Derived POINT Application: Motor Current Analysis

By Joost Boerhout • SKF USA Inc., Condition Monitoring Center – San Diego

Requirements

This article assumes the reader has adequate knowledge of the following concepts: motor current analysis, induction motor analysis, and broken/cracked rotor bars.

Note: Motor current analysis using Derived POINT calculations requires functions available only to CMSW 7400 SKF @ptitude Analyst platform users.

Abstract

Many studies have shown that faults in a stator or rotor generally show Motor Current Signature Analysis (MCSA) spectrum side band frequencies around the mains frequency (50 or 60 Hz) and also at higher harmonics. A developing failure is typically observed as side bands of machine speed around the mains frequency. The first “side band amplitude to mains frequency amplitude” ratio is taken as a failure trend indication. Expressed in decibels (dB), a value of –40 to –35 dB or less is generally regarded as a threshold above which motor repair is imminent.

This article briefly explains the application of Motor Current Signature Analysis and goes on to describe how to apply SKF @ptitude Analyst’s Derived POINT functions to compute a failure trend.

Motor Current Signature Analysis – Broken rotor bars

Motor Current Signature Analysis (MCSA) is a method used for analyzing electrical motor problems. A complete analysis may include stator winding condition, rotor condition, air gap static and dynamic eccentricity, bearing issues, etc. For this article, we will concentrate on broken rotor bar side bands. The reader is encouraged to review a more complete MCSA description than found here, and to apply the principals of derived POINT functions as explained in this article.

Broken rotor bars are generally found as side bands of slip frequency around the fundamental frequency. Given an induction motor connected at a 60 Hz supply frequency (F) with 4 poles (P), its synchronous running speed is calculated by (120 * F)/P = 1800 RPM. The actual speed measurement on this motor reveals a running speed of 1760 RPM, a slip of (1800 – 1760) * 4 poles = 160 RPM. Translating the RPM values to frequencies, the motor current spectrum would show a main speed of 30 Hz with side bands at 60 Hz ±2.66 Hz. The amplitude ratio between the main frequency and one of its side bands computed in decibels is calculated by:

Equation 1.

$$20 * Log\left(\frac{As}{Am}\right)[dB]$$

Where:

- ***As*** = the amplitude of a side band
- ***Am*** = the synchronous speed amplitude level.

Note: It is common to select the left side band. Therefore, for the remainder of this article, assume the left side band as the reference. It is not necessary to select an Fmax end frequency that includes both side bands.

At times it is interesting to calculate directly the number of suspected broken rotor bars. The following formula provides an estimation of the number of damaged rotor bars:

Equation 2.

$$n = \frac{2 * Nbars}{\left[10^{\frac{\Delta dB}{20}} + Np\right]} = \frac{2 * Nbars}{[\Delta A + Np]}$$

Where:

- ***Nbars*** = the number of rotor bars
- ***Np*** = the number of electrical pole pairs
- ***ΔdB*** = the value computed by equation 1
- ***ΔA*** = the simple ratio synchronous frequency amplitude/side band amplitude

Notice that the square brackets indicate to truncate the result to an integer.

Using the derived POINT Peak_Value() function

SKF @ptitude Analyst derived POINT functions include a Peak_Value() function that is used to extract a peak spectral value from a predefined spectral band. The derived POINT function is defined as follows:

PEAK_VALUE(<DYNAMIC VARIABLE> ,<BAND NUMBER>)

Where:

<DYNAMIC VARIABLE> is the FFT variable associated with the measurement POINT, and
<BAND NUMBER> refers to the frequency band in the order they were created.

In **Figure 1**, SBand is the first band, Sync is the synchronous speed frequency.

The Peak_Value() function can be used to calculate the "side band to synchronous speed amplitude" ratio given by formula 1. We use the function to first extract the side band amplitude and then the synchronous speed amplitude. To ensure proper operation of this purpose, it is necessary to first define two spectral bands on the POINT that captures the motor current spectrum;

- A spectral band around the synchronous motor speed frequency
- A spectral band around one of the side bands

The synchronous motor speed is well defined and is not expected to change much, if at all. The band defining this frequency should therefore be fairly narrow. The side band frequency may change based on machine and load conditions and should therefore be defined to capture the expected deviations.

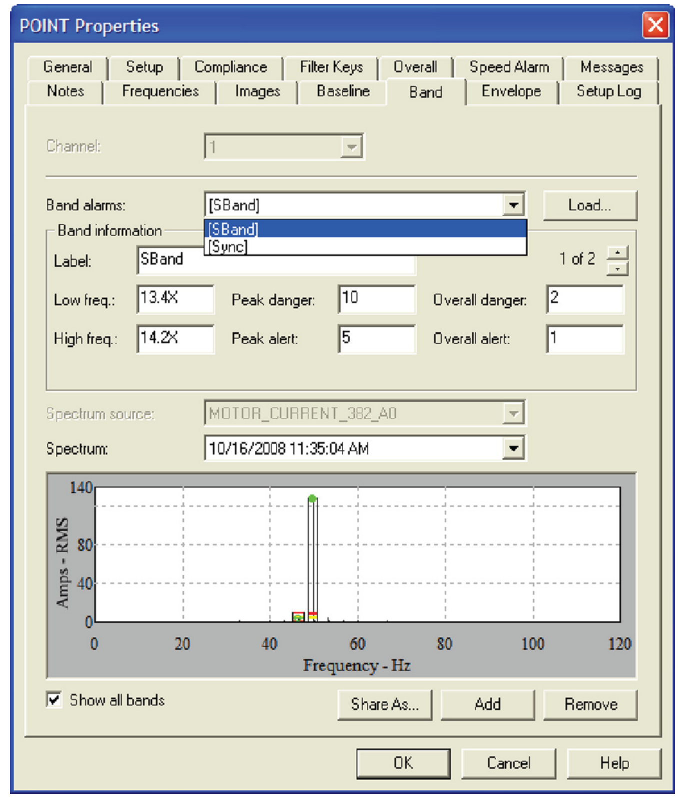


Figure 1. POINT setup showing the two frequency bands required for Motor Current Analysis with Derived POINTs.

It is important to notice that the Peak_Value() function uses the spectral band number, which is a value that follows the order in which the bands are created. This value is normally not exposed by SKF @ptitude Analyst, as SKF @ptitude Analyst attaches a hidden number in the order of which the bands are created. It is therefore best to name your bands starting with a number (e.g., _1_SBand, _2_Sync) to make the sequence clear.

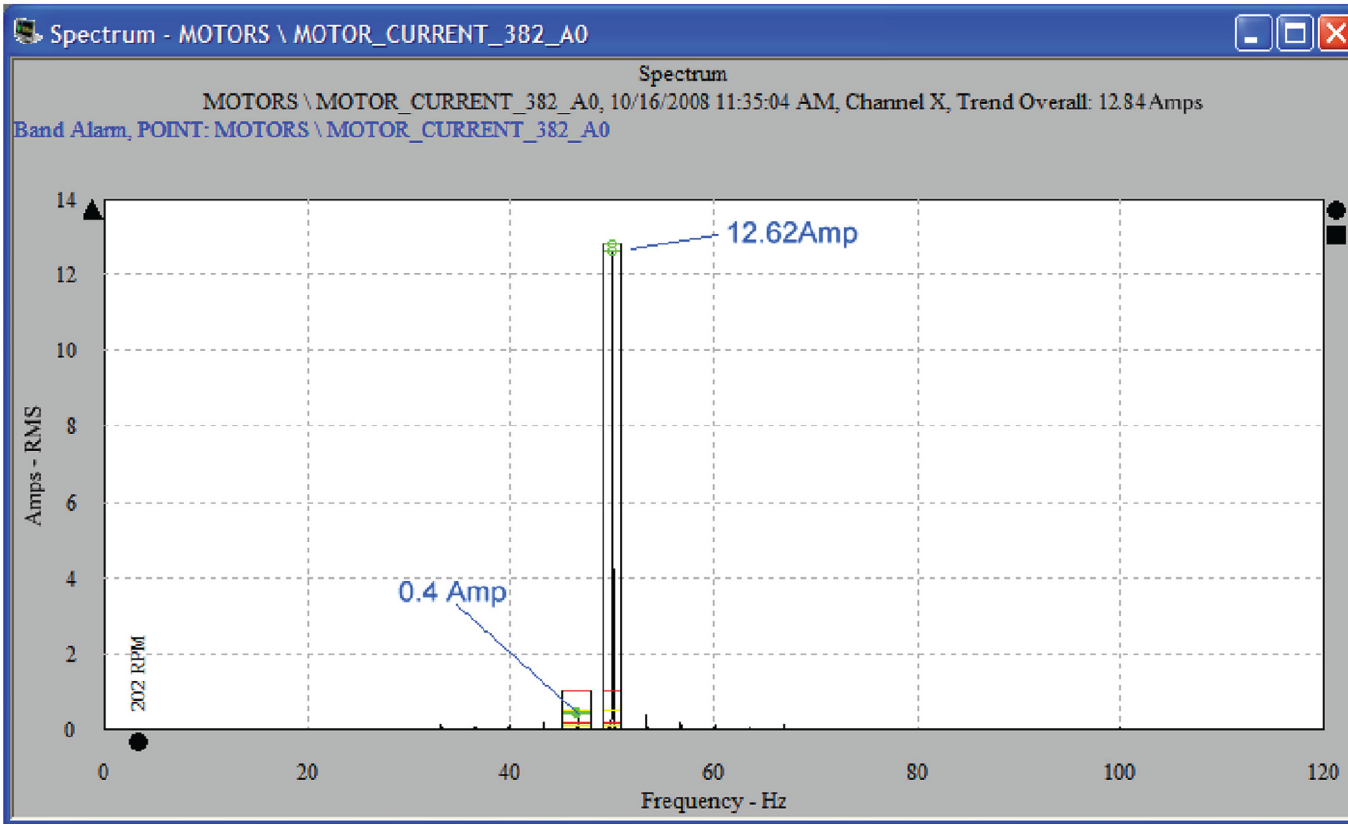


Figure 2. Motor current spectrum.

Example: calculating the motor current side band/sync ratio

The example shown in **Figure 2**, we measure a motor current signature spectrum with its synchronous speed at 50 Hz and first left side band at 46.6 Hz. The amplitudes as measured in the spectrum are 12.62 Amp and 0.4 Amp respectively.

The sideband/sync ratio is computed with: 20 * Log(0.4/12.62) = –29.9 dB. We can now set up a derived POINT that automatically calculates this ratio for us. **Figure 3** shows the setup of this POINT. Pay close attention to the formula and compare against the equation 1 provided.

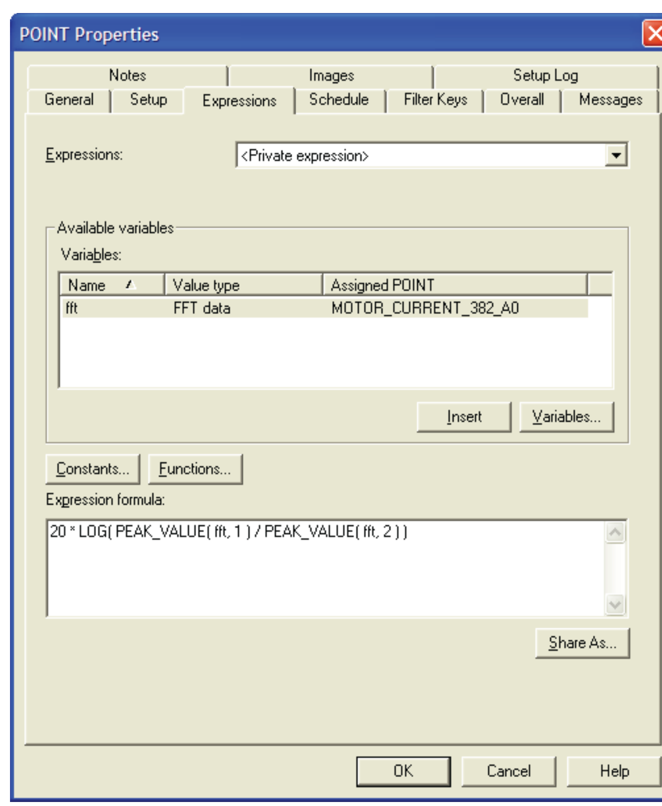
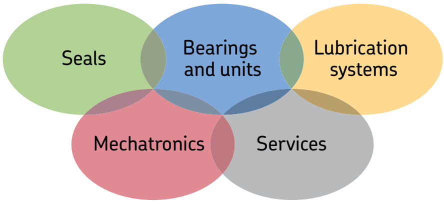


Figure 3: Derived POINT setup to measure side band/sync ratio.



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Please contact:

SKF USA Inc.
Condition Monitoring Center – San Diego
5271 Viewridge Court · San Diego, California 92123 USA
Tel: +1 858-496-3400 · Fax: +1 858-496-3531

Web: www.skf.com/cm

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