SHERLOG CRX

Implementation of compatibility requirements in components of electrical supply systems using digital fault recorder systems by way of example

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The ongoing construction and expansion of intelligent electricity networks, known as smart grids, and the concurrent move towards more decentralized structures for power generation, storage and transmission, mean that electricity networks are able to respond increasingly efficiently to variations in demand. The increased use and continuing development of state-of-the art IEDs (Intelligent Electronic Devices) and the extensive interconnection of different energy system components also play a key role in making this possible. However, this decentralized interconnection relies on the smooth interaction of all the individual components involved. IEDs made by different manufacturers and belonging to different device generations must be capable of exchanging measurement, status and control data with one another and must also be guaranteed to be suitably equipped to cope with future modifications and developments.

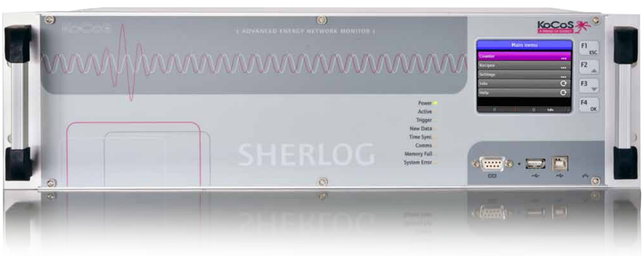

Figure 1: SHERLOG CRX Fault Recorder System

Such compatibilities between different devices and installations within electricity supply networks are already provided by communication standards and protocols such as IEC 61850 and IEC 60870. However, particularly when there is a need to extend or modify old systems and installations, a number of problems arise in connection with the fulfilment of even basic compatibility requirements. For example, it may not be possible to replace or repair individual defective devices because the manufacturer has discontinued production and support in the meantime. If the failure of one or more such devices calls the basic operation of the whole system into question, often the only solution is to replace all the devices which belong to the same series as the defective device. If the total costs of purchasing new equipment, removing the old devices and installing new ones are taken into consideration, having to decommission devices which are still in perfect working order is arguably the lesser evil. If the obviously cheaper approach is chosen instead, and defective older devices are replaced with appropriate equivalent devices made by other manufacturers, the challenge lies in maintaining their compatibility in such a way that the central evaluation of data and processes within the whole system, for example, is preserved.

Compatibility requirements using a digital fault recorder system by way of example

Digital fault recorders are a very good illustration of the transformation of a straightforward but nonetheless essential acquisition system for system disturbances into a comprehensive, multi-functional IED for complex monitoring and evaluation tasks in various different areas of electrical installations and systems. In view of the wealth of possibilities afforded by modern fault recorder systems with regard to configuration, functionality and evaluation, it is now hard to argue how such a broad performance spectrum could be covered by the very limited recording functions of digital protection relays. Comprehensive recording functions for fault, trend and power quality data allow a fault recorder system to be adapted flexibly and efficiently to meet a wide range of measurement and monitoring requirements, for example. Furthermore, fault recorder systems often assume the additional role of an independent administration unit which can automatically assess, process and distribute recorded measurement data and events, making them available to the human user in a form which is customized with regard to application and content. However, this fundamental process for guaranteeing efficient and targeted bundling of relevant measurement and status data can itself be severely degraded and limited. This can occur when different fault recorder systems are deployed in one and the same application or installation, for example, or when plans to extend such an application or installation require it. Because different software tools are used to operate the different fault recorder systems and evaluate their measurement data, any previously implemented centralized acquisition and processing of measurement data via a dedicated user and process interface has to be broken up, leading to the loss of the assignment of measurement data emanating from the same power systems but distributed across a number of different fault recorder systems. Status and event signals which fault recorders exchange with one another as well as with the user interface can no longer be managed and processed centrally. Serious compatibility problems can also occur in connection with the acquisition of analog measurement signals for voltage and current when old devices are replaced by new ones. The new device chosen may have the same number of analog measurement inputs, but the distribution in respect of voltages and currents may not match the given distribution of the signals which are actually to be measured, for example.

Using the SHERLOG CRX fault recorder system *(Figure 1)* made by KoCoS Messtechnik AG by way of example and the scenario of an existing installation of fault recorders belonging to a different system (type XYZ), a step-by-step description now follows of various ways of establishing suitable compatibilities for the following levels and processes:

- Optimum hardware adaptation when replacing existing fault recorder systems or installing new ones
- Amalgamation and management of measurement data in a central analysis database for further evaluation and processing
- Triggering of fault recordings using cross triggers between different fault recorder systems

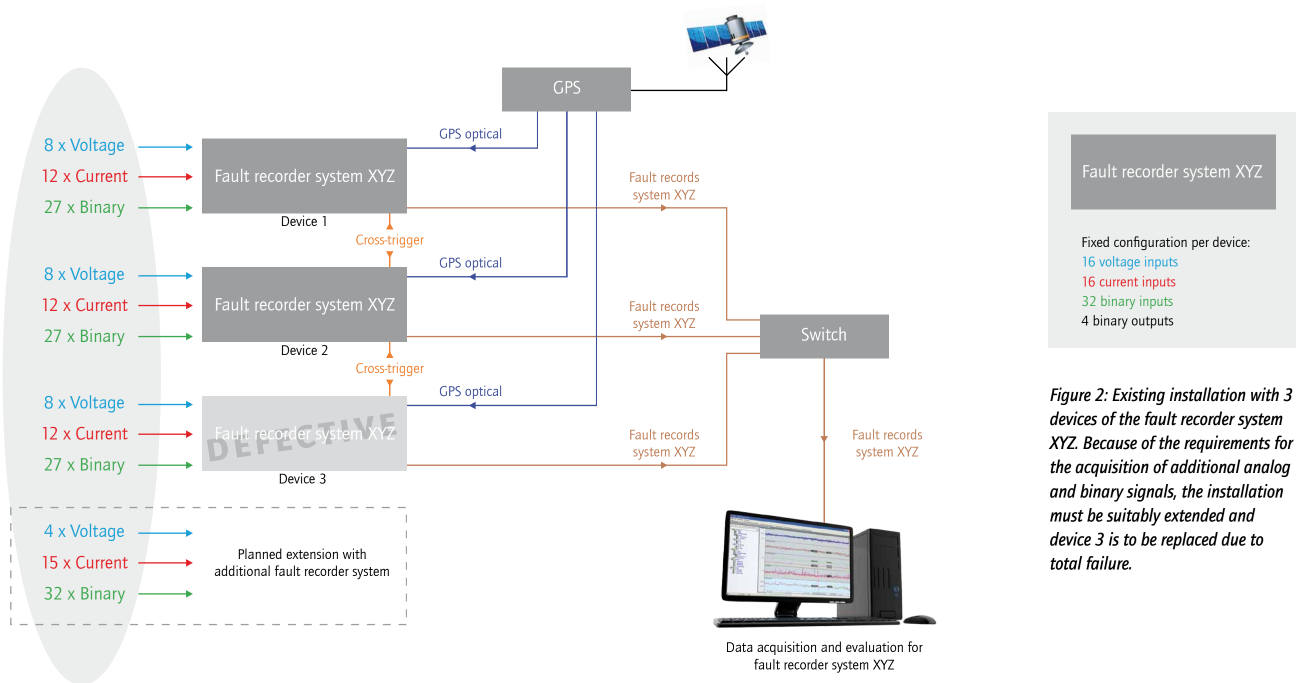

Figure 2: Existing installation with 3 devices of the fault recorder system XYZ. Because of the requirements for the acquisition of additional analog and binary signals, the installation must be suitably extended and device 3 is to be replaced due to total failure.

Overview of technical conditions and requirements using an existing fault recorder installation by way of example

For an existing installation of three fault recorders of type XYZ, a general extension of the entire installation is to be carried out and one device is to be replaced due to total failure *(Figure 2)*. Because the manufacturer has discontinued production, it is not possible to repair the defective device, nor is it possible to replace it with a device belonging to the same system and so a different system will have to be used. However, the central acquisition and evaluation of data and the exchange of cross-triggers are to be preserved despite the use of different fault recorder systems.

Step 1:
Replacement and new installation of a fault recorder system with optimised hardware adaptation

When replacing existing fault recorder systems, the adaptation of existing analog and digital measurement channels often proves difficult when the new system only offers fixed standard configurations for the type and number of measurement channels. Although existing measurement signals can usually be connected, it can often only be achieved by accepting the existence of a number of superfluous, unused measurement channels.

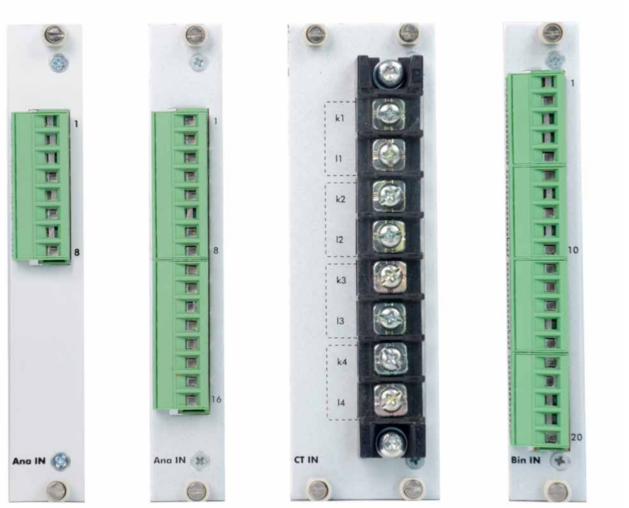

Figure 3: Analog and binary modules for modular equipment of the SHERLOG CRX. From left to right: 4-channel voltage module, 8-channel voltage module, 4-channel current module, 16-channel binary module.

Thanks to the modular hardware design of the SHERLOG CRX, the configuration of the measurement channels of each and every individual device can be composed flexibly using different modules to accommodate up to 32 analog and 128 binary signals *(Figure 3)*. This means that the SHERLOG CRX devices which are used for replacement and extension of the installation used here as an example can be adapted perfectly to fit the requirements for analog and digital measurement signals without the need to resort to models with a fixed configuration *(Figure 4)*. For synchronising the time of both SHERLOG CRX devices, an optional time synchronisation module can be used to integrate the optical GPS telegram from the central clock via one of the devices and pass it on to the second via a dedicated communication bus.

Because of its modular hardware design, SHERLOG CRX provides comprehensive possibilities for adapting to a wide variety of signal requirements. As shown above, this is advantageous when replacing existing fault recorder systems of another type as well as when installing additional new fault recorder systems. In addition, SHERLOG CRX can also be upgraded easily on site by adding further modules using simple Plug & Play technology. This means that future extensions can be integrated in existing systems with minimum effort and expense.

Step 2:
Amalgamation of the measurement data from different fault recorder systems for the purposes of central management, evaluation and further processing

While there may in principle be no reason not to operate different fault recorder systems in parallel, serious problems will still arise in connection with the acquisition and evaluation of their measurement data. The actual programming of the measurement and monitoring functions of each individual system is primarily limited to the relatively short time period of the initial installation and so it presents no problem if different configuration tools need to be used for this purpose. However, if different programmes have to be used for managing databases and analysis functions later on during operation of the measurement equipment, sometimes even distributed over a number of workstations, the central evaluation of processes and measurements can only be partially implemented and maintained. For this reason, it is imperative to ensure that all available data be made centrally available to the user of such management and analysis programmes, independently of the data's provenance from individual fault recorder systems.

Special Topic

The intuitive SHERLOG Online software provides a comprehensive total package for the configuration, operation and evaluation of SHERLOG CRX systems. The integration and automatic monitoring of an unlimited number of devices using just one workstation computer plays a particularly important role in enabling the creation of a highly centralized system structure. By assigning SHERLOG CRX units to different topologies, it is possible to manage and display them at separate voltage and installation levels within one device list, for example. New recordings can be transferred automatically to the local analysis database by dedicated devices at freely configurable time intervals and can then be further disseminated by means of e-mail or fault report printout, for example, on the basis of criteria which can be configured flexibly.

In order to integrate fault recorders made by other manufacturers, the SHERLOG Online software features the option of integrating them directly in the SHERLOG analysis database and device management by importing recordings in the COMTRADE format. All that is required for this purpose is to set up a storage path for the other systems, or for their operating software, which is accessible to SHERLOG Online and under which fault records are saved in the COMTRADE format. Existing recordings and new recordings are then automatically imported by the SHERLOG Online software into the central analysis database and can also be automatically passed on, just like recordings from SHERLOG CRX devices. This means that the SHERLOG Online software creates a vital compatibility layer between different fault recorder systems to allow the central management of devices and data.

For the installation we are using here as an example, the SHERLOG Online software is installed on the central computer connected to the communication network and the two existing SHERLOG CRX devices are linked up to the software. A software programme which runs in parallel to SHERLOG Online then saves the measurement data from the other two fault recorders of type XYZ as a COMTRADE export in storage paths which can be accessed by SHERLOG Online, thus creating a complete and centrally accessible overall system *(Figure 5)*.

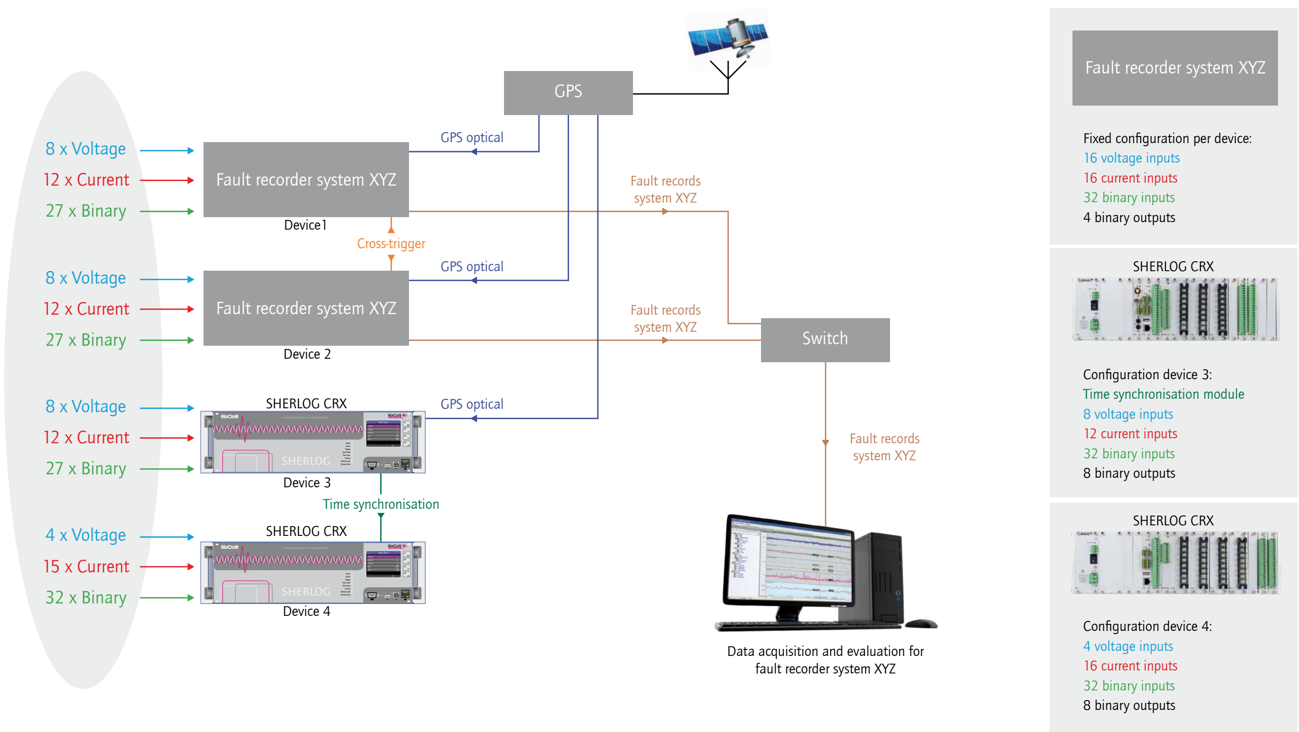

Figure 4: Installation equipped with 2 additional and differently configured SHERLOG CRX devices with integration and transfer of the existing time synchronisation.

Step 3:
Triggering of recordings using cross triggers between different fault recorder systems

Particularly when measurement signals in large power systems are distributed across a number of fault recorders, a detailed analysis of fault events requires more than just the measurement data of the fault recorder which triggers in response to a specific event. Other parts of the system and other process quantities may also be affected by the consequences of the fault which has occurred. However, they are not necessarily so strongly affected that the trigger criteria which have been set will trigger recordings in the fault recorders there. In order to obtain a comprehensive overview of the behaviour of the entire power system in these cases too, it is possible for the fault recorder on which the network fault triggered the recording to send trigger signals to other devices, these are known as cross-triggers. The recordings of all the devices involved can subsequently be merged on the basis of their time stamps to form an overall system recording and can then be analysed.

If all existing and newly added measurement signals in the installation used here as an example are seen as part of a single power system, then the challenge is to integrate all the devices in one common cross-trigger, although two different fault recorder systems are being used. Because cross-triggers are frequently exchanged via system-specific communication leads and protocols, another means of implementing this on a cross-system basis must be found. The option of using the binary inputs and outputs of the individual fault recorders to receive or generate trigger signals presents itself here. By addressing a dedicated binary output at the start of a fault recording, a trigger pulse can be passed on to a fault recorder belonging to the other system in order to start a recording there. Sending a cross-trigger to the other devices of the same system in connection with a recording does not only enable cross-system cross-triggering as desired, but also minimizes the number of binary inputs and outputs required, as only one device belonging to each fault recorder system is needed to send and receive trigger signals for connection to the other system *(Figure 6)*.

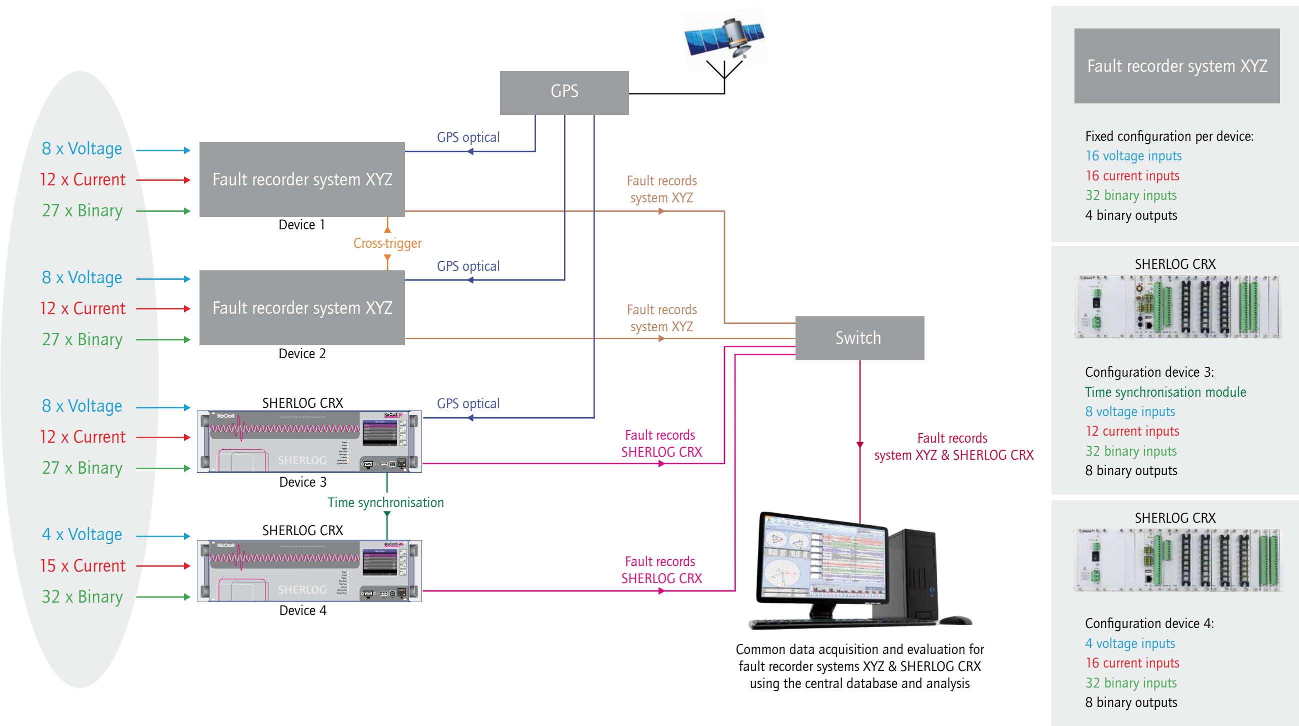

Figure 5: Integration and management of the measurement data of both fault recorder systems in a common analysis database. The measurement data of the XYZ system is automatically saved via a common communication network in COMTRADE format in a dedicated storage path, using which the SHERLOG analysis software integrates the data into the central database.

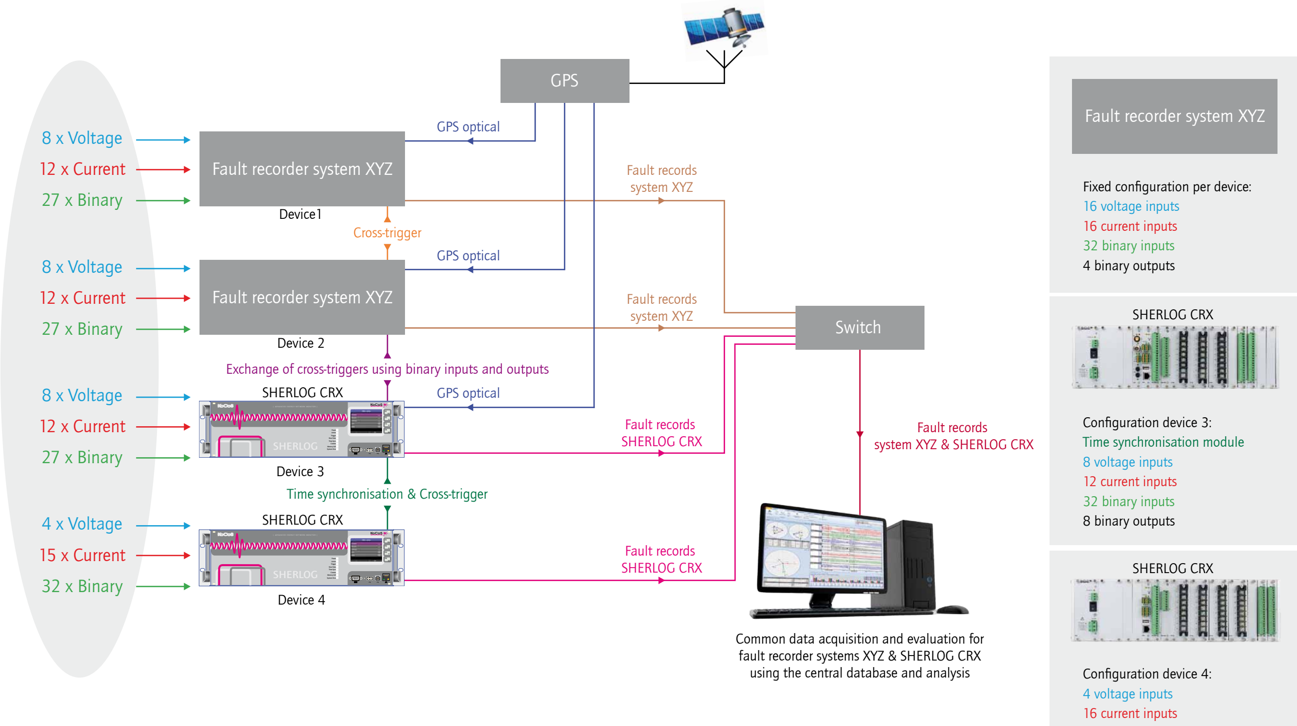

Figure 6: Transfer and receipt of cross-triggers between the two fault recorder system groups using binary inputs and outputs. The exchange of cross-triggers within the system groups themselves is still effected using their dedicated communication leads and protocols.

Summary and conclusion

The steady rise in decentralized structures within electricity supply systems goes hand in hand with an increase in the need to provide suitable interfaces and nodal points for the compatibility of their individual components with one another. If the components which are to be connected they themselves also feature decentralized structures and properties, then compatibilities have to be created at different levels and these compatibilities are often not immediately obvious from the outside.

Using the operation and extension of an existing fault recorder system as an example, various possible scenarios have been developed to identify the compatibility requirements which emerge at the lowest levels of an electricity supply system in particular and the approaches which are capable of meeting these requirements. Particularly when new fault recorders are integrated in existing systems of another type, a number of requirements arise in connection with the preservation of existing centralized interfaces within a decentralized structure at a higher level. When replacing defective devices, fundamental requirements regarding the number and type of measurement channels can be met to optimum effect by choosing a modular replacement system which features flexible configuration options.

By integrating and amalgamating measurement data and status signals, different fault recorder systems can be converted into a centralized overall system by means of a common software interface for higher levels. But appropriate compatibilities can also be realized for essential connections between the systems themselves, e.g. the dispatch and receipt of cross-triggers. Using a wealth of hardware and software interfaces, it is possible not only to plan and implement project-dependent requirements on a cross-system basis for the extension of existing installations, but also to replace individual defective or outdated devices without sacrificing existing structures for connections used for communication and for the acquisition of measurement values.

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