SHERLOG CRX

Efficient ways to optimise the costs of monitoring and evaluating electrical supply systems using modern IEDs

Dipl.-Ing. Hardy Nickell, Product Manager, KoCoS Messtechnik AG, Korbach

In 1965, Gordon Moore, co-founder of Intel, predicted that the complexity of integrated circuits with minimum component costs would double every 12 to 24 months. Although „Moore's Law", as it became known, has been challenged and rephrased repeatedly since then, it remains an accurate reflection of the general principle which lies behind our modern-day acceptance of technological progress: the continuous improvement of performance while minimising size and cost at the same time. This type of progress does not only bring positive effects for ordinary consumers in their day-to-day lives, it also brings benefits in the field of power generation and distribution with the use and continued development of IEDs in many different areas. The latest generation of IEDs must meet a multitude of different requirements, including high reliability and system stability. But the costs which automatically arise in connection with the installation, configuration and operation of a new IED should also be kept as low as possible. A number of different ways to optimise costs of this kind are described below, using the latest generation of SHERLOG CRX fault recorders from KoCoS Messtechnik AG by way of example:

- Reduction in the amount of space and the number of devices required due to compact system dimensions and high availability of measurement inputs
- Reduction in the number of analog measurement channels required, obviating the need for their installation thanks to software-based assignment and calculation of process data
- Use of IEC 61850-8-1 GOOSE messaging to reduce the number of hard-wired binary channels
- Network-based time synchronisation and cross-triggering
- User-friendly system planning and maintenance thanks to modular hardware design

Conventional digital fault recorder applications have been greatly enhanced by SHERLOG CRX *(Fig. 1)*. The fault recorder itself is just one of a range of functions for the comprehensive acquisition and evaluation of power system quantities and events. In addition to recordings made with sampling rates as high as 30 kHz, the acquisition and evaluation of binary status signals and a number of other event-driven and continuous measurement and recording functions for mean values and power quality all go to make a complete system with optimum capabilities for monitoring and assessing fundamental network quantities and characteristics.

Reduction of investment and installation costs due to compact design of devices and measurements

As the installation of a new IED often involves the requirement for the new device be as space-saving as possible, SHERLOG CRX's small size makes it the ideal choice. The installation of a number of systems can take up just half or even less than half the space which would normally be required, as up to 32 analog and 128 binary signals can be connected per device, using a mixture of direct inputs and external sensors for the acquisition of current measurements.

Fig. 1: SHERLOG CRX Fault Recorder System

Not only does the fact that each individual device can accommodate so many measurement inputs lead to fewer systems being needed, it also contributes to a reduction in general installation costs, such as those connected with system cabinet components or measuring leads, supply lines and communication leads, for example, as a result of the reduction in space requirements.

When the installation of a fault recorder system is considered in general terms, the costs for wiring and connecting measurement and communication channels surely make up the lion's share. But here too, a number of improvements can be provided by the system itself in order to reduce the number of connections required without compromising on functionality. For lines of the same bus bar, SHERLOG CRX, for example, offers the option of carrying out just one 3- or 4-phase measurement of the system voltage and then assigning the measured value to the appropriate current channels in the software-based device configuration. This means that up to 9 incoming and outgoing lines can be supported by one SHERLOG CRX device, without the voltage having to be measured individually for each line. Not only does this keep wiring down to a minimum, it also minimises the overall number of devices required because so many lines can be connected to each individual device. If a 4-phase measurement is required and the measuring system also offers a function for calculating the displacement voltage and neutral current internally, it is possible to achieve a 25% reduction in availability and wiring requirements for analog channels as well as a corresponding reduction in the overall number of measuring systems needed, when a large number of signals are to be measured.

Use of IEC 61850-8-1 GOOSE messaging to reduce the number of directly wired binary channels

With the transmission of the status of switchgear devices and other technical equipment in electrical substations via GOOSE messaging (Generic Object Oriented Substation Events), as defined in IEC 61850-8-1, the installation work required can be drastically reduced for all the IEDs involved. Depending on the proportional availability of status signals via GOOSE, their integration does not require anything more than the installation of suitable network structures, as is generally required, and does not involve direct wiring of binary inputs and outputs between different switchgear devices and other IEDs, as is otherwise needed.

The new SHERLOG GOOSE server system constitutes a continuation of the simple and modular configurability of the SHERLOG CRX system at IEC 61850-8-1 GOOSE level. Being a discrete server system, it can be integrated in the overall structure independently of the size and configuration of any existing CRX overall system complete with devices and evaluation computers *(Fig. 2 and 3)*. The intuitive user and configuration interface allows GOOSE signals from dedicated IEDs to be integrated in line with individual user requirements

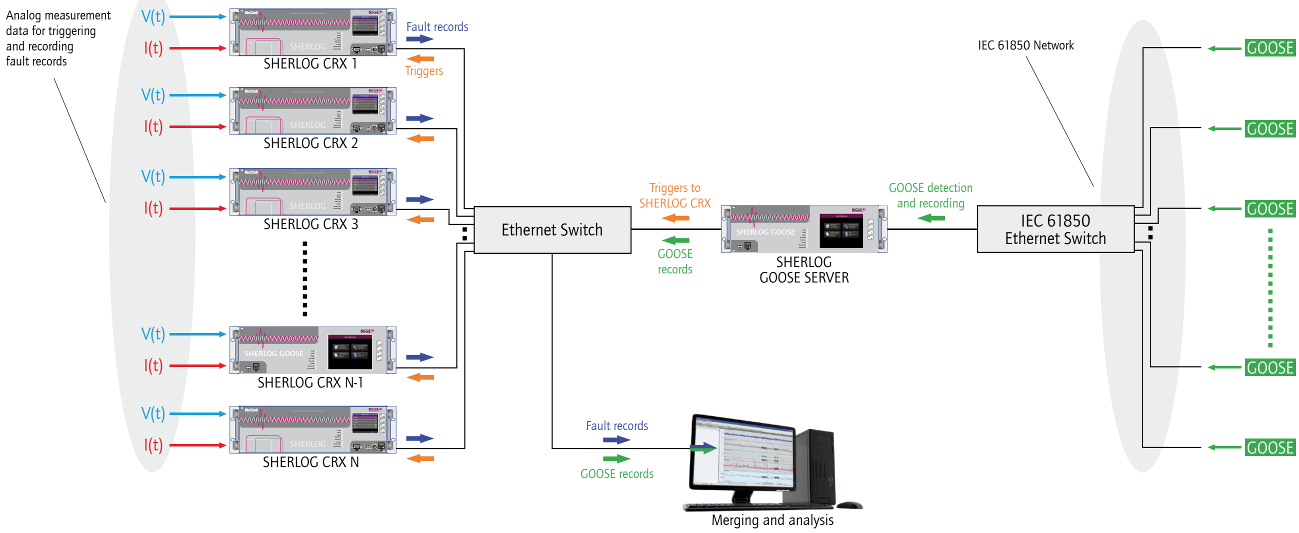


Fig. 2: Integration of IEC 61850-8-1 GOOSE Messaging, Variant 1: Direct integration of the SHERLOG GOOSE server system in the IEC 61850 network for the acquisition and recording of GOOSE signals. Network triggers can be passed on to dedicated SHERLOG CRX fault recorder units by the GOOSE server in the separate communications network in order to trigger recording. Recordings are automatically downloaded from both networks and merged by a higher-level master PC.

by using SCL files for monitoring and recording and by scanning network traffic for available GOOSE signals (GOOSE sniffing). Changes of state of individual GOOSE signals can be used to trigger recording selectively for all SHERLOG CRX fault recorders in the network with fully automatic merging and generation of fault recordings.

Network-based time synchronisation and cross-triggering

Efficient and comprehensive acquisition of measurement data for the analysis of general power quality and of disturbances in equipment within electricity supply systems does not only require powerful IEDs, it also calls for suitable communication channels for data transmission. TCP/IP connections over electrical and optical lines of communication provide optimum bandwidths and availability for this purpose and can also optimise the operation of measuring instruments by enabling extended communication between individual devices. Highly accurate measurement data, such as transient fault recordings, require time stamps which are suitably accurate and which can be made available by a number of different sources, such as GPS systems. The SHERLOG CRX system minimises the installation work and the costs involved by offering the option of passing on time signals from an externally synchronised device via a separate communication bus in accordance with the master-slave principle. If the network itself has a dedicated time server for NTP/SNTP synchronisation, additional component costs for GPS receivers and bus lines, for example, can be completely eliminated and each CRX system can be connected individually to the network-based time source.

In order to cover as wide an area as possible, many fault recorder systems feature what are known as cross-trigger functions. These functions typically use separate communication interfaces to provide the option of passing on trigger signals from one fault recorder to another group of fault recorders in order to trigger a number of recordings in parallel. Provided there is suitable time synchronisation of the various fault recorders involved, this allows all system quantities to be integrated in one recording when large power systems are divided up between a number of fault recorder units, for example.

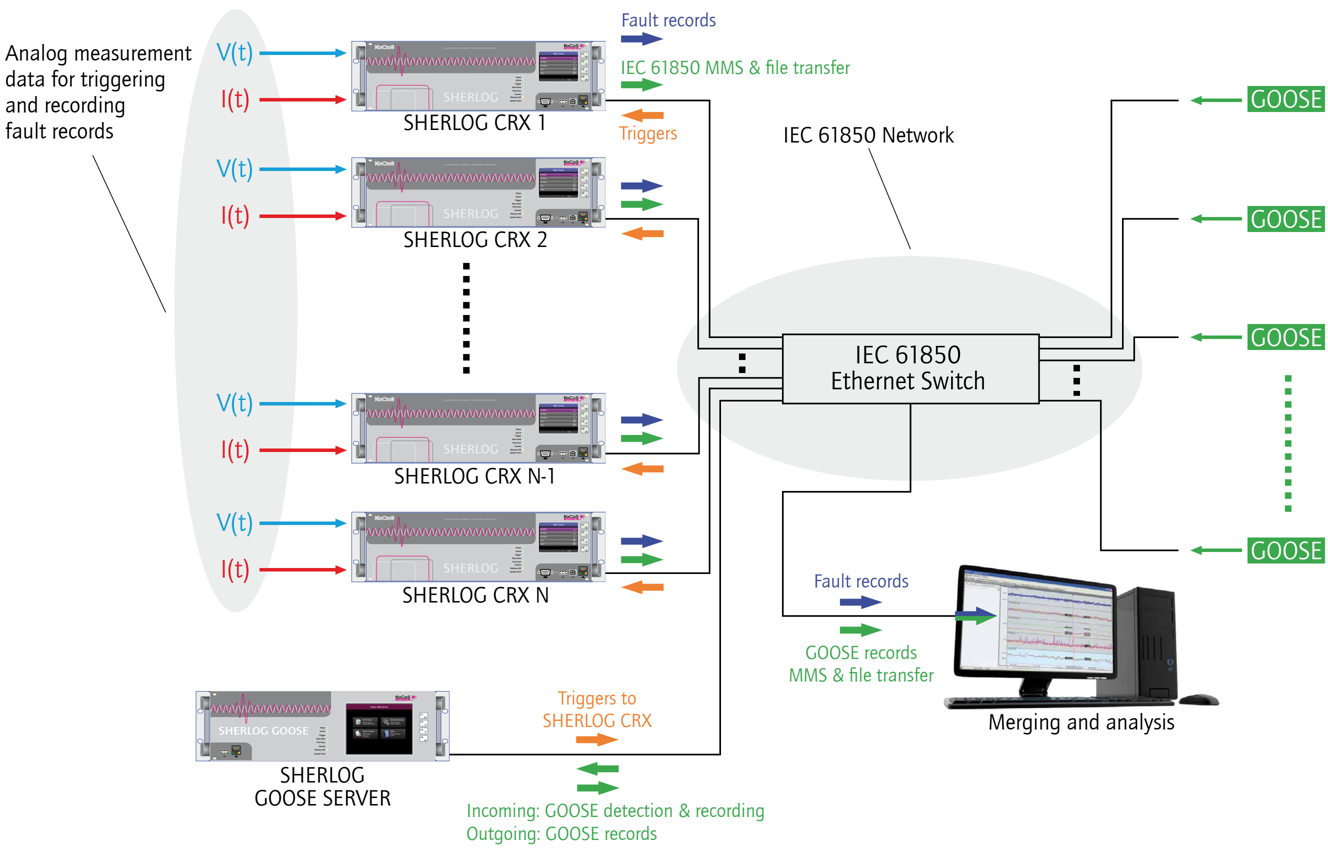
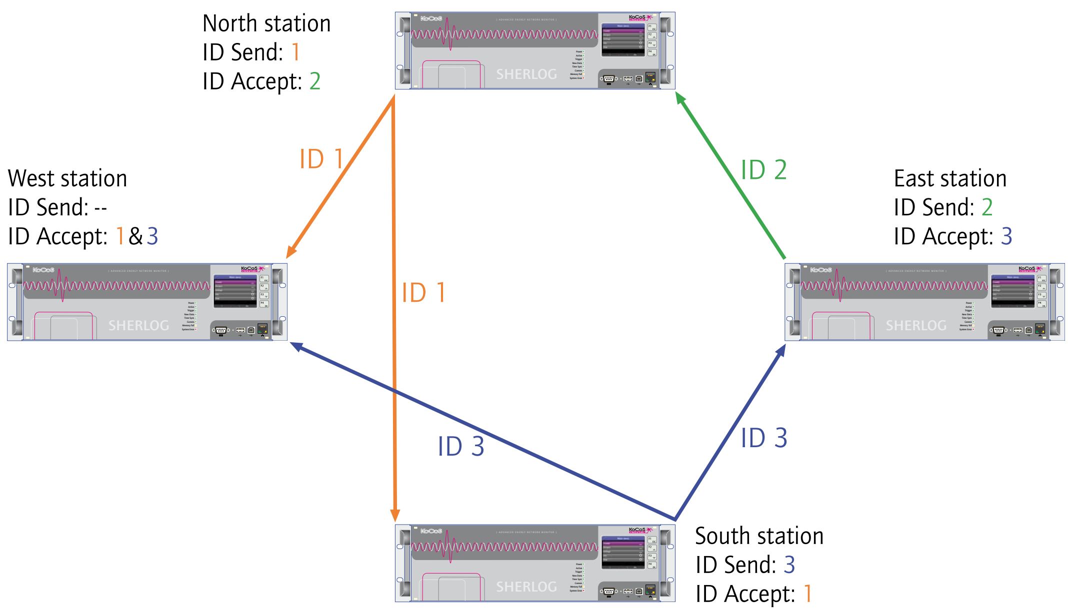


Fig. 3: Integration of IEC 61850-8-1 GOOSE Messaging, Variant 2: Integration of the SHERLOG GOOSE server system together with SHERLOG CRX fault recorder units in the IEC 61850 network with additional transfer of SHERLOG CRX measurement data and recordings via IEC 61850 MMS and file transfer.

However, the installation and operation of a cross-trigger interface often involve additional expense for wiring and components. Moreover, depending on the number of fault recorder units included, the simple binary transfer of the cross-trigger pulse itself often generates an unmanageable quantity of fault recordings which turn out not to be at all relevant for further evaluation. The SHERLOG CRX system employs the same method here as described above for time synchronisation and makes it possible for cross-triggers to be sent and received through the network, obviating the need for separate trigger lines to be laid. The cross-triggers themselves can be given individual IDs allowing targeted and selective cross-triggering between individual devices or groups and ensuring that only those devices whose measurement signals are relevant for the specific event concerned are triggered to make a recording *(Fig. 4)*.

Optimum system planning and maintenance thanks to modular hardware design

The purchase of a fault recorder system in the context of a new project does not only raise a multitude of questions to be answered with regard to technical requirements. As mentioned above, often only limited space is available for the installation of this type of system and this can be a further important criterion for the selection of a suitable device. Another aspect which can make planning and configuring a fault recorder system more difficult is the fact that specifications and requirements regarding the type and the number of signals involved can be unclear at the beginning of a new project. One option in this situation is to stay on the safe side and order the device with more analog and binary measurement channels than are needed to meet the technical requirements as they stand at the beginning of the project. This ensures that a sufficient number of free channels are available should the number of signals to be measured increase at a later stage. However, while this course of action does of course provide a certain degree of security because it makes it possible to react flexibly to changes, it can lead to an unnecessary inflation in project costs if a great many measurement channels remain unused - and the numbers soon mount up if several devices are equipped with superfluous channels.
However, if the alternative course of action is chosen and the new fault recorder is designed to adhere strictly to the requirements specified at the beginning of the



North station: Cross-Trigger to West & South (ID 1)
East station: Cross-Trigger to North (ID 2)
South station: Cross-Trigger to East & West (ID 3)
West station: No Outgoing Cross-Trigger

Fig. 4: Selective transfer and receipt of cross-triggers between individual SHERLOG CRX fault recorder units. Outgoing cross-triggers are given a fixed ID which only triggers a fault record in other CRX units if the incoming ID is appropriately assigned in the unit concerned. Each SHERLOG CRX unit can support several outgoing and incoming IDs..

project, the costs for channels which may possibly be redundant can be saved. But if the number of measurement channels required increases at some time in the future, it may become necessary to extend the hardware of a system which has already been installed and is in operation and this can be very costly indeed. The overall cost of extending the number of channels at a later date does not only include the cost of the hardware alone, but also often includes costs for on-site installation and removal work, as the device concerned has to be sent back to the manufacturer which can entail periods of unavailability lasting for several weeks. As technical aspects and timing must be planned for the protection circuits involved before a device can be removed, adding measurement channels can be expensive and time-consuming and often turns out not to be as simple as is first assumed.

Thanks to the modular hardware design of the SHERLOG CRX, analog and binary measurement channels or other device components, such as communication interfaces, can be added or reconfigured on site as needed using Plug & Play technology. This makes the matter of planning device configuration described above much simpler right from the start, as there is no need to allow for possible subsequent changes in the number of measurement signals by including reserve channels which, if the worst comes to the worst, may be superfluous and involve unnecessary additional costs. Instead, the operator's own personnel can add components to devices on site using pluggable measurement cards, reducing device downtimes from a few weeks to just a few minutes because so little work is involved *(Fig. 5)*. Because all the measurement channels have full galvanic isolation and are freely configurable with regard to the assigned power system and process signals, there is also no limitation when planning the configuration of individual signal groups. This means, for example, that new 3-phase line or bus bar systems can be put on previously unused individual channels on different input modules and then assigned to the same group in the software-based measurement configuration *(Fig. 6)*. This allows optimum usage of the available measurement channels and enables the fault recorder to be tailored to meet technical requirements instead of the other way round.

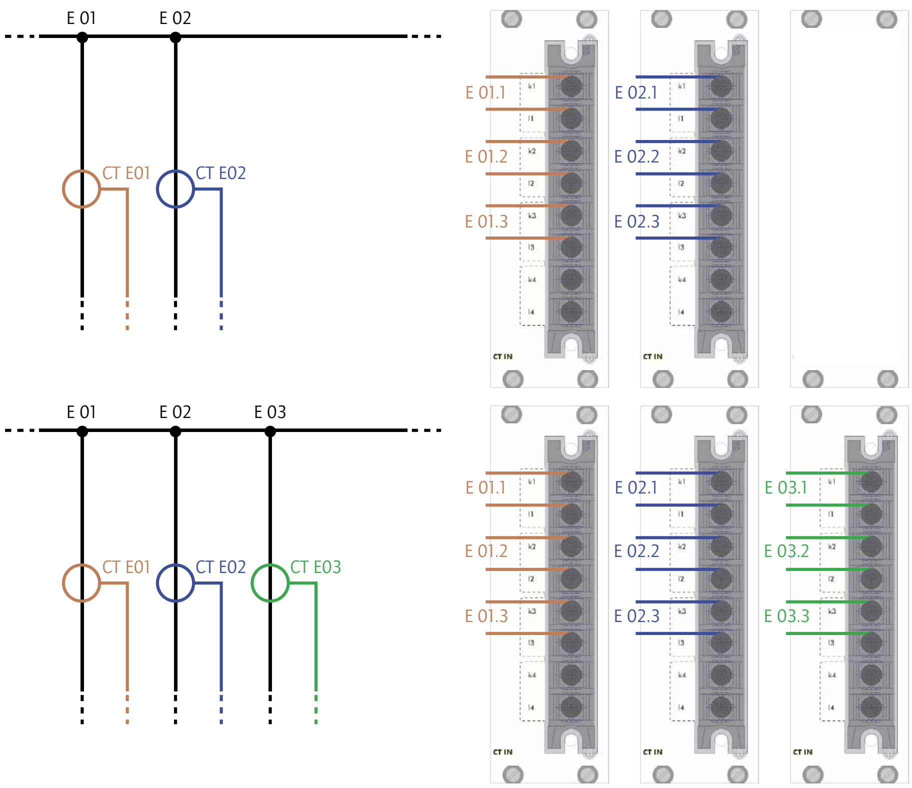


Fig. 5: Simple extension of SHERLOG CRX current channels by addition of a separate 4-channel current card. Thanks to the modular Plug&Play hardware design, the new card can be installed quickly and easily on site.

DIGITAL FAULT RECORDING

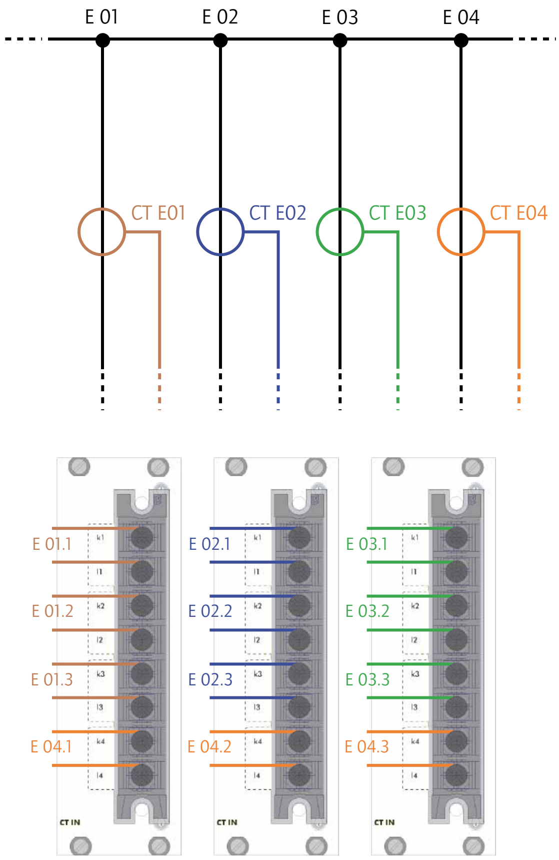


Fig. 6: The galvanic isolation of all the measurement channels of the SHERLOG CRX allows flexible distribution or assignment of measurement signals or power systems. For example, the currents of a new line system can be connected to measurement channels which are spread over a number of different input modules. The currents are assigned in relation to one another in the parameterization software of the SHERLOG CRX system.

Summary and conclusion

Efficient and reliable operation of electrical supply systems is as good as impossible without the use of state-of-the-art IEDs. Although many national and international projects in the field of smart grids and fully digital transformer substations are currently still undergoing initial tests, both the final destination and the way ahead are already fairly clear. Future generations of IEDs will need to keep pace with progress, especially if they are to meet increasing demands with regard to the minimisation of system components with a simultaneous increase in performance. The use of state-of-the-art processor technology, flexible hardware designs and the integration of various different methods of digital communication and measurement acquisition already offer a wide range of possibilities for implementing IEDs particularly cost-effectively without forfeiting any of the performance-related or operational benefits they bring. Using the SHERLOG CRX fault recorder system as an example, it has been shown that a modern IED can not only provide an optimum platform for comprehensive network monitoring thanks to its many measurement and evaluation functions. Intuitive design concepts for hardware and operation can also help to save and effectively plan the costs connected with the set-up, integration and maintenance of such systems right from the start.

hnickell@kocos.com

Dipl.-Ing. Hardy Nickell
Product Manager
Digital Fault Recording
KoCoS Messtechnik AG

Hardy Nickell completed an apprenticeship as a communication electronics technician with Deutsche Telekom AG in Kassel. After continuing his education and gaining a vocational baccalaureate diploma, he went on to obtain a degree in automation technology from Paderborn University. He joined KoCoS Messtechnik AG in 2013 and is now product manager for fault recorder systems.

KoCoS A FRIEND OF ENERGY

KoCoS Messtechnik AG
Südring 42
34497 Korbach, Germany
Phone +49 5631 9596-40
info@kocos.com
www.kocos.com