Test4Rail

TECHNICAL **APPLICATION**

Insulation monitoring devices manufactured by Bender GmbH & Co. KG are used in many parts of the transport network to raise safety levels. In railway engineering, many of these devices are installed in key items of infrastructure such as signal boxes. The limit values for these systems are monitored in accordance with regulations such as Corporate Directive 892 issued by Deutsche Bahn Netz AG (DB Netz).

New ideas for using data from insulation monitoring devices in the railway field

Datenlogger

In practice, the response or alarm value for the insulation resistance of cable systems in signal boxes is about 30 kΩ. Corrective or counter measures have to be taken if the resistance falls below this value. Unfortunately, no subsequent analysis of limit value observations takes place, even though the devices usually have the interfaces for data output.

Data logger collects values

DB Netz, Bender and Deutsche Zentrum für Luft- und Raumfahrt e. V. (DLR) have set up a joint project to develop a prototype system to assess the potential of continuously monitoring these measured values. As part of this project, a data logger developed by Bender has been installed in the signal box at Plattling (Bavaria) (Figure 1). The data logger records the individual measured values from the RS-485 interface and makes them available as a data file for further analysis. The RS-485 interface is parameterised in “isoData” mode to allow the necessary unidirectional communication for retrofitting. The data logger must operate free of feedback.

The availability of this data opens up several options for the user.

Fig. 1
Data logger on the RS-485 interface of a Bender ISOMETER® IRDH265 in Plattling

Better and more objective tracing of malfunctions

The first advantage is that malfunctions can be retrospectively analysed. When a malfunction occurs, the event can be more precisely and objectively recorded. For example, if a short-term drop below the limit value occurs and then disappears after a few seconds, this triggers the alarm and calls out the maintenance engineer. By looking at the data after the event, it may be possible to identify the cause of the malfunction, which had disappeared by the time the repair team arrived. From an analysis of the time of occurrence and the duration of the event, and, if possible, the state of the system at the time, the cause can be identified.
The second advantage is that the data can be combined with other information, e.g. weather or operational data. Figure 2 shows an example based on real data, in which a drop to an extremely low value was found to coincide precisely with heavy rain of 12l/m^2. In the light of this information, engineers can come up with theories and derive empirical values about how robust a system is, for example, against heavy rain. Once this is known, forecasting models can be created and, for example, used to predict and therefore better anticipate malfunctions using the weather forecast. At the same time, this also increases the understanding of how the system reacts to outside influences.

Fig. 2

Change of insulation resistance as a result of heavy rain

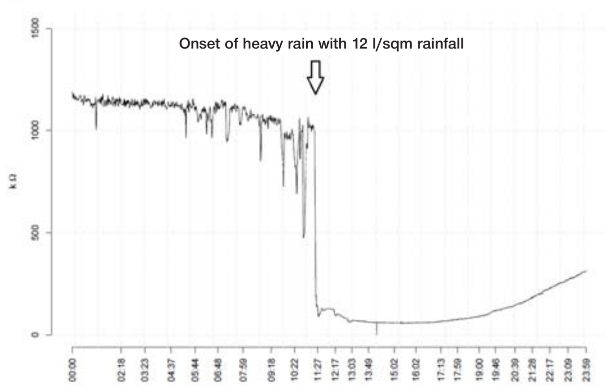
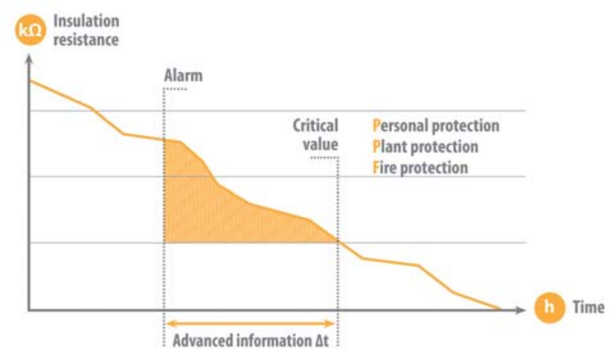


Fig. 3

Model of the information advantage gained from continuous monitoring after [1]



The third advantage is that, in addition to sporadic effects, which are mostly traced back to external influences (such as the weather), it would also be possible to observe long-term degradation processes. These arise through constant wear on the system or permanent loading. Figure 3 shows a model of this [2]. If this type of degradation can be monitored, the operator can use the information and gain some advanced warning of a future failure. He may then use this period of prewarning to work out the optimum time for re-investment before eventually renewing or repairing the system.

▶▶▶

[1] www.Bender-de.com: "Product overview: ISOMETER® – Insulation monitoring devices, ISOSCAN® – Insulation fault location systems EDS", page 4, http://www.bender-de.com/fileadmin/products/b/e/ProductOverview-Isometer_PROSP_en.pdf

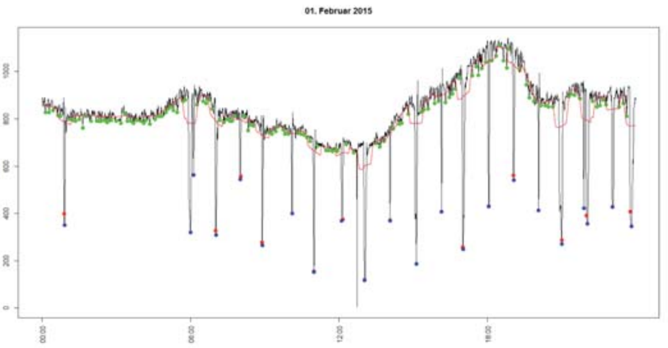
[2] Wolfgang Hofheinz: "Protection technology with insulation monitoring!", VDE Series 114, pages 151-154 (in German)

Empirical data for better understanding and prevention

The availability of this data gives the operator a better understanding of his system and therefore the option to change from a reactive (reacting to reported failures) to a preventive maintenance strategy. DB Netz has also seen the possibilities offered by this idea and has been working for some time on a diagnosis platform, known as DIANA, for collecting and processing diagnostic data from its infrastructure out in the field. DB Netz already has a large number of ISOMETER® model IRDH265 insulation monitoring devices installed in many of its signal boxes. Adding a data logger to these for this purpose would be relatively easy.

Fig. 5

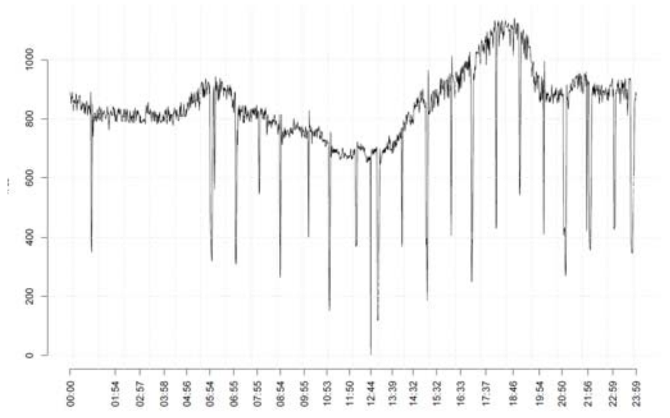
Raw data with automatic peak detection (blue points)

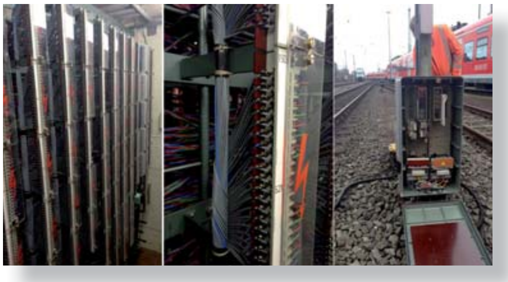


Furthermore, future device generations will not only recognise different and more accurate types of measured data, but also systematise the method with standardised data transmission interfaces using gateways. The methods and equipment for this joint project have been so smoothly integrated into the DB Netz strategy that Bender and its products are already well placed to take further part in its customer's innovative projects. DLR is also in the position to contribute to the project by transferring its experience in various applications, for example, switch points or superstructure diagnosis, gained from many years of assessing railway systems.

Fig. 4

Raw data from insulation measurements dated 1 February 2015





"**Future device generations** will not only recognise different and more accurate types of measured data, but also systematise the method with standardised data transmission interfaces using gateways"

Prognoses through visible peaks

In addition to weather effects, other phenomena can be observed and investigated in the data. Figure 4 shows the measured data from 1 February 2015. The eye is immediately drawn to the instantaneous peaks in the measured values. These appear to highlight a problem that is not yet serious enough to cause the values to drop below the failure limit, but could lead to potential malfunctions. These peaks could be detected automatically using a wavelet transformation, as can be seen in figure 5 (blue points). If the number of peaks per day is counted , it can be used to reveal a trend as shown in figure 6. The number of peaks decreases in summer, which indicates that the system is likely to be more robust at that time of the year. These are the first tentative approaches to a possible method of prognosis using as yet undetermined assessment parameters derived from the raw data and monitored over time. Figure 7 shows a model illustrating one possible way this could be taken forward.

Work at the moment is progressing on data collection and monitoring. The first abnormalities are being identified, for example the widespread reduction in values due to rain, and the unexplained short peaks.

The identification of parameters, the reasons for them, and their assessment are the subject of DLR's current research arising from this joint project with DB Netz and Bender, the scope of which will be extended in the future. ■

Dipl.-GeoInf. Christian Linder
Deutsches Zentrum für Luft- und Raumfahrt e.V.
Institut für Verkehrssystemtechnik

Fig. 6

The reducing number of peaks per day between February and May

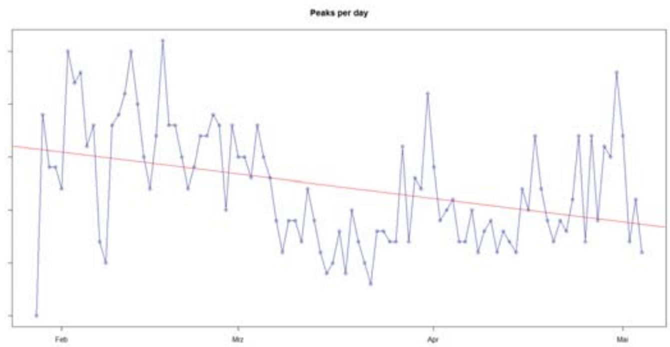


Fig. 7

Model of the complexity of system diagnosis systems compared with their benefits