

Substation Automation and Protection Division

## TELEBYTE RS 232/485 Converter Connection To ABB Protective Relays

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*ABSTRACT: There are many RS 232 to RS 485 converters on the market. Although ABB cannot and does not endorse a particular manufacturer of product, it does document several manufacturers' products with their use in systems using ABB protective relays. This application note illustrates the setup and connection of the TELEBYTE Model 245 optically isolated RS 232 to RS485 (2-wire/4wire) physical interface converter.*

### Typical Installation

The ABB protective relay is designed with a variety of physical communication interfaces. The ABB distribution relays such as the MSOC, GPU 2000R, TPU 2000R, DPU 2000R, DPU 2000, DPU 2000 and DPU 1500R are available with an RS 232, and/or RS 485 port(s).

Other devices such as the PONI M card for the REL 356 have only an RS 485 port.

Many host devices only have an RS 232 port(s). A method to connect such a device is required. Several converters are available to transform the physical interface on a device from RS 232 to RS 485. The advantages of RS 485 are that many devices may be attached to a single host in a multi-drop topology. RS 485 may communicate with up to 32 devices with an addressable protocol. An advantage of the Telebyte 245 converter is that, like the ABB protective relay, it is an isolated device.

### General Information

Figure 1 illustrates the packaging of the Telebyte converter. The Telebyte Converter has two sets of red LED's indicating transmission and reception of information on its ports. One set of LED's indicates transmission/reception of data on its RS 232 port. The second set of LED's indicates transmission/reception of data on its RS 232/RS 485 port. These LED's are invaluable in visual troubleshooting of communications.

The Telebyte converter has two sets of dB 25 connectors. One connector is a standard RS 232 interface whereas the other connector is the RS 485/RS 422 interface. Switches 1 and 2 configure the RS 485 interface. A DTE/DCE (Data Terminal Emulation / Data Communication Emulation) switch configures the RS 232 pins determining where the data is expected (DTE = Data is Transmitted on Pin 2 and Data is Receive on Pin 3 | DCE = Data is Transmitted on Pin 3 and Data is Received on Pin 2) on the RS 232 interface. Furthermore, Switch 2 configures the RS 485-control mode from the RS 232 port. In two-wire emulation, data control may occur from the RS 232 port's RTS (Request To Send) line or whether the data on the TD (Transmitted Data) pin is sensed. If the ABB device is a MSOC, GPU 2000R, TPU 2000R, DPU 2000R, DPU 2000, DPU 2000 and DPU 1500R, no data handshaking is permitted, thus the RS 232/485 converter must be configured for TD (Transmitted Data) mode. However, if the device attaching to the RS 232 port is a host which utilizes RTS/CTS (Request To Send/ Clear To Send) handshaking, the unit must be configured using the RTS dipswitch settings as illustrated in Figure 1. Additional information on the TELEBYTE 245 Optically Isolated converter is available on their website at [www.telebyteusa.com](http://www.telebyteusa.com).

There are several steps required to successfully install a communication network using a physical interface converter. They are:

1. Knowledge of the RS 232 interfaces. (What type of handshaking is employed?, Is the port DCE or DTE emulation?, Does the program executing on the attached device require certain signals such as CTS [Clear To Send], RTS [Request To Send], CD [Carrier Detect], DTR [Data Terminal Ready])? , What is the voltage of the RS 232 interface signals?)
2. Knowledge of the available power required. (If the converter requires external power, what is the voltage required?)
3. Knowledge of the RS 485 devices connected (2 Wire or 4 Wire?, Biasing Required?, Length of network?, Number of Devices Attached? Are the devices isolated?)
4. Proper installation of bias resistors.
5. Proper installation of termination resistors.
6. Proper selection and installation of the physical cable medium.
7. Proper configuration of the RS 232/485 physical interface switches and dipswitches.

TELEBYTE 245 OPTICAL ISOLATOR CONVERTER  
RS 232 RS485/RS422



The 245 uses Pin 2 (TX/RX -) & Pin 14 (TX/RX +), Pin 7 is Ground for its connections to the Two Wire RS-485 Relay.

RS 485 SWITCH MODE (2 wire)	SW 1				SW 2			
	1	2	3	4	1	2	3	4
TRANSMIT DATA CONTROL	UP	DOWN	UP	DOWN	X	DOWN	UP	Y
RTS DATA CONTROL	UP	UP	DOWN	UP	X	DOWN	UP	Y
X = TERMINATION RESISTOR, UP = INSERTED, DOWN = OUT					Y = DON'T CARE			

Figure 1 – Telebyte Dipswitch Settings

## RS232 Configuration And Cabling

The Telebyte RS 232 section of the converter uses the following pins:

- Pin 2 – Transmit Data
- Pin 3 - Receive Data
- Pin 7 - Ground

The RS 232 connector on the converter is a DB 25 male connector.

Depending upon the dipswitch settings, the following pins are used for transmit data control.

- Pin 4 – Request To Send
- Pin 5 – Clear To Send.

Although the TELEBYTE converter does use handshaking and control of the DTR signal (Pin 20), its use is not covered in this application note.

The Telebyte converter is an actively powered device requiring attachment to a supplied power transformer. This transformer supplies power to both ports on the unit. No additional power supplies are required for this converter to operate.

The TELEBYTE converter has an additional dipswitch configuring the RS 232 port for DCE or DTE configuration. Figures 2 and 3 illustrate cable pinouts to connect a PC or ABB to connect to a device. If the converter is attached to a PC Host device or an ABB IED, a straight through cable may be used (or a

9 pin to 25 pin cable) to attach the devices. The DTE/DCE switch must be placed in the DCE position due to the nature of RS 232 connections. If additional discussions of RS 232 are required, please consult the ABB Faxback System (610-877-0721) or the ABB website ([www.abbus.com/papd](http://www.abbus.com/papd)). Several documents are available explaining RS 232 communication. The TELEBYTE converter has a DB 25 connector whereas the ABB IED's and most personal computers have DB 9 connectors. Figures 2 and 3 illustrate the cable connections are handshaking is used (RTS/CTS) control or if no handshaking (data control using the Transmitted Data line) is employed. Configuration of the data control handshaking mode is performed via the dipswitches located at the side of the converter. Refer to Figure 1 of this document for dipswitch configuration.

Cable "A"- RS 232 Cable for Connection from a NODE (DTE OR DCE) and the TELEBYTE converter configured correctly (DTE DEVICE AND TELEBYTE SWITCH IN DCE MODE --OR-- DCE DEVICE AND TELEBYTE SWITCH IN DTE MODE). DATA CONTROL RTS/CTS HANDSHAKING EMPLOYED.

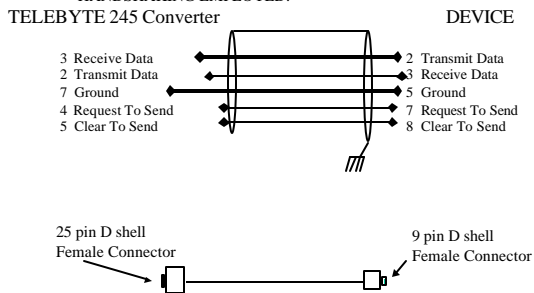


Figure 2 – RS 232 Cable Pinout With Handshaking Incorporated (See Figure 1 For Dipswitch Settings)

Cable "A"- RS 232 Cable for Connection from a NODE (DTE OR DCE) and the TELEBYTE converter configured correctly (DTE DEVICE AND TELEBYTE SWITCH IN DCE MODE --OR-- DCE DEVICE AND TELEBYTE SWITCH IN DTE MODE). NO HANDSHAKING Data Control via the Transmitted Data (TD) line.

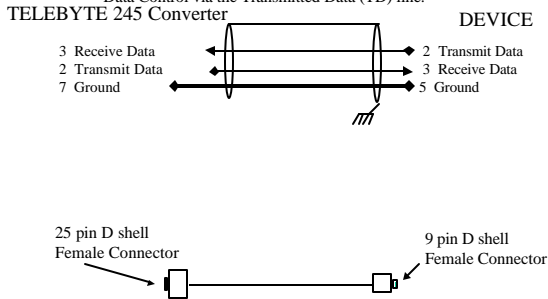


Figure 3 – RS 232 Cable Connections When No Handshaking Is Used. (See Figure 1 For Dipswitch Setting).

### Power Requirements

The TELEBYTE converter is available using a variety of power supply options. The converter is supplied with a power converter, which attaches to which attaches to the device. For current options, please consult the TELEBYTE website.

## RS485 Configuration And Cabling

The TELEBYTE converter supports RS 422, 4 Wire RS 485 and 2 Wire RS 485 connectivity. The ABB line of protective relays supports 2 Wire RS 485 connectivity. The dipswitch settings in Figure 1 are given only for the RS 485 two wire options. If additional configuration information is desired for RS 485 4 wire or RS 422 configuration please consult the TELEBYTE website.

The attractive feature of the TELEBYTE converter is the isolation of the RS 232 and RS 485/422 ports from external power supplies. This feature is important especially in utility applications where external noise is an issue.

RS 485 cabling is usually the source of most communication issues. Several issues must be remembered when installing such a cable:

1. In attachment to ABB relays in a Utility installation, one must remember to use a cable with 3 wires and a shield. Refer to Figures 4 through 7 for ABB recommended cables.
2. Termination must be attached to the extreme ends of the cable. If ABB relays are at the extreme ends of the cable, internal termination resistors are available to provide termination. If the TELEBYTE converter is inserted at the end of the cable, Switch Bank 2, Dipswitch position 1 inserts or removes a 120 ohm resistor in the circuit.
3. The cable attaching the nodes must be daisy- chained. Drops, Taps and stubs of cables are not supported. The addition of terminals, drops, taps, and cable stubs increase the signal reflections thus increasing the possibility of communication errors.
4. The CABLE SHIELD is grounded at one place only. The cable shield is continuous through all nodes, but it is isolated from the ground potential at each device.
5. The ABB protective device RS 485 ports are optically isolated, the ground wire must be attached to the shield ground at one place only. This is required to reference the field side of the device interface to a common reference.

## RS 485 Line Termination

RS 485 2 Wire connection diagrams are referenced in Figures 4 through 7. Figures 4 and 5 use the internal resistors within the DPU, GPU, TPU and MSOC units. Figures 6 and 7 illustrate an alternate method of using external resistors to provide biasing and line termination.

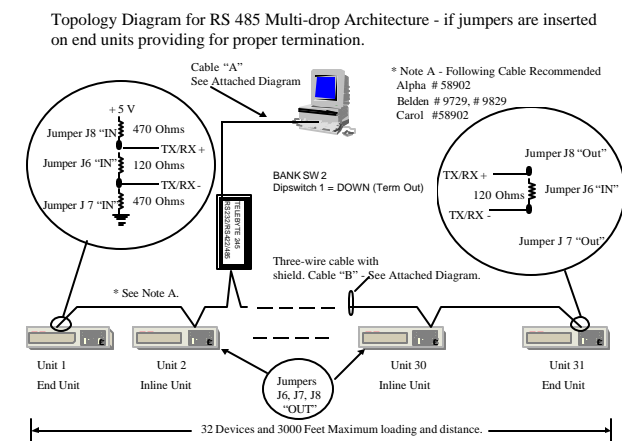


Figure 4 – RS 485 2 WIRE TERMINATION WITH THE RS 232/485 Converter INLINE and ABB Protective Relays At End Of Line Locations.

Topology Diagram for RS 485 Multi-drop Architecture - if jumpers are inserted on end units providing for proper termination and converter is at End Unit.

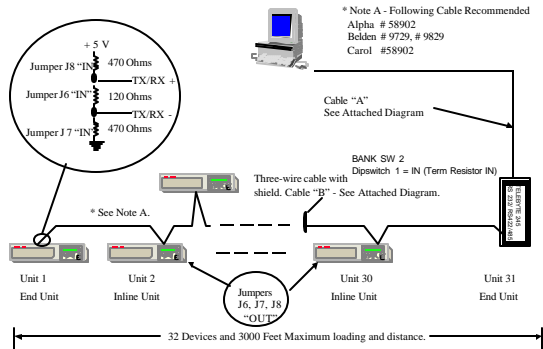


Figure 5 – Termination Using Internal Jumpers And Converter As An End Unit.

One should recognize that termination is at both extreme ends of the cable. Also Figures 4 and 5 have the cable daisy-chained, thus minimizing communication signal reflections.

Topology Diagram for RS 485 Multi-drop Architecture - if external resistors are installed providing proper termination. NOTE: Termination at end units.

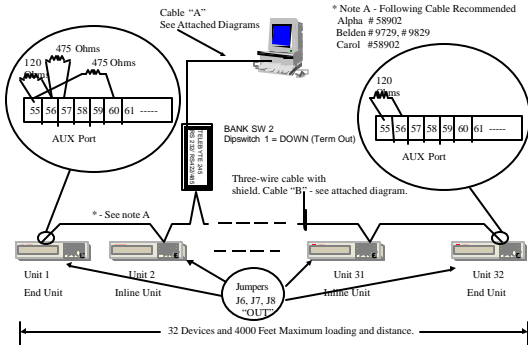


Figure 6 – Termination Using External Resistors And The Telebyte Converter Being An “In-Line” Unit.

Topology Diagram for RS 485 Multi-drop Architecture - if external resistors are installed providing proper termination. NOTE: Termination at end units.

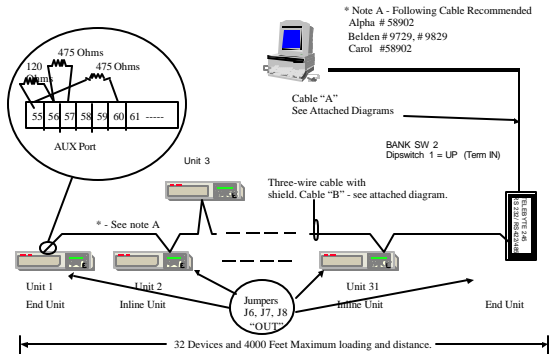


Figure 7 - Termination Using External Resistors On The IED's And Using The Telebyte Converter As An End Unit

## RS485 Biasing

Figures 4 through 7 illustrate the addition of resistors between the TX/RX (+) line and +V, and TX/RX (-) line and ground. These resistors are called bias resistors. Bias resistors are inserted at one node only, preferably at one extreme end of the network.

The TELEBYTE 245 is a “passive bias” unit in that when no device is communicating on the network, the data lines float. With the addition of the Pull-Up and Pull –Down resistors, the line is biased when no device is driving the lines. Biasing reduces the communication lines from being saturated with RFI or EMI induced noise from being coupled on the line. Addition of biasing on the network reduces the induced noise on the line.

The typical utility installation is an electrically noisy environment. Addition of data line biasing is recommended.

## RS485 Conductor Connectivity

The TELEBYTE unit uses the following pins for RS 485 communication:

- PIN 2 - TX/RX (A) or TX/RX (-) or A
- PIN 14- TX/RX (B) or TX/RX (+) or B
- PIN 7 – GROUND

The TELEBYTE interface is a DB 25 FEMALE interface.

Figures 8 and 9 illustrate the individual conductor connectivity for attaching the ABB protective relays in the DPU/TPU/2000 and the DPU/TPU/GPU 2000R. It is important to note that Figures 8 and 9 illustrate only the attachment of each device terminal. EACH NODE MUST BE DAISY-CHAINED AS ILLUSTRATED IN FIGURES 4 THROUGH 7.

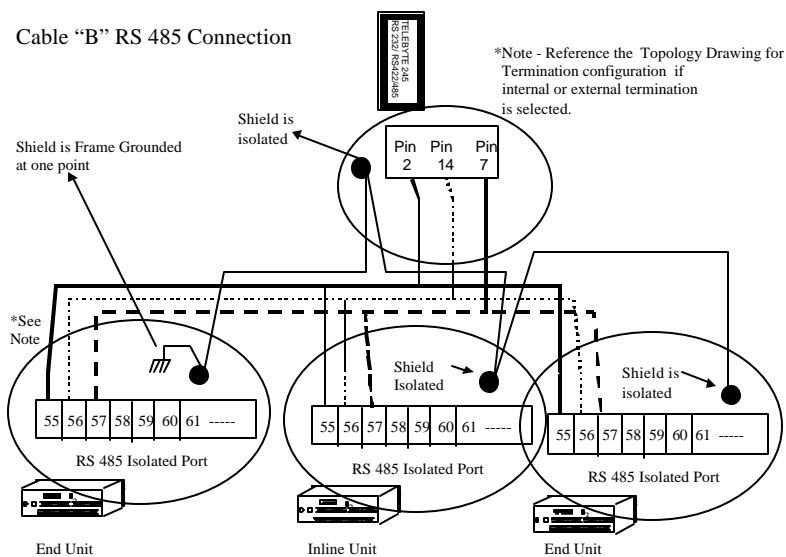


Figure 8 – Conductor Connectivity Diagram For The 2000R Products And The Telebyte Converter “Inline”

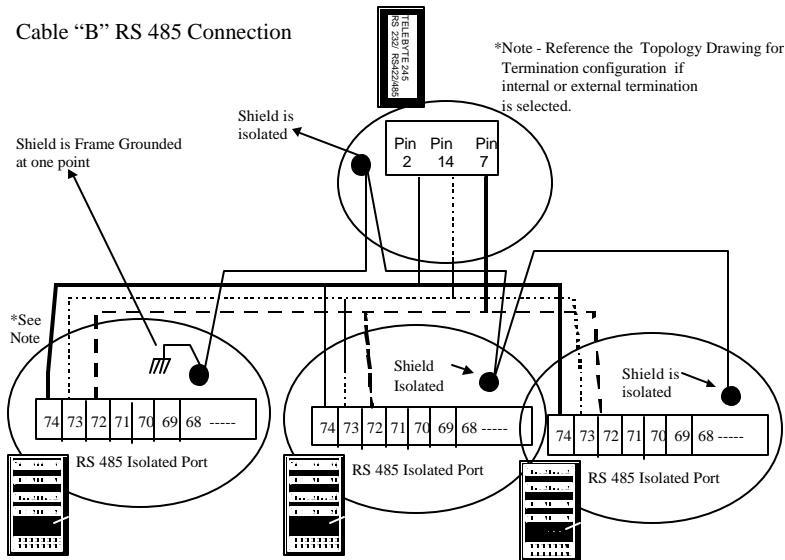


Figure 9 - Conductor Connectivity Diagram For The DPU/TPU 2000 Products

If an ABB relay uses a TYPE 8 card, COM PORT 3 is actually an RS 485 port presented in a DB 9 format. The Pin designation is presented in Table 1 and lists the cross listing for the AUX COM connector present on the 2000R product and 2000-product line. As illustrated in Figures 7 and 8, the AUX COM PORT connections are given. If one is installing RS 485 on a TYPE 8 card, both the AUX COM PORT and COM 3 have RS 485 connectivity available.

Table 1 - RS485 Communication Card RS485 Cross-Reference List

PIN DESIGNATION	COM 3 TYPE 8 COM PORT (2000R Family)	AUX COM PORT (2000R Family)	AUX COM PORT (2000 Family)
+ 5 VDC	8	60	77
RS485 Common	7	57	74
RS-485 (-)	2	56	73
RS-485 (+)	1	55	72

Wire attachment on an RS 485 TYPE 8 card's COM 3 DB 9 port can be tricky in an in-line installation. ABB has a special connector, which changes the female DB 9 port into a PHOENIX contact 9-pin connector (similar in format to the AUX COM PORT). The ABB part number of this 9 Pin male to Phoenix Card Connector is ABB part 602133-009. The same part is also available from Phoenix Contact and the part number is 27 61 50 9.

### Troubleshooting

The TELEBYTE RS 232/RS485 converter Model Number 245 has the advantage of four LED's present at the side of the unit (as indicated in Figure 1) indicating RS232 port transmit data, RS232 port receive data, RS 485 port transmit data and RS 485 port receive data. Visual indication of these LED's should allow the implementor to troubleshoot a unit, which does not communicate at all.

If communication messages do not appear to be transferred from the RS 232 port to the RS 485 port, one should investigate wiring, DTE/DCE emulation switches, and the wiring on the RS 232 and RS 485 ports.

If the error rate of communication message transmission and reception is high, investigate wiring in the areas of:

1. Biasing of the cable in only one location.
2. Installation of termination resistors at two nodes only (at both remote ends).
3. Cable installation with three wires AND A SHIELD. REMEMBER SHIELD IS NOT GROUND.
4. DAISY- CHAINING the RS 485 wiring so no in-line stubs, taps, and junction strips are inserted in the unit.
5. Incorrect installation of the Shield (connected at in line nodes and isolated at ground).
6. Incorrect lengths of RS 485 or RS 232 cables (3000 feet = RS 485 or 50 feet = RS 232).
7. Incorrect selection of "handshake control" for operation with the IED or Host (ABB IED's do not employ handshaking. Some hosts require RTS/CTS handshaking or the CD and DTR signal must be looped back in the cable.)

### ***In Conclusion***

There are many converters available on the market. Successful communication can result in using many manufacturers' physical interface converters. Success in implementing a physical interface relies on the implementor's knowledge of the software control of the physical interface, IED physical interface operation and knowledge of the particular brand of converter.

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