POWER SYSTEM AUTOMATION

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OVERVIEW

Power providers constantly deal with demands to increase productivity and reduce costs. This translates into the need for administrators, engineers, operators, planners, field crews, and others to collect and act on decision-making information.   Power system vendors are following a trend to make devices smarter so they can create and communicate this information. The term "power system" describes the collection of devices that make up the physical systems that generate, transmit, and distribute power. The term "instrumentation and control (I&C) system" refers to the collection of devices that monitor, control, and protect the power system.

Power system automation refers to using I&C devices to perform automatic decision making and control of the power system.

Data Acquisition

Data acquisition refers to acquiring, or collecting, data. This data is collected in the form of measured analog current or voltage values or the open or closed status of contact points. Acquired data can be used locally within the device collecting it, sent to another device in a substation, or sent from the substation to one or several databases for use by operators, engineers, planners, and administration.

Power System Supervision

Computer processes and personnel supervise, or monitor, the conditions and status of the power system using this acquired data. Operators and engineers monitor the information remotely on computer displays and graphical wall displays or locally, at the device, on front-panel displays and laptop computers.

Power System Control

Control refers to sending command messages to a device to operate the I&C and power system devices. Traditional supervisory control and data acquisition (SCADA) systems rely on operators to supervise the system and initiate commands from an operator console on the master computer. Field personnel can also control devices using front-panel push buttons or a laptop computer.

Power System Automation

System automation is the act of automatically controlling the power system via automated processes within computers and intelligent I&C devices. The processes rely on data acquisition, power system supervision, and power system control all working together in a coordinated auto-

matic fashion. The commands are generated automatically and then transmitted in the same fashion as operator initiated commands.

I&C System IEDs

I&C devices built using microprocessors are commonly referred to as intelligent electronic devices (IEDs). Microprocessors are single chip computers that allow the devices into which they are built to process data, accept commands, and communicate information like a computer. Automatic processes can be run in the IEDs, and communications are handled through a serial port like the communications ports on a computer. IEDs are found in the substation and on the pole-top.

Instrument Transformers

Instrument transformers are used to sense power system current and voltage values. They are physically connected to power system apparatus and convert the actual power system signals, which include high voltage and current magnitudes, down to lower signal levels.

Figure 1: Instrument Transformers

Transducer

Transducers convert the analog output of an instrument transformer from one magnitude to another or from one value type to another, such as from an ac current to dc voltage.
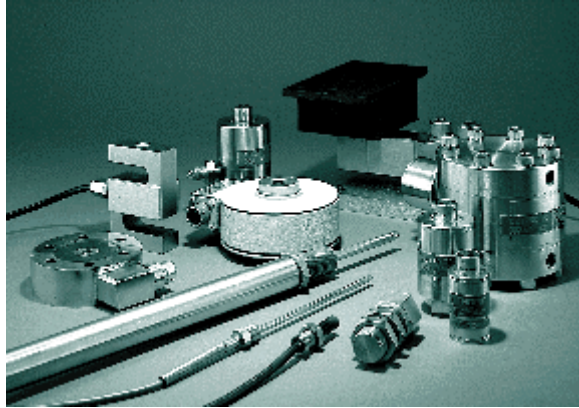
Figure 2: Transducers

Remote Terminal Unit, RTU

As the name implies, a remote terminal device, RTU, is an IED that can be installed in a remote location, and acts as a termination point for field contacts. A dedicated pair of copper conductors are used to sense every contact and transducer value. These conductors originate at the power system device, are installed in trenches or overhead cable trays, and are then terminated on panels within the RTU. The RTU can transfer collected data to other devices and receive data and control commands from other devices through a serial port. User programmable RTUs are referred to as "smart RTUs."

Figure 3: RTU

Communications Port Switch

A communications switch is a device that switches between several serial ports when it is told to do so. The remote user initiates communications with the port switch via a connection to the sub-station, typically a leased line or dial-up telephone connection. Once connected, the user can route their communications through the port switch to one of the connected substation IEDs. The port switch merely "passes through" the IED communications.

Figure 4: Communication Switch

Meter

A meter is an IED that is used to create accurate measurements of power system current, voltage, and power values. Metering values such as demand and peak are saved within the meter to create historical information about the activity of the power system.

Figure 5: Meter

Digital Fault Recorder

A digital fault recorder (DFR), is an IED that records information about power system distur-bances. It is capable of storing data in a digital format when triggered by conditions detected on the power system. Harmonics, frequency, and voltage are examples of data captured by DFRs.

Figure 6: Digital Fault Recorder

Load Tap Changer (LTC)

Load tap changers are devices used to change the tap position on transformers. These devices work automatically or can be controlled via another local IED or from a remote operator or process.

Recloser Controller

Recloser controllers remotely control the operation of automated reclosers and switches. These devices monitor and store power system conditions and determine when to perform control actions. They also accept commands from a remote operator or process.

Figure 7: SEL-351R Recloser Control

Time Synchronization Source

A time synchronization source is an IED that creates a time-of-day value which is then broadcast to the IEDs in order to set all their clocks to the same time.

Figure 8: Time Synchronization Source

Protocol Gateway

IEDs communicate over serial connections by speaking a particular language or protocol. A protocol gateway converts communications from one protocol to another. This task is often performed by software on a personal computer.

Human Machine Interface (HMI)

The front panel display and push buttons or a personal computer act as interfaces to system data and controls for personnel in the substation.

Figure 9: Protocol Gateway or HMI

Programmable Logic Controller (PLC)

As the name implies, a programmable logic controller (PLC), is an IED that can be programmed to perform logical control. As with the RTU, a dedicated pair of copper conductors for each contact and transducer value are terminated on panels within the PLC. Personnel familiar with the PLC development environment can program PLCs to create information from sensor data and perform automation. The PLC can transfer collected data to other devices and receive data and control commands from other devices through a serial port.

**Figure 10: Programmable Logic Controller Right Cabinet,
PC and Accessories Left Cabinet**

Protective Relay

A protective relay is an IED designed to sense power system disturbances and automatically perform control actions on the I&C system and the power system to protect personnel and equipment. The relay has local termination so that the copper conductors for each contact do not have to be routed to a central termination panel associated with RTUs and PLCs. Transducers are not necessary since the relay accepts signals directly from the instrument transformers. Protective relays create metering information, collect system status information, and store historical records of power system operation.

Figure 11: SEL-351 Relay

Communications Processor

A communications processor is a substation controller that incorporates the functions of many other I&C devices into one IED. It has many communications ports to support multiple simultaneous communications links. The communications processor performs data acquisition and control of the other substation IEDs and also concentrates the data it acquires for transmission to one or many masters inside and outside the substation. The communications processor incorporates features of many of the other IEDs including an RTU, a communications port switch, a protocol gateway, a time synchronization source, and a limited PLC functionality. The communications processor has locally terminated I/O and can perform dial-out to alert personnel or processes when a status changes.

Figure 12: SEL-2030 Communications Processor

POWER SYSTEM COMMUNICATIONS

Communications Protocols

The IEEE defines communications protocol as: a formal set of conventions governing the format and relative timing of message exchange between two communications terminals. A strict procedure required to initiate and maintain communication. This regulates the order and arrangement of information, transfer speed or baud rate and error checking.

In general, power system communication networks support four basic operations: establish communications, terminate communications, write data, and read data. The write data function can be used to tell an IED to perform a control action, change settings, or send data to the requesting device. Error checking is done by each device to determine if the message data was corrupted during transmission. The type of protocol, message format, and transfer speed are parameters that are configured during installation.

Communications schemes are polled, scheduled or unsolicited. In a polled situation, one IED acts as the host and initiates almost all data exchange. The other IED acts as a slave and does

only what it is told. The slave rarely initiates data exchange, it simply reacts to requests for data from the host. The exception is an unsolicited message from a slave which sends data to the host without the host requesting it. Often, this is a result of an unexpected change.

Popular Protocols

ASCII - Protocol that is easily converted to human-readable characters and numbers. This protocol is simple but generally slow.

Modbus$^®$ - A popular protocol with industrial users that has also become somewhat popular in substations. Designed to emulate PLCs transferring register data to one another.

Modbus$^®$ Plus - A medium speed network built with proprietary network interfaces using an extension of Modbus protocol.

DNP 3.0 - An ever increasingly popular SCADA protocol, governed by a standards committee and users group, that was designed to optimize efficiency through report by exception, remote modem connections, and multidrop capabilities. Predominantly popular in North America.

UCA/MMS - Utility Communications Architecture, currently being designed by North American utilities, vendors, and consultants to satisfy most requirements in substation feeder equipment and eventually all power system equipment.

Proprietary - Protocols created by the product vendors to communicate with their devices. These are generally unique for each vendor and are not inter-operable. Some vendors design their own protocol because existing protocols lack necessary robustness and efficiency.

Interleaved - Interleaved data streams is a simple way that multiple communications messages can occur on a single communications connection. Data acquisition, control, configuration, and time-synchronization communications can occur at the same time.

Communications Media

Many different types of communications media can be used to conduct the data between IEDs in a power system. They include copper communications cables, power line carrier (PLC), land line telephone, fiber, and wireless. Wireless includes FM and microwave radio as well as cellular telephone and satellite communications.

Direct copper - A copper communication cable dedicated to power system communications between two devices.

Land line telephone - Conventional dial-up or leased lines dedicated to power system communications.

Power line carrier (PLC) - A method of passing data on the power line conductor at high frequency.

Fiber - Fiber applications communicate data in the form of light conducted over a single direct connection or multiple direct connections bundled together.

Figure 13: Fiber-Optic Transceivers

Wireless - Where available, cellular telephone can be used as a dial-up connection. Radios supporting FM and microwave are installed as a dedicated connection for power system communications.

Communications Connections

Direct connect and multidrop are the two types of communications connections available to create networks. In a direct connection, there are only two devices connected to each other. The network media, or conductor, used for passing data can be metallic, wireless or fiber. Each interface consists of a separate transmit and receive connection at each device. Since there are only two devices, each of them can constantly control the connection on which they are transmitting and both can know implicitly to which other device they are connected. Having several individual direct connections to many IEDs would allow each of them to communicate simultaneously. A system of many direct connections originating from one device is called a star network topology. Figure 14 illustrates the star topology. Many star networks can be connected together.

Any protocol, including those designed for multidrop applications, can be used for direct connections in a star topology. Virtually all microprocessor-based relays, LTCs, and meters have a simple EIA-232 serial port connection to support direct connections. Fiber, wireless, and PLC can be used in a direct connection as well.

Star network designs support a wide range of IED capabilities. Simple, slow communicating devices can coexist with more complex, fast communicating relays. Devices from different manufacturers with different protocols can coexist in the same star network because each has a dedicated direct connection.

Most ethernet systems today are developed as star networks with the center of the star being a hub, switch, or router.
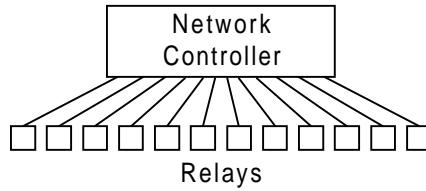
Figure 14: Star Topology

In a multidrop network topology, several devices can be physically connected in a bus or ring network. Figure 15 illustrates devices connected in a bus topology, and Figure 16 illustrates relays connected in a ring topology. A multidrop connection requires that only one device communicate at a time. Devices on a multidrop network must speak the same protocol, with the same baud rate, and the same physical network connection.

A broadcast multidrop is a common network that differs slightly in function and purpose. One-sided conversations are sent from the host to multiple receiving devices that do not respond. Inter-range instrumentation group (IRIG) time-synchronization messages are often sent to IEDs in this fashion. IEDs often need communications connections for this broadcast, separate from a data acquisition and control connection.
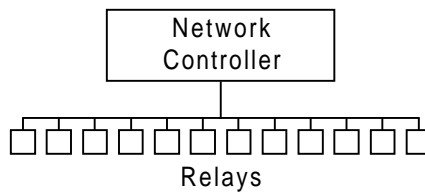
Figure 15: Bus Topology
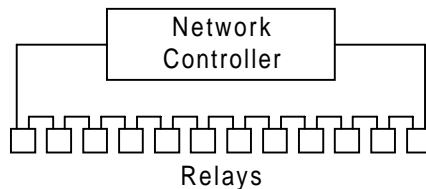
Figure 16: Ring Topology

It is important to keep in mind that if the control over which IED has permission to communicate should fail, none of the multidropped devices can communicate. This can be caused by IED communications hardware failure, IED communications software failure, or corruption of the network. Therefore, a communications problem may appear to be in one IED that is actually in another IED.

AUTOMATED METER READING (AMR)

Automated meter reading is a communications service that permits the transfer of data from utility meters to a utility company's metering collection system. As such, AMR automates the previously manual process of reading meters. Also, it allows the collection of much more and different types of information to benefit the utility and customer alike.

AMR Benefits to Utility

Utilities that use AMR benefit in several ways. First, AMR reduces the labor costs of individually reading each meter. It also improves the safety of personnel who previously had to enter high risk or difficult to access areas on a regular basis. Other benefits include reduced field visits, faster bill processing, and elimination of special reads and estimated bills.

Customer service is also improved by:

- The ability to answer billing questions quickly and accurately by checking current and historical usage while the customer is on the phone;

- Specialized billing and information services, such as summary billing to consolidate billing for multi-site operations and best rate analysis to help customers choose the optimal rate plan for their needs;

- Improved bill accuracy due to a decrease in estimated bills; and

- The ability to let customers select billing dates, and/or to receive summary bills.

The more detailed, customer-specific usage data available through AMR makes it easier for utilities to develop new products and services. This data is also key to developing targeted marketing strategies for attracting and keeping customers.

The lower operating costs and increased specific data made possible by AMR may help smooth a utility's transition from regulated to deregulated markets. Lowered costs can increase the resources available for product development and other needs. More, and further detailed, data provides better insight into an increasingly complex power market, as well as an opportunity to differentiate service via options such as on-line daily usage information, outage status, and customer outage notification.

AMR Benefits to Customer

- Flexible rate programs designed to reduce energy costs.

- Energy usage information to help manage energy costs and better allocate usage.

- Reduced outage time and fewer outages.

- Consolidated billing services and flexible billing dates.

AMR Technology

The basic system consists of a "thermostat-like" panel which allows consumers to use electricity more efficiently by programming appliances, such as the Heating, Ventilation and Air Conditioning (HVAC) system, and hot water heater. Devices within the home will communicate with one another over existing electrical wiring using powerline carrier (PLC) technology.

When connected to a wireless network, AMR systems become a low-cost, two-way communications interface between customers and their utility companies. Some systems allow customers to control and maintain desired temperature levels in their homes at the lowest cost; monitor electricity usage; receive daily updates on community information; pay bills electronically; and ultimately integrate and control lighting and home security systems.

AMR Communications Technologies

AMR technology decisions are dominated by the choice of a communications scheme. Cost is part of the communications scheme choice. The following are the choices:

Power line carrier (PLC) technology uses the power lines as media for sending and receiving low-bandwidth data at very low speed. This option tends to be cost effective for meters served by a single substation. In the US, this technology has been widely adopted by rural cooperatives.

Telephone-based technology uses telephone lines (either dedicated or shared with voice communications) to send and receive meter data. With dial outbound systems, the utility must know the customer's phone number to get the data, which can cause administrative problems. This factor, along with the relatively high prices charged by phone companies for this type of service, has made this option less attractive. With dial-inbound systems, by contrast, meters are equipped with an automated dialer that can call the utility at pre-assigned times, when an alarm condition is detected, or when signaled by the utility. Telephone-based systems tend to be cost-effective for selected meters that are sparsely spread throughout a service territory, and are typically used for large commercial and industrial customers.

Wireless radio-frequency (RF) AMR technologies rely on the use of a transmitter on the meter to communicate with a receiver that can be handheld, located in a vehicle, or installed at a fixed location. Wireless approaches tend to be more cost effective for meters within a clustered geographic area. Mobile radio systems that use handheld or van-based receivers cannot provide two-way real-time communications, and are best suited as replacements for manual meter reading, especially where the cost of manual reading is high. Fixed-network wireless systems, by contrast, can support a wide variety of applications, including metering, real-time pricing, energy management, and outage or theft detection. Of course, there will be an additional cost for these extended features.

Impact of AMR on Field Personnel Within the Utility

The affect of AMR on field personnel in the course of normal activities would be minimal. The field personnel may have to be trained to install, maintain, and be aware of how the equipment functions. This AMR equipment will vary depending on what type of system the utility procures. The equipment involved will range from the meters themselves to the master devices required in the fixed-network wireless systems. Depending on the type of system, they may get involved in installation of spread spectrum radios and other communications equipment. Field personnel will have to recognize if AMR equipment was installed at a customer facility since incorrect disconnects while doing service work can result in issues with the customers phone service. Utilities will be responsible for providing the required training and work procedure guidelines applicable to the products and installation.

POWER SYSTEM AUTOMATION

Power System Integration

Power system integration is the act of communicating data to, from, or among IEDs in the I&C system and remote users. Substation integration refers to combining data from the IED's local to a substation so that there is a single point of contact in the substation for all of the I&C data.

Poletop devices often communicate to the substation via wireless or fiber connections. Remote and local substation and feeder control is passed through the substation controller acting as a single point of contact. Some systems bypass the substation controller by using direct connections to the poletop devices, such as RTUs, protective relays, and controllers.

Power System Automation

Power system automation is the act of automatically controlling the power system via I&C devices. Substation automation refers to using IED data, control and automation capabilities within the substation, and control commands from remote users to control power system devices. Since true substation automation relies on substation integration, the terms are often used interchangeably.

Power system automation includes processes associated with generation and delivery of power. A subset of these processes deal with delivery of power at transmission and distribution levels, which is power delivery automation. Together, monitoring and control of power delivery systems in the substation and on the poletop reduce the occurrence of outages and shorten the duration of outages that do occur. The IEDs, communications protocols, and communications methods described in previous sections, work together as a system to perform power system automation.

Figure 17: Power System Automation and Supervision

Power Delivery Automation

Though each utility is unique, most consider power delivery automation of transmission and distribution substations and feeders to include:

- Supervisory Control and Data Acquisition (SCADA) - operator supervision and control

- Distribution Automation - fault location, auto-isolation, auto-sectionalizing, and auto-restoration

- Substation Automation - breaker failure, reclosing, battery monitoring, dead substation transfer, and substation load transfer

- Energy Management System, (EMS) - load flow, VAR and voltage monitoring and control, generation control, transformer and feeder load balancing

- Fault analysis and device maintenance

Systems without automated control still have the advantages of remote monitoring and operator control of power system devices including:

- Remote monitoring and control of circuit breakers and automated switches

- Remote monitoring of non-automated switches and fuses

- Remote monitoring and control of capacitor banks

- Remote monitoring and voltage control

- Remote power quality monitoring and control

System Automation Features

IEDs described in the overview are used to perform power system integration and automation. Most designs require that one IED act as the substation controller and perform data acquisition and control of the other IEDs. The substation controller is often called upon to support system automation tasks as well. The communications industry uses the term client/server for a device that acts as a master, or client, retrieving data from some devices and then acts as a slave, or server, sending this data to other devices. The client/server collects and forwards data dynamically. A data concentrator creates a substation database by collecting and concentrating dynamic data from several devices. In this fashion, essential subsets of data from each IED are forwarded to a master through one data transfer. The data concentrator database is used to pass data between IEDs that are not directly connected.

A substation archive client/server collects and archives data from several devices. The archive data is retrieved when it is convenient for the user to do so.

The age of the IEDs now in substations varies widely. Many of these IEDs are still useful but lack the most recent protocols. A communications processor that can communicate with each IED via a unique baud rate and protocol extends the time that each IED is useful. Using a communications processor for substation integration also easily accommodates future IEDs. It is rare for all existing IEDs to be discarded during a substation integration upgrade project.

Power System Automation Benefits to Utility

The benefits of monitoring, remote control, and automation of power delivery include improved employee and public safety, and deferment of the cost of purchasing new equipment. Also, reduced O&M costs are realized through improved use of existing facilities and optimized per-formance of the power system through reduced losses associated with outages and improved volt-

age profile. Collection of information can result in better planning and system design, and increased customer satisfaction will result from improved responsiveness, service reliability, and power quality.

AUTOMATION SYSTEM AND EQUIPMENT OPERATION EXAMPLES

Distribution Automation System Example

Distribution automation systems easily demonstrate the value in automating control of the power system. Figure 18 shows a two line radial distribution network with three manually operated switches for line segregation and load transfer. Given a permanent fault on Line 1, the relaying for Switch 1 (SW1) trips and all load on Lines 1 and 2 is interrupted. To restore load to Line 2, operators must manually open SW2 and then close SW5. In this example, we assume it takes an operator one-half hour to reach and operate each manual switch sequentially. Thus, Line 2 load is restored one hour after the permanent fault is cleared by SW1.
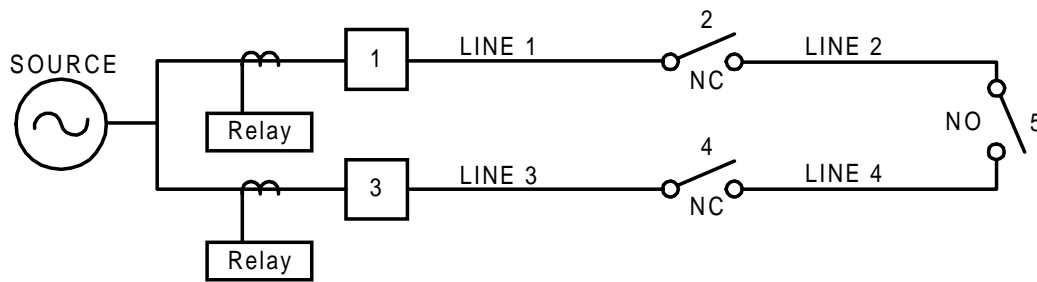
Figure 18: System Single-Line – Manual Isolation Switches

Let us next look at replacing the manual switches with automatically controlled fault interrupting devices (i.e., electronic reclosers, breakers, etc.). Further, let us assume that the protection supplied for all of the breakers and automatic switches is linked together via a communications link.

Figure 19 shows the same distribution network as above, with automatically controlled switches and the associated overcurrent protection and control scheme. The communications link dramatically advances the automation and control possibilities. For the purpose of this example, we assume that each protective relay shown in Figure 19 communicates with the adjacent relays that have control functions. This capability allows fast automatic restoration and avoids dispatching an operator to restore load. Most importantly, it saves approximately one hour in restoring service to the Line 2 load.
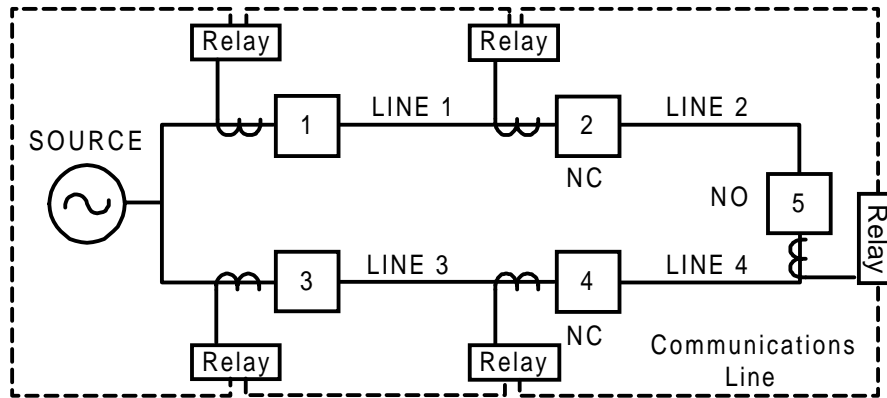
Figure 19: System Single-Line – Automatic Isolation Switches

Equipment Interface Example

Most of the IEDs in the I&C system have at least one simple EIA-232 serial port to support communications to another IED or PC. Some IEDs support data acquisition and control communications, as well as configuration communications, through a single connection. Many IEDs require separate links for each communication process; therefore, two communications links are necessary. Some products support many types of communications messages through one interleaved communications connection.

Figure 20: IED Communications

Many IEDs require a vendor-supplied proprietary PC software application for configuration, while others simply need a terminal emulation device and communicate via human-readable ASCII strings. The following example demonstrates the procedures necessary to connect an SEL-351 relay to a PC to perform a simple ASCII dialogue.

Connecting an SEL-351 to a PC

1) Make sure you have the proper equipment.

   Desktop PC or Laptop computer

   SEL-351 Directional Overcurrent Relay, Reclosing Relay, Fault Locator

   Cables: SEL-C234A or SEL-2800M & SEL-2800F Transceivers & Fiber-Optic cables

2) Turn on your computer and relay.

3) Start a Hyper Terminal session.

   Click on START , go to PROGRAMS → ACCESSORIES → HYPERTERMINAL

   Double click on the Hypertrm.exe

   Type in a name of the session you want to create (e.g., sel351), then press enter.

4) Select a communications (COM) port on the PC.

   In selecting a COM port you need to know a little about the computer you are going to use.

   - How many COM ports does it have available?

   - Which ones are you able to use?

   Connect your cable to one of the available COM ports.

   From your work session select the COM port you connected to in the back of your PC (e.g., Connect using: Direct to COM 1). Select O.K. and then, from the communication properties settings screen, select O.K..

   There is an experiment you can do if you are using fiber-optic cable with 2800 modems, to see if you've selected the correct COM port that you connected your cable to.

   - Unplug the cable from the receive (R) from the 2800M modem.

   - From the keyboard, press enter a few times while watching the receive line.

   - There should be an infrared light that you see when enter is pressed. This light is in the visible spectrum and is not dangerous.

   Troubleshooting:
   If there is no infrared light, then you might have selected the wrong COM port or your cable is not properly secure. Make sure your cable is securely fastened, then go to FILE → PROPERTIES and make sure you have selected the right COM port.

***Note: If you do change your work session properties you must disconnect, then reconnect. This is done by simply clicking on the icon of the telephone with the receiver off, then clicking on the telephone icon with the receiver back on.

5) Set Up Communications Properties.

Once you've selected the right communications port, you can then set up the communications properties for that port. Go to FILE → PROPERTIES → CONFIGURE.

Connect the cable to one of the EIA-232 ports, which are clearly marked on back of the relay.

The COM port properties need to match those of the relay communications port settings. You can use the front panel controls on the relay to view the port communications settings on the LCD HMI.

Press the Set button, then the down arrow (to put the cursor on port), then press the select button. This brings you to select Set or Show, select Show and press the select button since all you want to do is see the settings.

After selecting Show, there will be a message that scrolls across the screen. Just let it scroll across; you will then see the PROTO setting. Make sure this is set to SEL.

Use the down arrow on the front panel to scroll down to the SPEED setting. This setting is the speed or bits per second at which the relay and the PC communicate. The SPEED setting on the relay and the BITS PER SECOND setting on your hyperterm work session need to be the same to establish communication. If they are different, just click on the BITS PER SECOND box in hyperterm and select the value of the SPEED setting in the relay.

Next use the down arrow to scroll down again on the relay. This brings you to the BITS setting; in the same fashion as above make sure this matches the DATA BITS setting on your hyperterm work session.

Next, use the down arrow again to scroll down to the PARITY setting. Make sure this matches the PARITY setting in your hyperterm work session.

Scroll down to the STOP setting on the relay; make sure this matches the STOP BITS setting in your hyperterm work session.

Set the FLOW CONTROL setting in the hyperterm work session to None.

Click OK.

You should now be able to press the enter key and have equal (=) signs appear on the screen. Table 1 describes the ASCII commands available.

Table 1: Serial Port Command Summary

Access Level	Prompt	Serial Port Command	Command Description	Corresponding Front-Panel Pushbutton
0	=	ACC	Go to Access Level 1	
1	=>	BAC	Go to Access Level B	
1	=>	2AC	Go to Access Level 2	
1	=>	BRE	Breaker monitor data	OTHER
1	=>	COM	Mirrored Bits™ communications statistics	
1	=>	DAT	View/change date	OTHER
1	=>	EVE	Event reports	
1	=>	GRO	Display active setting group number	GROUP
1	=>	HIS	Event summaries/histories	EVENTS
1	=>	IRI	Synchronize to IRIG-B	
1	=>	LDP	Load profile report	
1	=>	MET	Metering data	METER
1	=>	QUI	Quit access level	
1	=>	SER	Sequential Events Recorder	
1	=>	SHO	Show/view settings	SET
1	=>	SSI	Voltage Sag/Swell/Interruption Report	
1	=>	STA	Relay self-test status	STATUS
1	=>	TAR	Display relay element status	OTHER
1	=>	TIM	View/change time	OTHER
1	=>	TRI	Trigger an event report	
B	==>	BRE n	Preload/reset breaker wear	OTHER
B	==>	CLO	Close breaker	
B	==>	GRO n	Change active setting group	GROUP
B	==>	OPE	Open breaker	
B	==>	PUL	Pulse output contact	CNTRL
2	=>>	CON	Control remote bit	
2	=>>	COP	Copy setting group	
2	=>>	LOO	Loopback	
2	=>>	PAS	View/change passwords	SET
2	=>>	SET	Change settings	SET

6)   Troubleshoot if necessary.

Problems may arise when you set up communications. The simplest and most frequent problem is incorrect baud rate (speed). Make sure that the relay and the work session that you created have the same baud rate.

If the baud rate is correct then make sure you have the correct COM port selected.

Make sure all cables are properly secure and the relay is turned on.