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SCADA Based Advanced Data Monitering System

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***Abstract* –Supervisory, Control and Data Acquisition (SCADA) functions and Protection and Control (P&C) functions have been indistinct since the approval and full utilization of microprocessor based relays. The control, data ability and protection functions contain been integrated interested in a single Intelligent Electronic Device (IED). SCADA functions into a protective IED has turned operation gaps that need to be address.A Human Machine Interface (HMI) is creature install in substations by many utilities for monitoring and control purpose. This paper will appraise several distribution and transmission substation designs that combine SCADA and Protection & Control.The paper will propose designs that balance SCADA and Protection & Control and include local HMI functionality, IED access and security.**

***Keywords* — SCADA (Supervisory Control & Data Acquisition), IED (Intelligent Electronic Device), RTU (Remote Terminal Unit), HMI (Human Machine Interface), P&C (Protection & Control), Input/output (I/O), Current Transformer (CT), Potential Transformer (PT), DNP3 (Distributed Network Protocol).**

I. INTRODUCTION

SCADA provides a manned control center with real-time data in order to monitor and operate their system, including energy management restoration, safety, and reliability / availability. P&C provides automated protection of primary equipment. The SCADA and P&C departments each have their individual responsibilities with clear lines of functionality and separate hardware as shown in Figure 1.

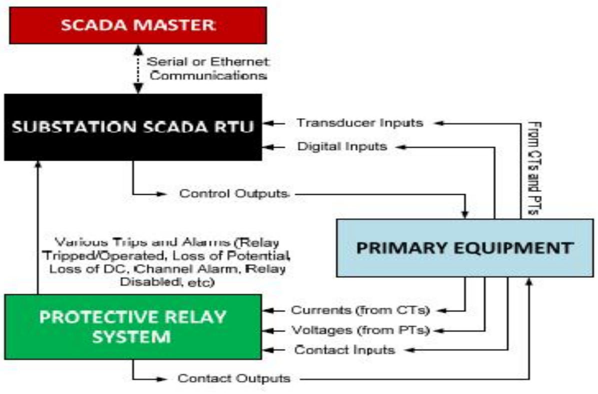

Fig. 1 – Traditional Hardwired Substation SCADA and Protective Relay System Design

The primary apparatus is one place that the SCADA and P&C hardware have links in common. However, the acceptance of IEDs and specifically microprocessor based relays for protection, metering and control functions has created a need to look at how to reliably and economically provide electricity to end users by optimizing the functionality of the SCADA RTU (Remote Terminal Unit) and microprocessor based protective relays or IEDs within the substation.

A conventional hardwired SCADA architecture consists of discrete transducers mount all over the substation measuring currents from current transformers (CTs), voltages from potential transformers (PTs) and station batteries, and power (MW and MVARs) from the combination of these transducers. These DCmA signals are then wired to analog input terminations that are coupled to the substation RTU (see Figure 2).

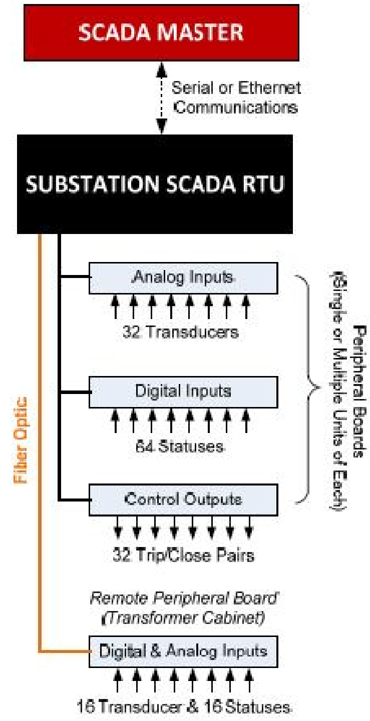

Fig. 2 – Traditional Hardwired SCADA Architecture

In a substation that fully utilizes microprocessor based relays and meters as IEDs, their metered data can be used to provide this same capability and communicate it digitally to the RTU. IEDs include serial (RS232 and/or RS485) and/or Ethernet ports with various communication protocols, such as DNP3 (Distributed Network Protocol), Modbus RTU, ASCII (American Standard Code for Information Interchange) and IEC61850 for example. In addition, these new devices typically have configurable data maps with settable scaling factors and offer multiple simultaneous connections to the devices. Transmitting the analog signals from the substation primary equipment is best accomplished by direct substation SCADA RTU communications to the IEDs via serial or Ethernet communications as shown in Figure 3.

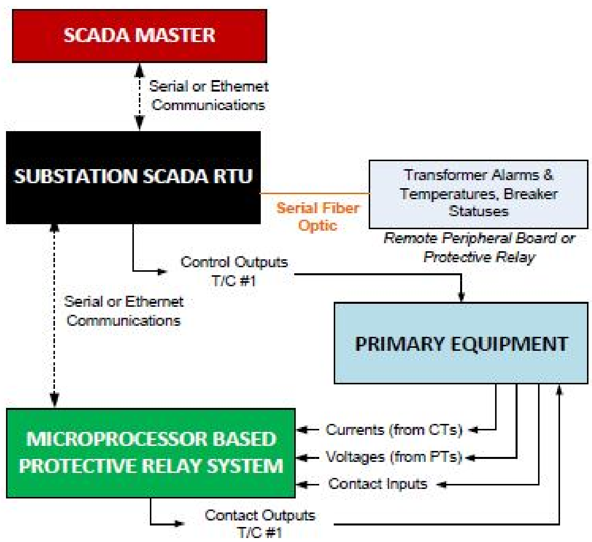

Fig. 3 –Merger of SCADA and P&C within Substation

If redundant microprocessor based relays are used, such as a transmission substation or generating station, one could configure the substation SCADA RTU to simultaneously poll analog values from IED-A and IED-B. If IED-A stops responding or goes off-line, the analog values are replaced with values from IED-B. This is called redundant I/O functionality in the SCADA RTU.

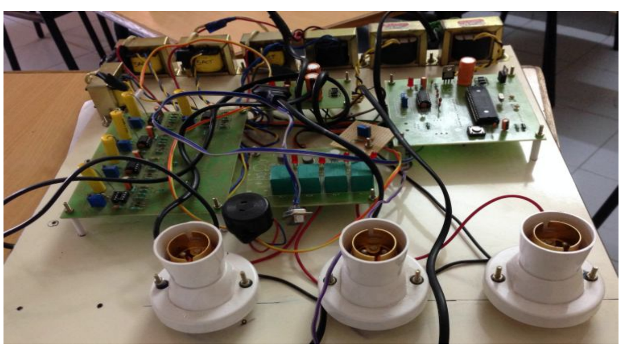

Fig. 4 SCADA based advanced data Monitoring system

Embedded System Plays a major role in day to day advancement in Fig 4. Here we are using 2 center tap transformer 15-0-15 V.One to the power supply circuit board of Potential Transformer and Current Transformer circuit. Another center tap transformer 12 V to the relay driver to the relay circuit and 5V to the multiple power supply board and LDR (light dependent register) for density measurement. Here we are using RS232 serial communication for Interfacing between PC and Micro Controller.

MCLR is using for refreshing the circuit and Crystal circuit is for measurement of time oscillations for frequency of 4MHz of current limit or voltage limit .

The output of the controller decides buzzer operation. The buzzer works only if the Positive and the Ground is connected to the appropriate terminals. We control the buzzer by controlling the ground signal given to the buzzer using a transistor. crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits designed around them became known as "crystal oscillators." Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cellphones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.

The Industrial and control area will be different. So a human vigilance cannot be possible is this circumstances, essentially we must go for auto flame detection system to overcome the above problem and to inform the control room about the status of the flame. Here we use powerful and sensitive "LDR" (Light Dependent Resistor) for the flame detection. Normally LDR senses all the lights. We have provided necessary circuit to reject ambient and luminaries lightings and senses only desired flame coloring. We are using simple and effective potential divider to find out flame.

II. PIC MICRO CONTROLLER

Microcontrollers PIC Family supports more features, so we have chosen PIC 16F877 as the main controller. The Main Features and Peripherals are discussed below.

Other than the normal Microcontrollers PIC Family supports more features, so we have chosen PIC 16F877 as the main controller. The Main Features and Peripherals are discussed below.

The PIC Microcontroller board consists of circuits necessary to operate a Microcontroller with PC interface. The board contains provisions for interfacing 8 analog inputs and 23 Digital level signals. The Description of the circuit is given below.

A. Power supply unit:

As we all know any invention of latest technology cannot be activated without the source of power. So it this fast moving world we deliberately need a proper power source which will be apt for a particular requirement. All the electronic components starting from diode to Intel IC's only work with a DC supply ranging from -+5v to -+12v. We are utilizing for the same, the cheapest and commonly available energy source of 230v-50Hz and stepping down, rectifying, filtering and regulating the voltage. This will be dealt briefly in the forth-coming sections.

B. Step Down Transformer

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/15-0-15v is used to perform the step down operation where a 230V AC appears as 15V AC across the secondary winding. One alteration of input causes the top of the transformer to be positive and the bottom negative. The next alteration will temporarily cause the reverse. The current rating of the transformer used in our project is 2A. Apart from stepping down AC voltages, it gives isolation between the power source and power supply circuitries.

C. Rectifier Unit

In the power supply unit, rectification is normally achieved using a solid state diode. Diode has the property that will let the electron flow easily in one direction at proper biasing condition. As AC is applied to the diode, electrons only flow when the anode and cathode is negative. Reversing the polarity of voltage will not permit electron flow.

D. Voltage Regulator

The voltage regulators play an important role in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device. Power supplies without regulators have an inherent problem of changing DC voltage values due to variations in the load or due to fluctuations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output. IC7812 and 7912 is used in this project for providing +12v and –12v DC supply.

III. INSTRUMENT TRANSFORMERS

Instrument transformers are used in the measurement and control of alternating current circuits.Direct measurement of high voltage or heavy currents involves large and expensive instruments, relays, and other circuit components of many designs. The use of instrument transformers, however, makes it possible to use relatively small and inexpensive instruments and control devices of standardized designs. Instrument transformers also protect the operator, the measuring devices and the control equipments from the dangers of high voltage. The use of instrument transformers results in increased safety, accuracy and convenience.

Relays are electromagnetic switches used as protective devices, indicating devices and as transmitting devices. Protective relay protect good component from the effects of the circuit components that have failed. Transmission relay are used in communication systems. Indicating relay may be used to identify a component which has failed. Transmission relay may be used to identify a component which has failed.

The relay is one of the most widely used components in industrial electronic. Contacts which are opened and close others. Contacts which are opened when energized are called "Normally Open" (NO) or simply open contacts. Contacts which are closed when energized are called "Normally Closed" (NC) or simply open contacts.

Relay contact are held in their normal position by either springs or by some gravity-activated mechanism. An adjustment or adjustments are usually provided to set the restraining force to cause the relay to operate within predetermined conditions.

This type of redundancy would assure that analog signals are continuously transmitted in an event that IED-A or IED-B were taken out of service for maintenance. Additionally, this gives redundancy and reliability of the signal which is typically not available with discrete transducer inputs. If a transducer fails, the signal is lost.keyboard and other controllers for computers, CD players and consumer electronics,timing and control electronics in microwave ovens, coffee makers, controllers for vacuum cleaners and washing machines for sensing dirt loads, control of the dashboard, ignition, fuel injection, suspension stiffness and environmental temperature and noise in automobiles, parking meter controllers.

IV. DIGITAL STATUS CONSIDERATIONS

This method is often preferred by substation engineers in that every status point has a clear indication light of a given point's status

However, there are still cases where remote statuses need to be monitored that are not wired into IEDs because they are either not necessary to the IED or difficult to route to an IED (such as door alarms, motion and loss of or low power (DC) sensors, health status points for the IEDs, copper theft alarms and transformer/breaker alarms). Critical status points (breaker / switch status, transformer alarm, or battery alarm) in smaller substations, that do not warrant redundancy, would benefit from terminated status points to the RTU to serve as redundant to IED statuses.

Using control termination boards with control relays that are connected to breaker trip and close circuits. This method could use a different trip or close coil on the breaker or switch than the microprocessor based protective relays. The control termination boards would be connected to the substation SCADA RTU.For distribution substations that only have one microprocessor based protective relay on a breaker, a combination of Method A and Method B is could be used.

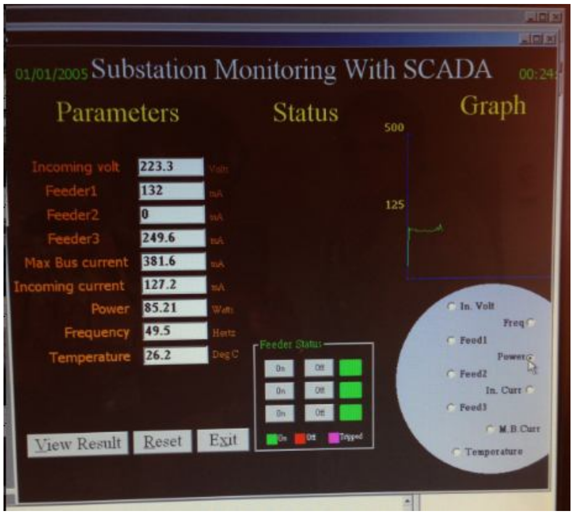

Fig-Monitoring graph of SCADA

This would provide operators the means to remotely control the substation in the case that the microprocessor based relay has a damaged output contact, or trouble condition on microprocessor relay, communications failure or control termination board trouble. Redundant I/O could be accomplished using a combination termination board with analogs, statuses and controls.

V. Communication Considerations

As mentioned previously, microprocessor based relays include RS232, RS485 and Ethernet ports with various communication protocols, such as DNP3, Modbus RTU, ASCII and IEC61850. It is recommended to connect the devices to the substation SCADA RTU by direct serial or Ethernet communications.The SCADA RTU serves as an important part of the SCADA system. On small systems it may be possible to poll the IED directly from the SCADA Master. In this way, the SCADA RTU parses the data to be served up to the SCADA master and only uses one remote address for many devices. Further, there may be a communications bandwidth limitation to the substation. The more devices that the master has to poll at one location may impact communications to that site and/or other locations, providing slower response times (longer waits between polls), dropped polls, or the need for larger bandwidth with greater cost. It should also be noted that most master stations only communicate using one protocol. The use of two protocols would double the bandwidth requirement. A concern if the utility network is carried over public network that local network access is not used for Internet downloads which will affect bandwidth. Use of a SCADA RTU within the substation also allows for protocol conversion to accommodate this requirement regardless of the protocol used by the substation IED and allowing legacy devices to be used.SCADA communication redundancy to the master may also be accomplished using redundant RTUs at the substation,where a single RTU is in service at a time.

VI. Cyber Security Considerations

Cyber security is a concern of each electric utility. It is recommended to consider microprocessor based protective relays and substation SCADA RTU that deliver full cyber security features that help comply with NERC CIP and NIST (National Institute of Standards and Technology) IR7628 cyber security requirements.Authentication, Authorization, Accounting (AAA) server support and RADIUS (Remote Authentication Dial-In User Service) within the substation SCADA RTU and microprocessor based protective relays accomplishes these security requirements

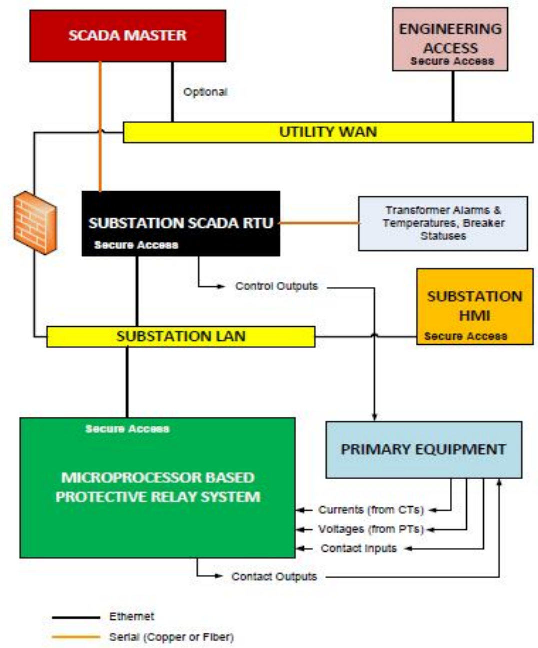

Fig. 4 – Secure Merger of SCADA and P&C within Substation

With the architecture shown in Figure 4, the substation SCADA RTU could provide data directly to a substation HMI.The substation HMI would communicate DNP3 / IP or IEC61850 to the substation SCADA RTU and poll and control the exact same points as the SCADA master. Thus, the substation HMI could act as a back-up SCADA master.

With the HMI having connection to the microprocessor based protection system through Ethernet commutations as shown in Figure 4 allows redundancy to provide local control of substation protective relays in the event of SCADA RTU being off-line due to maintenance or failure. A disadvantage is the complexity of the control and status configuration within the HMI. In addition, the HMI could be securely accessed remotely to retrieve fault data, event data, waveforms and settings from substation microprocessor based protective relays.

VII. CONCLUSION

SCADA based advanced monitoring systems have advanced futures of functions and Protection and Control functions is continuously evolving. This paper has reviewed analog input (metering), binary / digital input (status) and binary / contact output (control) considerations and optimization and redundancy between the substation SCADA RTU and IEDs within the substation. Redundant I/O considerations were reviewed. SCADA Monitoring graph had monitored separate frequencies and different loads.An architecture was reviewed that use substation SCADA RTU, substation HMI, microprocessor based relays and discrete termination modules. Also discussed were Ethernet communications that can be used and have secure remote access to substation SCADA RTU and microprocessor based protective relays.

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