7SR21 Non-Directional
7SR22 Directional

Overcurrent Relay

Document Release History

This document is issue **2010/05**. The list of revisions up to and including this issue is:

2010/05	Additional Comms modules option of (RS485 + IRIG-B) and (RS232 + IRIG-B) and typographical revisions
2010/02	Document reformat due to rebrand
2009/09	Third Issue. Software revision 2435H80004/5 R4b-4
2008/07	Second issue. Software revision 2435H80004/5 R3d-3.
2008/03	First issue

Software Revision History

2009/09	2435H80004/5 R4b-4	CTS-I Supervision. Undercurrent 37G & 37SEF. Vx U/O Voltage. 46BC U/C. Comms Settings. Waveform Storage Settings. Fault Storage Settings. Energy Storage. Trip test function. Local/Remote modes. Settings ranges extended. Protocol changes.
2008/07	2435H80004/5R3d-3	Demand records. Optional DNP3.0 data comms.
2008/03	2435H80004/5R2c-2b	First Release

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Section 1: Introduction

The relay can communicate with control and automation systems, or with PCs running Reydisp Evolution software, to provide operational information, post-fault analysis, settings, interrogation and editing facilities. This section describes how to use the Communication Interface with a control system or interrogating computer. Appropriate software within the control system or on the interrogating computer (e.g. Reydisp Evolution) is required to access the interface.

This section specifies connection details and lists the events, commands and measurands provided in each product as detailed in the Diagrams and Parameters section. For further information regarding the IEC60870-5-103 interface, reference should be made to the separate Informative Communications Interface manual (reference 434/TM/5 available from www.siemens.com/energy).

The Communications Interface for dialogue communications by the Protection Engineer is provided by the Reydisp Evolution software package, also available from the website, using the IEC60870-5-103 protocol.

Section 2: Physical Connection

The relay range provides as standard one 'Front' USB communication interface located on the fascia and one RS485 located at the 'Rear' with optional Fibre Optic ports (COM3 & COM4), RS485 (COM3) & RS232 (COM3) also located on the rear. Communication settings are only available from the relay front fascia via the **COMMUNICATIONS MENU**

1. Com2-USB: this port is used for IEC60870-5-103 (default setting) communication with the Reydisp software. An ASCII protocol, the main use of which is to allow firmware to be updated from the front connection, is also available through this port.
2. Com1-RS485: this port can be used for IEC60870-5-103, MODBUS RTU and DNP 3.0 communications to a substation SCADA or integrated control system or engineer remote access.
3. Com3/Com4: Optional ports located on the rear of the relay can be used for IEC60870-5-103, MODBUS RTU and DNP 3.0 communications to a substation SCADA or integrated control system or engineer remote access.

Any or all ports can be mapped to the IEC60870-5-103, MODBUS RTU or DNP 3.0 protocol at any one time.

Siemens Protection Devices Limited can provide a range of interface devices, please refer to product portfolio catalogue.

Full details of the interface devices can be found by referring to the website www.siemens.com/energy

2.1 Communication ports

2.1.1 Standard USB Interface

The USB communication port is connected using a standard USB cable with a type B connection to the relay and type A to the PC.

The PC will require a suitable USB driver to be installed; this will be carried out automatically when the Reydisp software is installed. When the Reydisp software is running with the USB cable connected to a device an additional connection is shown. Connections to these devices are not shown when they are not connected.

The USB communication interface on the relay is labelled Com 2 and its associated settings are located in the Data communications menu. To enable communication with Reydisp via the USB port the following setting changes must be made on the relay via the keys on the relay fascia.

Setting name	Range	Default	Setting	Notes
Station Address	0 … 254	0	1-254	An address between 1 and 254 must be given to identify the relay
COM2-USB Protocol	OFF, IEC60870-5-103, DNP3.0, MODBUS-RTU, ASCII	IEC60870-5-103	IEC60870-5-103	Reydisp software uses IEC60870-5-103 to communicate.

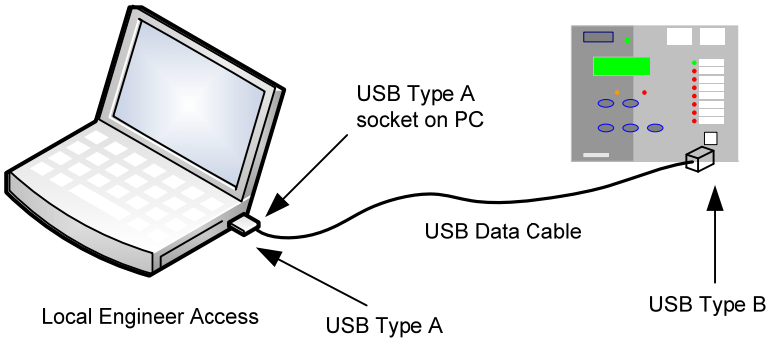

Figure 2-1 Communication to Front USB Port

2.1.2 Standard RS485 Interface

The RS485 communication port is located at the rear of the relay and can be connected using a suitable RS485 120 ohm screened twisted pair cable.

The RS485 electrical connection can be used in a single or multi-drop configuration. The RS485 master must support and use the Auto Device Enable (ADE) feature. The last device in the connection must be terminated correctly in accordance with the master device driving the connection. The relays are fitted with an internal terminating resistor which can be connected between the A and B by fitting an external wire loop between terminals 18 and 20 on the power supply module.

The maximum number of relays that can be connected to the bus is 64.

The following settings can be configured via the relay fascia or Reydisp Evolution when using the RS485 interface.

Setting name	Range	Default	Setting	Notes
Station Address	0 – 254 for IEC60870-5-103 0 – 247 for Modbus RTU 0 – 65520 for DNP3.0	0	As Required	An address within the range of the relevant protocol must be given to identify the relay. Each relay must have a unique address.
COM1-RS485 Protocol	OFF, IEC60870-5-103, MODBUS-RTU, DNP3.0	IEC60870-5-103	As Required	Sets the protocol used to communicate on the standard RS485 connection.
COM1-RS485 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400	19200	As Required	The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM1-RS485 Parity	NONE, ODD, EVEN	EVEN	As Required	The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
Unsolicited Mode	DISABLED ENABLED	DISABLED	As Required	Setting is only visible when COM1 Protocol is set to DNP3
Destination Address	0 … 65520	0	As Required	Setting is only visible when COM1 Protocol is set to DNP3

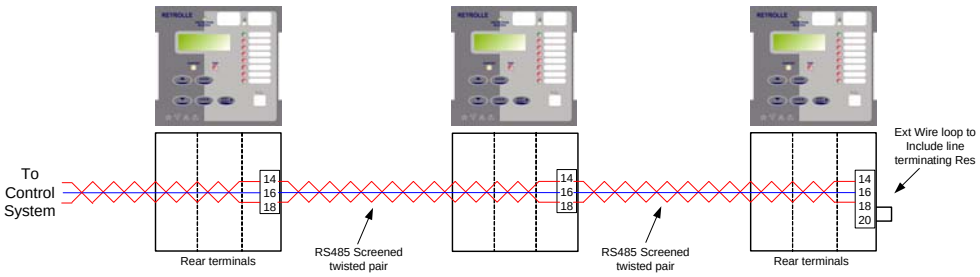

Figure 2-2 Communication to Multiple Devices from Control System using RS485

2.1.3 Optional Fibre Optic Interface

When connecting via the optional fibre optic interface the selection of fibre-optic cable is important. Fibres must be terminated with ST™ (BFOC/2.5) connectors.

The recommended type is 62.5/125µm glass fibre. Communication distances over 1 km are achievable using this type of fibre.

A budget loss calculation should be made for all installations. The following table gives the Launch power and receiver sensitivity of each of the fibre optic communication ports on the 7SR21 & 7SR22 relays when used with specific fibre optic types.

Fibre Type	Tx Launch Power (dB)		RX Receive Sensitivity (dB)	
	Min	Max	Min	Max
62.5/125µm	-11.7	-15.7	-24	-9.2
1mm Polymer	-6.4	-10.4	-24	-9.2
200µm PCS	-2.8	-6.8	-24	-9.2

The main factors limiting transmission distances with fibre-optics are: -

- Transmitter launch power
- Attenuation, based on light frequency, fibre material and fibre diameter
- Number of intermediate connectors and splices
- Receiver sensitivity
- The light power at the receiver must be above the sensitivity of the receiver in order that effective communication can occur.
- Consult fibre manufacturers' data for actual values of fibre attenuation.
- Fibre cables are supplied on reels of finite length which may necessitate additional jointing.
- Typical losses at connectors are 0.5-1.0dB each. This allows for normal age related deterioration. Consult manufacturers' data for actual values.
- Typical Splice losses are <0.3dB.
- A 3dB safety margin is usually allowed after the budget calculation is performed.
- Following installation the actual losses should be measured for each fibre using a calibrated light source and meter and the measured values compared to the calculated estimate before the relay is applied.
- The fibre optic data Comms link will be broken if the relay element is withdrawn from the case.

The following table can be used to record budget calculations:

A	Launch power	dB
B	Fibre Type	
C	Loss (dB/km)	dB/km
D	Length	km
E	Total fibre loss (CxD)	dB
F	No. of Splices	
G	Loss at each splice	dB
H	Total loss at splices (FxG)	dB
I	No. of connectors	
J	Loss per connector	dB
K	Total loss at connectors (IxJ)	dB
L	Total losses (E+H+K)	dB
M	Receive power budget (A-L)	dB
N	Safety Margin	dB
O	Device Receive Sensitivity	dB

There are two optional ports, com3 and com4, and when fitted the associated settings are available in the Data Communication menu. To allow communication using either or both of these ports the relay settings must be changed, via the fascia, in accordance with the method of connection and master device.

Setting name	Range	Default	Setting	Notes
Station Address	1 – 254 for IEC60870-5-103 0 – 247 for Modbus RTU 0 – 65520 for DNP3.0	0	As Required	An address within the range of the relevant protocol must be given to identify the relay. Each relay must have a unique address.
COM3 Protocol	OFF, IEC60870-5-103, MODBUS-RTU, DNP3.0	IEC60870-5-103	As Required	Sets the protocol used to communicate on the connection – Com3
COM3 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400 57600 115200	57600	As Required	The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM3 Parity	NONE, ODD, EVEN	EVEN	As Required	The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
COM3 Line Idle*	LIGHT ON, LIGHT OFF	LIGHT OFF	As Required	Sets the idle state of the line in accordance with master device
COM3 Data Echo*	ON,OFF	OFF	As Required	Set to ON when relays are connected in a ring configuration.
COM4 Protocol**	OFF, IEC60870-5-103, MODBUS-RTU, DNP3.0	IEC60870-5-103	As Required	Sets the protocol used to communicate on the connection – Com4.
COM4 Baud Rate**	75 110 150 300 600 1200 2400 4800 9600 19200 38400	57600	As Required	The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM4 Parity**	NONE, ODD, EVEN	EVEN	As Required	The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
COM4 Line Idle**	LIGHT ON, LIGHT OFF	LIGHT OFF	As Required	Sets the idle state of the line in accordance with master device
COM4 Data Echo**	ON,OFF	OFF	As Required	Set to ON when relays are connected in a ring configuration.

*Not applicable for RS 485 or RS 232 options

**COM 4 is fibre optic only

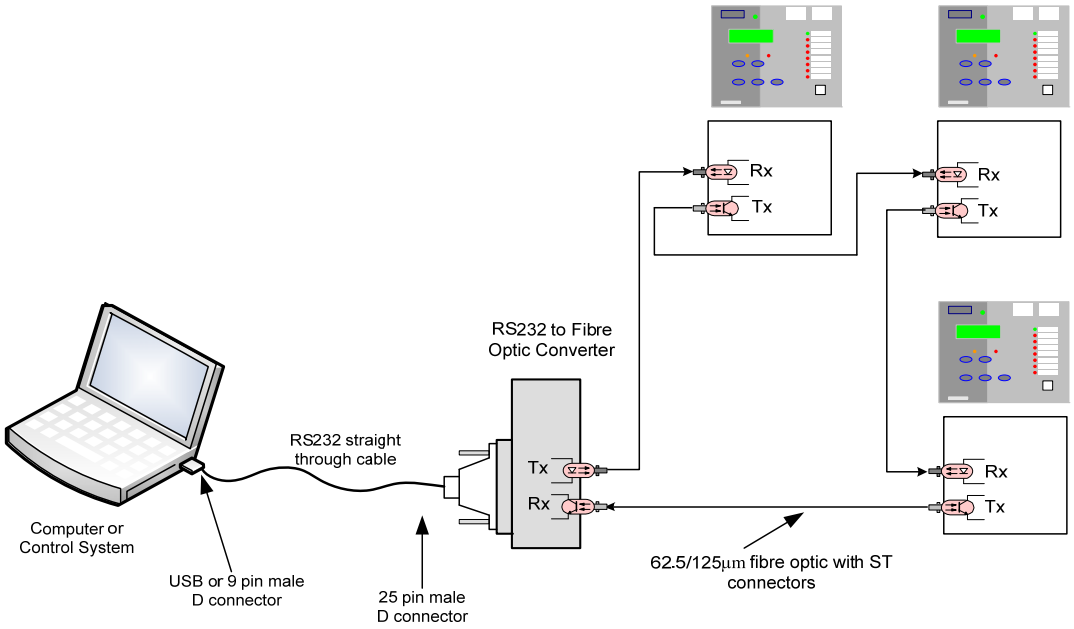

Figure 2-3 Communication to Multiple Devices using Fibre-optic Ring Network

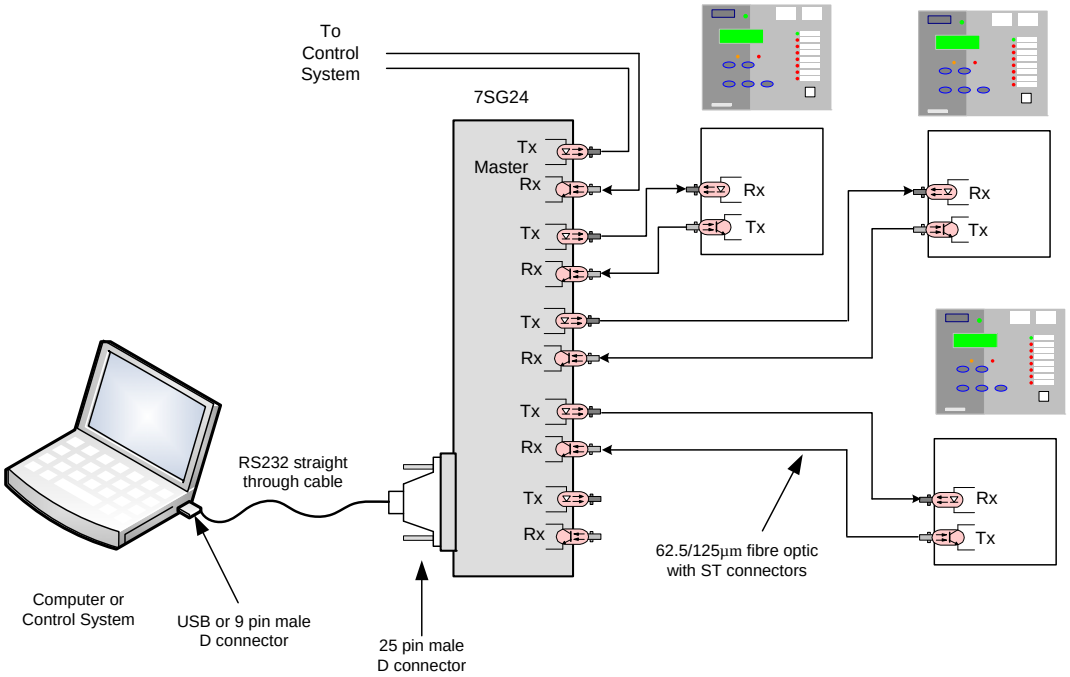

Figure 2-4 Communication to Multiple Devices from Control System and Laptop using Fibre-optic Star Network

2.1.4 Optional Rear RS485 + IRIG-B Interface

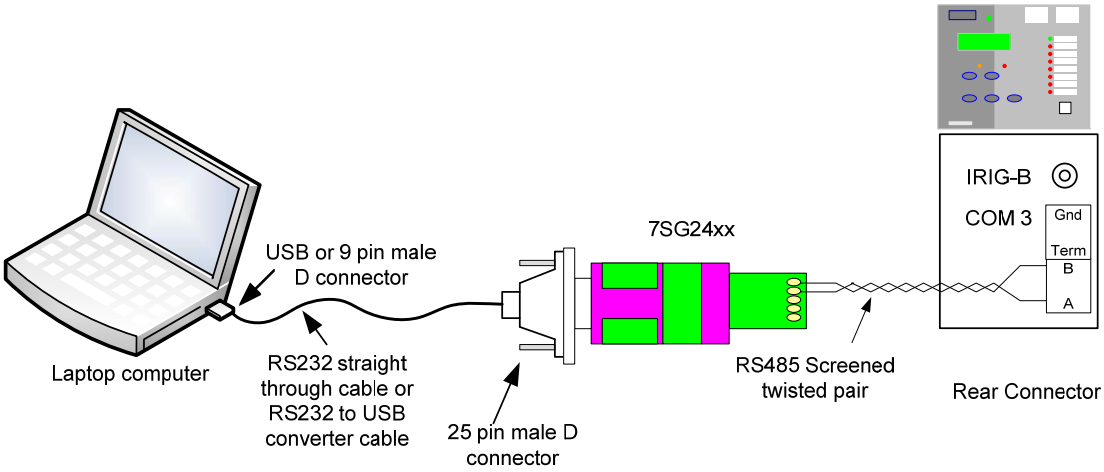

Figure 2-5 Additional (Optional) Rear RS485 + IRIG-B Connection to a PC

2.1.5 Optional Rear RS232 + IRIG-B Connection

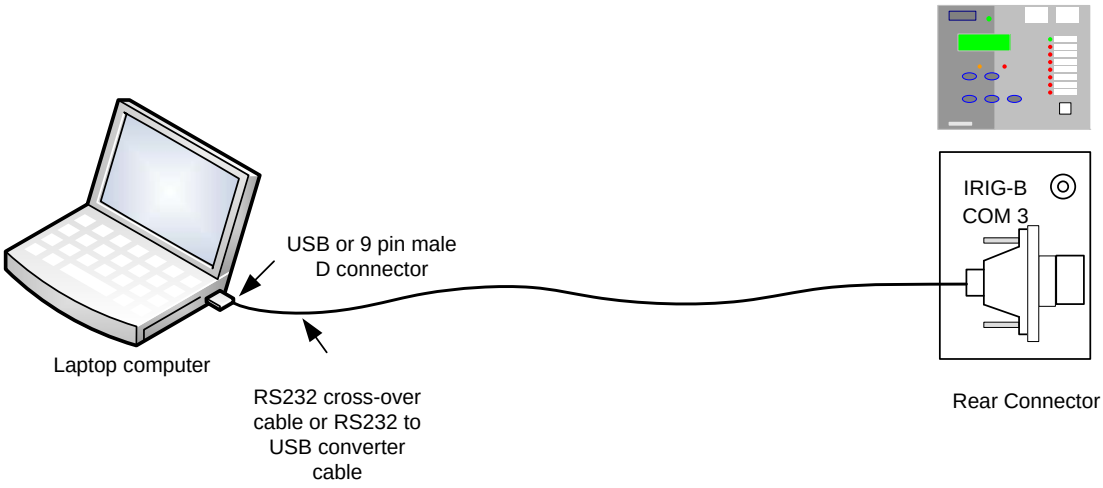

Figure 2-6 Additional (Optional) Rear RS232 + IRIG-B Connection to a PC

Pin	Relay Function
1	Not Connected
2	Receive Data (RXD)
3	Transmit Data (TXD)
4	Input Supply +5 V
5	Signal Ground (GND)
6	Input Supply +5 V
7	Linked to 8 (volts free)
8	Linked to 7 (volts free)
9	Output Supply +5 V 50mA

Figure 2-7 RS232 Data Comms Pin Connections

Section 3: Modems

The communications interface has been designed to allow data transfer via modems. However, IEC 60870-5-103 defines the data transfer protocol as an 11 bit format of 1 start, 1 stop, 8 data and even parity, which is a mode most commercial modems do not support. High performance modems will support this mode, but are expensive. For this reason, a parity setting is provided to allow use of easily available and relatively inexpensive commercial modems. This will result in a small reduction in data security and the system will not be compatible with true IEC 60870-5-103 control systems.

3.1 Connecting a Modem to the Relay(s)

RS232C defines devices as being either Data Terminal Equipment (DTE) e.g. computers, or Data Communications Equipment (DCE), e.g. modems, where one is designed to be connected to the other. In this case, two DCE devices (the modem and the fibre-optic converter) are being connected together, so a null terminal connector is required, which switches various control lines. The fibre-optic converter is then connected to the relay Network Tx to Relay Rx and Network Rx to Relay Tx.

3.2 Setting the Remote Modem

The exact settings of the modem are dependent on the type of modem. Although most modems support the basic Hayes 'AT' command format, different manufacturers use different commands for the same functions. In addition, some modems use DIP switches to set parameters, others are entirely software configured.

Before applying settings, the modem's factory default settings should be applied, to ensure it is in a known state.

Several factors must be considered to allow remote dialling to the relays. The first is that the modem at the remote end must be configured as auto answer. This will allow it to initiate communications with the relays. Next, the user should set the data configuration at the local port, i.e. baud rate and parity, so that communication will be at the same rate and format as that set on the relay and the error correction is disabled.

Auto-answer usually requires two parameters to be set. The auto-answer setting should be switched on and the number of rings after which it will answer. The Data Terminal Ready (DTR) settings should be forced on. This tells the modem that the device connected to it is ready to receive data.

The parameters of the modem's RS232C port are set to match those set on the relay, set baud rate and parity to be the same as the settings on the relay and number of data bits to be 8 and stop bits 1. Note, although the device may be able to communicate with the modem at say 19200 bps, the modem may only be able to transmit over the telephone lines at 14400 bps. Therefore, a baud rate setting on which the modem can transmit should be chosen. In this example, a baud rate of 9600 should be chosen.

As the modems are required to be transparent, simply passing on the data sent from the controller to the device and vice versa, error correction and buffering is turned off.

If possible, Data Carrier Detect (DCD) should be forced on, as this control line will be used by the Fibre-optic converter.

Finally, these settings should be stored in the modem's memory for power on defaults.

3.3 Connecting to the Remote Modem

Once the remote modem has been configured correctly, it should be possible to dial up the modem and make connection to the relay. As the settings on the remote modem are fixed the local modem should negotiate with it on connection, choosing suitable matching settings. If it cannot do this, the local modem should be set with settings equivalent to those of the remote modem as described above.

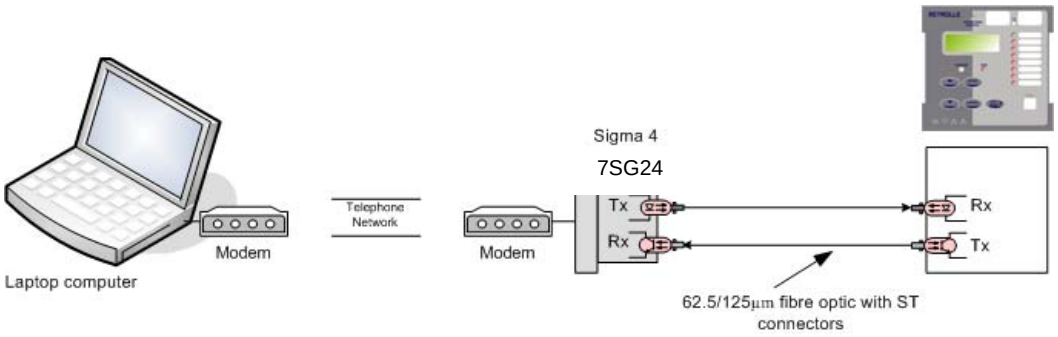

Figure 3-1 Communication to Device using 7SG24 and Modem

Section 4: Configuration

The data points and control features which are possible within the relay is fixed and can be transmitted over the communication channel(s) protocols in the default format described earlier in this section. The default data transmitted is not always directly compatible with the needs of the substation control system and will require some tailoring, this can be done by the user with the Reydisp software comms editor tool.

The Comms Editor is provided to allow its users to configure the Communications Files Protocols in Reyrolle brand Relays manufactured by Siemens Protection Devices Limited (SPDL).

The editor supports configuring DNP3, IEC60870-5-103 and MODBUS protocols.

The editor allows configuration files to be retrieved from the relay, edited, then uploaded back to the relay. Files may also be saved/loaded from disc to work offline. The protocols will be stored in a Reyrolle Protection Device Comms file (RPDC), which will be stored locally, so that the editor can be used when the relay is not connected.

DNP3

The tool will allow: -

- Data Points to be enabled or disabled.
- Changing the point numbers for the Binary Inputs, Binary Outputs and Analogue Inputs.
- Changing their assigned class and object variants.
- Setting Binary points to be inverted before transmission.
- Setting the Control Relay Output Block (CROB) commands that can be used with a Binary Output.
- Specifying a dead-band outside which Analogue Events will be generated.
- Specifying a multiplier that will be applied to an analogue value before transmission.

IEC60870-5-103

The tool will allow: -

- Data Points to be enabled or disabled.
- Changing the point numbers Function Type (FUN) and Information (INF), returned by each point.
- Changing the text returned to Reydisp for display in its event viewer.

MODBUS-RTU

The tool will allow: -

- Changing the Addresses for the Coils, Inputs and Registers.
- Changing the format of the instrument returned in a register, e.g. 16 or 32 bit.
- Note, as MODBUS points are polled they do not need to be enabled or disabled

The user can check if the relay contains user configured communication files via a meter in the relay menus. Pressing the Enter and down arrow buttons on the fascia, then scrolling down, the number of files stored in the relay is displayed. The file name can also be viewed by pressing the Cancel and Test/Reset buttons together when in the relay Instruments menu. The user must ensure when naming the file, they use a unique file name including the version number.

Please refer to the Comms Editor Technical Manual for further guidance.

Section 5: Glossary

Baud Rate
Data transmission speed.

Bit
The smallest measure of computer data.

Bits Per Second (bps)
Measurement of data transmission speed.

Data Bits
A number of bits containing the data. Sent after the start bit.

Data Echo
When connecting relays in an optical ring architecture, the data must be passed from one relay to the next, therefore when connecting in this method all relays must have the Data Echo ON.

Half-Duplex Asynchronous Communications
Communications in two directions, but only one at a time.

Hayes 'AT'
Modem command set developed by Hayes Microcomputer products, Inc.

Line Idle
Determines when the device is not communicating if the idle state transmits light.

Modem
MOdulator / DEModulator device for connecting computer equipment to a telephone line.

Parity
Method of error checking by counting the value of the bits in a sequence, and adding a parity bit to make the outcome, for example, even.

Parity Bit
Bit used for implementing parity checking. Sent after the data bits.

RS232C
Serial Communications Standard. Electronic Industries Association Recommended Standard Number 232, Revision C.

RS485
Serial Communications Standard. Electronic Industries Association Recommended Standard Number 485.

Start Bit
Bit (logical 0) sent to signify the start of a byte during data transmission.

Stop Bit

Bit (logical 1) sent to signify the end

USB

Universal Serial Bus standard for the transfer of data.