

## Cepstrum Analysis

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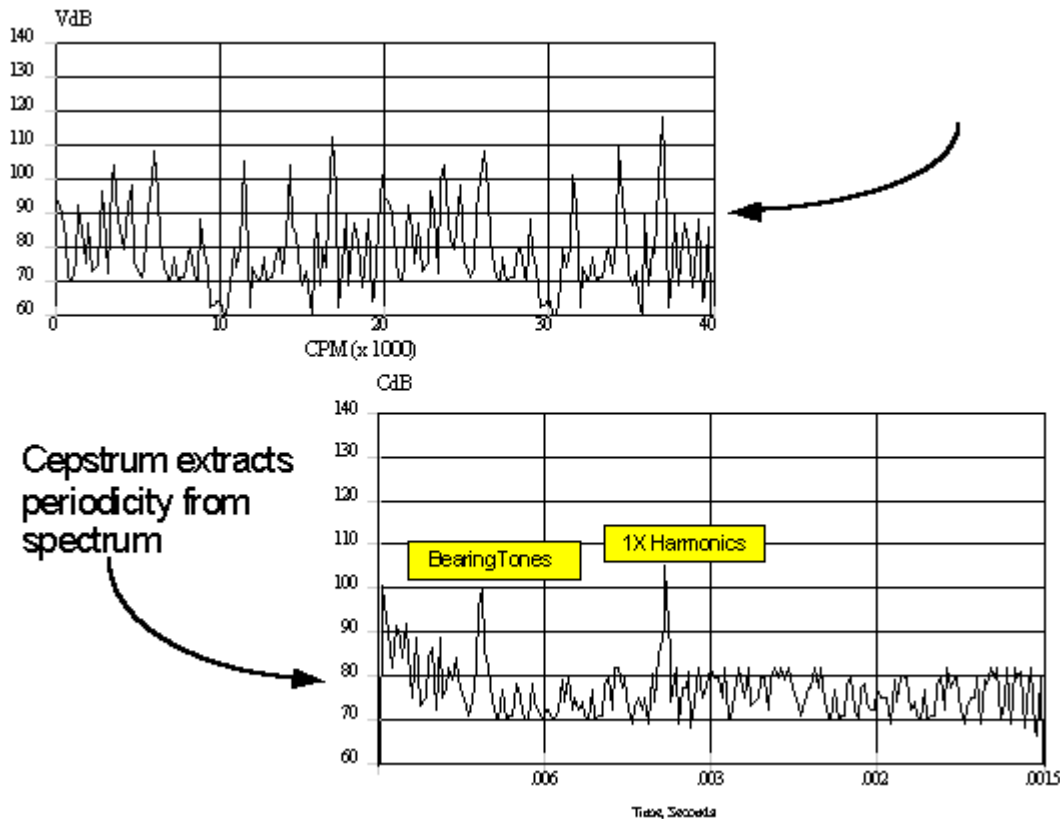
One of the ways the Expert System detects bearing tones is by looking at the spectrum of a spectrum. This process is called Cepstrum Analysis, "Cepstrum" being a play on the word "Spectrum".

### Identifying Bearing Signatures

The one characteristic common to most rolling contact bearing wear vibration signatures, is that there exists some kind of a harmonic series not directly synchronized with the shaft speed. This series may be in the low frequency end of the spectrum, or the high end, or both. It also may be comprised of multiples of the fundamental bearing tones and/or rotational rate sidebands thereof. In any case, there exists a common frequency spacing separating the peaks of signature groups. Cepstrum Analysis converts a spectrum back into a time domain signature, which has peaks corresponding to the period of the frequency spacings common in the spectrum. These peaks can be used to find the bearing wear peaks in the original spectra.

### Expert System Procedure

Spectra from a rotating machine may be quite complex, containing several sets of harmonics from rotating parts and maybe several sets of sidebands from various modulations. Because cepstrum has peaks corresponding to the spacing of the harmonics and sidebands, they can be more easily identified. Significant peaks in the cepstrum corresponds to possible fundamental bearing frequencies. Using a set of embedded rules, the Expert System automatically compares these frequencies to the peaks in the spectra that are not related to any machine fundamental forcing frequency. If a match is found, then the spectral peak is considered to be a possible bearing tone, and it is passed to another part of the Expert System for rule base application. Through cepstrum analysis, the Expert System has the advantage of detecting rolling contact bearing wear without knowing exactly what model bearings are in the machine. Cepstrum also distinguishes bearing wear patterns from flow noise, or cavitation. Thus Cepstrum Analysis is responsible for a majority of the bearing calls by the Expert



System.