Application Note

Substation Automation and Protection Division

B & B RS 232/485 Converter Connection To ABB Protective Relays

ABSTRACT: There are many RS 232 to RS 485 converters on the market. Although ABB cannot and does not endorser 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 B & B Models 485HSPR and 485 OISPR optically isolated RS 232 to RS485 (2-wire) physical interface converters.

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 B & B model converters 485HSPR and 485 OISPR is that, like the ABB protective relay, they are isolated devices. The B & B converters listed in this document require special configuration in order to communicate with an ABB device. Since the ABB protective relay RS 232 com port does not use handshaking, external power must be supplied to the unit using both the supplied unit converter and an additional converter to assert the circuitry required for RS 232.

General Information

Figure 1 illustrates the packaging of the B& B converter. The B & B Converter has no visual indication of communication capability. One should use a communication analyzer to troubleshoot during commissioning of the system. Specifications for the physical interface converters are available from the B & B web-site at www.bb-elec.com.

The B & B Model 485HSPR and 485OISPR converters have 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. The B & B converters have a DB 25 female connector for the RS 232 physical interface. The emulation is DTE. Thus Pin 2 is Transmit Data (Data shall be received from the device attached to the converter on that pin) and Pin 3 is Receive Data (Data is transmitted from the B & B converter to the device attached on that pin). NOTE that the DPU, TPU, GPU, MSOC are DTE RS 232 emulation's at their port.

485 OISPR Converter RS 232 Interface Considerations

The 485OISPR converter is an economical device allowing transformation of RS 232 signals to a RS 485 or RS 422 format. The RS 485/422 format may be configured via two jumpers located internally to the unit. JP 2 provides for RS 232 Transmit data control. Data sensed on Pin 2 of the converter's RS 232 port shall place the converter in the transmit mode. The turnaround time is specified to be 1 mS.

If the ABB device is a MSOC, GPU 2000R, TPU 2000R, DPU 2000R, DPU 2000, DPU 2000 or DPU 1500R, no data handshaking is permitted, thus the RS 232/485 converter must be configured for TD (Transmitted Data) mode (JP 2 inserted). Also, since no power is provided on the DTR, DSR, CD, RTS, or CTS pins from the aforementioned devices, external power must be provided on the RS 232 port at the converter end. The manufacturer recommends that a supply of +12 VDC be provided between pins 25 and 12.

If the device attached to the 232 port is a personal computer or other device using the aforementioned pins (DTR [pin 20 on a 25 pin connector or pin 4 on a 9 pin connector], DSR [Pin 6], CTS [Pin 4 on a 25 pin connector or pin 8 on a 9 pin connector], RTS [Pin 5 on a 25 pin connector or pin 7 on a 9 pin connector], It is advisable to loop them back in the cable to enable the appropriate program to operate.

> For connection to ABB protective relays and software packages using ECP for configuration via Standard 10 Byte protocol ports, it is recommended that JP 2 be inserted for RS 232 TD mode with no data echo, and JP 4 be inserted for RS 485 2 Wire emulation Half Duplex mode.

Please refer to document 485 OISPR1997 for additional information on this converter.

485 HSPR Converter RS 232 Interface Considerations

The Model 485HSPR converter allows devices, which require handshaking. Jumpers JP 2, JP 3, and JP 4 may be configured for handshaking. However, as stated previously, 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 for handshaking.

For connection to ABB protective relays and software packages using ECP for configuration via Standard 10 Byte protocol ports, it is recommended that JP 1 is removed (2 Wire RS 485 mode enabled), JP 3 shall be removed while JP 2 and 4 shall be inserted. The combination of jumpers allow RS 485 4 wire control using the RS 232 Transmit Data Line to provide receiver turn-around and control. As stated previously, this is required since the aforementioned relays do not provide power through the aforementioned pins.

Please refer to document 485 HSPR1896 for additional information on this converter.

Converter Baud Rate Considerations

According to the manufacturer, the standard off- the shelf configuration for the B & B converters B & B Model 485HSPR and 485OISPR will communicate to a variety of devices using various baud rates. However, the standard model uses an RC (Resistive – Capacitive) circuit controlling timeout. The standard unit is configured to operate at 9600 baud. If other baud rates are required, C9 and C 15 must be un-soldered from the circuit board and the acceptable combinations of the device must be inserted to provide for proper communication. Please refer to the appropriate B& B documentation for the correct resistor and capacitor combinations for your baud rate and application.

Successful Communication

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 Female Connector

RS485/RS422 Male Connector

The uses Pins 2 and 5 (TX/RX - or [A]) & Pins 14 and 17 (TX/RX + or [B]), Pin 7 is Ground for its connections to the Two Wire RS-485 Relay.

Jumper for MODE (2 wire) RS 485	485 HSPR				485IOSPR	
	JP1	JP2	JP3	JP 4	JP2	JP4
TRANSMIT DATA CONTROL		X	X		X	X
RTS DATA CONTROL		X		X	NA	NA
X = Jumper Inserted , NA = Not Applicable.						

Figure 1 – B & B Jumper Settings

RS232 Configuration And Cabling

The B & B RS 232 section of the converter uses the following pins for connection to ABB protective relay devices without handshaking:

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

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

Although the B & B 485HSPR converter does use handshaking and control of the DTR signal (Pin 20), its use is not covered in this application note.

The B & B converter requires power on the unit via a DC transformer supplied with the unit. Also the B & B converter requires power on the RS 232 side. If ABB relays are used with this converter, additional +12 VDC must be supplied on pins 12 and 25 as illustrated in Figures 2 and 3.

The B & B converter is designed for DTE configuration. Figures 2 and 3 illustrate cable pinouts to connect a PC or ABB to connect to a device. Cable connections are illustrated as such. 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). Several documents are available explaining RS 232 communication. The B & B converter has a DB 25 connector whereas the ABB IED's and most personal computers have DB 9 connectors. Figures 2, 3, 4, and 5 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 jumpers located at the side of the converter. Refer to Figure 1 of this document for jumper configuration.

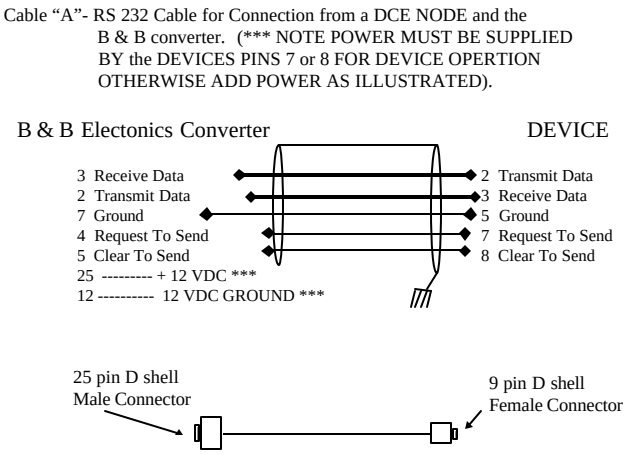

Figure 2 – RS 232 Cable Pinout Handshaking Incorporated (See Figure 1 For Jumper Settings According To Model. DTE To DCE Connection (9 Pin To 25 Pin RS 232 Converter Connection)

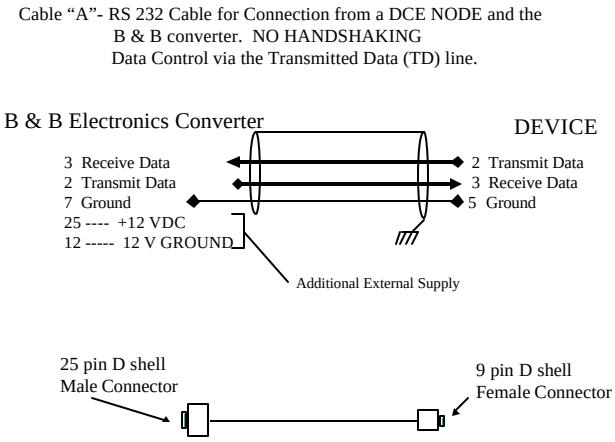

Figure 3 – RS 232 Cable Connections When No Handshaking Is Used. See Figure 1 For Jumper Settings. DTE To DCE Connection. (9 Pin To 25 Pin RS 232 Connection)

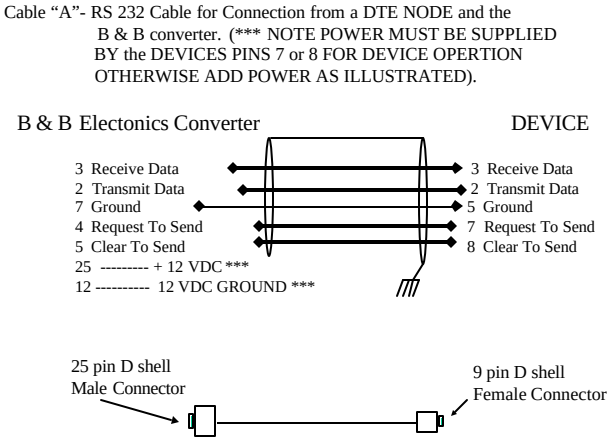

Figure 4 – RS 232 Cable Pinout Handshaking Incorporated (See Figure 1 For Jumper Settings According To Model. DTE To DTE Connection (9 Pin To 25 Pin Rs 232 Converter Connection)

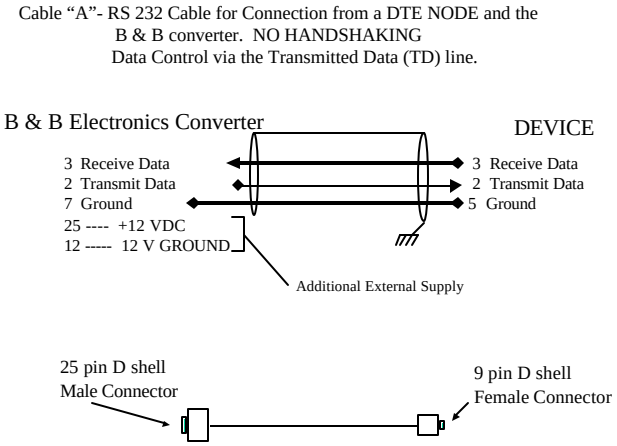

Figure 5 – RS 232 Cable Connections When No Handshaking Is Used. See Figure 1 For Jumper Settings. DTE To DTE Or Connection. (9 Pin To 25 Pin RS 232 Connection).

RS485 Configuration And Cabling

The B & B converters covered in this note support 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 jumper 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 manufacturer's documentation referenced within this note.

The attractive feature of the B & B 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 B & B converter is inserted at the end of the cable, insert a termination resistor of 120 ohms at that end as illustrated in the illustrations 6 through XX.
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.
6. The manufacturer recommends that the ground be of an impedance of 100 ohms. If it is not, solder a resistor of 100 ohms in series with the signal ground as illustrated in the B & B manufacturer's literature.

RS 485 Line Termination

RS 485 2 Wire connection diagrams are referenced in Figures 6 through 9. Figures 6 and 7 use the internal resistors within the DPU, GPU, TPU and MSOC units. Figures 8 and 9 illustrate an alternate method of using external resistors to provide biasing and line termination.

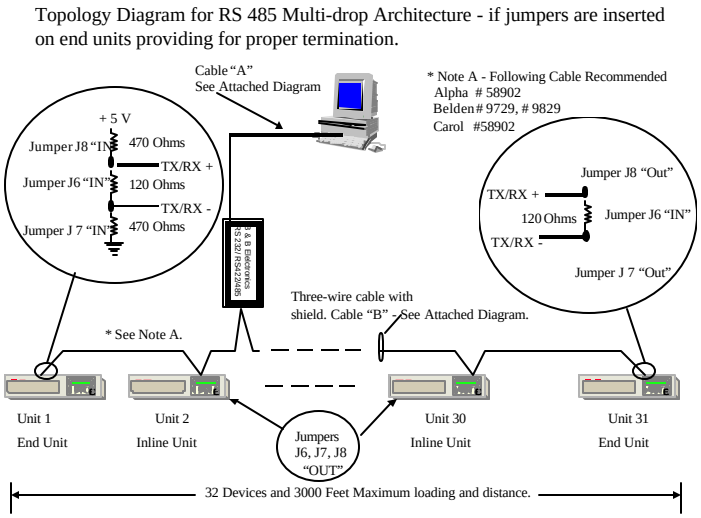

Figure 6 – RS 485 2 Wire Termination With The RS 232/485 Converter Inline And ABB Protective Relays At End Of Line Locations.

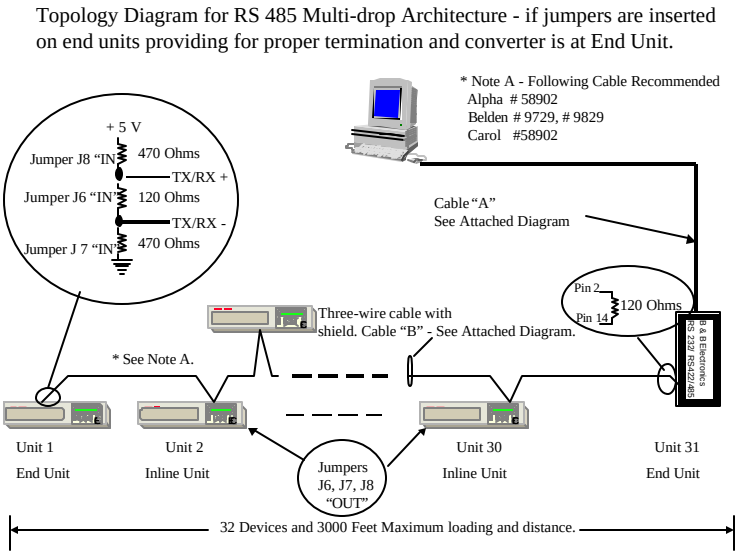

Figure 7 – Termination Using Internal Jumpers And Converter As An End Unit.

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.

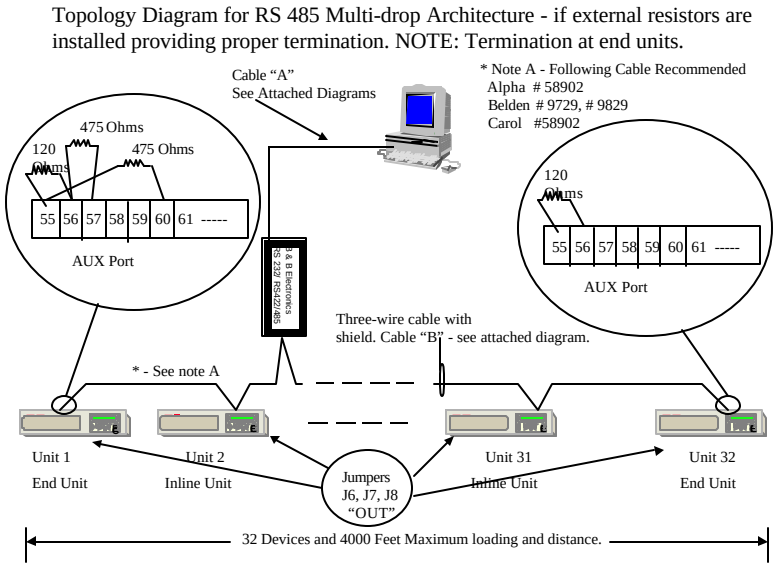

Figure 8 – Termination Using External Resistors And The B & B Electronics Converter Being An "In-Line" Unit.

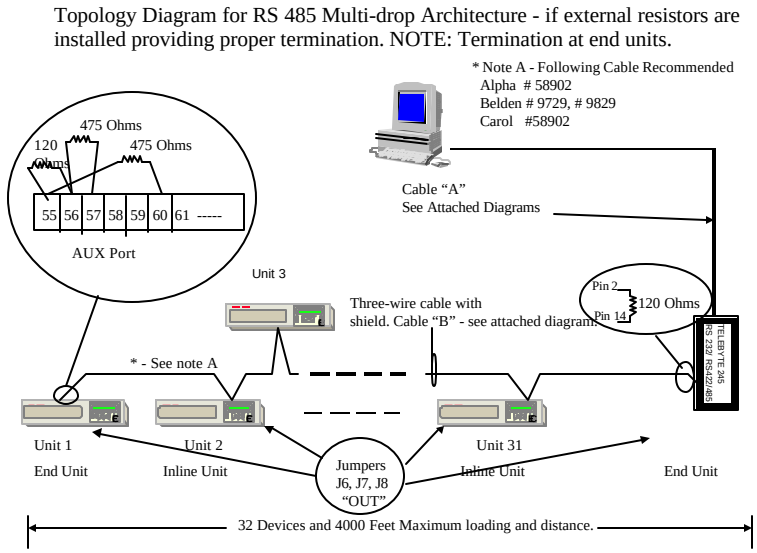

Figure 9 - Termination Using External Resistors On The IED's And Using The B & B Electronics Converter As An End Unit

RS485 Biasing

Figures 6 through 9 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. Note: external resistors must be added with appropriate voltages providing for termination as the diagrams illustrate.

The B & B ELECTRONICS 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 B and B converters use the following pins for RS 485 communication:
PINS 2 and 5 - TX/RX (A) or TX/RX (-) or A
PINS 14 and 17 - TX/RX (B) or TX/RX (+) or B
PIN 7 – GROUND

The B & B ELECTRONICS interface is a DB 25 MALE interface.

Figures 10 and 11 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 6 THROUGH 9.

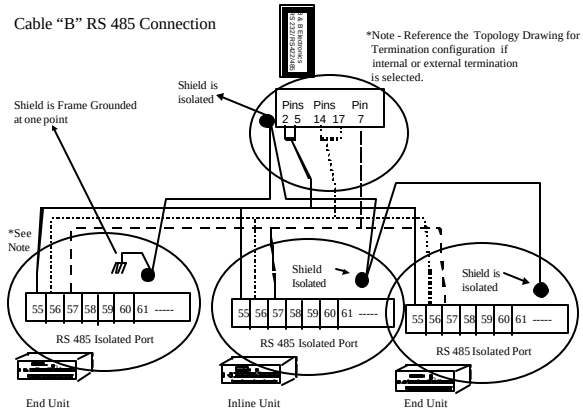

Figure 10 – Conductor Connectivity Diagram For The 2000r Products And The B & B Electronics Converter "Inline"

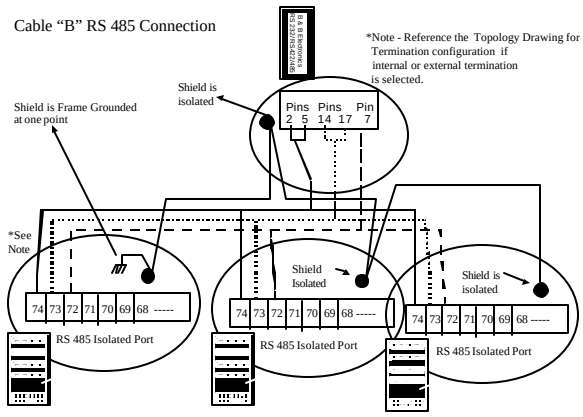

Figure 11 - Conductor Connectivity Diagram For The DPU/TPU 2000 Products

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

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.)
8. Incorrect resistor selection for the baud rate used with the converterers. Please consult the B & B literature for correct C9 and R 15 component selection.
9. Power is not being supplied through the handshaking pins or the supply required for RS 232 pins 12 and 25 is absent. Review and correct this installation.

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.

Contributed by:
John Popiak
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ABB, Inc.
7036 Snowdrift Road
Allentown, PA 18106
800-634-6005 Fax 610-395-1055
Email: powerful.ideas@us.abb.com
Web: www.abb.com/substationautomation