Intelligent Electronic Devices with fault disturbance display

L&T’s Supervision Series Relays are comprehensive devices offering protection and metering with communication. In addition to the graphical representation of motor starting characteristics display on its LCD, these relays now offer:

- Graphical representation of fault disturbance record with a facility to zoom in / out for the selected parameters
- Trip / alarm history for the last 15 faults
- Smart card facility for downloading data / settings
- Real time stamping with time synchronisation

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In an industrial environment, occurrence of any undesired event resulting in to unintentional operation needs analysis e.g. sudden switching off of a conveyor in a coal handling plant results in process interruption and loss of production. Reason for such interruption needs to be identified and analysed. The initial symptoms, the extent and location of damage, if any, sequence of event occurrence as reported by the operators become the inputs for such analysis. These details get processed by an experienced team of persons and probable cause of the interruption is worked out.

On many instances, the cause can be altogether different than the symptom e.g. failure of a contactor pole due to overheating (where other two poles remain intact) can be due to improper cable termination, resulting in overheating of the joint, which in turn conducts the heat to the contactor pole. An experienced eye of analyst always tries to get such inputs. But, it is not so simple and straightforward in most of the cases.

During a rainy night, tripping of a motor, which is required to be attended by the electrical department, can be easily attributed to leakage/insulation failure. However, it is not so straightforward. There are cases in which, when subsequently analysed in detail, it is observed that the tripping is due to an inadvertent command from DCS or a limit switch interlock opening in the field.

How to really capture this event? Such momentary/fleeting events need to be recorded and submitted as additional inputs for diagnosis to get the correct analysis of the event.

**Event recording**

It is a common practice to use hardwired recorders for sequence of event record. This arrangement not only adds to the cost of equipment but it also necessitates hardwired cabling from each one of the equipment to the central location. It is a cumbersome arrangement. For accurate sequence, the recorder must have 10msec or 1msec time stamping. As the least count time reduces, cost of event recorder goes up disproportionately.

With the advent of control function getting incorporated in protection relay, the era of Intelligent Electronic Devices (IEDs) began. These IEDs have Digital Inputs (DIs) and Digital Outputs (DOs), which can be configured for specific interlocks, permissive for logic building. This brings flexibility in operations. IEDs facilitate controls through the hard wired DIs as well as through serial link. Hence, they can be connected in the plant automation systems such as DCS, SCADA on a data-bus eliminating extensive control cabling and interposing relays.

Concept of IEDs has removed the functional/operational boundary between electrical and instrumentation engineers. It has a disadvantage in present scenario. Sometimes, an automation command generated at DCS/SCADA causes unwarranted operation in electrical system. Since such commands are fleeting/momentary, it becomes electrical engineer's responsibility to analyse the events and prove that his system is correct. Mal-operation may not be caused by electrical system. IEDs offer the clue. They are capable of recording the events, commands, source of last start command, source of last stop command and the time, date of such events along with actual description of caused of alarms/trips. The data on IED screen is sufficient to assess the cause of unwarranted operation. Thus, no more disputes between different functions.

**Motor Starting Data**

The IEDs also give graphical representation of the motor's starting characteristics. The starting curve can be stored as the ideal characteristic and each new start of motor will record a new curve. The two curves can be compared on the LCD and status of motor can be found. A user can also find the starting time of the motor and the starting current taken by the motor. These data can further help user in defining the protection system and the
Time stamping

IEDs can also have a facility of a built-in real time clock. This clock facilitates time stamping on occurrence of any event such as starting or tripping. With the information being available about exact time when the event has occurred, even in case of a cascade tripping, the propagation of fault and assessment of the cause becomes easy. However, clocks of all these relays will have their own accuracies. Thus, over a period, if the time displayed by the relays drifts, it can result in wrong data, which can mislead the analysis process. If the data is transmitted on a serial link based on the polling, the time stamped by the data acquisition system will also differ. In short, such data really does not serve any purpose.

Time synchronisation

Time synchronisation facility ensures identical time displays on all the relays at a geographical location. This facility takes the time synchronising signals from Global Position System (GPS) and synchronises the clocks in all the relays connected on a common network. Thereby, the data acquired on a serial link including the time of an event will have real time of occurrence as recorded by the relay. Hence, multiple events, all with precision time stamping, can be chronologically sequenced.

Intelligent Electronic Devices (IEDs) have the provision of real time clock for time and date stamping of an event and tripping. In a substation or in a plant, the time setting of these IEDs should be synchronised for correct sequence of event or fault diagnosis. IEDs use signals from Global Position System (GPS) for synchronising their time.

Global Position System

GPS is a globally accepted system for time synchronisation. It was developed by the US defense. There are 24 GPS satellites which orbit around the earth twice in 24 hours. Each of the GPS satellite is equipped with a atomic clock which generates precise time. There is always a GPS receiver on the earth where the timing signal generated by the satellite clock is received. Once the receiver receives the time signal, it generates a time code. The receiver then transmits the time code for synchronising the IEDs / devices.

The synchronisation can be at a substation level by synchronising the data concentrator. This data concentrator then can broadcast the time code to all the IEDs connected with it. The advantage of this type of system are:

- reduced hardware
- the timing signal can be transmitted to specified address for the time in IEDs.

This facilitates time synchronisation of IEDs irrespective of the type of protocol used by the IEDs.
There are six time code formats defined by the standards – A, B, D, E, G, H. These formats contain three coded expressions or words.

- The first word of the time code frame is the time of the year in Binary Coded Decimal (BCD) notation in days, hours, minutes, seconds and fractions depending upon the code-frame rate.
- The second word is a set of bits reserved for encoding of various control, identification and other special purpose functions.
- The third word is seconds-of-day weighted in straight binary seconds notation.

The last word or the control word is not incorporated in the IRIG (Inter Range Instrument Group) serial time code generators.

The resolution of the time synchronisation depends upon the time code format chosen and the modulation type used. Numerical relays generally follow format type B. Type B specifies 100 pps (pulse per second) of bit rate i.e. the repetition rate at which bit occurs. (Each pulse in a time code word / sub-word is called a bit). The format type B gives a resolution of 10ms.

A report on sequence of events can be generated through the IED using GPS.

Disturbance Recording

Yet another feature of microprocessor based relays is the fault data record. Fault data is basically the values of currents and voltages recorded by the relay at the time of tripping. This data is a valuable input in fault analysis process. The relays should store this fault data in a non volatile memory. If the data storage requires auxiliary power, on switching off the control supply, the fault data is lost. The users must ensure that the fault data and other related event log is essentially stored in non-volatile memory.

Some relays have the capability to store fault disturbance record data. It is not seen on the relays. Specific software is required to download the data in COMTRADE formats and then it can be analysed separately. This process has many limitations.

When a relay is connected to a laptop, in most cases its other port (connected in DCS/SCADA system) is switched OFF. Since this cannot be permitted while the feeder is ON, from such relays, fault disturbance record data can be downloaded only OFFLINE.

Modern relays have a larger graphical LCD. This LCD can be made use of for fault disturbance data view. Some relays now support this facility. This makes data view easy. Even ONLINE, the data can be viewed, compared with associated feeders on the same bus (since the relays are located in adjacent panels) for further analysis. It can be zoomed in for specific instances right on the relay screen. Need of a separate laptop and additional software is eliminated. However, for further storage, if such data needs to be downloaded, a facility is essential to download it without disturbing the other communication with DCS/SCADA. A medium like Smart Card for downloading the data is useful and handy. It also offers cost effective solution to the users.

Conclusion

New generation IEDs have:

- Graphical representation of motor starting characteristics
- Graphical representation of fault disturbance record
- Event recording with date and time stamping
- Real time stamping with time synchronisation

All this can eliminate separate devices like

- Disturbance Recorder
- Sequence of events recorder

Thus, such IEDs will make fault diagnosis a fast and easy process giving cost effectiveness and enhanced accuracy.