

# Enveloped Acceleration with the Machine Condition Transmitter (MCT)

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Enveloped acceleration is a powerful technique for identifying the existence of bearing and gear problems in operating machinery. This capability has been incorporated into the new Machine Condition Transmitter (MCT) Enveloped Acceleration module to enable plant operations and maintenance personnel to quickly and easily detect such problems and take timely corrective action before breakdown occurs. This paper provides a brief overview of the technology and how it works in the MCT Enveloped Acceleration module.

When a defect occurs in a bearing or a gearbox, impulse signals are generated. To translate the mechanical impacts of vibration to electrical impulse signals, an accelerometer sensor is placed on the bearing or gearbox housing. The Machine Condition Transmitter incorporates such a sensor input, in addition to two alarm indicators in the event that preset limits (Alert and Danger) are exceeded.

When impulse signals combine with the overall structural vibration signal and the normal noise signal of the machine, a complex vibration signal is produced. To separate the signal of interest from the unwanted low and high frequency vibrations, a process known as band pass filtering is used.

Both narrow and wide band pass filtering can help to detect a specific condition within the component. For example, imbalance or misalignment generates a sinusoidal, single frequency component, in which the once per revolution and twice per revolution vibration fundamentals are dominant. In these cases, the impulse signal is generated by local defects in bearings and gears as the defects pass between the mating surfaces of the raceway and the rolling element or between the gear teeth.



Fig. 1. Machine Condition Transmitter, MCT ENV (enveloped acceleration).

Wide band filtering is used to select that part of the frequency spectrum that contains the least interference from other signals, but enough energy in the impulse components to enable detection of the defect signal at an early stage of the defect's development. Typically, this signal includes a large number of both low and high frequency components, throughout which the energy is spread, resulting in low energy per component.

Enveloped acceleration is a method that groups the energy of the spread frequency components of an impulse signal into a single component. This enables sufficient energy within the impulse signal to detect a bearing or gearbox problem, while ignoring the components generated by unrelated events. The filtered acceleration signal is then full wave rectified and low pass filtered – or enveloped. High frequency components of the rectified signal are removed. The combination of rectifying and enveloping results in forcing the energy of multiple regularly spread frequency components coherent in the time signal.

Signals generated by impacting forces from a rolling element bearing under load or rolling over a local defect are very wide band in frequency. From the wide band acceleration signal generated in the sensor, the signals of interest are extracted by filtering out the unwanted frequencies. From the band pass filtered signal, peak detection is accomplished in the MCT. The peak signal is then integrated, ensuring that the impulses are repetitive so the peak follower can reach its maximum amplitude value.

The MCT ENV has several outputs:

- Standard 4 to 20 mA current output, proportional to the amplitude of the enveloped acceleration in the specified filter band
- Two buffered acceleration outputs: one BNC connector accessible via front panel and one buffered output located on the screw-terminals for permanent connection
- Two alarm relays: one Alert and one Danger relay and contacts
- Transducer “OK” relay and contacts

Additionally, the MCT features:

- Trip-multiply, to increase the preset alarm level by a factor (of two or three) until reset, usually for a short period of time to avoid false alarming; for example, during the start up phase of the machine
- Adjustable delay time – the change over contact of the relay switches when the alarm level set by the user is exceeded for a time period longer than the selected delay time
- Three standard filter bands integrated and jumper-selectable (→ table 1)

Table 1

**Integrated enveloped acceleration filter.**

Band number	Band pass frequency (Hz) (SKF Microlog)	Second order low pass filter roll off Fmin to Fmax	Filter option frequency (Hz)	Jumper (MCT)
# 2	50 to 1 000	100	-44	E4 and E7
# 3	500 to 10 000	1 000	-66	E3 and E6
# 4	5 000 to 40 000	10 000	-88	E2 and E5

- Latching or non-latching (standard) relay operations
- Compact DIN rail mount, for both "G" rail and "T" rail

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