NAME :	Yusuke Kakumoto	GROUP REF. :	SC B5
COUNTRY :	JAPAN	PREF. SUBJECT :	PS2
REGISTRATION NUMBER :	7287	QUESTION N° :	Q2_06

Solution for Communication Delay Times under a New Process Bus-based System using oversampling

Question :
What are the key innovation for an intelligent algorithm based protection and how to address challenges during the application of the proposed protection schemes?

Answer :
The key innovation in our research is the application of oversampling to process bus-based system. However in case of applying oversanpling to the system, asynchronous error due to communication delay time may occur and protection performance may be affected. In order to deal with this problem, optical splitters which have a characteristic of little communication delay time are applied in the system.

1. Introduction

In process bus-based protection system in digital substations, high reliability and availability is required, however some factors which may effect the protection performance are introduced. In order to improve the reliability and availability, extremely high frequency sampling is being developed and this makes time synchronisation unnecessary in the process bus-based system. Instead, if the SV data sent from each MU have different communication delay times or IED receives SV data at different timings, these will cause asynchronous error and may have impacts on protection performance. Therefore communication delay times and their fluctuations so called “jitters” should be controled as little as possible. In this contribution, a method to reduce impacts of these factors using optical splitters as passive communication distributers is proposed.

2. Issues and solutions for process bus-based system using oversampling (slide 2)

Generally, process bus-based system contains optical fiber cables and active communication devices such as L2-switch. Active devices most likely contain DC power supply and digital signal processing circuit inside. Those devices may cause communication delay times and jitters. Therefore, asynchronous error may occur and protection performance may be affected. For instance, if the communication delay time is 500 μs, the error gets to 18.8% as shown in the table on slide 2. In the proposed system, these factors will have an impact on its protection performance and should be minimized.

As a solution for these issues, optical splitter devices which consist of optical glass material and work as optical distributor are applied and SV data communication channels between MUs and IEDs are constructed with optical fibers and optical splitters only. These devices have a characteristic of little communication delay times and jitters only due to the channel length. Therefore, it can be expected that the influence on the relay operation will be extremely small. In addition, the splitter has good reliability, environmental resistance, and lifetime because the splitter does not contain DC power supply and/or electronic circuit.

3. Verification test result (slide 3)

To verify the performance of the proposed system, test configuration was built using two MUs and three IEDs connected via optical splitters as shown in Figure 1 (Figure 3 on slide 3).

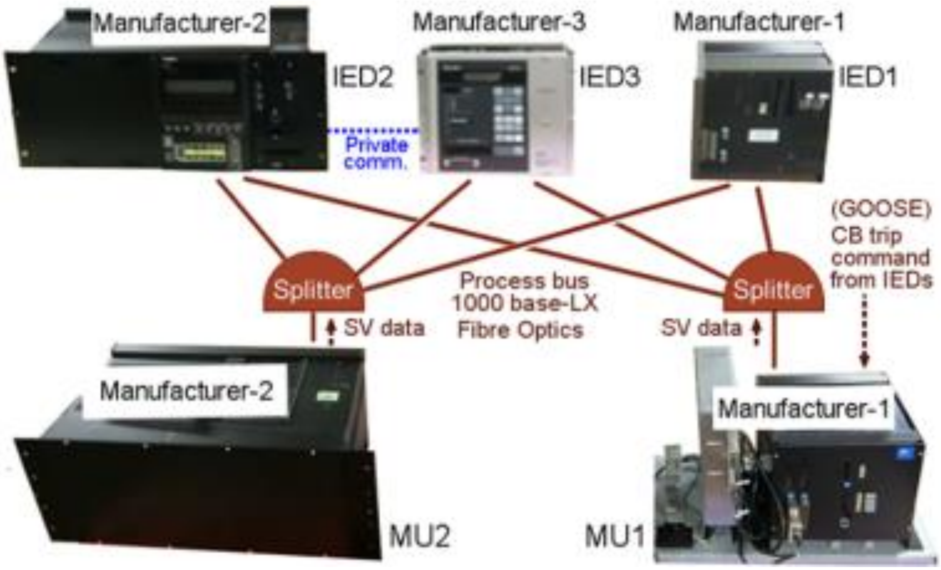

Figure 1. Multi vendor's MUs and IEDs configuration under verification test

In the test configuration, input 60 Hz, 5 A penetration current to each MU which operates under asynchronous condition (sampling and SV data communication). IED receives these asynchronous SV data and measures differential current. Then, survey the current value. Asynchronous error is recognised as the differential current value. Figure 2 (Figure 4 on slide 3) introduces a measured data of the instantaneous SV data (IED received) and differential current value in case of 5 A r.m.s. penetration current input. Each SV instantaneous current ("MU1-I" and "MU2-I") shows same waveform, and maximum differential current (sine wave form component) was up to +/- 0.2% per input. The differential current "diff-I (Waveform)" also contained 0.1% offset value error. These errors were well within the accuracy requirements of many usual protection relays. From this result, it is found that the asynchronous error due to the communication delay times is very small and it is expected that the proposed system will work properly as process bus- based protection system.

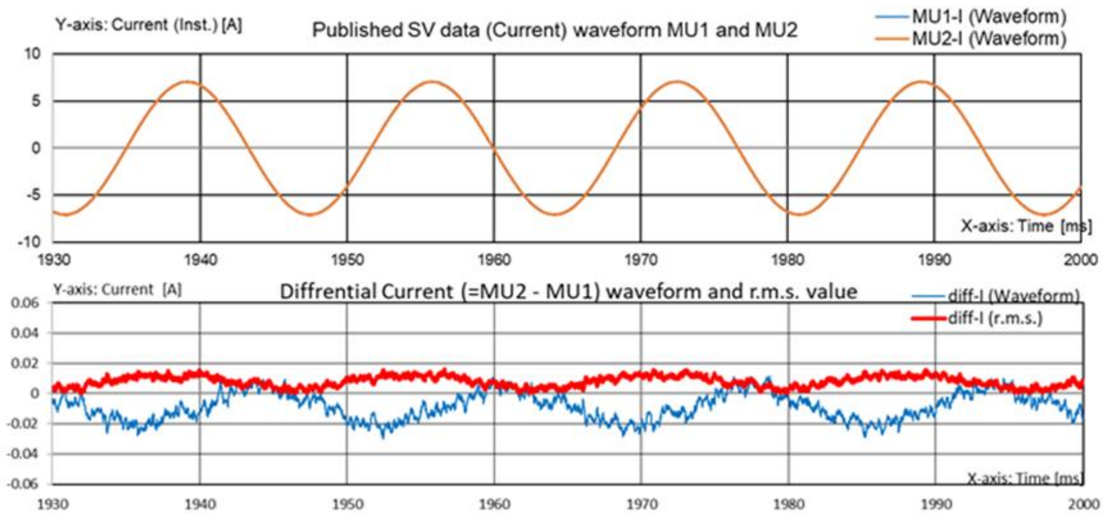

Figure 2. Example of SV data waveform and instantaneous differential current

4. Conclusions

As a process bus-based system, oversampling technology using optical splitters, passive communication devices with smaller impacts on protection performance had been proposed. This method has an advantage that time synchronisation is not necessary, however even in this system, communication delay times and jitters may cause problems. As a solution for these factors, a system using optical splitters, passive device is proposed and verified through several tests.