SIEMENS

DF CS MD – Customer Services for Mechanical Drives

Vibration sensor technology

Selection of vibration sensor technology for gear-unit monitoring

Characteristic data for vibration monitoring

Vibrations of machinery are often used for assessing the condition of a machine. There are various methods for the acquisition and appraisal of machinery vibrations. Depending on the particular application there are various types of sensors used, the selection of which will be discussed below.

With machine monitoring it is often of interest to know how much energy is contained in the vibrations of a machine, i.e. how much it vibrates. A suitable characteristic value is e.g. the effective vibration velocity v_{eff} according to ISO 10816-3. According to this standard the vibration velocity values, measured over a measuring period, are determined as root mean square or RMS. The effective vibration velocity v_{eff} can be used as a limit value for the protection of the machine against excessive vibrations, arising e.g. from the process. By means of effective vibration velocity damage to the machinery can mostly be detected at a late point of time only, when the complete machine commences to vibrate more strongly. With regard to the damaged component or the type of damage there is normally no information available.

Various methods are used for early detection of damage to bearings, motors or toothed components, by which machinery vibrations are analysed frequency-selectively. The basis of all diagnostic procedures is high-resolution time raw-data from acceleration sensors from which spectra are calculated. These resolve the machine's vibration into its frequency components. In this way conspicuous vibrations can be followed up to individual components of the drive train. Also weak vibrations, caused e.g. by damaged bearings, can be detected at an early stage in this way.

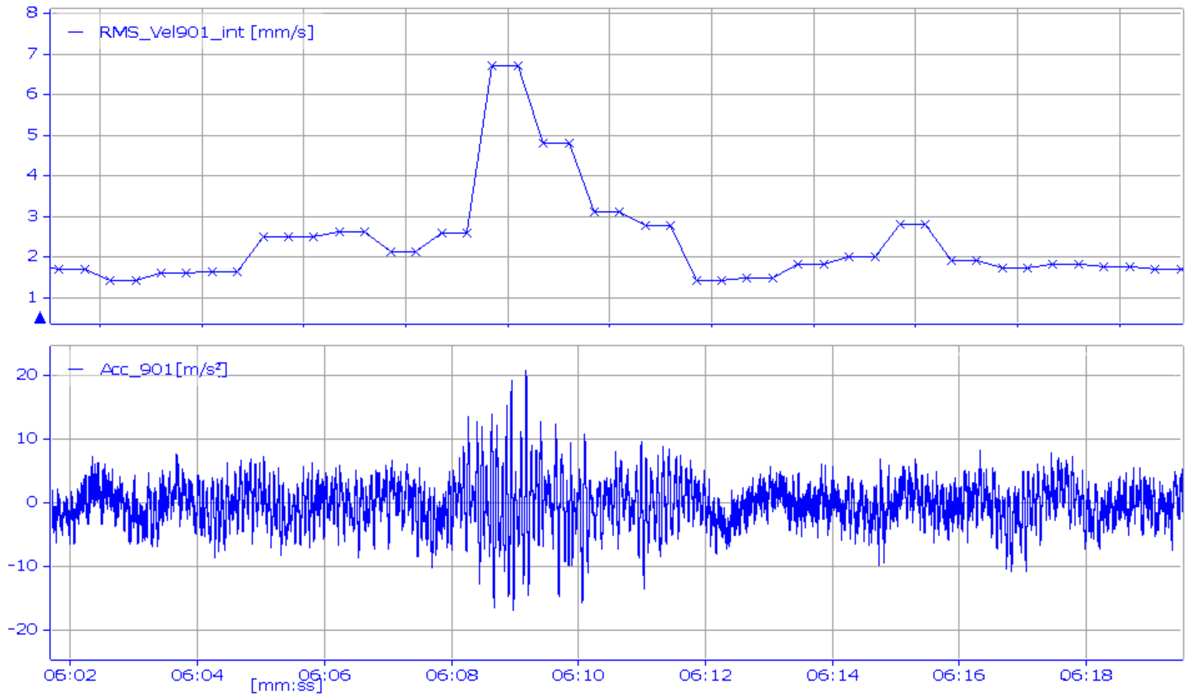

Figure 1: Effective vibration velocities (top) and high-resolution raw data (below)

Selection of suitable sensors

Depending on whether effective vibration velocities or high-resolution time raw-data are required, different types of sensors are employed. Effective vibration velocity can be measured in an uncomplicated way by means of *vibration transmitters* which output the effective vibration velocity as 4...20 mA analog signal. This signal can be read-in directly into an existing programmed logic controller (PLC) and integrated into the automation system, e.g. for the purpose of machine protection. The specifications of vibration transmitters for effective vibration velocities with 4....20 mA are laid down in Works Standard F6110 in Variant 4.

Sensors supplying high-resolution time raw-data can, because of the sensor power supply and the required sampling rates, not be integrated directly into an existing control system. The mostly used sensors for such applications are the *Integrated Electronics Piezo Electric sensors*, abbreviated *IEPE* sensors. These must be connected to a specifically dedicated interface. For this, special measuring systems are required which often also analyse and monitor the calculated results. Suitable measuring systems are in the market, mobile systems for varying applications, as well as permanently installed continuously measuring monitoring systems. Sensors for connection to such measuring systems are defined in Factory Standard F6110 in Variants 2 and 5. Both variants are identical with regard to measuring technology and differ only in respect of the position of the cable outputs.

	Vibration transmitters for effective vibration velocities (F6110/4)	ICP acceleration sensors (F6110/2 and F6110/5)
Application:	▪ Machine protection ▪ Detection of damage at a late point of time	▪ Early detection of bearing and gear damage
Connection:	▪ Controllers (4...20 mA analog signal)	▪ Special mobile or permanently installed measuring systems (IEPE Standard)
Advantages:	+ Easy integration into existing control system + No complex analytics	+ Early detection of bearing and toothing damage (when employing suitable analytics)
Disadvantages:	- No early detection of bearing and gear damage - No information regarding damaged components	- No direct connection to control system possible - More complex analytics
Example:	▪ Shut-down of cement mill due to increased vibrations originating in the process ▪ Monitoring of non-critical drives and processes via plant control system	▪ Predictive maintenance of drives based on mobile measurement ▪ Monitoring of critical drives and processes by means of on-line measuring system

Table 1: Overview for the selection of suitable vibration sensors

The selection of a suitable vibration sensor depends, therefore, on its task and the available connection features. An overview over the fields of application, connections and advantages and disadvantages is given in Table 1.

