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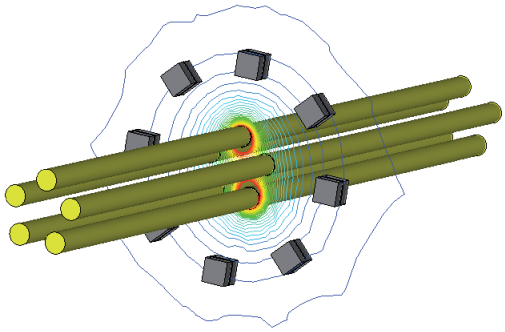

1 *Multi-core cables for the energy supply of machines*
2 *Sensor principle – stray field analysis of a multi-core cable*

NON-INVASIVE MULTI-CORE CABLE SENSOR

SENSORS FOR DIGITALIZATION

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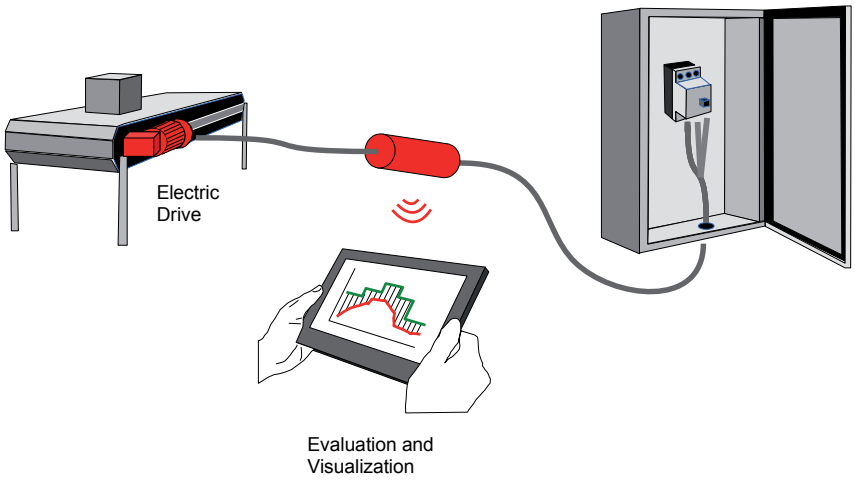
The enhancement of equipment availability, the improvement of energy efficiency and the optimization of industrial processes are tasks that are to be solved by means of digitalization. Corresponding solutions are part of the Internet of Things (IoT) and Industry 4.0 technologies. These include solutions for the acquisition and provision of relevant parameters of energy assets or production machines by networked sensors. A common problem is the accessibility of corresponding data from existing plants and machines. Obstacles in the implementation of IoT and Industry 4.0 solutions can be missing sensors, inaccessible interfaces or increased effort to reach suitable measuring points. Especially in existing machineries this presents an insurmountable challenge. Often older machines do not have open interfaces or sensors cannot be installed. For this reason, a non-invasive easy installable sensor solution to monitor energy assets and machinery is of great interest.

In many applications the currents in supply lines of assets or machines give detailed information about its operation mode, energy efficiency and maintenance demand. Therefore, it is of interest to be able to measure parameters like current, voltage and energy flow direction in multi-core cables in a non-invasive way. This means that the insulation will not be damaged to separate the single cores.

For these applications Fraunhofer IMS has developed a non-invasive sensor for multi-core cables:

- non-invasive and wireless operation for easy installation
- measurement of currents and voltages in multi-core cables

Every electrical current flow in a conductor is surrounded by a magnetic field. This fact is exploited by the innovative method used here. Using sensitive miniaturized magnetic



field sensors in conjunction with intelligent algorithms, the so-called stray fields are taken, analyzed and the currents of the individual conductors of the multi-core cable are derived. The challenge here is to be able to do measurements without impracticable calibration procedures even without knowing the relative position of the conductors within the cable.

Based on this innovative method a non-invasive current sensor for multi-core cables can be realized. The sensor can be easily clipped around a cable and current measurement of each conductor inside the cable will be performed. Separation of the individual conductors is not necessary anymore using this concept.

Wireless Operation

Wireless operation of sensors avoids cabling and enables easy retrofitting.

Innovative Measurement Principle

Non-invasive measurement of currents in multi-core cables by analysis of magnetic stray field surrounding the cable.

Self-Calibration Algorithm

Due to an intelligent self-calibration algorithm no manual calibration procedure is necessary to consider unknown relative positions of the conductors inside multi-core cables.

System Properties of the Demonstrator

- Measurement Range: 1 A … 32 A (each conductor)
- Wireless communication: Wifi
- Current measurement: stray field analysis
- Mounting: can be clipped around cables

Applications

- Ad-hoc energy flow monitoring
- Connecting machines to the Industrial Internet of Things (IIoT)
- Process optimization
- Energy monitoring
- Peak load management
- Condition monitoring

3 *Application scenario*