

**SCADAPack E Communication
Interfaces Reference**



Documentation

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I Communication Interfaces



Documentation

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

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Failure to observe this information can result in injury or equipment damage.

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2 Safety Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

	<p>The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.</p>
---	---

	<p>This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.</p>
---	---

 DANGER
<p>DANGER indicates an imminently hazardous situation which, if not avoided, will</p>

result in death or serious injury.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result** in death or serious injury.

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result** in minor or moderate.

CAUTION

CAUTION used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage..

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and the installation, and has received safety training to recognize and avoid the hazards involved.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

CAUTION

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

Failure to follow these instructions can result in injury or equipment damage.

Follow all start-up tests recommended in the equipment documentation. Store all equipment

documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and grounds, except those grounds installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove ground from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

3 Introduction

The purpose of this document is to detail the configuration and operation of the SCADAPack E RTU communication interfaces.

Communication with the SCADAPack E RTUs can be accomplished through several physical interfaces.

The following sections detail direct physical interfaces (Section [Direct Physical Interfaces](#)^[8]) and multi-drop physical interfaces (Section [Multi-Drop Physical Interfaces](#)^[9]), and their configurations and operational characteristics.

Keyed RS232 communication is covered in Section [Keyed RS232 Interface](#)^[11].

RS485 serial interfaces are described in Section [RS485 Interfaces](#)^[12].

Ethernet interfaces are described in Section [Ethernet](#)^[17].

Hayes Modem interfaces are described in Section [Hayes Modem Communications](#)^[19].

The operating system firmware for the SCADAPack E RTU also provides GPRS and 1xRTT communications (for more information see the *SCADAPack E TCP/IP Technical Reference*).

Not every communication interfaces are supported for every SCADAPack E port function. SCADAPack E Configurator presents the supported combinations of functions and modes on the Ports settings page for each RTU type.

4 Direct Physical Interfaces

The SCADAPack E RTU supports direct physical serial communication using RS232 and RS422 interface standards.

SCADAPack E Configurator software provides each RTU physical port with a *Port Interface Mode* parameter that is used to select the appropriate interface.

This is located on SCADAPack E Configurator “Ports” page.

Table 4.1: SCADAPack E Serial Physical Interface Characteristics

Physical Serial Port Interface MODE	Characteristics
RS232 (RTS On)	Interface Type: DTE Data Lines: RX, TX, GND Control Lines: RTS out (ON), CTS in (IGNORED) Speeds: 300,1200,2400,4800,9600, 19200, 38400, 57600, 115200 bps RTS is constantly asserted on DNP3, Modbus Slave, IEC60870-5-101 and IEC60870-5-103 selected ports. No hardware hand-shaking is required or supported
RS232 (RTS Off)	Interface Type: DTE Data Lines: RX, TX, GND Control Lines: RTS out (OFF), CTS in (IGNORED) Speeds: 300,1200,2400,4800,9600, 19200, 38400, 57600, 115200 bps RTS is constantly de-asserted for port functions. No hardware hand-shaking is required or supported
RS422	Interface Type: DTE Data Lines: RX+, RX-, TX+, TX- Control Lines: None Speeds: 300,1200,2400,4800,9600, 19200, 38400, 57600, 115200 bps No hardware hand shaking is required or supported. Lines should be terminated in accordance with RS422 standard requirements.

5 Multi-Drop Physical Interfaces

The following information details the data parameters for multi-drop communications drivers in the RTU.

The RTU starts multi-drop interface driver tasks when a *Port Interface Mode* parameter is set to a multi-drop interface types. E.g. RS485, Keyed RS232

This section describes the parameters used by:

- [Keyed RS232 interface](#)¹¹.

The following parameters determine multi-drop communication driver operation. They may be modified via SCADAPack E Configurator on the “**Ports**” configuration page.

Network Access Parameters	
Tx Warmup Delay	Fixed Delay
60 (mS)	0 (mS)
Max. Random Delay	Response Delay
100 (mS)	0 (mS)
Postamble Delay	
20 (mS)	

Figure 5.1: SCADAPack E Network Access Parameters

Table 5.1: SCADAPack E Multi-drop Communication Parameters

Analog System Point	DESCRIPTION	Unit	Default Value
53210	Transmit Warm-up Delay	ms	60
53211	Response Delay	ms	0
53212	Network Access Fixed Delay	ms	0
53213	Max. Network Access Random Delay	ms	100
53214	Postamble Delay	ms	20

The **Transmit Warm-up Delay** parameter is used to delay transmission after access to the transmission media is activated. The use of these parameters for each interface type is detailed in the sections below.

The **Response Delay** parameter delays the transmission of data for a fixed period prior to detecting and initiating collision avoidance. This parameter could typically be used where a radio repeater may be slow to drop its carrier and then tries to respond to a request too quickly. Similarly it can be used to delay transmission while a communication channel is allocated.

The **Network Access Fixed Delay** parameter delays the transmission of data from the RTU onto the

physical channel, if the channel is busy when the RTU first goes to transmit (after the “*Transmit Response Delay*”). This time is valid for communications drivers using collision avoidance, and is applied after the RTU first detects the channel becoming available. It waits this time (as well as an additional random time described below) before checking the channel is still available, at which time the data is actually transmitted. See below for more details on the random delay.

Setting this value differently in different RTUs can be used as a method for prioritising messages from particular RTUs (by prioritising access to the physical channel). It can also be used to delay transmission to overcome physical channel limitations after another device has completed its transmission.

The **Max. Network Access Random Delay** parameter sets a maximum on the random delay that is added to the “*Network Access Fixed Delay*” (described above). The actual transmission delay for data from the RTU onto the physical channel (excluding *Transmit Warm-up Delay*) may be:

- “0”, if the channel is free when the RTU first goes to transmit
- *Network Access Fixed Delay* + (0 ~ *Max. Network Access Random Delay*) if the channel is free after being busy

If both Network Access parameters are zero, no collision avoidance is performed on the multi-drop channel.

It is possible for the RTU to have multiple physical ports operating with multi-drop drivers. i.e. multiple *Keyed RS232* ports. In this case, the “*Network Access Fixed Delay*”, “*Transmit Response Delay*”, “*Max. Network Access Random Delay*” and “*Transmit Warm-up Delay*” parameters apply to multi-drop ports. Their settings should be set to the WORST case of any of the ports for successful operation of ports.

The **Postamble Delay** parameter is used to delay deactivation of the transmission media after the completion of a message. It is used in *Keyed RS232* mode only. Some transmission media deactivate a communication channel too early, resulting in missing of some of the data transmitted by the RTU.

6 Keyed RS232 Interface

The RTU multi-drop communication driver uses collision avoidance mechanisms for DNP3 protocol communication on this interface, and can control an external device to transmit data. This is achieved through the use of RS232 CTS and RTS control lines, respectively.

Before transmitting data, the RS232 keyed interface driver waits for the “*Transmit Response Delay*” before checking for an active CTS signal. If active, no data is transmitted and the driver waits for the channel to become available (CTS inactive). When the channel is available, a timer is started and the driver waits. The time to wait is made up of two components: a fixed delay specified by the “*Network Access Fixed Delay*” parameter, and a random value between 0 and the “*Max. Network Access Random Delay*”. After this period, the driver again checks CTS. If still active it waits until CTS is inactive, and starts the timer again after it becomes inactive, this time waiting with the fixed delay and a new random value. After finally waiting and then detecting CTS inactive, the driver allows message transmission.

If both Network Access parameters are zero, no collision avoidance is performed on the multi-drop channel.

The following occurs for transmission of the DNP3 message on a Keyed RS232 Interface:

- delay specified by the “*Transmit Response Delay*” parameter
- activation of RTS on the RS232 port
- delay specified by the “*Transmit Warm-up Delay*” parameter
- transmission of DNP3 data
- wait for completion of RS232 transmission plus the delay specified by the “*Postamble Delay*” parameter
- deactivation of RTS on the RS232 port

The Keyed RS232 Interface is primarily used for DNP3 communications, though it also a valid mode for the following Port functions:

- DNP3
- ES Remote I/O
- PLC Device
- Modbus Slave
- ISaGRAF
- IEC 60870-5-103 Master
- IEC 60870-5-101 Slave
- DNP VT Service
- TCP Service

7 RS485 Interfaces

RS485 standard interfaces may be used on a SCADAPack E Smart RTU RTU in a variety of ways.

It is recommended that the user consult RS485 specifications and applications notes for information regarding the optimum way to electrically interconnect devices using RS485.

See also Section [Special RTU Cables](#)³⁰ for cabling connections to SCADAPack E Smart RTU.

Both RS485 2-wire and RS485 4-wire communications are supported by SCADAPack ES and SCADAPack ER RTUs.

RS485 2-wire only is supported by SCADAPack 300E RTUs.

In RS485 4-wire systems, the SCADAPack ES or SCADAPack ER RTU may be either a 4-wire Master or 4-wire Slave device.

See the relevant hardware manual for the RTU model for information on which ports support RS485 interfaces.

The following tables summarize the SCADAPack E RTU interface characteristics when using RS485.

Table 7.1: SCADAPack 300E RS485 2-wire Interface Characteristics

RTU Physical Port Interface MODE	Characteristics
RS485 2-wire	Interface Type: DTE Data Lines: A(+), B(-) GND if required for biasing Control Lines: None Speeds: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps Collision Avoidance: received data detect, multiple access, random back-off RS485 receiver and transmitter are controlled by firmware. See RS485 2-Wire ¹⁶ No hardware hand shaking is required or supported. Lines should be terminated in accordance with RS485 standard requirements.

Table 7.2: SCADAPack ES / SCADAPack ER RS485 2-wire Interface Characteristics

RTU Physical Port Interface MODE	Characteristics
RS485 2-wire	<p>Interface Type: DTE</p> <p>Data Lines: RX+/TX+ (bridged, A), RX-/TX- (bridged, B) GND if required for biasing</p> <p>Control Lines: None</p> <p>Speeds: 300,1200,2400,4800,9600, 19200, 38400, 57600, 115200 bps</p> <p>Collision Avoidance: received data detect, multiple access, random back-off</p> <p>RS485 receiver and transmitter are controlled by firmware. See RS485 2-Wire^[16]</p> <p>No hardware hand shaking is required or supported.</p> <p>Lines should be terminated in accordance with RS485 standard requirements.</p>

Table 7.3: SCADAPack ES / SCADAPack ER RS485 4-wire Interface Characteristics

RTU Physical Port Interface MODE	Characteristics
RS485 4-wire Master	<p>Interface Type: DTE</p> <p>Data Lines: RX+(A), RX-(B), TX+(A), TX-(B) GND if required for biasing</p> <p>Control Lines: None</p> <p>Speeds: 300,1200,2400,4800,9600, 19200, 38400, 57600, 115200 bps</p> <p>RS485 transmitter is constantly asserted, RS485 receiver is constantly enabled. See RS485 4-Wire^[14]</p> <p>No hardware hand shaking is required or supported.</p> <p>Lines should be terminated in accordance with RS485 standard requirements.</p>
RS485 4-wire Slave	<p>Interface Type: DTE</p> <p>Data Lines: RX+(A), RX-(B), TX+(A), TX-(B) GND if required for biasing</p> <p>Control Lines: None</p> <p>Speeds: 300,1200,2400,4800,9600, 19200, 38400, 57600, 115200 bps</p> <p>RS485 transmitter is Tri-stated (transmit inactive) unless sending. RS485 receiver is constantly enabled. See RS485 4-Wire^[14]</p> <p>No hardware hand shaking is required or supported.</p> <p>Lines should be terminated in accordance with RS485</p>

	standard requirements.
--	------------------------

RTU Port Functions that may be used with RS485 mode are described in [Table 7.4](#)¹⁴.

Table 7.4: SCADAPack E Port Functions Supporting RS485

Port Function	Port Mode	Comments
DNP3	RS485 2w	DNP3 nodes connected to the communication channel in this mode must be "RS485 2w". Peer to peer and Unsolicited messaging is supported.
	RS485 4w Master	One node configured as Master, every other node needs to be Slave
	RS485 4w Slave	Peer communication between slaves not supported. Unsolicited operation when using multiple slaves is not recommended.
PLC Device Modbus Slave IEC--103 Master IEC--101 Slave TCP Service	RS485 2w	Attached device(s) needs to support 2-wire RS485 with disabled transmitters when not transmitting. No hardware control is available from SCADAPack E RTU for switching.
PLC Device IEC--103 Master TCP Service	RS485 4w Master	Attached devices need to be RS485 4-wire slaves. Where multiple slaves are multi-dropped, the transmitters needs to be disabled when not transmitting.
Modbus Slave IEC--101 Slave TCP Service	RS485 4w Slave	A single attached RS485 4-wire master, or RS422 master is permitted. (this is not a common arrangement for a PLC device)

7.1 RS485 4-Wire

In the following discussion, "4-wire RS485" refers to the operation of devices using four RS485 differential data lines (TX+, TX-, RX+, RX-). Additional lines such as "GND" for biasing may be required for electrical operation of RS485 systems, but have no effect on the software data communication for RS485 operation, and are not considered in these discussions. See [Figure 10.2 4-Wire RS485 / RS422 Connections](#)³⁶ for information on connections.

RS485 4-wire systems need to have one, and one only RS485 4-wire Master. They may have one or more RS485 4-wire slaves. A SCADAPack E RTU communication interface may be selected as "RS485 4w Master" or "RS485 4w Slave".

An RS485 4-wire Master constantly asserts its transmitter on 2 of the 4 lines (TX+ & TX-), and each of the RS485 4-wire Slaves have a constantly enabled receiver (RX+ & RX-) connected to these 2 lines.

An RS485 4-wire Master has its constantly enabled receiver (RX+ & RX-) connected to the other 2 lines, and the RS485 4-wire Slave(s) transmitter (TX+ & TX-) are connected to these 2 lines. RS485 4-wire Slave devices need to have their transmitters disabled while not transmitting. This allows multiple slaves to be multi-dropped without interfering with one another.

4-wire Slave devices can only answer in-bound requests from the 4-wire Master RTU, and where multiple slaves are multi-dropped, unsolicited data is not usually generated. RS485 4-wire multi-drop communication cannot use collision avoidance, and peer to peer communication between slaves is not possible.

If a SCADAPack E RTU communication channel is selected for RS485 4-wire Slave mode, the RTU is a slave to a single RS485 4-wire Master. Multiple slaves may be multi-dropped and communicate with the Master. The 4-wire RS485 slave RTU that is responding to the master enables the RS485 transmitter during transmission of reply messages to the master. There are no communication parameters that need to be set for this mode of operation. After receiving a request from the master, the RTU asserts the RS485 transmitter just prior to sending the response message, and releases the RS485 transmitter when the message has been completely sent.

7.2 RS485 2-Wire

In the following discussion, 2-wire RS485 operation refers to two RS485 differential data lines. Additional lines such as "GND" for biasing may be required for electrical operation of RS485 systems, but have no effect on the software data communication for RS485 operation, and are not considered in these discussions. See [Figure 10.3 2-Wire RS485 Connections](#)^[36] for information on connections.

In RS485 2-wire mode, each device is a peer, and can communicate with other devices on the RS485 link. The SCADAPack E RTU can operate in a similar way to other communication interfaces and support unsolicited and peer communications.

RS485 2-wire devices connect both their RX+ & TX+ to one of the 2 communication lines, and RX- & TX- to the other communication line.

SCADAPack E RTU RS485 2-wire multi-drop communication uses collision avoidance, detecting when other devices are transmitting by reception of data from them. The RTU normally has the RS485 receiver enabled and transmitter disabled. Before transmitting data, the RS485 2-wire interface driver checks for received data. If receiving, no data is transmitted and the driver waits until data receiving has finished. After detecting the completion of receiving, the driver starts a timer and waits. The time to wait is made up of two components: a fixed delay of 2 character times after the transmission of characters is complete, and the "TX Response Delay" property in milliseconds. Character timing is automatically set by the RTU using the selected data rate on the channel. After the fixed + configured wait period, the driver again checks for received data. If receiving again, it waits for receiving to finish, and then waits again. After finally waiting, and detecting no received data, the driver allows message transmission.

The following occurs for transmission of a message on the 2-wire RS485 link:

- determination channel is clear for transmission (no data being received)
 - deactivation of RS485 receiver
 - activation of RS485 transmitter
 - transmission of message data
 - wait for completion of message transmission
 - deactivation of RS485 transmitter
 - activation of RS485 receiver
-

8 Ethernet

Standard Ethernet cabling restrictions apply to the Ethernet hardware interfaces on the SCADAPack E RTU.

For more information see the relevant *SCADAPack E Smart RTU Hardware Manual* and IEEE standards documentation.

SCADAPack ES and SCADAPack ER RTUs support dual 10/100BASE-T (UTP) Ethernet connections. SCADAPack 300E RTUs support single 10/100BASE-T (UTP) Ethernet connections.

SCADAPack ES Remote I/O

The SCADAPack ES and [SCADAPack ER](#) RTUs provides Remote I/O facilities to SCADAPack ES units using the Ethernet interfaces described above.

Communication to SCADAPack ES Remote I/O Units uses IEEE 802.3 framing, IEEE 802.3 MAC addressing, IEEE 802.2 LLC (Link Layer Control) and SNAP (Sub-Network Access Protocol) sub-layer information.

Ethernet Remote I/O is supported on SCADAPack ES Units without any additional configurations.

See the *SCADAPack E Remote I/O Technical Reference* manual for details.

TCP/IP Communications

The SCADAPack E RTU firmware provides TCP/IP communications using the Ethernet interfaces described above.

A suite of TCP/IP communication applications is provided by the SCADAPack E RTU, which may utilize Ethernet links, serial links, or both types of links simultaneously.

The SCADAPack E RTU requires configurations for Ethernet TCP/IP operation.

[Figure 8.1](#)¹⁸ shows an example configuration for a SCADAPack 300E RTU Ethernet port.

[Figure 8.2](#)¹⁸ shows an example configuration for a SCADAPack ES / SCADAPack ER RTU Ethernet port.

For SCADAPack ES & SCADAPack ER RTUs, both Ethernet interfaces each require separate configurations.

If both Ethernet interfaces are to be utilized, each Ethernet interface needs to be configured on **different subnets**.

Ethernet 1 Function <input type="text" value="TCP/IP Enabled"/>	Enabled TCP/IP Services <input checked="" type="checkbox"/> ISaGRAF/TCP <input checked="" type="checkbox"/> Modbus/TCP (Client) <input type="checkbox"/> Modbus/TCP (Server) <input checked="" type="checkbox"/> Telnet Server <input checked="" type="checkbox"/> FTP Server <input type="checkbox"/> BOOTP Server <input checked="" type="checkbox"/> NTP Network Time <input type="checkbox"/> IEC60870-5-104 Slave
Ethernet IP Address <input type="text" value="192.168.0.241"/>	
Ethernet Subnet Mask <input type="text" value="255.255.255.0"/>	

Figure 8.1: SCADAPack 300E Ethernet TCP/IP Settings

Ethernet 1 Function <input type="text" value="TCP/IP + RemI/O"/>	Ethernet 2 Function <input type="text" value="ES Remote I/O"/>	Enabled TCP/IP Services <input checked="" type="checkbox"/> ISaGRAF/TCP <input checked="" type="checkbox"/> Modbus/TCP (Client) <input type="checkbox"/> Modbus/TCP (Server) <input checked="" type="checkbox"/> Telnet Server <input checked="" type="checkbox"/> FTP Server <input type="checkbox"/> BOOTP Server <input checked="" type="checkbox"/> NTP Network Time <input type="checkbox"/> IEC60870-5-104 Slave
Ethernet IP Address <input type="text" value="192.168.0.241"/>	Ethernet 2 IP Address <input type="text" value="0.0.0.0"/>	
Ethernet Subnet Mask <input type="text" value="255.255.255.0"/>	Ethernet 2 Subnet Mask <input type="text" value="0.0.0.0"/>	

Figure 8.2: SCADAPack ES / SCADAPack ER Ethernet TCP/IP Settings

See the *SCADAPack E TCP/IP Technical Reference* manual for details.

9 Hayes Modem Communications

The following sections describe configuration parameters and operation of the SCADAPack E RTU with Hayes Modem communications.

This type of RTU communication is often called “PSTN” (Public Switched Telephone Network) or dial-up communication, and requires the use of commercial modem equipment.

From the perspective of a SCADAPack E RTU, “GSM” and “CDMA” and other wireless public network communications are identical in operation to PSTN. As such “GSM” and “CDMA” communications are not identified separately in the following information, but operate in the same way.

“GPRS” and other similar “always on” mobile IP communications technologies are quite different in their operation compared with the Hayes Modem communications described in this section. These are described in more detail in the *SCADAPack E TCP/IP Technical Reference* manual.

- [Hayes Modem Parameters](#)²⁴
- [Hayes Modem Operation](#)²⁰
- [Hayes Modem Pool Operation](#)²⁸

9.1 Hayes Modem Operation

The SCADAPack E RTU supports DNP3 network operations using an external Hayes compatible modem.

Dial-in and dial-out operation is supported, both on the same communication channel.

As detailed in [Hayes Modem Parameters](#)^[24], each DNP3 Route Table entry in the SCADAPack E RTU can be associated with a **Connect No.** entry. Each remote modem to be dialled by an RTU needs to have a corresponding ROUTE entry with the phone number in the **Connect No.** field. Where groups of nodes are contacted through the same modem on a SCADAPack E RTU, route entries with DNP3 address ranges can have a single phone number. Multiple route entries for DNP3 nodes can have the same phone number, or any combination can be used.

The RTU Ports used for both dial-out and dial-in facilities should have their modems set for Auto-Answer (e.g. S0=1 in the initialisation string). Where multiple modems are used on the same RTU, dial-out communication will use the same local modem for the same target communications (as set by the ROUTE table entry). Dial-in communications should dial the same modem from the same remote devices.

The SCADAPack E RTU Hayes Modem driver uses a combination of Hayes Commands, Hayes response codes, and RS232 control lines to interact with the Hayes modem. The table below describes the interaction used.

The SCADAPack E RTU uses the modem initialization string to periodically check the health of a local modem. The *Modem Status* indicates *Modem Not OK* if the health check does not receive a valid 0 (OK) response. This check is performed at the rate set by the **Modem Test Interval** (in Seconds) while the modem is not connected.

When a message is being sent (or routed) to a particular port whose *Port Interface Type* is Hayes Modem, the SCADAPack E RTU uses the Modem **Port Dial Prefix** and the **Connect No.** (from the route table) to dial the target modem. The destination communication node is not necessarily directly connected to the target modem being dialled. I.e. the dialled remote RTU may re-route the DNP3 message to another communication channel and on to further remote RTUs.

Modem(s) connected to the RTU may be set with *Hang-up ENABLED* or *DISABLED* as illustrated in the figure below (from the 'Hayes Modem' page of SCADAPack E Configurator).



When set for *Hang-up Enable*, the RTU monitors activity on the modem channel. A message being sent or received restarts the inactivity timer. When the timer expires, the RTU hangs the modem up by issuing the Hayes hang-up command. If no response is received from the hang-up command, DTR is lowered on the modem to force a hang-up. When communication is established between two RTU's, either of the RTU's on the modem link may initiate the hang-up. To operate with hang-ups **DISABLED**, **both** RTUs must be set for *Hang-up Disable*. A change in this control may be issued at any time, and takes effect immediately.

Some systems (for example ClearSCADA software) closely control PSTN connections with outstations. These systems may regard an RTU prematurely hanging up (e.g. before the master initiates the hang-

up) as a communication line condition. In these circumstances, the SCADAPack E RTU Connection Mode should be set to Hang-up DISABLED, or be configured with an adequate [Inactivity Time](#)^[26].

Modem channels used for dial-in will normally be set for auto-answer. The RTU detects an inbound call when modem DCD is active. If the RTU receives a RING response from the modem before DCD is active, the RTU will delay attempting to send any new outbound messages in order to keep the modem from hanging up. The sending delay time is set by the **Send Delay** parameter. See [Hayes Modem Parameters](#)^[24] for more information.

RTU Modem Driver function	Interaction with Hayes Modem device	
Initialize / Modem Health Check (periodic)	Controls: Hayes Commands: Hayes Responses: Controls:	RTU Raises DTR *1 Modem Port Initialization String (e.g. ATE0Q0V0&D2S0=1) 0 (OK), 3 (No Carrier) Port Modem Status = Modem OK
Dial-out	Hayes Commands: Hayes Responses: Controls:	Modem Port Dial Prefix & Connect No. (modem Dial number) 1 or 10~99 (Connect) or DCD active *2 Port Connect Status = Modem Connected
Hang-up	Hayes Commands: Hayes Responses: Controls:	+++ ATH Response Code 0 (OK) Port Connect Status = Modem Available RTU lowers DTR *3 Wait 1.5 seconds RTU raises DTR
Detect Dial-in	Modem Operation: Hayes Responses: Controls:	Auto-answer Response Code 2 (RING) modem activates DCD *2 Port Connect Status = Modem Connected
Handle bad Initialization / Modem Health Check status	Controls:	Port Modem Status = Modem Fault Port Connect Status = <blank> RTU lowers DTR Wait 1.5 seconds RTU raises DTR

- *1 Modem DTR is connected to the SCADAPack E RTU RS232 port – see Section [Modem Cable \(RJ-12 – DB25\)](#)^[35].
- *2 When the modem asserts DCD, the SCADAPack E modem driver goes into “connect” mode. Modem DCD is connected to SCADAPack E RTU RS232 port – see [Special RTU Cables](#)^[30].
- *3 DTR is lowered to the modem by the SCADAPack E RTU if a “0” response is not received to the ATH hang-up command.

The RTU modem driver requires the modem to operate in the following modes (typically set by the **Port Initialization String**):

- Echo Off (E0)
- Quiet Mode Off (Q0)
- Verbose Mode Off (V0) - i.e. use numeric codes
- Release call when DTR is lowered (&D2)
- Auto-answer (S0=1)
- DCD matches remote modem data carrier (&C1)

Unfortunately, modem operation is not universal. Specific modems may have other configuration requirements.

For example:

- if power to the modem is lost, it may speed up reconnection by having the modem save its configurations (&W)
- RTS line state on the modem may have particular requirements not handled by the RTU or cabling. See the modem Hayes Command set for more information if the modem can connect but cannot transmit or receive data
- Numeric connection codes may be specific to the modem and out of range of the response codes recognized by the RTU driver. See the modem Hayes Command set for more information on restricting response codes if the modem answers but does not connect to the RTU.

The ROUTE table's **Connect No.** string is appended to the **Port Dial Prefix** to request the modem to dial a specific remote device.

- **Port Dial Prefix** string is typically: *ATDT* (tone dialling)
- The **Connect No.** string is normally the numeric phone number, no spaces, optional comma for a pause (depending on modem support and telephone system requirements)

The SCADAPack E Diagnostic Stream can be useful in troubleshooting modem connections. No specific diagnostic filters need to be enabled for modem operations, rather modem connection state information will be displayed on the diagnostic stream as they occur. For more information see the *SCADAPack E Operational Reference* manual.

9.1.1 Low Power Modem support

When this support is enabled (using the **Port Low Power** check box on the Hayes Modem Configuration page in SCADAPack E Configurator), the RTU's modem driver will raise the DTR line when communicating with the modem and will drop the DTR line when communication is completed. When the modem is connected, the DTR line will remain asserted.

The RTU's modem driver will also delay for a user definable period of time between asserting DTR and sending a command string to the modem. This is to allow a low-powered modem to “wake” from sleep mode. This time period is set by the *Modem DTR Delay* parameter (in milliseconds). The default value of this parameter is 500 milliseconds and the maximum value is clamped by the modem driver to 5000 milliseconds.

9.2 Hayes Modem Parameters

The following information details the data parameters for the Hayes Modem communications driver in the SCADAPack E RTU.

The parameters are grouped in two tables, one for Hayes configuration and status information, and the other for dial number records. These are available through the SCADAPack E Configurator interfaces as shown below.

Port 0 Modem Hangup Enabled ▼	Port 1 Modem Mode Hangup Enabled ▼	Port 2 Modem Mode Hangup Enabled ▼	Port 3 Modem Mode Hangup Enabled ▼	Port 4 Modem Mode Hangup Enable ▼
Port 0 Modem []	Port 1 Modem Status []	Port 2 Modem Status []	Port 3 Modem Status []	Port 4 Modem Status []
Port 0 Connect []	Port 1 Connect Status []	Port 2 Connect Status []	Port 3 Connect Status []	Port 4 Connect Status []

RTU Port	Analog System Points			Binary System Points
	Modem Mode *1	Modem Status *2	Modem Connect Status *3	Low Power Mode *4
PORT0	50200	50210	50220	50620
PORT1	50201	50211	50221	50621
PORT2	50202	50212	50222	50622
PORT3	50203	50213	50223	50623
PORT4	50204	50214	50224	50624

*1 Modem mode values: **0**= Hang-up Enabled
1 = Hang-up Disabled

*2 Modem status values: READ ONLY
0 = No Modem connected (no response)
1 = Modem Failed (bad response)
2 = Modem OK (good response)

*3 Modem connect status: READ ONLY
0 = No Modem connected
1 = Modem Connected
2 = Modem Available

*4 Low Power Mode: **0** = Low Power Disabled (default - DTR line asserted)

1 = Low Power Enabled (DTR line keyed)

Port 0 Init.	Port 1 Init. String	Port 2 Init. String	Port 3 Init. String	Port 4 Init. String
ATE0Q0V0&D2S0=1	ATE0Q0V0&D2S0=1	ATE0Q0V0&D2S0=1	ATE0Q0V0&D2S0=1	ATE0Q0V0&D2S0=
Port 0 Dial	Port 1 Dial Prefix	Port 2 Dial Prefix	Port 3 Dial Prefix	Port 4 Dial Prefix
ATDT	ATDT	ATDT	ATDT	ATDT

RTU Port	String System Points	
	Modem Initialisation String *4	Modem Dial Prefix String *5
PORT 0	50200	50210
PORT 1	50201	50211
PORT 2	50202	50212
PORT 3	50203	50213
PORT 4	50204	50214

*4 Null terminated string, Max. 25 characters

Default value = **ATE0Q0V0&D2S0=1**

*5 Null terminated string, Max. 11 characters

Default value = **ATDT**

Each row in the table below complements the parameters in the corresponding row of the SCADAPack E RTU DNP3 Routing Table

String System Point
Connect No. *6
50300
50301
...
50349

The "Connect No." field is used for the modem dial number.

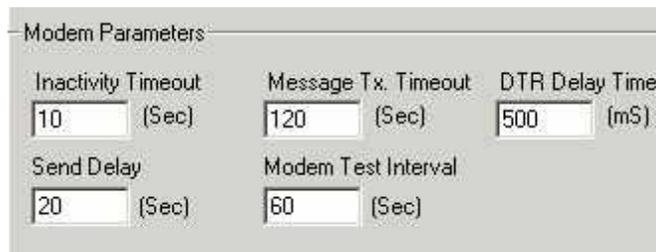
*6 Null terminated string, Max. 15 chars
Default value = Null.

May contain alphanumeric characters & modem control characters

(eg. 0,12345678 = 0 <pause> 12345678)

The following parameters control the communications operation of the Hayes Modem driver.

They are available through the SCADAPack E Configurator "**Ports**" page.



Modem Parameters		
Inactivity Timeout	Message Tx. Timeout	DTR Delay Time
10 (Sec)	120 (Sec)	500 (mS)
Send Delay	Modem Test Interval	
20 (Sec)	60 (Sec)	

DNA Point Index	Description	Units
50347	Modem Inactivity Timeout	Secs
50348	Modem Send Timer Delay	Secs
50351	Modem Message Tx Timeout	Secs
50357	Modem Test Interval	Secs
50358	Modem DTR Delay Time	msec

The Modem **Inactivity Timeout** parameter is used by the driver to hang-up the modem when no further

messages are being sent on the modem channel. This operation is affected by the modem Hangup Enable parameter. For more information and restrictions on using Hang-up modes, see [Hayes Modem Operation](#)²⁰.

The Modem **Send Delay** parameter sets a delay for a new out-bound request if the modem channel is about to be connected by an in-bound call. This delay is triggered by the reception of a Hayes "RING" response and allows the existing modem transaction to complete before attempting to send the new request. If an attempt to send the new message occurred at this time, the modem would hang up prematurely. Typically this value will be set higher than the Modem Inactivity Timeout to allow the modem to hang-up normally.

The Modem **Message Tx Timeout** parameter sets the time, in seconds, that the RTU's modem driver will store an outbound message in its transmit queue before discarding it. This parameter should be set to slightly less than the RTU's DNP3 Application Layer Timeout parameter.

The **Modem Test Interval** parameter sets the time, in seconds between Modem health tests while the modem is not connected.

The Modem **DTR Delay Time** parameter is used when "Low Power" mode is enabled. The RTU's modem driver will delay for a user definable period of time between asserting DTR and sending a command string to the modem. This time period is in milliseconds and the maximum value is clamped by the modem driver to 5000 milliseconds. Also see [Low Power Modem support](#)²³.

9.3 Modem Pool Operation

The SCADAPack E RTU supports communication with multiple modems simultaneously.

Modem Pool operation allows sharing of modem channels for the same communications. Where multiple modems are used for dial-in to an RTU, Hayes Pool permits any modem to answer the incoming call. This will typically be used in conjunction with a PSTN facility such as dial-in "Rotary" to rotate use of multiple lines on the same telephone number. Once a group of modems are selected for Hayes Pool operation, outbound (dial-out) calls are also distributed among the modems by the RTU. If one or more Hayes Pool modems are currently connected, the RTU will select a free modem for the new outbound call.

As detailed above, each DNP3 Route Table entry in the SCADAPack E RTU can be associated with a Modem Dial number. Therefore, each remote modem to be connected by an RTU must have a corresponding ROUTE entry with phone number. Where groups of nodes are contacted through the same modem on a DNA RTU, route entries with DNA address ranges can have a single phone number, multiple route entries for DNA nodes can have the same phone number, or any combination can be used. In POOL mode, when transmitting or receiving DNP3 frames, the SCADAPack E RTU will automatically adjust the ROUTE TABLE entries to allow DNP3 communication through the appropriate communication channel that the modem is connected to. For correct operation, route entries that can be active on "Hayes Pool" ports should have their "Dest Port" field set to "POOL". When operating as a connected modem port, the Hayes Pool driver updates this field to the actual port in use, and searches the route table for matching groups of DNP nodes with the same phone number. This allows communication with those nodes while the communication channel is open. When the modem connection is terminated, the route table's "Dest Port" entries return to "POOL".

When using Hayes Modem Pool operation on the SCADAPack E RTU, there are no other settings for operation of this mode. Apart from the in-bound and out-bound modem pooling, the configuration and operation is the same as described above in Sections [Hayes Modem Parameters](#)^[24] and [Hayes Modem Operation](#)^[20].

10 GPRS and other Mobile IP Communications

GPRS and other similar “always on” mobile IP communications technologies such as **1xRTT**, **HSDPA**, etc are quite different in their operation compared to the Hayes Modem communications. These are described in detail in the *SCADAPack E TCP/IP Technical Reference* manual.

11 Special RTU Cables

SCADAPack 300E Cables

The SCADAPack 300E RTUs provide RJ-45 connectors for serial ports.

These sections detail cable connections for th RJ-45 connectors.

- [SCADAPack 300E RS232 DTE Cable \(RJ-45\)](#)^[31]
- [SCADAPack 300E RS232 DTE Cable with Handshaking \(RJ-45\)](#)^[32]
- [SCADAPack 300E Modem Cable \(RJ-45\)](#)^[33]
- [SCADAPack 300E RS485 Connections](#)^[34]

SCADAPack ES and SCADAPack ER Cables

These sections detail the cable connections for Hayes Modem and RS485/RS422 connections to an RJ-12 connector on the SCADAPack ES and SCADAPack ER RTUs.

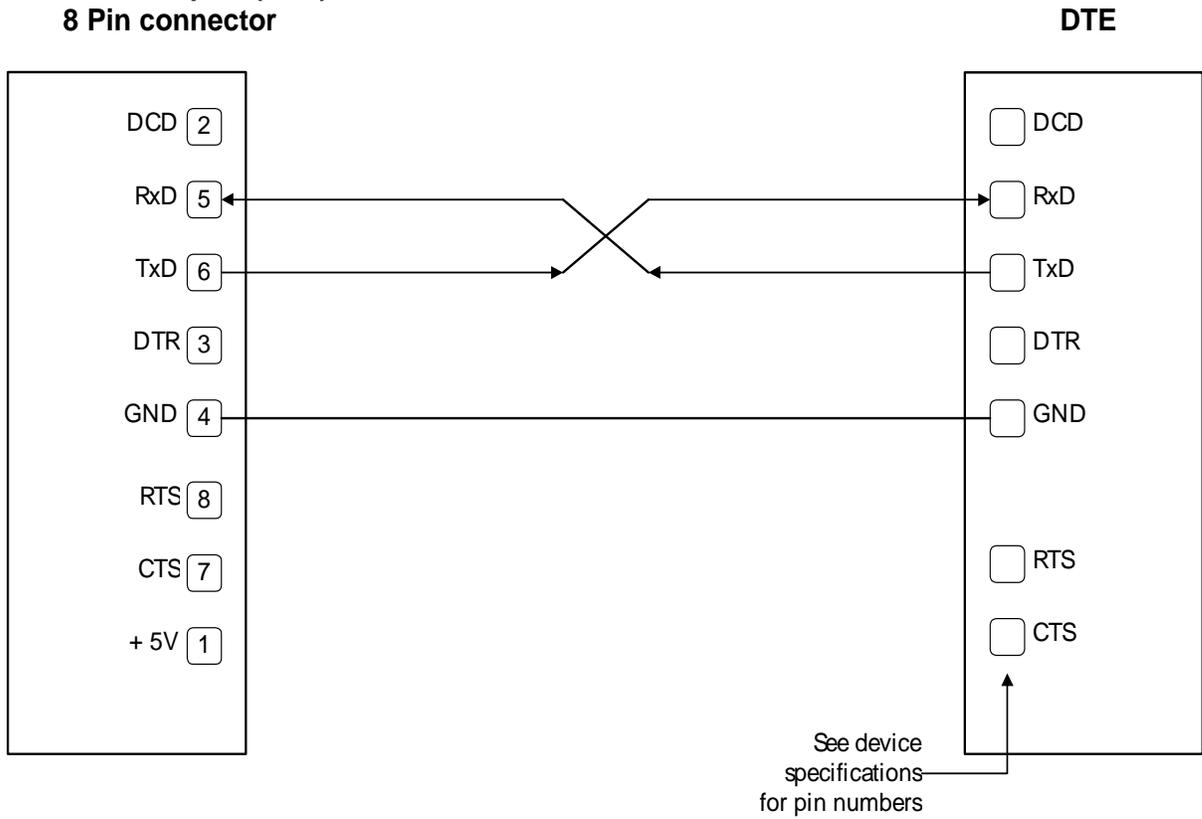
Port 0 on the SCADAPack ER has a DB9 connector that offers complete hardware flow control. The cabling required for a modem connection to Port 0 of the SCADAPack ER simply requires a standard PC modem cable.

- [Modem Cable \(RJ-12 – DB25\)](#)^[35]
 - [SCADAPack ES – RS485 Connections \(Port 2 and 3\)](#)^[36]
 - [SCADAPack ER – RS485 Connections \(Port 2 and 3 ONLY\)](#)^[37]
 - [SCADAPack ER - RS485 Connections \(Ports 5 – 8 : SCADAPack ER-P620 ONLY\)](#)^[38]
-

11.1 SCADAPack 300E RS232 DTE Cable (RJ-45)

The following cabling is required for correct operation of a SCADAPack 300E RTU with an RS232 DTE communications device with no handshaking signals (e.g., PC serial COM port, Terminal Server port) using an RJ-45 connector on the RTU.

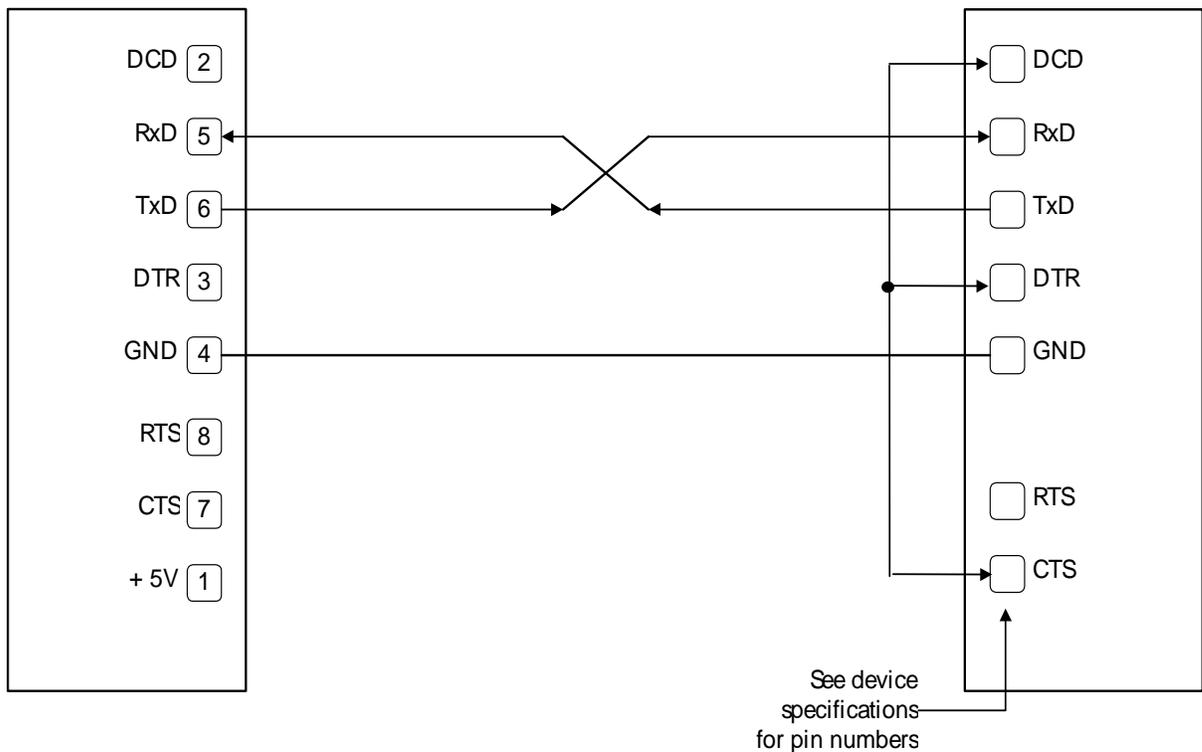
RS-232 COM port (DTE) 8 Pin connector



11.2 SCADAPack 300E RS232 DTE Cable with Handshaking (RJ-45)

The following cabling is required for correct operation of a SCADAPack 300E RTU RJ-45 RS232 connector with an RS232 DTE communications device requiring additional control signals. (e.g., Radio, Line Modem)

RS-232 COM port (DTE) 8 Pin connector

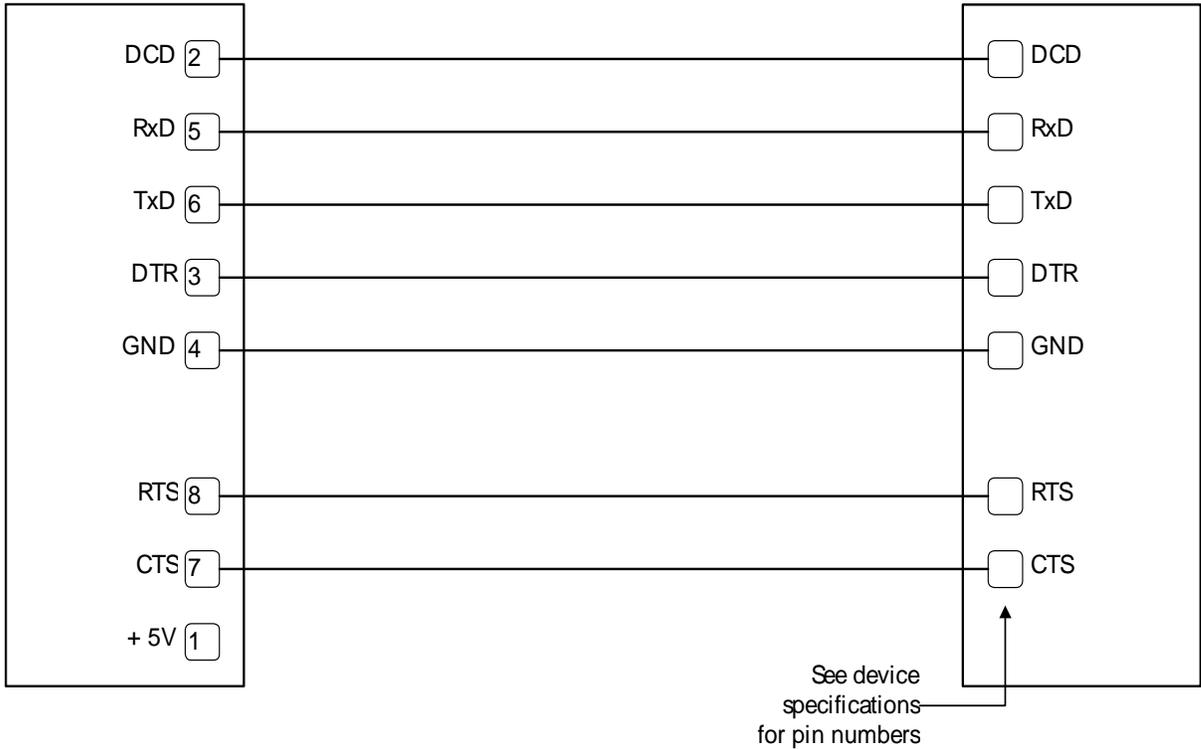


11.3 SCADAPack 300E Modem Cable (RJ-45)

The following cabling is required for correct operation of a SCADAPack 300E RTU with a commercial Hayes Modem using an RJ-45 connector on the RTU.

**RS-232 COM port (DTE)
8 Pin connector**

DCE

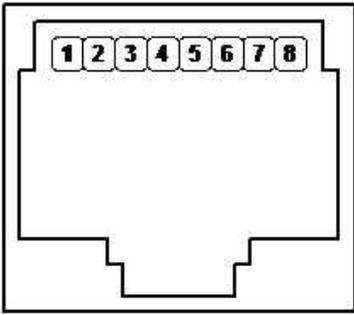


11.4 SCADAPack 300E RS485 Connections

SCADAPack 300E RS485 using RJ-45 Connection

Modular Jack Pin	RJ-45 when RS485 jumper in place*
1	+5V when jumper installed*
2	Do not connect
3	Do not connect
4	GND
5	B 
6	A 
7	Do not connect
8	Do not connect

RJ-45 Modular Jack



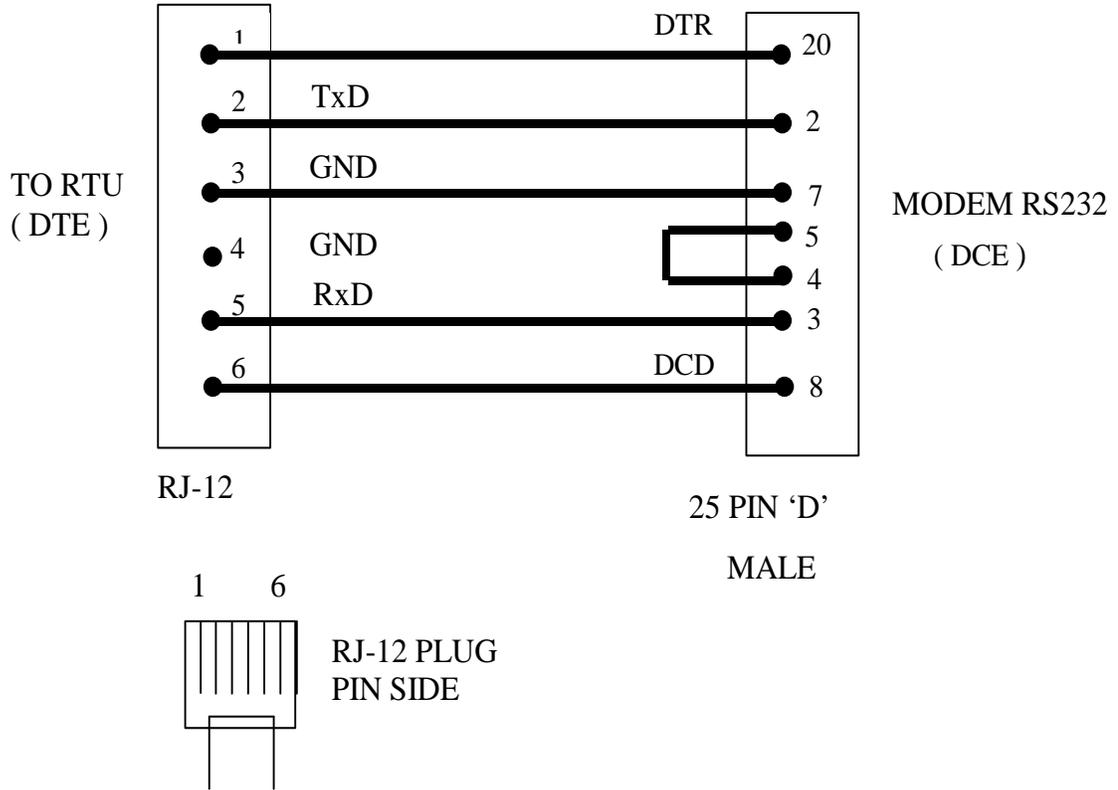
* see specific SCADAPack 300E Hardware Manual for information on setting port jumpers

SCADAPack 350E RS485 using Terminal Connection

P6 - GND	Ground
P6 - A	A 
P6 - B	B 

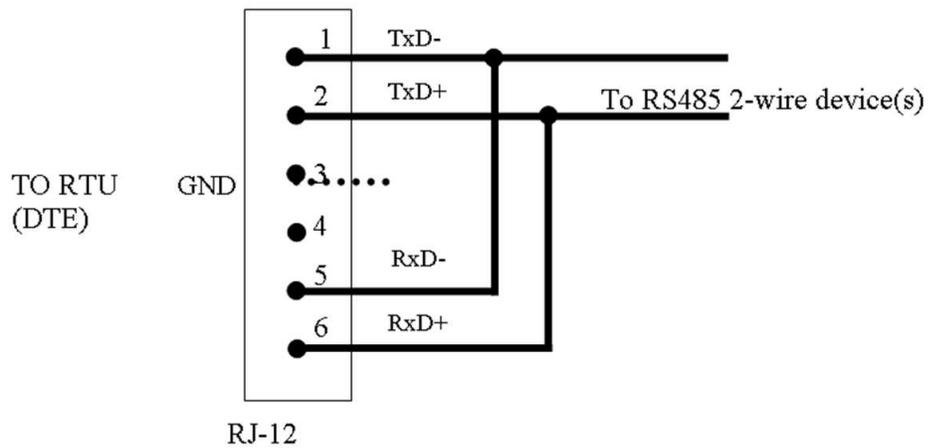
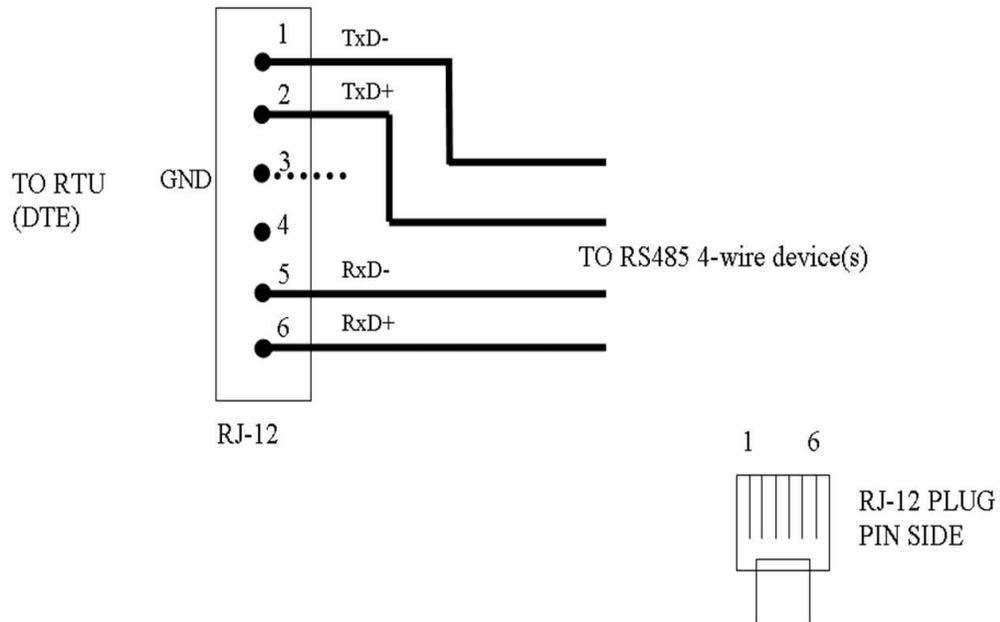
11.5 SCADAPack ES & SCADAPack ER Modem Cable (RJ-12 - DB25)

The following cabling is required for correct operation of SCADAPack ES and SCADAPack ER RTUs with a commercial Hayes Modem using an RJ-12 connector on the RTU.



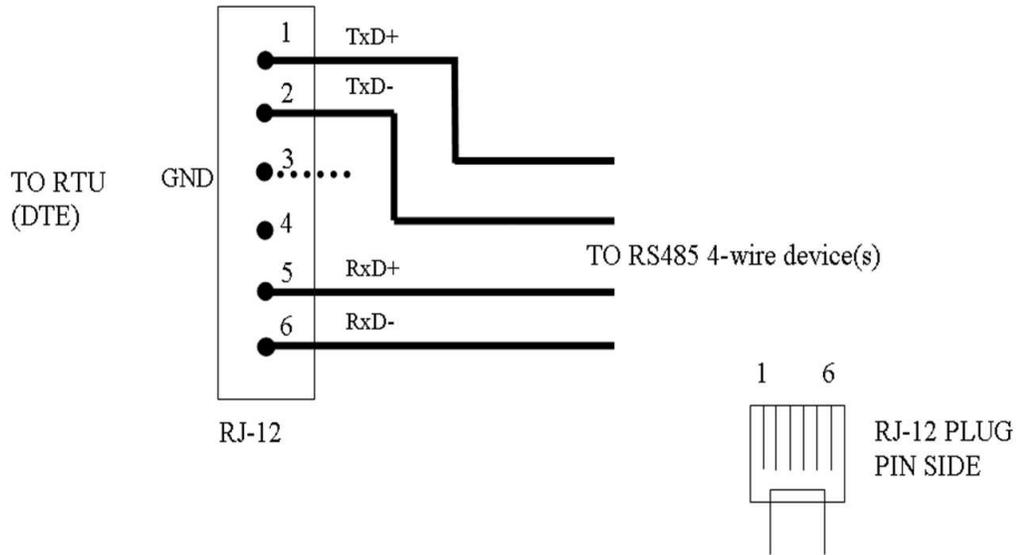
11.6 SCADAPack ES - RS485 Connections (Port 2 and 3)

This section details the RJ-12 connections for the SCADAPack ES.

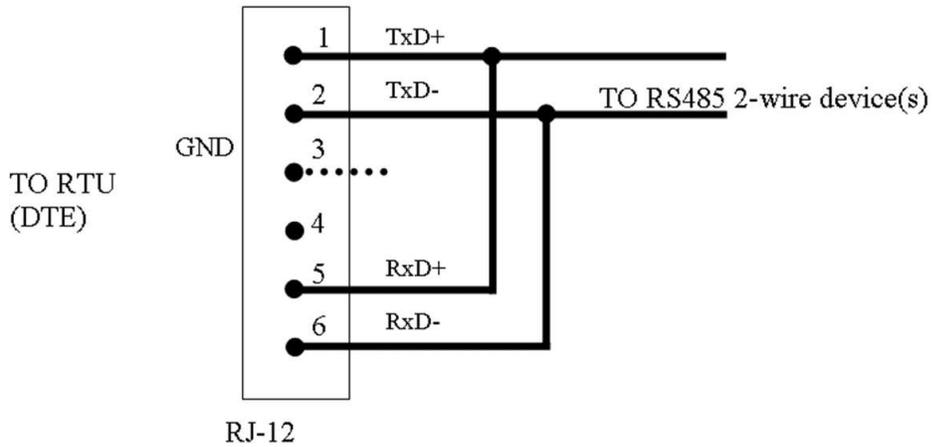


11.7 SCADAPack ER - RS485 Connections (Port 2 and 3 ONLY)

This section details the RJ-12 connections for Ports 2 and 3 of the SCADAPack ER processors.



4-Wire RS485 / RS422 Connections

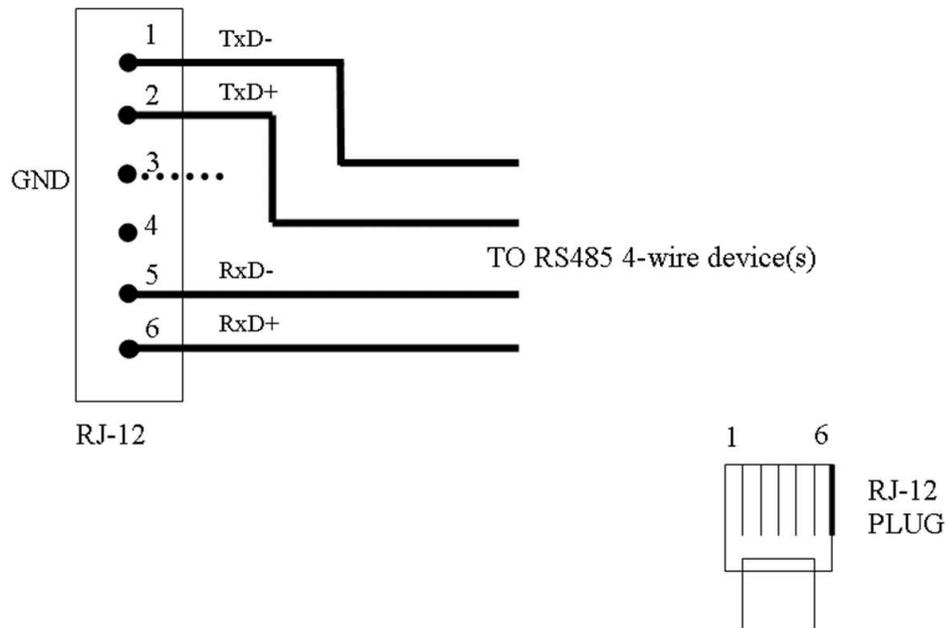


2-Wire RS485 Connections

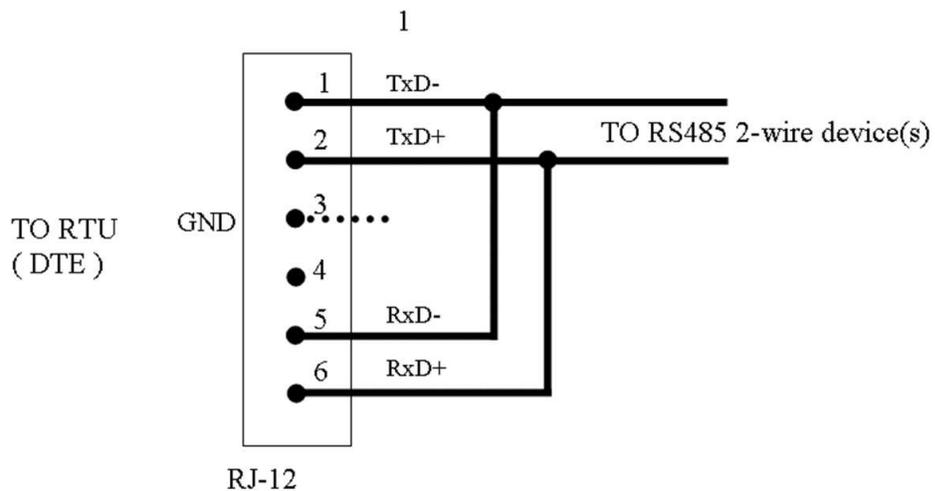
11.8 SCADAPack ER - RS485 Connections (Ports 5 - 8 : SCADAPack ER-P620 ONLY)

This section details the RJ-12 connections for Ports 5 – 8 on the SCADAPack ER P620 Processor.

The cabling for RS485 connections for Port 2 and 3 are different. Refer to Section [SCADAPack ER – RS485 Connections \(Port 2 and 3 ONLY\)](#)^[37].



4-Wire RS485 / RS422 Connections



2-Wire RS485 Connections