Simple Method to Improve Time Quality on Vintage Relays

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Abstract: With satellite clocks and IRIG B technology becoming the standard for protective relay applications it is increasingly evident that time synchronized protective relays provide a major advantage to relays that do not have a managed time source. However, this task can be difficult to implement for relays that do not have a dedicated IRIG B interface or other network time synchronization option. This paper explores how the writing of modbus or other registers may provide adequate time sourcing for legacy relays.

I. Introduction

Being able to compare synchronized event reports or event logs in any facility can greatly improve the understanding of how individual pieces of equipment in the system operated during an event. In many industrial facilities there are 10s to 100s of protective relay devices that were installed before time synchronization became an industry standard.
This means that some of these relays may not have a dedicated IRIG, NTP, or PTP interface and they simply rely on the internal clock of the relay which over time begins to drift in accuracy and typically must be programmed by the user via laptop or the induvial relay interface. This method can be time consuming or generally forgotten unless a site routinely synchronizes relay clocks on a predetermined interval. If there are truly 10s or 100s a relays that a site must manage, this also can be financially taxing when the team could be focused on other matters.
However, many of the older microprocessor-based relays have Modbus or other forms of read/write communications to allow a dedicated PLC or DCS system to poll information like amperage, current, or power. It also allowed the relays to be operated by Client/Master devices by writing individual registers with a specific command.
If the internal relay clock has dedicated Mobus or other protocol type registers, the registers can be consistently rewritten at a predetermined time which will allow the time source in the relay to stay more synchronized when compared to an internal clock.

II. Problem

An industrial facility with a limited budget wanted to provide communications from 20 MV (medium voltage) motors back to their plant DCS systems so operations could monitor amperage and other electrical information. The protection relays associated with the motors were GE Multilin SR 469 type relays and GE Multilin 339 relays. The sites standard communication protocol was Modbus/TCP or Modbus Serial/RTU. The site electrical engineer wanted to synchronize the relays times but felt that running individual IRIG-B circuits along with serial Modbus circuits would not be a cost-effective option. Instead, it was agreed upon to try and implement a simpler form of time synchronization that would not be as accurate as IRIG but would still provide consistent time stamps across all relays in the substation.

III. Solution

The agreed upon solution was to use an SEL RTAC 3530 1U with minimal software additions, a SEL 2407 Satellite clock, and (4) SEL 2886 RS485 to RS232 adapters.
The SEL 3530 would be the Client device when poling the server-related protective relays and would be the single source time distributor to the relays by deriving its time signal from the SEL 2407 Satellite clock. The SEL 3530 would then act as a data concentrator to deliver information back to the site's DCS system via ethernet.
(4) RS485 daisy changed serial networks were routed through all associated MCCs (Motor Control Centers) and routed to the rear of the SEL 3530 RTAC.

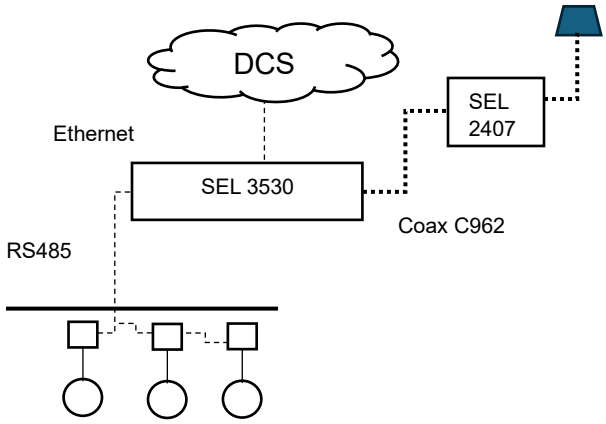

Fig.1 Simplified Layot

Ethernet may have provided a faster, more simplified solution but that would have caused the need for a new ethernet switch, routing of multiple individual ethernet circuits, and 50% of the existing devices did not have adequate ethernet communication capability.

The SEL 3530 allows the internal IRIG-B source to broken down by month, day, year, hour, minute, second. Using structured text-based programing when the IRIG B internal to the RTAC reached 12:00PM everyday a write of the hexadecimal equivalent of the exact time would be written into the GE Multilin holding registers. The baud rate/data transmission rate between devices was set at 19200bps. The Multilin devices to generally updated to within +/- 1 second of the actual satellite clock which was far more accurate than the existing internal clock.

GROUP	ADDR (HEX)	DESCRIPTION	MIN.	MAX.	STEP VALUE	UNITS	FORMAT CODE	DEFAULT
	102F	Reserved						
REAL TIME CLOCK	1030	Date	--	--	--	--	F18	--
	1032	Time	--	--	--	--	F19	--
	1034	Reserved						
	1035	Reserved						
	...	...						
	103F	Reserved						

Fig.2 Holding Register of SR relay Clock [1]

F18	**32 bits**	**DATE (MM/DD/YYYY)**
	1st byte	Month (1 to 12)
	2nd byte	Day (1 to 31)
	3rd & 4th byte	Year (1995 to 2094)
	Example: Feb. 20, 1995 stored as 34867142 (i.e. 1st word: 0214, 2nd word 07CB)	
F19	**32 bits**	**TIME (HH:MM:SS:hh)**
	1st byte	Hours (0 to 23)
	2nd byte	Minutes (0 to 59)
	3rd byte	Seconds (0 to 59)
	4th byte	Hundredths of seconds (0 to 99)
	Example: 2:05pm stored as 235208704 (i.e. 1st word: 0E05, 2nd word 0000)	

Fig.3 Format Codes and examples of holding registers [1]

The date function was utilized in the same manner to where a specific date was chosen for comparison and automatically written into the registers as well. An increment function was used to increase the year +1 after each execution of the loop.

IV. Conclusion

A simple yet effective method of time synchronization was used to provide a more consistent time stamp to all the protective relays in a substation. By implementing this method, the site did not have to go through the process of upgrading all the existing relays to newer models with appropriate IRIG-B capabilities. Money was also saved by not having the site engineering resources tied up constantly updating time settings. An increase in reliability and troubleshooting capabilities was also added by allowing equipment in the same vicinity to now be on a much more accurate time base. Any event records between devices moving forward should be of consistent time accuracy.

This project/methodology does not address speed of communication for precise time stamping nor does it offer an effective solution for devices that may be turned off for maintenance for long periods of time and must wait till 12PM everyday to receive updated timing. The same applies if the satellite clock and RTAC ever need to be taken out of service. The time will not be consistently accurate until 12:00PM on the day after the device was returned to service. The site understood the limitations of the design and were content with the results provided.

V. References

[1] GE Multilin, *469 Motor Management Relay Communications Guide,* 5.2 ed, Markham, GE Multilin, 2017