**Application Note**

Substation Automation and Protection Division

# RS232 Point to Point Connectivity for the DPU/TPU/GPU 2000(R) Protection Units

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***Today's requirements for rapid data acquisition necessitate understanding the physical interface requirements for connection of a DPU2000(R), TPU2000(R) ,or GPU 2000(R). One of the many available options within the ABB DPU2000(R), TPU2000(R) ,or GPU 2000(R). Protection Units is RS 232 connectivity. What follows is an explanation of RS 232 serial port connectivity and physical connection considerations in a point to point communication architecture.***

## What is RS 232?

*RS 232 is perhaps the most utilized and least understood communication interface in use. RS 232 is sometimes misinterpreted to be a protocol; it is in fact a physical interface. A physical interface is the hardware and network physical media used to propagate a signal between devices. Examples of physical interfaces are RS 232 serial link, printer parallel port, current loop, V. 24, IEEE Bus… Examples of network media are, twisted copper pair, coaxial cable, free air…*

*A protocol is a specific set of rules and regulations regulating data transmission and reception. Examples of protocols are: DNP 3.0, Modbus, INCOM, etc., which can communicate over a variety of physical interfaces and media. Every DPU2000(R), TPU2000(R) ,or GPU 2000(R) protective device includes an RS232 connection as part of the base product.*

*RS 232 gained widespread acceptance due to its ability to connect to another RS232 device or to a modem. A modem is a device, which takes a communication signal and modulates it into another form. Common forms of modems include telephone, fiber optic, microwave, and radio frequency. Modem connectivity allows attachment of multiple devices on a communication network or allows extension of communication distances in a network with two nodes. Physical connection of two devices or more than two devices require differing approaches. This note shall explore point to point serial communication in depth and illustrate its inclusion into substation applications.*

*The first RS 232 specification issued by the Electronic Industries Association defined the interface as consisting of 25 pins within a D shell connector. One of four categories of functionality is assigned to each pin (ground, data, control and timing). With the introduction of the IBM PC AT, the RS 232 port was reduced in form factor and functionality to consist of 9 pins within a D shell connector. That has been the de-facto standard for RS232 port implementation included on most electronic equipment. The DPU/TPU/GPU 2000(R) family of protective devices includes at least one RS 232 port emulating a common utility industry protocol.*

## RS 232 Connectivity Issues

*Common issues arise when two devices communicate. Typical communication architectures are illustrated in Figures 1 and 2. Configuration of an ABB DPU2000(R), TPU2000(R) ,or GPU 2000(R) family of protection relays is accomplished via a software program called ECP (External Communication Program). Figure 1 illustrates a typical connection in a point to point topology. DPU2000R configuration through a personal computer requires two steps, 1.) Correct physical interconnection between the PC and DPU2000, 2.) Configuration of the DPU and the PC with a common protocol. The DPU2000(R), TPU2000(R) ,or GPU 2000(R) protocol may be assigned to each port through a configuration sequence via the front keypad of the device. Please refer to the respective product manuals for communication port configuration instructions.*

Figure 1. Point to Point Topology

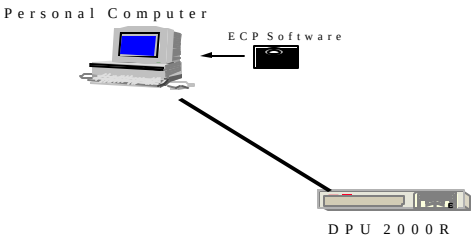
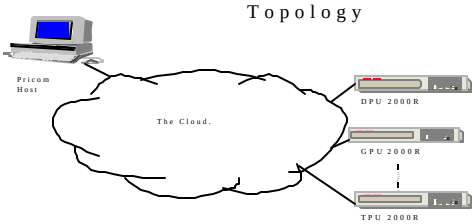



*Figure 2 illustrates another typical communications topology, multi-drop. A typical implementation of multi-drop architecture is one in which a host computer (for example, a personal computer with Pricom SE software) collects metering information from a distributed set of protective relays. In this case a great distance separates the personal computer from each device. However, an RS232 port is available on each node. Device interconnection is possible through the addition of a modem or line driver. Interconnection of these devices requires a different setup and implementation process. The topic of multi-drop topology is covered in other application notes.*

Figure 2. Multi-Drop Topology




*Point to point connectivity can be accomplished via a copper cable connection. An explanation of this implementation follows. The physical copper cable can be referred to as the physical medium. Other types of physical medium can be air (as used in radio or microwave modems), as well as plastic or glass fiber (as used in fiber optics).*

*EIA specifications of an RS 232 port provide port and line characteristics. The applied communication signal transmission voltage, can range from 5 to 25 Volts (Space or 0) or –5 to -25 Volts (Mark or 1) through a load impedance with a resistance of 3,000 ohms to 7,000 ohms and a shunt capacitance of no more than 2500 picofarads. If these electrical characteristics are met, a signal can propagate up to 50 feet (17 meters). If the distance between nodes is greater than 50 feet, additional devices may be utilized to extend communication distances. These devices are known as short haul line drivers, telephone modems, radio frequency modems or microwave modems. Some device manufacturers lower voltage on the RS232 port to a level of 3 volts. While a bipolar 3-volt level is within the electrical range of the RS232 specification, transmission length is severely decreased.*

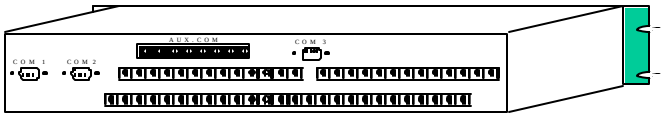



Figure 3 - Rear Panel Com Port Location.

*The RS 232 ports on the protective relay are designated as Com 0, Com 1, Com 2, and Com 3. Com 0 is located on the front of the unit. As illustrated on Figure 3, Com ports 1 through 3 are located on the back of the unit. The inherent design of the RS 232 electrical interface is designed for point to point communication over copper medium. The RS232 pin designations on the DPU2000(R), TPU2000(R) ,or GPU 2000(R ) is illustrated in Figures 4 and 5.*

## Port Isolation

*Network installation within a substation requires special considerations. A substation environment is harsh in that high levels of electromagnetic interference are present. Additional ground currents are present in such installations. RS232 is an unbalanced network in that all signals are referenced to a common ground. On longer cable runs, the potential of the signals at the sending device can be significantly lower than at the receiving end due to electrical interference and induced ground current. This increases with long runs of cable and use of unshielded cable. ABB's Power Automation*

*and Protection Division recommends the length of RS232 cable be less than 10 feet (3 meters) and that the cable be shielded. Internal to a typical device, the RS232 transceivers are referenced to the electronic components internal ground. Any electrical interference could be coupled through the chip set and fed back to the device. Typical isolation ratings of a non-isolated port could be as low as 1 volt. Such a port could allow electrical feedback of noise to the electronics for any signal interference over 1 volt. Coms 0 through 2 on DPU/TPU/GPU units are non – isolated. However an RS232 implementation on Com 3 uses opto-isolation technology which increases electrical isolation from the port to the devices internal circuitry to 2.3 kV. It is highly desirable to utilize this port in connection to devices in longer cable runs and dedicated communication networks.*

## Point to Point Cable

*A cable diagram is illustrated in Figure 4. Figure 4 shows the direction of communication signal transmission and the gender of the connectors used in constructing a communication cable.*

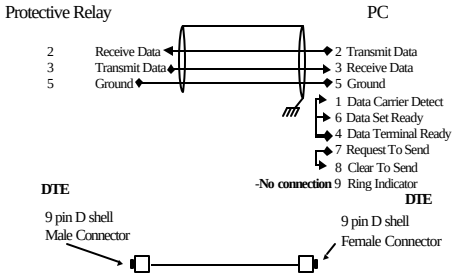



Figure 4 - DPU2000(R), TPU2000(R), or GPU 2000(R) to PC Cable 9 to 9 Pin-out

*An RS 232 interface was designed to simplify the interconnection of devices. Definition of terms may demystify issues concerning RS 232 interconnection. Two types of RS 232 devices are available, DTE and DCE. DTE stands for **D**ata **T**erminal **E**quipment whereas DCE stands for **D**ata **C**ommunication **E**quipment. These definitions categorize whether the device originates/receives the data (DTE) or electrically modifies and transfers data from location to location (DCE) Personal Computers are generally DTE devices while line drivers/ modems/ converters are DCE devices. DPU/TPU/GPU devices have RS232 DTE implementation. Generally, with a few exceptions, a "straight through cable"(a cable with each pin being passed through the cable without jumpering or modification) will allow a DTE device to communicate to a DCE device.*

*Connection of a PC to a DPU/TPU/GPU requires cable modification since the interconnected devices are both DTE. The same cabling would be utilized if one would connect two DCE devices. The classifications of DTE/DCE devices allow the implementers to determine which device generates the signal and which device receives the signal. Studying Figure 4, Pins 2 and 3 are data signals, pin 5 is ground whereas pins 1,6,7,8,9 are control signals. The arrows illustrate signal direction in a DTE device. The family of DPU/TPU/GPU protective devices do not incorporate hardware or software "handshaking'.*
*Handshaking is the ability of the device to control the flow of data between devices. There are two types of "handshaking", hardware and software. Hardware handshaking involves the manipulation of the RTS (Request to Send) and CTS (Clear to Send) card control signal lines allowing data communication direction and data flow rates to be controlled by the DTE device. Also the flow is controlled by the DTR (Data Terminal Ready) signal which allows the DCE operation.*

*Software handshaking involves the data flow control by sending specific characters in the data streams. To enable transmission, the XON character is transmitted. To disable reception of data, the transmitting device sends an XOFF character. If the XOFF character is imbedded within the data stream as information, the receiving node automatically turns*

*off. This is the main weakness of software handshaking, inadvertent operation due to control characters being imbedded within data streams. Software handshaking is usually used in printer control.*

*The DPU/TPU/GPU devices do not incorporate handshaking, therefore, the control lines may be ignored as illustrated in Figure 4. However, some PC software utilizes handshaking, thus the port on the personal computer may require a special hardware configuration of the cable to the port. Consult with the software vendor to determine RS232 control and buffering requirements and the need for signal jumpers required in RS232 cabling.*

*The ports on the DPU/TPU.GPU have been tested for operation up to a speed of 19,200 baud. 19,200 baud is the typical data rate applicable for the operation of an asynchronous communication connection over RS 232 without the use of additional timing lines.*

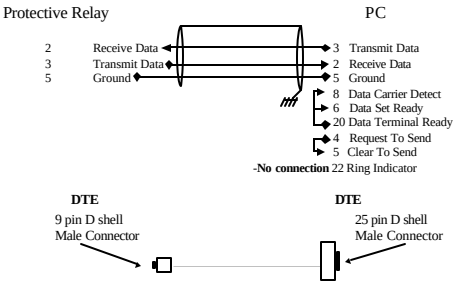



Figure 5 - DPU2000(R), TPU2000(R), GPU2000(R) to PC Cable 9 to 25 Pin-out

*Some installations require connection to a traditional 25-pin RS232 interface. The pin designations differ from the 9-pin implementation. Figure 5 illustrates the connection cable for implementation of a 9 to 25 pin cable.*

## Conclusion

*RS 232 communication through a copper connection in a point to point configuration is easily achieved with the correct cable connection. Understanding common terms as DTE, DCE and handshaking are important in designing the correct cable to connect similar devices on an RS 232 physical interface.*

*References:*

*ABB Power T&D Company , Inc. Instruction Booklet: ABB Distribution Protection Unit 2000R 1MRA587219-MIB, Rev B , October 1997.*
*ABB Power T&D Company Inc., Instruction Booklet: ABB Transformer Protection Unit 2000R 1MRA588372-MIB, Rev B , February 1997.*
*Electronic Industries Association, EIA Standard – Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange RS232 – C, August 1969*

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