

Expected difficulty of line current differential relays with process bus application
~WHOLE SYSTEM SYNCHRONISATION~

Introduction

Combination of process bus system and conventional line current differential relays, whole system synchronisation will be required. In technical and security reason, whole system synchronisation is difficult to be operated in real grid system. To solve this issue, we introduce asynchronous line current differential relays.

1. Sampling synchronisation in process bus system

We have been attempting to utilize process bus system in order to simplify protection and control in substations. With process bus system consisted by IEDs and MUs, we can streamline facilities including cables between main circuit devices and protection relays, devices such as CTs, and so on.

In general, digital relays use instantaneous value of voltage and current at the same timing in order to perform relay calculation. Unlike in conventional relay system, A/D converters in process bus system are not implemented in relay units but in MUs, and they are shared with multiple relay units. Considering all the connection between MUs and IEDs, precise sampling synchronisation of all MUs in the substation is necessary, and SNTP (Simple Network Time Protocol) or PTP (Precision Time Protocol) is used for sampling synchronisation in MUs.

2. Application of process bus to line current differential relays

In the case process bus system is applied to the substation without line current differential relays, the range of sampling synchronisation is limited to its own substation, and there might be a master clock on each site. The topology of process bus network is simple enough to use non-special network component.

Line current differential relays, however, are quite common in Japan, thus we cannot ignore the use of line current differential relays also in process bus system. In the case process bus system is applied to the substation with line current differential relays, the range of sampling synchronisation in both substations would be combined. It is because line current differential relays need to synchronise the sampling timing in all terminals of its targeted power line. Ultimately, the use of the line current differential relays in process bus system might expand the range of sampling synchronisation to whole system.

To realize sampling synchronisation in whole system, each master clock located in substation is considered to be synchronised via grand master clock, and for the large network topology, each network components should be high-graded ones which are compatible with PTP. This requirement is also applied to TSO (DSO) - TSO (DSO) interconnection lines, TSO (DSO) - power provider lines and TSO (DSO) - load lines. In consideration on the real application, however, synchronising master clocks across companies is quite difficult for security reason.

3. Asynchronous line current differential relays

To decrease networking cost for line current differential relays, we have developed new relays, which we call "IP relays", which are asynchronous line current differential relays whose communication path is IP network. In IP network, there are several matters to be considered: the difference of upstream and downstream communication delay time, the delay time variation (jitter) and so on. In order to correspond to the matters, we adopt asynchronous method. For further details about the method of IP relays, refer to the paper B5_PS2_10612.

Although the main purpose for developing "IP relay" is conversion of communication path from dedicated fibres to shared IP network, IP relays can also solve the problem shown above.

4. Combination of process bus system and asynchronous line current differential relays

With the asynchronous line current differential relays, there is no requirement of the sampling timing synchronisation in each terminal of its targeted line. So in the case process bus system is applied to the substation with these relays, the range of sampling synchronisation for MUs is remain in its own substation. Herewith, we can enjoy the benefit of both process bus system and line current differential relays without building large scale synchronisation system. Also in this configuration, synchronisation across companies is naturally unnecessary, and in the highest-security sites such as nuclear power plants, this specification would be particularly welcomed.