Application Note

Substation Automation and Protection Division

Commissioning Microprocessor Based IED Communication Systems.

ABSTRACT: *Substation commissioning to verify correct data reporting between a host device and an IED is a tedious and lengthy process. Integrity of data exchange between the field device(s) and a host traditionally involved taking the system protection offline and testing each point using test switches, current and voltage generators and applying each known case to the system to prove data integrity. Using an advanced concept using software bit setting though the IED's auxiliary ports, the events may be simulated in software, without removing the IED from service and testing the database link between the IED and host device.*

Historical Perspective:

In any relay installation, commissioning the installation can be an exceptionally time-consuming procedure. The IED must be placed out of service and a crew must attach current and voltage simulator equipment to the out of service IED and read all data values for each fault scenario. The remote commissioning team must be in contact with the SCADA or Energy Management System personnel to verify that the correct data is being received and interpreted correctly. Testing Phase A,B,C, Amps, Volts and Watts may be the least complicated portion of the commissioning process. Verifying activation or de-activation of functions such as reclosing, ground blocking, or other functions and reporting them correctly to the host device is one of the more tedious and time consuming processes in commissioning an microprocessor based relay. Intricate knowledge of the IED configuration software must be known. Usually the relay engineer may be familiar with the procedure of setting the relay and forcing the functions, however, the SCADA engineer may not be knowledgeable with the process to enable or disable these functions. The SCADA engineer may only know the memory map of the device undergoing commissioning and the format of the data reporting to the host device. The SCADA engineer is primarily interested in data and database integrity such that an event is displayed and archived correctly at the host level.

ABB has incorporated a new concept to verify end to end integrity of data between microprocessor based relay IED devices. The new technique is called SCADA – REDI ® (SCADA **R**apid **E**lectronic **D**evice **I**ntegration). ABB devices traditionally have "read" only components (reporting the present state of the function or input/output device). ABB microprocessor based protective relays traditionally have control capabilities in forcing physical devices attached to the relay, but there was no method to force analog readings, to verify database mapping integrity. The analog readings are stored in the MODBUS protocol in 4X memory and were traditionally "read" only. ABB DPU 2000, DPU 2000R, TPU 2000 and TPU 2000R relays have the capability to allow a read only 4X register to be forced from a personal computer through the relay's communication port. SCADA REDI ® allows one port (attached to a computer) to force a register with data, while the host device polls the second port and verifies the data forced by the auxiliary computer. Figure 1 illustrates the methodology with SCADA REDI ® enabled and disabled.

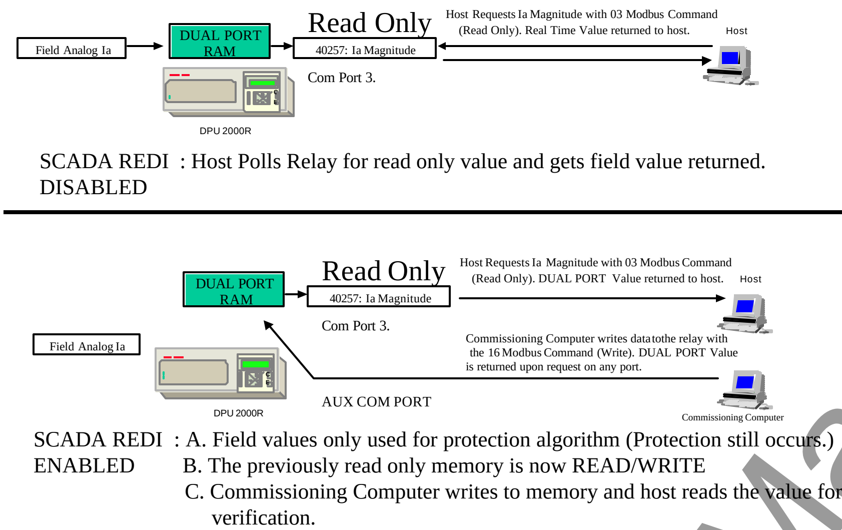

Figure 1 - SCADA-REDI ® Methodology

Methodology:

The DPU 2000, DPU 2000R, TPU 2000 and TPU 2000R have two microprocessors operating in parallel. One microprocessor provides the functionality required for the protective functions. The other microprocessor is resident on the communications card providing its functionality. An internal electronic bus with a dual-port RAM memory resident on the communication card provides the electronic interconnection of the main board and the communication board. In this way, the protocol is included within the protective relay. No expensive port switches, cabling or auxiliary power sources are required to establish communications with common protocols such as Modbus, Modbus Plus, and other industry standard protocols. Figure 2 illustrates the typical DPU 2000 and DPU 2000R memory map.

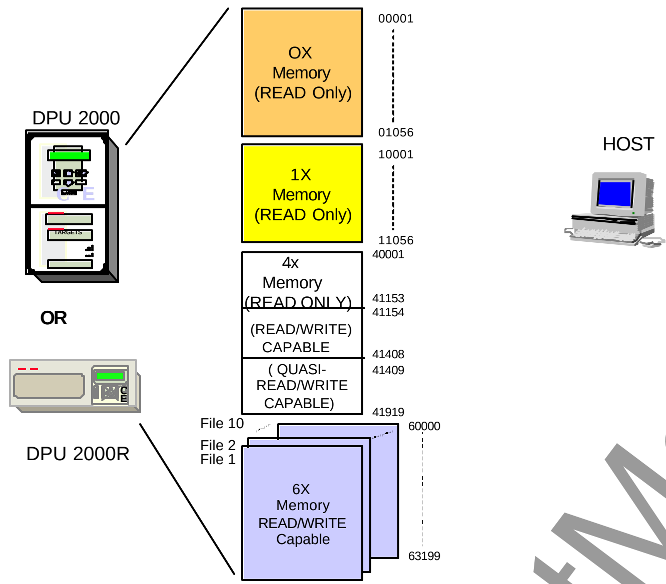

Figure 2 - Typical Modbus/Modbus Plus Register Definition

During the commissioning process, it is required that the correct data is mapped from the relay to the host device. The conventional method is to have an individual with expensive test gear to apply individual voltages and currents to the relay terminals to simulate field conditions. The individual must be at the substation and a direct link must be made to the individual at the host device verifying the correct data is being received and interpreted correctly.

With 6X memory and some of the 4X memory, a host device can force the read/write capable 4X and 6X memory locations and verify data is sent and received to some memory location. The SCADA REDI® process provides much more flexibility, allowing streamlining of the commissioning process.

Within the DPU 2000 and DPU 2000R control register memory map a single bit (Bit 13 in Register 411159) may be set to allow READ, WRITE, and READ/WRITE Modbus /Modbus Plus commands to be sent to the previously READ ONLY memory locations. A typical scenario is illustrated in Figures 3, 4, and 5.

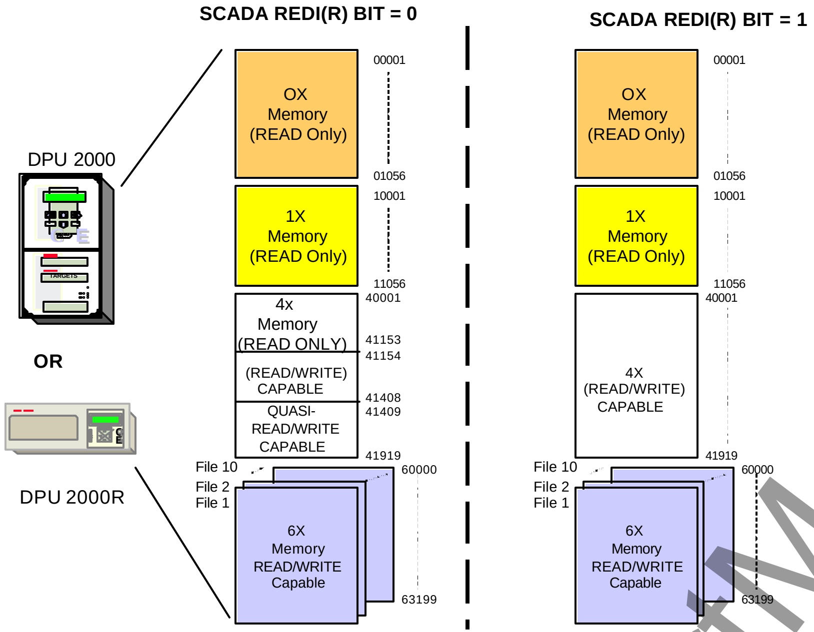

Figure 3 - SCADA REDI ® Memory Map Modification

As per Figure 3, all 4X memory is read/write capable. In other words, Modbus commands 03 –READ HOLDING REGISTERS, 16 – WRITE HOLDING REGISTERS, and 23 WRITE/READ HOLDING REGISTERS, may be used to communicate with the relay. **IT IS MOST IMPORTANT TO REALIZE THAT THE RELAY DISABLES THE LINK BETWEEN THE PROTECTIVE RELAY AND THE COMMUNCATION CARD (SIMILAR TO THE LOCAL REMOTE FEATURE). RELAY PROTECTION FUNCTIONS ARE STILL ENABLED IF SCADA REDI ® IS SET. ONLY COMMUNICATION IS DISABLED BETWEEN THE RELAY AND COMMUNICATION CARD. AS ILLUSTRATED IN FIGURE 1, THE DUAL PORT RAM UPDATE CYCLE BETWEEN THE COMMUNICATION CARD AND PROTECTIVE RELAY IS HALTED.**

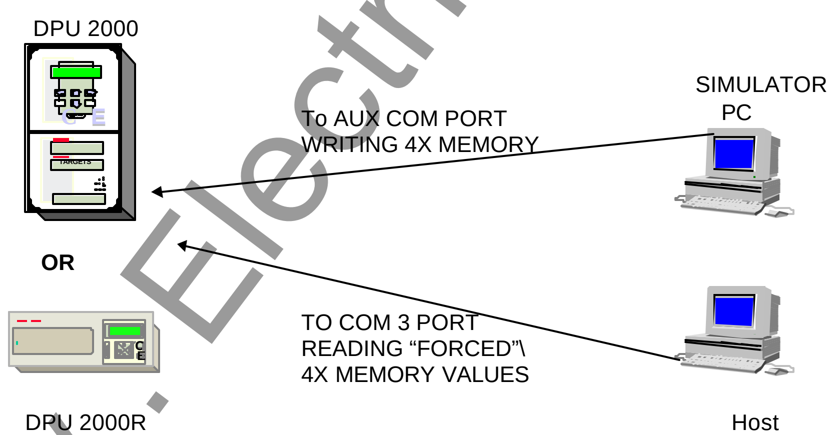

Figure 4 - Typical Commissioning System

As shown in figures 1 and 4, one system (a typical PC operating with a DDE utility and WINDOWS utility for example) could be forcing the registers and the second system, “the host” verifies that the data values are received correctly. Although the illustration shows a direct connect scenario, the Host and Simulator devices may be located offsite and connected to the substation via a modem or fiber optic connection.

To initiate SCADA REDI ® refer to Figure 5 illustrating the method to initiate the function through a series of Modbus or Modbus Plus control writes. Once SCADA REDI ® has been initiated, any register within the 4X Modbus or Modbus Plus register range (as illustrated in Figure 4) may be forced to a values using a Modbus /Modbus Plus 16 command (Write Multiple Holding Register Command).

To de-activate the SCADA REDI® command, repeat the same procedure as illustrated in Figure 4 except load registers 41158 and 41159 with a value of 0.

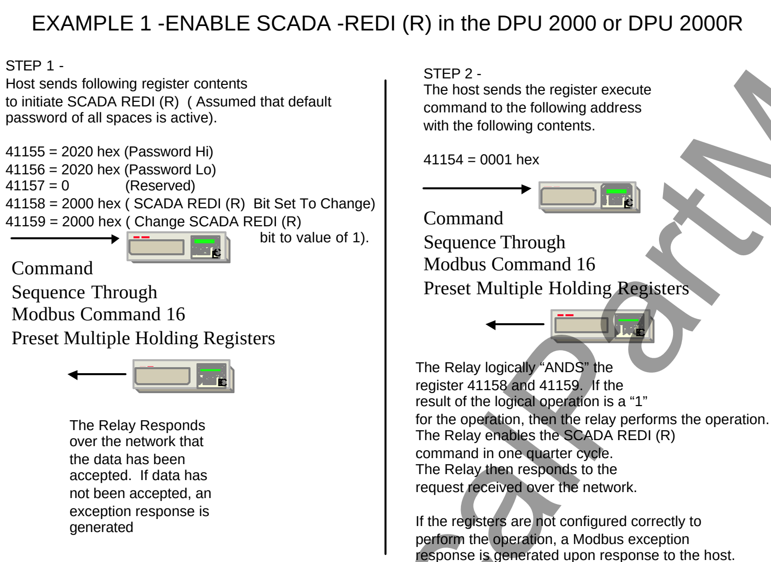

Figure 5 - Enabling SCADA-REDI ® Mode in the DPU 2000 or DPU 2000R.

A DDE (Dynamic Data Exchange) package may be utilized to perform the forcing functions. A DDE editor may be used with a spreadsheet program to form a powerful, yet simple and inexpensive method to force the variables during a commissioning session. Such DDE packages are sold by a variety of manufacturers including Square D, and KEP (Kessler Ellis Products). The DDE link allows a spreadsheet to link to the protocol (Modbus or Modbus Plus) and perform data reads/writes to the IED. The spreadsheet program (Windows operating system capable), serves as the operator interface for troubleshooting and commissioning the system.

Economics:

Through evaluation and comparison between SCADA-REDI ® and traditional methods of commissioning, substantial cost savings can be realized using SCADA–REDI ®. Economics are evaluated using two commissioning models:

A. A Traditional RTU Equipped Substation with 25 breakers testing a limited amount of data such as breaker status, V, I, W, Vars reported to the RTU and Host Device.

B. A fully Integrated IED equipped substation with 25 breakers testing the full complement of data displayed on a local monitoring system and RTU. Data verified includes, but is not limited to that of scenario A, but also , alarms, control, status, events, reports …).

When using the test criteria of insuring that the test variable displays correctly in all host screens, event lists, logs, and that all analog quantities are displayed and trigger proper alarms when out of range, the following can be realized:

WITHOUT SCADA REDI ® , a traditional RTU- equipped substation (CASE A) with 25 breakers can be checked out in about 1 day.

WITHOUT SCAD REDI ®, an IED-Equipped substation with 25 breakers (CASE B) can require 25 days to fully check out all data .

A SCADA REDI ® IED equipped substation with 25 breakers (CASE A) can be checked out in 3 hours.

A SCADA REDI ® IED equipped substation with 25 breakers (CASE B) can require 3 days to check out all data .

The time savings is realized in that test equipment does not have to be located and each time consuming setting of the test set or relay need not be performed. The data is set via an auxiliary test set connected to another port. The forcing of the data is instantaneous leading to rapid verification of the event and data at the host level. In a substation with SCADA REDI ® with 2 technicians performing test (at a rate of $60 dollars per hour),the cost savings of using SCADA REDI ® versus the traditional method of substation checkout is 22 days saved at a cost of $21,120. The potential savings are enormous.

Conclusion:

SCADA REDI® is a time savings device designed to increase productivity. An often overlooked but expensive task is that of commissioning the interface between the host and IED. Using the traditional methods of troubleshooting often neglects the integrity of the MMI system during all case scenarios. Using SCADA REDI ® saves time through utilizing proven technologies that are synergetic with microprocessor based IED's. Combining automated SCADA-REDI ® checkout can further increase the time and staff labor savings.

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