anymore. For example, the Test Products International TPI 9043/Ultra III costing from £5,000, combines a high resolution (24-bit ADC) three channel data capture unit (TPI 9043) with easy-to-use display software (Ultra III) that runs on any Android device (tablet or smartphone). With its 51,200 lines of resolution, the TPI 9043/Ultra III combo can produce DeMod frequency spectrum resolution of better than 0.1Hz, more than sufficient to enable clear identification of bearing fault frequencies.

True simultaneous 3 channel capture for versatility, 24-bit A/D converter for high resolution, and wireless communication to an Android tablet running the TPI Ultra III app.

The DeMod technique works on the principle that the component parts of worn bearing strike against each other as they spin and cause localised “ringing” in the bearing. This is exactly like striking a bell, where the harder the bell is struck, the louder it rings. By demodulating the vibration waveform, it is possible to determine how hard the bearing parts are being struck and therefore how badly the bearing is damaged.

By examining the DeMod frequency spectrum it is also possible to determine the frequency at which the bearing components are being struck and therefore identify the likely cause of the fault. For example, a peak at the bearing’s ball pass outer frequency (BPFO) would indicate a fault on the outer race of the bearing.

The DeMod spectrum for our damaged bearing clearly shows a series of peaks at harmonics of 152Hz, which corresponds to the BPFO for this particular type of bearing running at 50Hz. As you might have guessed, this bearing had a damaged outer race!

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