TCG 01 - Case Study Transpower

Background

When you are the owner and operator of a national electricity grid, ensuring continuity of supply is vital. For Transpower New Zealand Ltd, being able to reliably identify the order in which fault events occur at different places in the network is a must. With this timing information better protection systems can be designed.

Time-tagged circuit breakers are the key to providing trip indications at substations, and traditionally a minicomputer based SCADA system collected these time-tagged events from the Remote Terminal Units (RTUs). All time-tagged events were synchronised to the SCADA master clock. Time sync information was interleaved with normal RTU data traffic for distribution over a low cost data communications link. From this valuable time-tagged event data, Protection Engineers could analyse the fault event sequence.

Accuracy of the time tagging in these late 1970s systems was thought to be between ±5 ms ±15ms, but Transpower were unable to confirm this accuracy in the field.

The Problem: Accurate time Synchronisation

During the mid 1990s numerical protection relays began to take over the data acquisition role from the RTUs at substations. This greatly reduced the number of analogue transducers as well as the amount of wiring. Serial links between the new protection relays and the RTU replaced much of the point-to-point status wiring. Now, however, the real-time clocks in the new relays needed to be accurately synchronised to the same time source that synchronised all the RTUs. This would retain the ability to accurately correlate events still time-tagged by SCADA, with events time-tagged by the new relays.

The Trials

Transpower's nationwide grid comprises over 12,000 km of transmission line and 173 substations and switchyards. To time synchronise all these sites, two choices were available;

Either:

1. Find a way to distribute time to all sites using an existing communications infrastructure.
Or:
2. Install receivers at each site to recover time from any available broadcast source.

A GPS based clock source is the only practical and reliable receiver system that will give nationwide coverage with the needed accuracy. But, initially, the cost of installing a GPS and time-code distribution system seemed

TEKRON
www.tekroninternational.com

About Tekron

Tekron International is a leading developer of exceedingly accurate GPS clocks and time synchronization solutions for use in industrial applications.

Tekron GPS clocks are simple to install and use and are extremely rugged, attributes that are a prerequisite in the often extreme environments in which the clocks are installed.

Tekron GPS clocks have been installed in thousands of power stations & substations across the globe, where they prove invaluable in assisting power companies to operate efficiently, minimizing downtime and increasing the accuracy of control decisions.

With a Tekron GPS clock you can be confident that you can set it up and walk away.

unjustifiable. Solutions using existing communications infrastructure were trialled between 1996 and 2000. Because the RTUs were already synchronised to the SCADA master station for event time tagging, attempts were made to use the RTUs to synchronise the protection relays. The DNP3 protocol was chosen for communications between the devices in substations. Relays that supported this protocol were then synchronised using DNP3 from the RTU.

When a master station sent out a synchronising message to the RTU, it was found that the relays were logging a time- change message almost every 15 minutes. These frequent messages caused the relay event buffer to be completely, or largely, overwritten in the time it could take to visit the site to manually retrieve the relay events log whenever a significant power system event occurred.

To solve this problem an alternative and more universal method of time synchronisation was tried. This method made use the of RTU's ability to generate and distribute IRIG-B time code to the protection relays. Again, the result was the same, important system data was being overwritten and lost in the event buffers because of synchronisation failure events. It was found that the IRIG-B time code from the RTU could be corrupted or deviate from specification due, perhaps, to interrupting the generation of IRIG-B code while the RTU CPU performed some higher priority task. Some relays ignored the bad time codes while others logged an event in the relay event buffer.

The Solution: Tekron TCG 01

While Transpower was trying various solutions to the synchronisation problem, price and availability of OEM GPS receiver hardware and high quality antennae continued to improve. Cheap, sophisticated, and well-proven GPS receiver modules could now be incorporated into a range of clock products by manufacturers to suit various niche markets.

Tekron designed a prototype GPS clock specifically for Transpower to evaluate in their substation environment. Time code outputs were configurable to meet all Transpower's needs and, unlike other products, Tekron's clock did not need additional hardware to meet power supply requirements and isolation for the time code outputs. This lowest cost, total solution to the problem, also uses the least panel space.

A trial installation during 2000 used a Tekron TCG01 clock in a substation to synchronise 34 feeder protection relays and 2 RTUs using IRIG-B time code. Apart from minor corrections that needed to be made by the RTU supplier to the firmware for the RTU IRIG-B input application, the trial was completely successful.

The Tekron GPS clock enabled accurate time synchronisation and was proven compatible with the protection relays.

The Results: Deployment

The roll out of clocks has been an essential part of larger protection upgrades to substations in the grid. To date, about 160 Tekron clocks have been deployed leaving about 20 sites yet to complete.

Initial deployment of clocks was carried out in two stages. The first stage used the clocks to provide IRIG-B timing to the protection relays, but kept the RTUs synchronised to the SCADA master station via the data communications. Once the RTU firmware upgrade became available, the second stage changed over the RTU synchronisation from the SCADA master station to the substation IRIG-B time signal.

The Benefit

Transpower has found the TCG01 Time Code Generator to be a “highly cost-effective solution” which quite simply “always works and does not give any trouble”.

Deployment of the clocks has been trouble free. Overwriting important event data in the relay event buffers with spurious time synchronising failure messages, caused by the way some relays handle errors, has been the most serious problem. Although loss of sync needs to be notified, deficiencies in some devices receiving the synchronising signals caused them to generate error messages too often so that useful information is overwritten.

Transpower has minimised loss of sync events by carefully positioning the GPS antenna, and by attention to proper shielding and earthing of the IRIG-B signal cabling.

Initial trials tested both amplitude modulated IRIG-B signal distribution using coaxial cabling, and dc level shift signalling over twisted pair cabling. The later was adopted as the final design standard due to its simpler installation requirements.

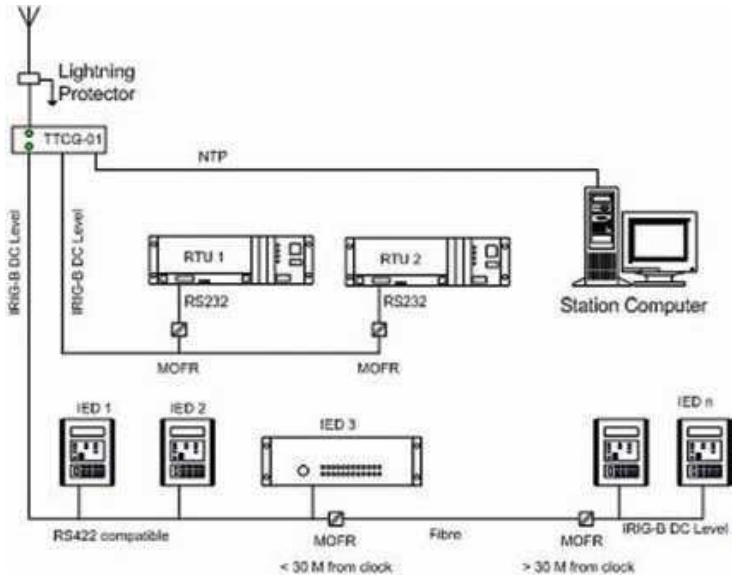
To maintain electrical isolation between devices and systems, fibre optic cabling is extensively used. The Tekron MOFR range of signal repeaters provided an ideal, low cost solution to convert between fibre and copper so that the IRIG-B signal could be daisy-chained around devices yet still maintain high isolation levels.

The high quality antenna supplied as standard with the Tekron TCG01 clock together with an optional lightning protection kit also contribute to reliable and trouble free installations.

Summary

Tekron has been “very responsive” to Transpower’s needs by readily providing advice and assistance during the initial trials, and by building Transpower’s requirements into the design as the product evolved. The Tekron solution “meets all Transpower’s requirements now and has the versatility to meet future needs.”

As a low cost, highly reliable and accurate time source for time dependent equipment, the Tekron TCG01 clock is an ideal versatile building block for power system infrastructure monitoring and for new emerging architectures such as IEC 61850.



In the diagram we can see that IEDs in close proximity to the clock are cabled in shielded copper while those a greater distance away from the clock make use of fibre. Electrically harsh situations such as feeder protection relays being located close to the CB would also have the time sync distributed by fibre even when the distances are less than 30 metres.

The station computer is shown connected to an NTP server in the clock.