7SR242 Duobias

Multi-Function 2-Winding Transformer Protection Relay

Document Release History

This document is issue **2010/06**. The list of revisions up to and including this issue is:

2010/06	Additional Comms modules option of (RS485 + IRIG-B) and (RS232 + IRIG-B) and typographical revisions
2010/02	Document reformat due to rebrand
2010/02	Third issue. Software revision 2662H80001 R4c-3
2008/07	Second issue. Software revision 2662H80001R3d-2c.
2008/05	First issue

Software Revision History

2010/02	2662H80001 R4c-3	Revisions to: VT ratio settings, 87BD 1st bias slope limit setting increments, CB fail function, LED CONFIG menu, DATA STORAGE menu. Added: Open circuit detection (46BC), CONTROL MODE menu, Close circuit supervision (74CCS), Measured earth fault undercurrent (37G), Pulsed output contacts.
2008/07	2662H80001R3d-2c.	Demand metering. Optional DNP3.0 data comms.
2008/05	2662H80001R3-2b	First Release

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Section 1: Introduction

This section provides information on the use of 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.

The relay data communication facility incorporates user selectable protocols to provide compatibility with control and automation systems.

When IEC60870-5-103 protocol is selected the relay can communicate with PCs running Reydisp software which provides operational information, post-fault analysis, settings interrogation and editing facilities etc. Reydisp software can be downloaded from the website.

This section specifies connection details and lists the events, commands and measurands available in the IEC60870-5-103, Modbus RTU and optional DNP3.0 protocols.

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).

Section 2: Physical Connection

As standard the relay provides one 'Front' USB communication interface (COM2) located on the fascia and one RS485 (COM1) located on the 'Rear'.

Optionally additional fibre optic (x2), RS232 (x1) or RS485 (x1) data comms ports can be provided on the rear, these are designated COM3/COM4.

1. COM1-RS485: this port can be used for IEC60870-5-103, MODBUS RTU or optionally DNP3 communications to a substation SCADA or integrated control system or engineer remote access.

2. COM2-USB: this port is used for IEC60870-5-103 (default setting) communication with Reydisp software. MODBUS RTU or optional DNP3 are also available via COM2.

   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.

   Access to COM2 settings is only available from the relay front fascia via the **COMMUNICATIONS MENU**

3. COM3/COM4: Located on the rear of the relay these optional ports can be used for IEC60870-5-103, MODBUS RTU or optional DNP3 communications to a substation SCADA or integrated control system or engineer remote access.

SPDL 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

To allow communication to the relay the Station Address setting must be within the range of the selected protocol i.e. 0 – 254 for IEC60870-5-103, 0 – 247 for MODBUS-RTU or 0 – 65520 for DNP3.

Setting name	Range	Default	Setting	Notes
Station Address	0 … 65534	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay must have a unique address.

2.1.1 USB Interface (COM2)

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 from the relay fascia.

Setting name	Range	Default	Setting	Notes
Station Address	0 … 65534	0	0 – 254	
COM2-USB Protocol	OFF, IEC60870-5-103, MODBUS-RTU, ASCII, DNP3	IEC60870-5-103	IEC60870-5-103	Reydisp software is compatible with IEC60870-5-103.
COM2-USB Mode	Local, Local or Remote, Remote	Local	Local	

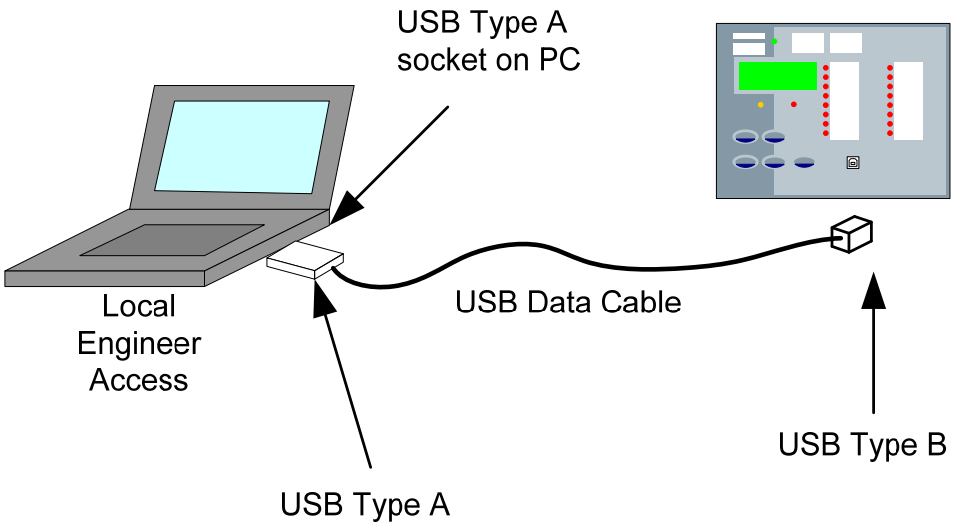

Figure 2-1 Communication to Front USB Port

2.1.2 RS485 Interface (COM1)

The RS485 communication port is located on 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 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.

Each relay has an internal terminating resistor – this can be connected in circuit where necessary.

The following settings must be configured when using the RS485 interface.

Setting name	Range	Default	Setting	Notes
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.
COM1-RS485 Mode	Local, Local or Remote, Remote	Remote		
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 DNP3 Unsolicited Events set to Enabled.

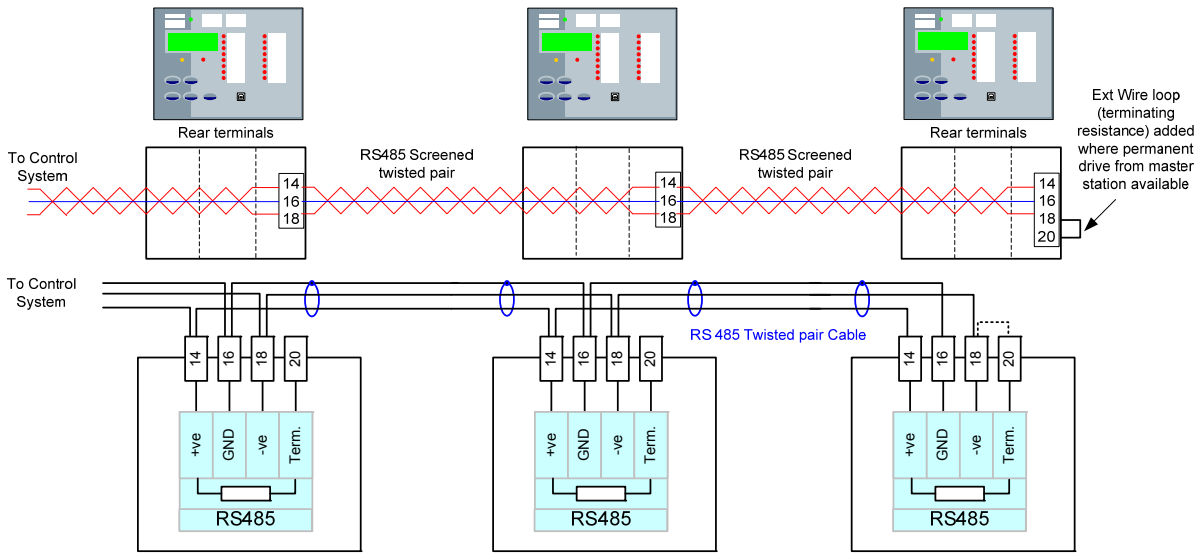

Figure 2-2 Communication to Multiple Devices using RS485 (Standard Port)

2.1.3 Optional Rear Fibre Optic Interfaces (COM3 and COM4)

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.

The fibre optic data comms link will be interrupted if the relay element is withdrawn from the case.

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 Argus M relay 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

Factors to be considered when calculating fibre-optic transmission distances:

- 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.
- 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 and prior to putting into service the actual losses should be measured for each fibre using a calibrated light source and meter. Measured and calculated values can be compared.

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

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	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.
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	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.
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

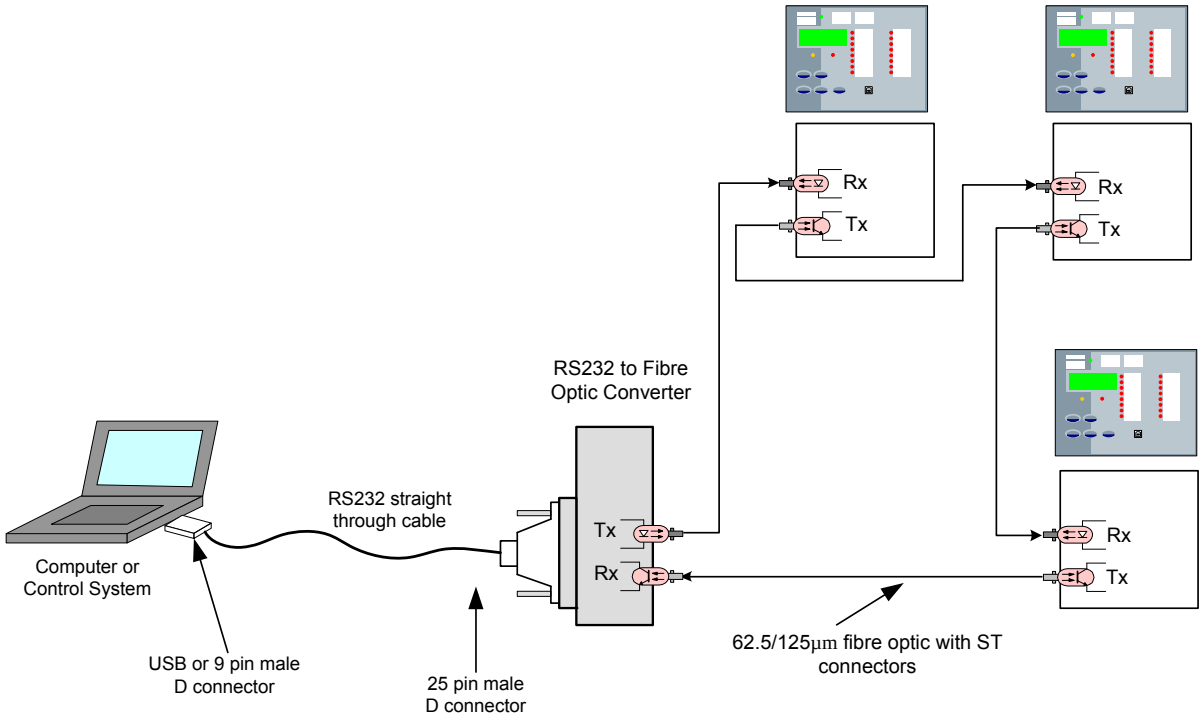

Figure 2-3 Communication to Multiple Devices using Fibre-optic Ring Network

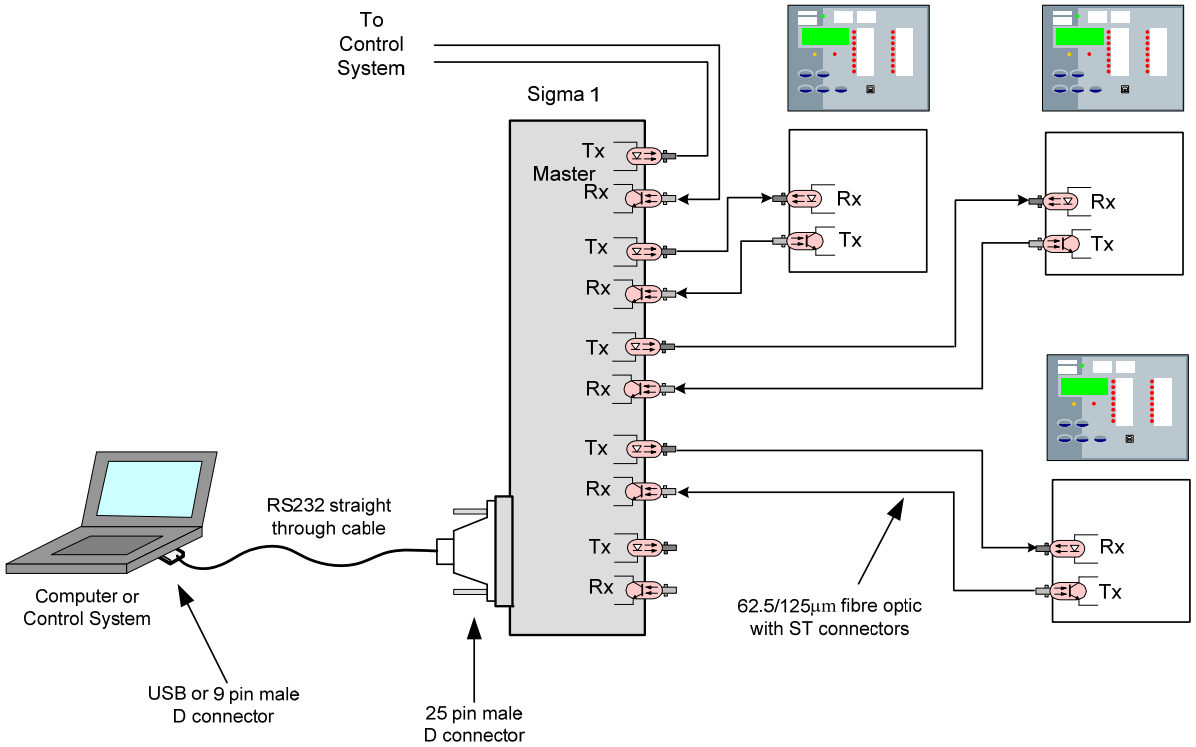

Figure 2-4 Communication to Multiple Devices from Control System and Laptop using Fibre-optic Star Network

2.1.4 Optional Rear RS485 (COM3)

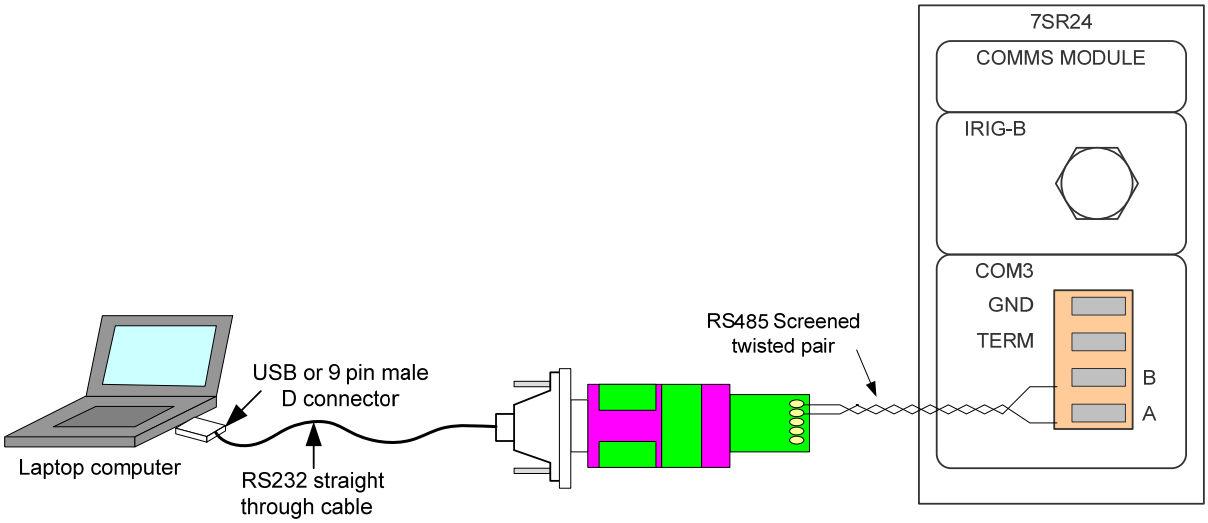

Figure 2-5 Additional (Optional) Rear RS485 + IRIG-B Connection to a PC

2.1.5 Optional Rear RS232 (COM3)

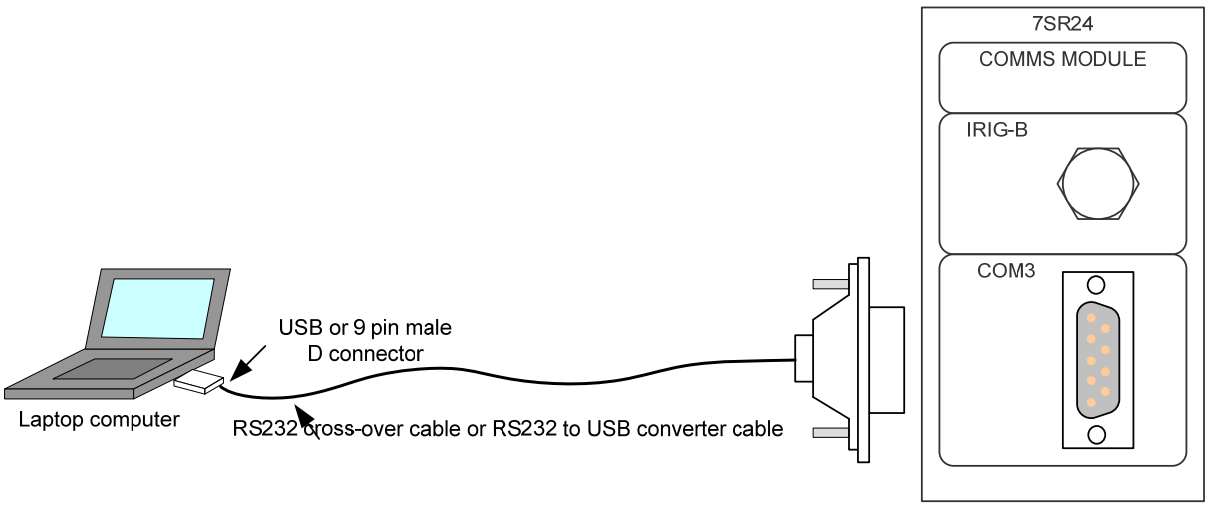

Figure 2-6 Additional (Optional) Rear RS232 + IRIG-B Connection to a PC

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

Figure 2-7 RS232 Data Comms Pin Connections

Section 3: IEC 60870-5-103 Definitions

3.1 Introduction

This section describes the IEC 60870-5-103 protocol implementation in the relays. This protocol is used for the communication with REYDISP software and can also be used for communication with a suitable control system. The control system or local PC acts as the master in the system with the relay operating as a slave responding to the master's commands. The implementation provides event information, time synchronising, commands and measurands and also supports the transfer of disturbance records.

This protocol can be set to use any or all of the relays hardware interfaces (USB, Fibre Optic and RS485) and is the standard protocol used by the USB port. The relay can communicate simultaneously on all ports regardless of protocol used.

Each relay must be given an address to enable communication and can be set by the *Communication Interface:**Relay Address***. Valid settings are within the range **1 – 254**, a relay with the default address of **0** will not be able to communicate.

Cause of Transmission

The cause of transmission (COT) column of the 'Information Number and Function' table lists possible causes of transmission for these frames. The following abbreviations are used:

Abbreviation	Description
SE	spontaneous event
T	test mode
GI	general interrogation
Loc	local operation
Rem	remote operation
Ack	command acknowledge
Nak	Negative command acknowledge

Note: Events listing a GI cause of transmission can be raised and cleared; other events are raised only.

Function Type

Abbreviation	Description
1	Time tagged message (monitor direction)
2	Time tagged message (relative time) (monitor direction)
3.1	Measurands I
4	Time-tagged measurands with relative time
5	Identification message
6	Time synchronisation
7	General Interrogation Initialization
9	Measurands II
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Definitions with shaded area are not available on all relay models.

Function	Information Number	Description	Function Type	Cause of Transmission
60	1	IEC870 Active Com 1	1	SE, GI,
60	2	IEC870 Active Com 2	1	SE, GI,
60	3	Front Port Override	1	SE, GI,
60	4	Remote Mode	1	SE, GI,
60	5	Service Mode	1	SE, GI,
60	6	Local Mode	1	SE, GI,
60	7	Local & Remote Mode	1	SE, GI,
60	8	Real time clock set	1	SE, GI,
60	9	Real time clock drift corrected	1	SE, GI,
60	10	Real time clock not synchronised	1	SE, GI,
60	11	Real time clock synchronised	1	SE, GI,
60	12	Control Received	1	SE
60	13	Command Received	1	SE
60	128	Cold Start	1	SE
60	129	Warm Start	1	SE
60	130	Re-start	1	SE
60	135	Trigger Storage	1	SE
60	136	Clear Waveform Records	1	SE
60	137	Clear Fault Records	1	SE
60	138	Clear Event Records	1	SE
60	140	Demand metering reset	1	SE
60	170	General Alarm 1	1	SE, GI,
60	171	General Alarm 2	1	SE, GI,
60	172	General Alarm 3	1	SE, GI,
60	173	General Alarm 4	1	SE, GI,
60	174	General Alarm 5	1	SE, GI,
60	175	General Alarm 6	1	SE, GI,
60	176	General Alarm 7	1	SE, GI,
60	177	General Alarm 8	1	SE, GI,
60	178	General Alarm 9	1	SE, GI,
60	179	General Alarm 10	1	SE, GI,
60	180	General Alarm 11	1	SE, GI,
60	181	General Alarm 12	1	SE, GI,
60	182	Quick Logic E1	1	SE, GI,
60	183	Quick Logic E2	1	SE, GI,
60	184	Quick Logic E3	1	SE, GI,
60	185	Quick Logic E4	1	SE, GI,
60	186	Quick Logic E5	1	SE, GI,
60	187	Quick Logic E6	1	SE, GI,
60	188	Quick Logic E7	1	SE, GI,
60	189	Quick Logic E8	1	SE, GI,
60	190	Quick Logic E9	1	SE, GI,
60	191	Quick Logic E10	1	SE, GI,
60	192	Quick Logic E11	1	SE, GI,
60	193	Quick Logic E12	1	SE, GI,
60	194	Quick Logic E13	1	SE, GI,
60	195	Quick Logic E14	1	SE, GI,
60	196	Quick Logic E15	1	SE, GI,

Function	Information Number	Description	Function Type	Cause of Transmission
60	197	Quick Logic E16	1	SE, GI,
70	5	Binary Input 5	1	SE, GI,
70	6	Binary Input 6	1	SE, GI,
70	7	Binary Input 7	1	SE, GI,
70	8	Binary Input 8	1	SE, GI,
70	9	Binary Input 9	1	SE, GI,
70	10	Binary Input 10	1	SE, GI,
70	11	Binary Input 11	1	SE, GI,
70	12	Binary Input 12	1	SE, GI,
70	13	Binary Input 13	1	SE, GI,
70	14	Binary Input 14	1	SE, GI,
70	15	Binary Input 15	1	SE, GI,
70	16	Binary Input 16	1	SE, GI,
70	17	Binary Input 17	1	SE, GI,
70	18	Binary Input 18	1	SE, GI,
70	19	Binary Input 19	1	SE, GI,
80	1	Binary Output 1	1	SE, GI,
			20	Ack, Nak
80	2	Binary Output 2	1	SE, GI,
			20	Ack, Nak
80	3	Binary Output 3	1	SE, GI,
			20	Ack, Nak
80	4	Binary Output 4	1	SE, GI,
			20	Ack, Nak
80	5	Binary Output 5	1	SE, GI,
			20	Ack, Nak
80	6	Binary Output 6	1	SE, GI,
			20	Ack, Nak
80	7	Binary Output 7	1	SE, GI,
			20	Ack, Nak
80	8	Binary Output 8	1	SE, GI,
			20	Ack, Nak
80	9	Binary Output 9	1	SE, GI,
			20	Ack, Nak
80	10	Binary Output 10	1	SE, GI,
			20	Ack, Nak
80	11	Binary Output 11	1	SE, GI,
			20	Ack, Nak
80	12	Binary Output 12	1	SE, GI,
			20	Ack, Nak
80	13	Binary Output 13	1	SE, GI,
			20	Ack, Nak
80	14	Binary Output 14	1	SE, GI,
			20	Ack, Nak
176	0	Data lost	5	Data lost
176	2	Reset FCB	5	Reset FCB
176	3	Reset CU	5	Reset CU
176	4	Start/Restart	5	Start/Restart
176	5	Power On	5	SE
176	19	LEDs reset (Reset Flag & Outputs)	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
176	22	Settings changed	1	SE
176	23	Settings Group 1 Select	1	SE, GI
			20	Ack, Nak
176	24	Settings Group 2 Select	1	SE, GI
			20	Ack, Nak
176	25	Settings Group 3 Select	1	SE, GI
			20	Ack, Nak
176	26	Settings Group 4 Select	1	SE, GI
			20	Ack, Nak
176	27	Binary Input 1	1	SE, GI
176	28	Binary Input 2	1	SE, GI
176	29	Binary Input 3	1	SE, GI
176	30	Binary Input 4	1	SE, GI
176	36	Trip circuit fail	1	SE, GI
176	64	Starter/Pick Up L1	1	SE, GI
176	65	Starter/Pick Up L2	1	SE, GI
176	66	Starter/Pick Up L3	1	SE, GI
176	67	Starter/Pick Up N	1	SE, GI
176	68	General Trip	2	SE
176	69	Trip L1	2	SE
176	70	Trip L2	2	SE
176	71	Trip L3	2	SE
176	84	General Starter/Pick Up	1	SE, GI
176	85	Circuit breaker fail	2	SE
176	90	Trip I>	2	SE
176	91	Trip I>>	2	SE
176	92	Trip In>	2	SE
176	93	Trip In>>	2	SE
177	8	87BD	2	SE, GI
177	9	87HS	2	SE, GI
177	10	51-1	2	SE, GI
177	11	50-1	2	SE, GI
177	12	51N-1	2	SE, GI
177	13	50N-1	2	SE, GI
177	14	51G-1	2	SE, GI
177	15	50G-1	2	SE, GI
177	16	51-2	2	SE, GI
177	17	50-2	2	SE, GI
177	18	51N-2	2	SE, GI
177	19	50N-2	2	SE, GI
177	20	51G-2	2	SE, GI
177	21	50G-2	2	SE, GI
177	26	51G-3	2	SE, GI
177	32	51G-4	2	SE, GI
177	34	50BF-1-1	2	SE, GI
177	35	50BF-1-2	2	SE, GI
177	36	50BF-2-1	2	SE, GI
177	37	50BF-2-2	2	SE, GI
177	38	Thermal Alarm	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
177	39	Thermal Trip	2	SE, GI
177	41	46IT-1	2	SE, GI
177	42	46DT-1	2	SE, GI
177	43	46IT-2	2	SE, GI
177	44	46DT-2	2	SE, GI
177	45	64H-1	2	SE, GI
177	46	64H-2	2	SE, GI
177	48	37-1	2	SE, GI
177	48	37-2	2	SE, GI
177	52	27/59-1	2	SE, GI
177	53	27/59-2	2	SE, GI
177	54	27/59-3	2	SE, GI
177	55	27/59-4	2	SE, GI
177	56	59NIT	2	SE, GI
177	57	59NDT	2	SE, GI
177	58	81-1	2	SE, GI
177	59	81-2	2	SE, GI
177	60	81-3	2	SE, GI
177	61	81-4	2	SE, GI
177	62	81-5	2	SE, GI
177	63	81-6	2	SE, GI
177	64	24DT-1	2	SE, GI
177	65	24DT-2	2	SE, GI
177	66	24IT	2	SE, GI
177	67	Trip Circuit Fail 1	2	SE, GI
177	68	Trip Circuit Fail 2	2	SE, GI
177	69	Trip Circuit Fail 3	2	SE, GI
177	70	Trip Circuit Fail 4	2	SE, GI
177	71	Trip Circuit Fail 5	2	SE, GI
177	72	Trip Circuit Fail 6	2	SE, GI
177	77	Settings Group 5 Selected	1	SE, GI
			20	Ack, Nak
177	78	Settings Group 6 Selected	1	SE, GI
			20	Ack, Nak
177	79	Settings Group 7 Selected	1	SE, GI
			20	Ack, Nak
177	80	Settings Group 8 Selected	1	SE, GI
			20	Ack, Nak
177	83	CB 1 Total Trip Count	1	SE, GI
177	84	CB 1 Delta Trip Count	1	SE, GI
177	86	Reset CB 1 Total Trip Count	1	SE, GI
			20	Ack, Nak
177	87	Reset CB 1 Delta Trip Count	1	SE, GI
			20	Ack, Nak
177	89	I^2t CB 1 Wear	1	SE, GI
177	90	Reset I^2t CB 1 Wear	1	SE, GI
			20	Ack, Nak
177	91	I^2t CB 2 Wear	1	SE, GI
177	92	Reset I^2t CB 2 Wear	1	SE, GI
			20	Ack, Nak

Function	Information Number	Description	Function Type	Cause of Transmission
177	93	CB 2 Total Trip Count	1	SE, GI
177	94	CB 2 Delta Trip Count	1	SE, GI
177	96	Reset CB 2 Total Trip Count	1	SE, GI
			20	Ack, Nak
177	97	Reset CB 2 Delta Trip Count	1	SE, GI
			20	Ack, Nak
177	99	81HBL2	2	SE, GI
177	100	81HBL5	2	SE, GI
177	101	CB 1 Total Trip Count	2	SE, GI
177	102	CB 1 Delta Trip Count	2	SE, GI
177	103	37G-1	2	SE, GI
177	104	37G-2	2	SE, GI
177	105	Close CB1	2	SE, GI
177	106	CB1 Fail To Close	2	SE, GI
177	107	CB1 DBI	2	SE, GI
177	108	Open CB1	2	SE, GI
177	109	CB1 Fail To Open	2	SE, GI
177	110	Close CB2	2	SE, GI
177	111	CB2 Fail To Close	2	SE, GI
177	112	CB2 DBI	2	SE, GI
177	113	Open CB2	2	SE, GI
177	114	CB2 Fail To Open	2	SE, GI
177	115	Close Circuit Fail 1	2	SE, GI
177	116	Close Circuit Fail 2	2	SE, GI
177	117	Close Circuit Fail 3	2	SE, GI
177	118	Close Circuit Fail 4	2	SE, GI
177	119	Close Circuit Fail 5	2	SE, GI
177	120	Close Circuit Fail 6	2	SE, GI
177	125	CB1 Trip Time Alarm	2	SE, GI
177	126	CB2 Trip Time Alarm	2	SE, GI
177	127	E/F Out	2	SE, GI
177	128	CB 2 Total Trip Count	2	SE, GI
177	129	CB 2 Delta Trip Count	2	SE, GI
200	1	CB1	1	SE, GI
			20	Ack, Nak
200	2	CB2	1	SE, GI
			20	Ack, Nak
200	255	Blocked by Interlocking	1	
255	0	GI Initiation	7	End of GI
255	0	GI End	8	End of GI
255	0	Time Synchronisation	6	Time Synchronisation

Measurand

Function	Information Number	Description	Function Type	Cause of Transmission
178	230	W1 $I_{L1,2,3}$ I_{L1} (2.4 x) I_{L2} (2.4 x) I_{L3} (2.4 x)	9	Cyclic – Refresh rate 5 seconds or value change greater than 1%.
178	231	W2 $I_{L1,2,3}$ I_{L1} (2.4 x) I_{L2} (2.4 x) I_{L3} (2.4 x)	9	Cyclic – Refresh rate 5 seconds or value change greater than 1%.
178	220	V,f V (1.2 x) f (1.2 x)	9	Cyclic – Refresh rate 5 seconds or value change greater than 1%.

Disturbance Recorder Actual Channel (ACC) Numbers

Function	ACC Number	Description
183	0	Global
183	1	W1 Ia
183	2	W1 Ib
183	3	W1 Ic
183	4	IG1
183	5	W2 Ia
183	6	W2 Ib
183	7	W2 Ic
183	8	IG2
183	9	Vx

Section 4: Modbus Definitions

4.1 Introduction

This section describes the MODBUS-RTU protocol implementation in the relays. This protocol is used for communication with a suitable control system.

This protocol can be set to use the Fibre Optic and RS485 ports. The relay can communicate simultaneously on all ports regardless of protocol used.

Each relay must be given an address to enable communication and can be set by the *Communication Interface:**Relay Address***. Valid settings are within the range **1 – 247**, a relay with the default address of **0** will not be able to communicate.

Definitions with shaded area are not available on all relay models.

Coils (Read Write Binary values)

Address	Description
00001	Binary Output 1
00002	Binary Output 2
00003	Binary Output 3
00004	Binary Output 4
00005	Binary Output 5
00006	Binary Output 6
00007	Binary Output 7
00008	Binary Output 8
00009	Binary Output 9
00010	Binary Output 10
00011	Binary Output 11
00012	Binary Output 12
00013	Binary Output 13
00014	Binary Output 14
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8
00109	CB1
00110	CB2
00111	Reset CB1 Total Trip Count, write only location.
00112	Reset CB1 Delta Trip Count, write only location.
00113	Reset CB1 Lockout Trip Count, write only location.
00114	Reset I^2t CB1 Wear, write only location.
00115	Reset I^2t CB2 Wear, write only location.
00116	Reset CB2 Total Trip Count, write only location.
00117	Reset CB2 Delta Trip Count, write only location.
00118	Reset CB2 Lockout Trip Count, write only location.
00119	Demand Metering Reset
00120	Local Mode
00121	Remote Mode
00122	Service Mode
00123	Local & Remote Mode
00124	E/F Out

Inputs (Read Only Binary values)

Address	Description
10001	Binary Input 1
10002	Binary Input 2
10003	Binary Input 3
10004	Binary Input 4
10005	Binary Input 5
10006	Binary Input 6
10007	Binary Input 7
10008	Binary Input 8
10009	Binary Input 9
10010	Binary Input 10
10011	Binary Input 11
10012	Binary Input 12
10013	Binary Input 13
10014	Binary Input 14
10015	Binary Input 15
10016	Binary Input 16
10017	Binary Input 17
10018	Binary Input 18
10019	Binary Input 19
10101	General Start/Pick-up
10102	General Trip
10103	Start/Pick-up L1
10104	Start/Pick-up L2
10105	Start/Pick-up L3
10106	Start/Pick-up N
10107	Trip/Operation L1
10108	Trip/Operation L2
10109	Trip/Operation L3
10110	Trip/Operation N
10111	Trip Circuit Fail
10120	LOCAL control allowed
10121	REMOTE control allowed
10122	SERVICE mode/non-operational
10123	Local & Remote
10124	Front Port OverRide
10130	Trip Cct Fail 1
10131	Trip Cct Fail 2
10132	Trip Cct Fail 3
10133	Trip Cct Fail 4
10134	Trip Cct Fail 5
10135	Trip Cct Fail 6
10200	87 Operated A
10201	87 Operated B
10202	87 Operated C
10203	87 Harmonic Detector A
10204	87 Harmonic Detector B
10205	87 Harmonic Detector C
10206	87 Trip
10207	87HS Operated A
10208	87HS Operated B
10209	87HS Operated C
10210	87HS Trip
10220	64REF-1 Operated
10221	64REF-1 Starter
10223	64REF-2 Operated
10224	64REF-2 Starter
10230	51G-1 Starter
10231	51G-1 Operated
10233	51G-2 Starter
10234	51G-2 Operated
10242	UVGuardBlock
10243	27/59-1 Operated

10244	27/59-1 Starter
10246	27/59-2 Operated
10247	27/59-2 Starter
10249	27/59-3 Operated
10250	27/59-3 Starter
10252	27/59-4 Operated
10253	27/59-4 Starter
10260	81-1 Operated
10261	81-1 Starter
10263	81-2 Operated
10264	81-2 Starter
10266	81-3 Operated
10267	81-3 Starter
10269	81-4 Operated
10270	81-4 Starter
10272	81-5 Operated
10273	81-5 Starter
10275	81-6 Operated
10276	81-6 Starter
10280	24DT-1 Operated
10281	24DT-1 Starter
10283	24DT-2 Operated
10284	24DT-2 Starter
10286	24IT Starter
10287	24IT Operated
10290	49 Trip
10291	49 Alarm
10310	50G-1 Operated
10311	50G-1 Starter
10320	50G-2 Operated
10321	50G-2 Starter
10333	51G-3 Starter
10334	51G-3 Operated
10336	51G-4 Starter
10337	51G-4 Operated
12100	51-1 Starter A
12101	51-1 Starter B
12102	51-1 Starter C
12103	51-1 Operated A
12104	51-1 Operated B
12105	51-1 Operated C
12107	50-1 Starter A
12108	50-1 Starter B
12109	50-1 Starter C
12110	50-1 Operated A
12111	50-1 Operated B
12112	50-1 Operated C
12114	51N-1 Starter
12115	51N-1 Operated
12117	50N-1 Starter
12118	50N-1 Operated
12120	51-1
12121	50-1
12200	51-2 Starter A
12201	51-2 Starter B
12202	51-2 Starter C
12203	51-2 Operated A
12204	51-2 Operated B
12205	51-2 Operated C
12207	50-2 Starter A
12208	50-2 Starter B
12209	50-2 Starter C
12210	50-2 Operated A
12211	50-2 Operated B

12212	50-2 Operated C
12214	51N-2 Starter
12215	51N-2 Operated
12217	50N-2 Starter
12218	50N-2 Operated
12220	51-1
12221	50-1
12400	50BF-1 ReTrip
12401	50BF-1 BackTrip
12402	50BF-2 ReTrip
12403	50BF-2 BackTrip
12405	59NIT Starter
12406	59NDT Starter
12407	59NIT Operated
12408	59NDT Operated
12410	46IT-1 Starter
12411	46IT-2 Starter
12412	46IT-1 Operated
12413	46IT-2 Operated
12414	46DT-1 Operated
12415	46DT-2 Operated
12416	37-1 Starter
12417	37-2 Starter
12418	37-1 Operated
12419	37-2 Operated
12500	General Alarm 1
12501	General Alarm 2
12502	General Alarm 3
12503	General Alarm 4
12504	General Alarm 5
12505	General Alarm 6
12506	General Alarm 7
12507	General Alarm 8
12508	General Alarm 9
12509	General Alarm 10
12510	General Alarm 11
12511	General Alarm 12
12512	Quick Logic E1
12513	Quick Logic E2
12514	Quick Logic E3
12515	Quick Logic E4
12516	Quick Logic E5
12517	Quick Logic E6
12518	Quick Logic E7
12519	Quick Logic E8
12520	Quick Logic E9
12521	Quick Logic E10
12522	Quick Logic E11
12523	Quick Logic E12
12524	Quick Logic E13
12525	Quick Logic E14
12526	Quick Logic E15
12527	Quick Logic E16
12544	Close Circuit Fail 1
12545	Close Circuit Fail 2
12546	Close Circuit Fail 3
12547	Close Circuit Fail 4
12548	Close Circuit Fail 5
12549	Close Circuit Fail 6
12560	46BC-1
12561	46BC-2
12562	CB1 Total Trip Count
12563	CB1 Delta Trip Count
12564	CB1 Lockout Trip Count

12565	I^2t CB1 Wear
12566	I^2t CB2 Wear
12567	CB2 Total Trip Count
12568	CB2 Delta Trip Count
12569	CB2 Lockout Trip Count
12570	81HBL2
12571	81HBL5
12572	37G-1
12573	37G-2
12574	Close CB1
12575	CB1 Fail To Close
12576	CB1 DBI Alarm
12577	Open CB1
12578	CB1 Fail To Open
12579	Close CB2
12580	CB2 Fail To Close
12581	CB2 DBI Alarm
12582	Open CB2
12583	CB2 Fail To Open
12584	CB1 Trip Time Alarm
12585	CB2 Trip Time Alarm

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Event Record	8 Registers[3]	
30010	Number of Fault Records	UINT16	
30012	Number of Event Records	UINT16	
30014	Number of Waveform Records	UINT16	
30016	Number of CPU resets	UINT16	
30018	Number of CPU warmstarts	UINT16	
30100	Operate Ia	FP_32BITS_3DP[1]	Ia x Inom
30102	Operate Ib	FP_32BITS_3DP[1]	
30104	Operate Ic	FP_32BITS_3DP[1]	
30106	Restrain Ia	FP_32BITS_3DP[1]	
30108	Restrain Ib	FP_32BITS_3DP[1]	
30110	Restrain Ic	FP_32BITS_3DP[1]	
30112	W1 2nd Harmonic Ia	FP_32BITS_3DP[1]	
30114	W1 2nd Harmonic Ib	FP_32BITS_3DP[1]	
30116	W1 2nd Harmonic Ic	FP_32BITS_3DP[1]	
30118	W2 2nd Harmonic Ia	FP_32BITS_3DP[1]	
30120	W2 2nd Harmonic Ib	FP_32BITS_3DP[1]	
30122	W2 2nd Harmonic Ic	FP_32BITS_3DP[1]	
30200	Primary Ig-1	FP_32BITS_3DP[1]	Ig kA
30202	Secondary Ig-1	FP_32BITS_3DP[1]	Ig A
30204	Nominal Ig-1	FP_32BITS_3DP[1]	Ig x Inom
30206	Primary Ig-2	FP_32BITS_3DP[1]	Ig kA
30208	Seondary Ig-2	FP_32BITS_3DP[1]	Ig A
30210	Nominal Ig-2	FP_32BITS_3DP[1]	Ig x Inom
30400	Primary Voltage kV	FP_32BITS_3DP[1]	kV
30402	Secondary Voltage V	FP_32BITS_3DP[1]	V
30404	Nominal Voltage xVn	FP_32BITS_3DP[1]	X Vnom
30406	Frequency Hz	FP_32BITS_3DP[1]	
30500	V/f Voltage xVn	FP_32BITS_3DP[1]	
30502	V/f Value xVn/fn	FP_32BITS_3DP[1]	
30504	V/f IDMTL Status %	FP_32BITS_3DP[1]	
30602	Thermal Status Ph A	FP_32BITS_3DP[1]	%
30603	Thermal Status Ph B	FP_32BITS_3DP[1]	%
30604	Thermal Status Ph C	FP_32BITS_3DP[1]	%
31100	W1 Primary Ia	FP_32BITS_3DP[1]	kA
31102	W1 Primary Ib	FP_32BITS_3DP[1]	kA
31104	W1 Primary Ic	FP_32BITS_3DP[1]	kA
31106	W1 Secondary Ia	FP_32BITS_3DP[1]	A
31108	W1 Secondary Ib	FP_32BITS_3DP[1]	A
31110	W1 Secondary Ic	FP_32BITS_3DP[1]	A
31112	W1 Nominal Ia	FP_32BITS_3DP[1]	x Inom
31114	W1 Nominal Ib	FP_32BITS_3DP[1]	x Inom
31116	W1 Nominal Ic	FP_32BITS_3DP[1]	x Inom
31118	W1 Line Ia	FP_32BITS_3DP[1]	kA
31120	W1 Line Ib	FP_32BITS_3DP[1]	kA
31122	W1 Line Ic	FP_32BITS_3DP[1]	kA
31124	W1 Relay Ia	FP_32BITS_3DP[1]	x Inom
31126	W1 Relay Ib	FP_32BITS_3DP[1]	x Inom
31128	W1 Relay Ic	FP_32BITS_3DP[1]	x Inom
31200	W2 Primary Ia	FP_32BITS_3DP[1]	kA
31202	W2 Primary Ib	FP_32BITS_3DP[1]	kA
31204	W2 Primary Ic	FP_32BITS_3DP[1]	kA
31206	W2 Secondary Ia	FP_32BITS_3DP[1]	A

Address	Name	Format	Description
31208	W2 Secondary Ib	FP_32BITS_3DP[1]	A
31210	W2 Secondary Ic	FP_32BITS_3DP[1]	A
31212	W2 Nominal Ia	FP_32BITS_3DP[1]	x Inom
31214	W2 Nominal Ib	FP_32BITS_3DP[1]	x Inom
31216	W2 Nominal Ic	FP_32BITS_3DP[1]	x Inom
31218	W2 Line Ia	FP_32BITS_3DP[1]	kA
31220	W2 Line Ib	FP_32BITS_3DP[1]	kA
31222	W2 Line Ic	FP_32BITS_3DP[1]	kA
31224	W2 Relay Ia	FP_32BITS_3DP[1]	x Inom
31226	W2 Relay Ib	FP_32BITS_3DP[1]	x Inom
31228	W2 Relay Ic	FP_32BITS_3DP[1]	x Inom
32400	W1 I Phase A Max	FP_32BITS_3DP	Max Current W1 Ia
32402	W1 I Phase B Max	FP_32BITS_3DP	Max Current W1 Ib
32404	W1 I Phase C Max	FP_32BITS_3DP	Max Current W1 Ic
32406	W2 I Phase A Max	FP_32BITS_3DP	Max Current W2 Ia
32408	W2 I Phase B Max	FP_32BITS_3DP	Max Current W2 Ib
32410	W2 I Phase C Max	FP_32BITS_3DP	Max Current W2 Ic

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

3) Sequence of 8 registers containing an event record. Read address 30002 for 8 registers (16 bytes), each read returns the earliest event record and removes it from the internal store. Repeat this process for the number of events in the register 30001, or until no more events are returned. (the error condition exception code 2)

Holding Registers (Read Write values)

Address	Description
40001	Time Meter

Event Format

The format of the event record is defined by the zero byte. It signifies the type of record which is used to decode the event information. The zero byte can be one of the following.

Type	Description
1	Event
2	Event with Relative Time
4	Measurand Event with Relative Time

Section 5: DNP3.0 Definitions

5.1 Device Profile

The following table provides a "Device Profile Document" in the standard format defined in the DNP 3.0 Subset Definitions Document. While it is referred to in the DNP 3.0 Subset Definitions as a "Document," it is in fact a table, and only a component of a total interoperability guide. The table, in combination with the Implementation Table provided in Section 5.2 (beginning on page 29), and the Point List Tables provided in Section 5.3 (beginning on page 34), should provide a complete configuration/interoperability guide for communicating with a device implementing the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library.

<table>
<tr><td colspan="2">DNP V3.0
DEVICE PROFILE DOCUMENT
(Also see the DNP 3.0 Implementation Table in Section 5.2, beginning on page 29.)</td></tr>
<tr><td colspan="2">Vendor Name: Siemens Protection Devices Ltd.</td></tr>
<tr><td colspan="2">Device Name: 7SR242, using the Triangle MicroWorks, Inc. DNP3 Slave Source Code Library, Version 3.</td></tr>
<tr><td>Highest DNP Level Supported:

For Requests: Level 3
For Responses: Level 3</td><td>Device Function:

☐ Master
☒ Slave</td></tr>
<tr><td colspan="2">Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

For static (non-change-event) object requests, request qualifier codes 07 and 08 (limited quantity), and 17 and 28 (index) are supported. Static object requests sent with qualifiers 07, or 08, will be responded with qualifiers 00 or 01.

Output Event Object 11 is supported.</td></tr>
<tr><td>Maximum Data Link Frame Size (octets):

Transmitted: 256
Received 256</td><td>Maximum Application Fragment Size (octets):

Transmitted: 2048
Received 2048</td></tr>
<tr><td>Maximum Data Link Re-tries:

☐ None
☒ Fixed (3)
☐ Configurable from 0 to 65535</td><td>Maximum Application Layer Re-tries:

☒ None
☐ Configurable</td></tr>
<tr><td colspan="2">Requires Data Link Layer Confirmation:

☒ Never
☐ Always
☐ Sometimes
☐ Configurable as: Never, Only for multi-frame messages, or Always</td></tr>
<tr><td colspan="2">Requires Application Layer Confirmation:

☐ Never
☐ Always
☒ When reporting Event Data (Slave devices only)
☒ When sending multi-fragment responses (Slave devices only)
☐ Sometimes
☐ Configurable as: "Only when reporting event data", or "When reporting event data or multi-fragment messages."</td></tr>
</table>

DNP V3.0
DEVICE PROFILE DOCUMENT
(Also see the DNP 3.0 Implementation Table in Section 5.2, beginning on page 29.)

Timeouts while waiting for:

Data Link Confirm:	☐ None	☒ **Fixed - 2sec**	□ Variable	□ Configurable.
Complete Appl. Fragment:	☒ **None**	□ Fixed at ____	□ Variable	□ Configurable
Application Confirm:	□ None	☒ **Fixed - 10sec**	□ Variable	□ Configurable.
Complete Appl. Response:	☒ **None**	□ Fixed at ____	□ Variable	□ Configurable

Others: **Transmission Delay, (0 sec)**
Select/Operate Arm Timeout, (5 sec)
Need Time Interval, (30 minutes)
Application File Timeout, (60 sec)
Unsolicited Notification Delay, (5 seconds)
Unsolicited Response Retry Delay, (between 3 – 9 seconds)
Unsolicited Offline Interval, (30 seconds)
Binary Change Event Scan Period, (Polled, Not Applicable)
Double Bit Change Event Scan Period, (Unsupported - Not Applicable)
Analog Change Event Scan Period, (Unsupported - Not Applicable)
Counter Change Event Scan Period, (Unsupported - Not Applicable)
Frozen Counter Change Event Scan Period, (Unsupported - Not Applicable)
String Change Event Scan Period, (Unsupported - Not Applicable)
Virtual Terminal Event Scan Period, (Unsupported - Not Applicable)

Sends/Executes Control Operations:

WRITE Binary Outputs	☒ **Never**	□ Always	□ Sometimes	□ Configurable
SELECT/OPERATE	□ Never	☒ **Always**	□ Sometimes	□ Configurable
DIRECT OPERATE	□ Never	☒ **Always**	□ Sometimes	□ Configurable
DIRECT OPERATE – NO ACK	□ Never	☒ **Always**	□ Sometimes	□ Configurable
Count > 1	☒ **Never**	□ Always	□ Sometimes	□ Configurable
Pulse On	□ Never	□ Always	☒ **Sometimes**	□ Configurable
Pulse Off	□ Never	□ Always	☒ **Sometimes**	□ Configurable
Latch On	□ Never	□ Always	☒ **Sometimes**	□ Configurable
Latch Off	□ Never	□ Always	☒ **Sometimes**	□ Configurable
Queue	☒ **Never**	□ Always	□ Sometimes	□ Configurable
Clear Queue	☒ **Never**	□ Always	□ Sometimes	□ Configurable

Attach explanation if 'Sometimes' or 'Configurable' was checked for any operation.

Reports Binary Input Change Events when no specific variation requested:

- □ Never
- □ Only time-tagged
- □ Only non-time-tagged
- ☒ **Configurable to send one or the other**

Reports time-tagged Binary Input Change Events when no specific variation requested:

- □ Never
- □ Binary Input Change With Time
- □ Binary Input Change With Relative Time
- ☒ **Configurable**

Sends Unsolicited Responses:

- □ Never
- ☒ **Configurable**
- □ Only certain objects
- □ Sometimes (attach explanation)
- ☒ **ENABLE/DISABLE UNSOLICITED Function codes supported**

Sends Static Data in Unsolicited Responses:

- ☒ **Never**
- □ When Device Restarts
- ☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:

- ☒ **No Counters Reported**
- □ Configurable
- □ Default Object
  Default Variation:
- □ Point-by-point list attached

Counters Roll Over at:

- ☒ **No Counters Reported**
- □ Configurable (attach explanation)
- □ 16 Bits
- □ 32 Bits
- □ Other Value: _____
- □ Point-by-point list attached

DNP V3.0
DEVICE PROFILE DOCUMENT
(Also see the DNP 3.0 Implementation Table in Section 5.2, beginning on page 29.)

Sends Multi-Fragment Responses:

- ☒ **Yes**
- ☐ No
- ☐ Configurable

Sequential File Transfer Support:

File Transfer Support	☐ Yes	☒ **No**
Append File Mode	☐ Yes	☒ **No**
Custom Status Code Strings	☐ Yes	☒ **No**
Permissions Field	☐ Yes	☒ **No**
File Events Assigned to Class	☐ Yes	☒ **No**
File Events Send Immediately	☐ Yes	☒ **No**
Multiple Blocks in a Fragment	☐ Yes	☒ **No**
Max Number of Files Open	**0**	

5.2 Implementation Table

The following table identifies which object variations, function codes, and qualifiers the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library supports in both request messages and in response messages. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

In the table below, text shaded as 00, 01 (start stop) indicates Subset Level 3 functionality (beyond Subset Level 2).

In the table below, text shaded as 07, 08 (limited qty) indicates functionality beyond Subset Level 3.

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input – Any Variation	1 (read) 22 (assign class)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)		
1	1 (default – see note 1)	Binary Input	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
1	2	Binary Input with Status	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
2	0	Binary Input Change – Any Variation	1 (read)	06(no range, or all) 07, 08(limited qty)		
2	1	Binary Input Change without Time	1 (read)	06(no range, or all) 07, 08(limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	2	Binary Input Change with Time	1 (read)	06(no range, or all) 07, 08(limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	3 (default – see note 1)	Binary Input Change with Relative Time	1 (read)	06(no range, or all) 07, 08(limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
10	0	Binary Output – Any Variation	1 (read) 22 (assign class)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)		

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
10	1	Binary Output	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 1)
			1 (write	00, 01(start-stop)		
10	2 (default – see note 1)	Binary Output Status	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
11	0	Binary Output Change – Any Variation	1 (read)	06(no range, or all) 07, 08(limited qty)		
11	1 (default – see note 1)	Binary Output Change without Time	1 (read)	06(no range, or all) 07, 08(limited qty)	129 (response) 130 (unsol. resp)	17, 28(index)
11	2	Binary Output Change with Time	1 (read)	06(no range, or all) 07, 08(limited qty)	129 (response) 130 (unsol. resp)	17, 28(index)
12	0	Control Relay Output Block	22 (assign class)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)		
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6(dir. op, noack)	17, 28 (index)	129 (response)	echo of request
12	2	Pattern Control Block	3 (select) 4 (operate) 5 (direct op) 6(dir. op, noack)	7(limited quantity)	129 (response)	echo of request
12	3	Pattern Mask	3 (select) 4 (operate) 5 (direct op) 6(dir. op, noack)	00, 01(start-stop)	129 (response)	echo of request

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
30	0	Analog Input - Any Variation	1 (read) 22(assign class)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)		
30	1	32-Bit Analog Input	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
30	2	16-Bit Analog Input	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
30	3 (default – see note 1)	32-Bit Analog Input without Flag	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
30	4	16-Bit Analog Input without Flag	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
30	5	short floating point	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 2)
30	6	long floating point	1 (read)	00, 01(start-stop) 06(no range, or all) 07, 08(limited qty) 17, 27, 28(index)	129 (response)	00, 01(start-st 17, 28(index – see note 1)
50	0	Time and Date				
50	1 (default – see note 1)	Time and Date	1 (read)	07, (limited qty = 1)	129 (response)	07 (limited qt
			2 (write)	07(limited qty = 1)		
50	3	Time and Date Last Recorded Time	2 (write)	07(limited qty)		
51	1	Time and Date CTO			129 (response) 130 (unsol. resp)	07(limited qty) (qty = 1)

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	**Variation Number**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
51	2	Unsynchronized Time and Date CTO			129 (response) 130 (unsol. resp)	07(limited qty) (qty = 1)
52	1	Time Delay Coarse			129 (response)	07(limited qty) (qty = 1)
52	2	Time Delay Fine			129 (response)	07(limited qty) (qty = 1)
60	0	Not Defined				
60	1	Class 0 Data	1 (read)	06(no range, or all)		
60	2	Class 1 Data	1 (read)	06(no range, or all) 07, 08(limited qty)		
			20(enbl. unsol.) 21(dab. unsol.) 22(assign class)	06(no range, or all)		
60	3	Class 2 Data	1 (read)	06(no range, or all) 07, 08(limited qty)		
			20(enbl. unsol.) 21(dab. unsol.) 22(assign class)	06(no range, or all)		
60	4	Class 3 Data	1 (read)	06(no range, or all) 07, 08(limited qty)		
			20(enbl. unsol.) 21(dab. unsol.) 22(assign class)	06(no range, or all)		
80	1	Internal Indications	1 (read)	00, 01(start-stop)	129(respons	00, 01 (start-stop)
			2 (write) (see note 3)	00 (start-stop) index=7		
		No Object (function code only)	13(cold restart)			
		No Object (function code only)	14(warm restart)			
		No Object (function code only)	23(delay meas.)			
		No Object (function code only)	24 (record current time)			

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Default variations are configurable; however, default settings for the configuration parameters are indicated in the table above.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Writes of Internal Indications are only supported for index 7 (Restart IIN1-7)

5.3 Point List

The tables below identify all the default data points provided by the implementation of the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library.

Binary Input Points

The default binary input event buffer size is set to allow 100 events.

Note, not all points listed here apply to all builds of devices.

Static Variation reported when variation 0 requested: **2 (Binary Input 2 with status)** Change Event Variation reported when variation 0 requested: **3 (Binary Input Change with Relative Time)**				
Point Index	Name/Description	Default Class	Default Variation Static Object 1	Default Variation Event Object 2
1	Binary Input 1	2	2	2
2	Binary Input 2	2	2	2
3	Binary Input 3	2	2	2
4	Binary Input 4	2	2	2
5	Binary Input 5	2	2	2
6	Binary Input 6	2	2	2
7	Binary Input 7	2	2	2
8	Binary Input 8	2	2	2
9	Binary Input 9	2	2	2
10	Binary Input 10	2	2	2
11	Binary Input 11	2	2	2
12	Binary Input 12	2	2	2
13	Binary Input 13	2	2	2
14	Binary Input 14	2	2	2
15	Binary Input 15	2	2	2
16	Binary Input 16	2	2	2
17	Binary Input 17	2	2	2
18	Binary Input 18	2	2	2
19	Binary Input 19	2	2	2
20	*Binary Input 20*	*2*	*2*	*2*
21	*Binary Input 21*	*2*	*2*	*2*
22	*Binary Input 22*	*2*	*2*	*2*
23	*Binary Input 23*	*2*	*2*	*2*
24	*Binary Input 24*	*2*	*2*	*2*
25	*Binary Input 25*	*2*	*2*	*2*
26	*Binary Input 26*	*2*	*2*	*2*
27	*Binary Input 27*	*2*	*2*	*2*
28	*Binary Input 28*	*2*	*2*	*2*
29	*Binary Input 29*	*2*	*2*	*2*
30	*Binary Input 30*	*2*	*2*	*2*
31	*Binary Input 31*	*2*	*2*	*2*
32	*Binary Input 32*	*2*	*2*	*2*
34	Front port override	2	2	2
35	Remote mode	2	2	2
36	Service mode	2	2	2
37	Local mode	2	2	2
38	Local & Remote	2	2	2
41	Trip Circuit Fail	2	2	2
42	A-Starter	2	2	2
43	B-Starter	2	2	2

Static Variation reported when variation 0 requested: **2 (Binary Input 2 with status)** Change Event Variation reported when variation 0 requested: **3 (Binary Input Change with Relative Time)**				
Point Index	Name/Description	Default Class	Default Variation Static Object 1	Default Variation Event Object 2
44	C-Starter	2	2	2
45	General Starter	2	2	2
49	Start/Pick-up N	2	2	2
52	87BD	2	2	2
53	87HS	2	2	2
54	51-1	2	2	2
55	50-1	2	2	2
56	51N-1	2	2	2
57	50N-1	2	2	2
58	51G-1	2	2	2
59	50G-1	2	2	2
60	51-2	2	2	2
61	50-2	2	2	2
62	51N-2	2	2	2
63	50N-2	2	2	2
64	51G-2	2	2	2
65	50G-2	2	2	2
66	51-3	2	2	2
67	50-3	2	2	2
68	51N-3	2	2	2
69	50N-3	2	2	2
70	51G-3	2	2	2
71	50G-3	2	2	2
72	51-4	2	2	2
73	50-4	2	2	2
74	51N-4	2	2	2
75	50N-4	2	2	2
76	51G-4	2	2	2
77	50G-4	2	2	2
78	50BF-1-1	2	2	2
79	50BF-1-2	2	2	2
80	50BF-2-1	2	2	2
81	50BF-2-2	2	2	2
82	49-Alarm	2	2	2
83	49-Trip	2	2	2
85	46IT-1	2	2	2
86	46DT-1	2	2	2
87	46IT-2	2	2	2
88	46DT-2	2	2	2
89	64H-1	2	2	2
90	64H-2	2	2	2
91	64H-3	2	2	2
92	37-1	2	2	2
93	37-2	2	2	2
94	46BC-1	2	2	2
95	46BC-2	2	2	2
96	27/59-1	2	2	2
97	27/59-2	2	2	2

Static Variation reported when variation 0 requested: **2 (Binary Input 2 with status)** Change Event Variation reported when variation 0 requested: **3 (Binary Input Change with Relative Time)**				
Point Index	Name/Description	Default Class	Default Variation Static Object 1	Default Variation Event Object 2
98	27/59-3	2	2	2
99	27/59-4	2	2	2
100	59NIT	2	2	2
101	59NDT	2	2	2
102	81-1	2	2	2
103	81-2	2	2	2
104	81-3	2	2	2
105	81-4	2	2	2
106	81-5	2	2	2
107	81-6	2	2	2
108	24DT-1	2	2	2
109	24DT-2	2	2	2
110	24IT	2	2	2
111	Trip Circuit Fail 1	2	2	2
112	Trip Circuit Fail 2	2	2	2
113	Trip Circuit Fail 3	2	2	2
114	Trip Circuit Fail 4	2	2	2
115	Trip Circuit Fail 5	2	2	2
116	Trip Circuit Fail 6	2	2	2
117	Trip Circuit Fail 7	2	2	2
118	Trip Circuit Fail 8	2	2	2
119	Trip Circuit Fail 9	2	2	2
120	Trip Circuit Fail 10	2	2	2
121	CB1 Total Trip Count	2	2	2
122	CB1 Delta Trip Count	2	2	2
123	CB1 Lockout trip Count	2	2	2
124	I^2t CB1 Wear	2	2	2
125	I^2t CB2 Wear	2	2	2
126	CB2 Total Trip Count	2	2	2
127	CB2 Delta Trip Count	2	2	2
128	CB2 Lockout trip Count	2	2	2
129	General Alarm 1	2	2	2
130	General Alarm 2	2	2	2
131	General Alarm 3	2	2	2
132	General Alarm 4	2	2	2
133	General Alarm 5	2	2	2
134	General Alarm 6	2	2	2
135	General Alarm 7	2	2	2
136	General Alarm 8	2	2	2
137	General Alarm 9	2	2	2
138	General Alarm 10	2	2	2
139	General Alarm 11	2	2	2
140	General Alarm 12	2	2	2
141	Quick Logic E1	2	2	2
142	Quick Logic E2	2	2	2
143	Quick Logic E3	2	2	2
144	Quick Logic E4	2	2	2
145	Quick Logic E5	2	2	2
146	Quick Logic E6	2	2	2
147	Quick Logic E7	2	2	2
148	Quick Logic E8	2	2	2

Static Variation reported when variation 0 requested: **2 (Binary Input 2 with status)** Change Event Variation reported when variation 0 requested: **3 (Binary Input Change with Relative Time)**				
Point Index	Name/Description	Default Class	Default Variation Static Object 1	Default Variation Event Object 2
149	Quick Logic E9	2	2	2
150	Quick Logic E10	2	2	2
151	Quick Logic E11	2	2	2
152	Quick Logic E12	2	2	2
153	Quick Logic E13	2	2	2
154	Quick Logic E14	2	2	2
155	Quick Logic E15	2	2	2
156	Quick Logic E16	2	2	2
191	81HBL2	2	2	2
192	81HBL5	2	2	2
193	37G-1	2	2	2
194	37G-2	2	2	2
195	Close Circuit Fail 1	2	2	2
196	Close Circuit Fail 2	2	2	2
197	Close Circuit Fail 3	2	2	2
198	Close Circuit Fail 4	2	2	2
199	Close Circuit Fail 5	2	2	2
200	Close Circuit Fail 6	2	2	2
201	Close Circuit Fail 7	2	2	2
202	Close Circuit Fail 8	2	2	2
203	Close Circuit Fail 9	2	2	2
204	Close Circuit Fail 10	2	2	2
205	CB1 Trip Time Alarm	2	2	2
206	CB2 Trip Time Alarm	2	2	2
207	Close CB1	2	2	2
208	CB1 Fail To Close	2	2	2
209	CB1 DBI	2	2	2
210	Open CB1	2	2	2
211	CB1 Fail To Open	2	2	2
212	Close CB2	2	2	2
213	CB2 Fail To Close	2	2	2
214	CB2 DBI	2	2	2
215	Open CB2	2	2	2
216	CB2 Fail To Open	2	2	2
217	E/F Out	2	2	2

Binary Output Status Points and Control Relay Output Blocks

The following table lists both the Binary Output Status Points (Object 10) and the Control Relay Output Blocks (Object 12).

While Binary Output Status Points are included here for completeness, they are not often polled by DNP 3.0 Masters. It is recommended that Binary Output Status points represent the most recent DNP "commanded" value for the corresponding Control Relay Output Block (CROB) point. Because many, if not most, Control Relay Output Block points are controlled through pulse mechanisms, the value of the output status may in fact be meaningless. Binary Output Status points are not recommended to be included in class 0 polls.

As an alternative, it is recommended that "actual" status values of Control Relay Output Block points be looped around and mapped as Binary Inputs. (The "actual" status value, as opposed to the "commanded" status value, is the value of the actuated control. For example, a DNP control command may be blocked through hardware or software mechanisms; in this case, the actual status value would indicate the control failed because of the blocking. Looping Control Relay Output Block actual status values as Binary Inputs has several advantages:

- it allows actual statuses to be included in class 0 polls,
- it allows change event reporting of the actual statuses, which is a more efficient and time-accurate method of communicating control values,
- and it allows reporting of time-based information associated with controls, including any delays before controls are actuated, and any durations if the controls are pulsed.

The default select/control buffer size is large enough to hold 10 of the largest select requests possible.

Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**

Point Index	Name/ Description	Default Class	Default Static Object 10 Variation	Default Event Object 11 Variation	Supported CROB Fields	Default CROB Fields
1	Binary Output 1	1	2	2	Pulse On Latch On	Pulse On
2	Binary Output 2	1	2	2	Pulse On Latch On	Pulse On
3	Binary Output 3	1	2	2	Pulse On Latch On	Pulse On
4	Binary Output 4	1	2	2	Pulse On Latch On	Pulse On
5	Binary Output 5	1	2	2	Pulse On Latch On	Pulse On
6	Binary Output 6	1	2	2	Pulse On Latch On	Pulse On
7	Binary Output 7	1	2	2	Pulse On Latch On	Pulse On
8	Binary Output 8	1	2	2	Pulse On Latch On	Pulse On
9	Binary Output 9	1	2	2	Pulse On Latch On	Pulse On
10	Binary Output 10	1	2	2	Pulse On Latch On	Pulse On
11	Binary Output 11	1	2	2	Pulse On Latch On	Pulse On
12	Binary Output 12	1	2	2	Pulse On Latch On	Pulse On
13	Binary Output 13	1	2	2	Pulse On Latch On	Pulse On
14	Binary Output 14	1	2	2	Pulse On Latch On	Pulse On
33	LED reset	1	2	2	Pulse On Latch On	Pulse On
34	Settings Group 1	1	2	2	Pulse On Latch On	Latch On
35	Settings Group 2	1	2	2	Pulse On Latch On	Latch On

Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**

Point Index	Name/ Description	Default Class	Default Static Object 10 Variation	Default Event Object 11 Variation	Supported CROB Fields	Default CROB Fields
36	Settings Group 3	1	2	2	Pulse On Latch On	Latch On
37	Settings Group 4	1	2	2	Pulse On Latch On	Latch On
38	Settings Group 5	1	2	2	Pulse On Latch On	Latch On
39	Settings Group 6	1	2	2	Pulse On Latch On	Latch On
40	Settings Group 7	1	2	2	Pulse On Latch On	Latch On
41	Settings Group 8	1	2	2	Pulse On Latch On	Latch On
42	CB 1	1	2	2	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
43	CB 2	1	2	2	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
44	Demand metering reset, write only location.	1	2	2	Pulse On Latch On	Pulse On
45	Reset CB1 Total Trip Count, write only location.	1	2	2	Pulse On Latch On	Pulse On
46	Reset CB1 Delta Trip Count, write only location.	1	2	2	Pulse On Latch On	Pulse On
47	Reset CB1 Lockout Trip Count, write only location.	1	2	2	Pulse On Latch On	Pulse On
48	Reset I^2t CB1 Wear	1	2	2	Pulse On Latch On	Pulse On
49	Reset I^2t CB2 Wear	1	2	2	Pulse On Latch On	Pulse On
50	Reset CB2 Total Trip Count, write only location.	1	2	2	Pulse On Latch On	Pulse On
51	Reset CB2 Delta Trip Count, write only location.	1	2	2	Pulse On Latch On	Pulse On
52	Reset CB2 Lockout Trip Count, write only location.	1	2	2	Pulse On Latch On	Pulse On
53	Remote mode	1	2	2	Pulse On Latch On	Pulse On
54	Service mode	1	2	2	Pulse On Latch On	Pulse On
55	Local mode	1	2	2	Pulse On Latch On	Pulse On
56	Local & Remote	1	2	2	Pulse On Latch On	Pulse On

Analog Inputs

The following table lists Analog Inputs (Object 30). It is important to note that 16-bit and 32-bit variations of Analog Inputs, Analog Output Control Blocks, and Analog Output Statuses are transmitted through DNP as signed numbers.

The "Default Deadband," and the "Default Change Event Assigned Class" columns are used to represent the absolute amount by which the point must change before an analog change event will be generated, and once generated in which class poll (1, 2, 3, or none) will the change event be reported.

The default analog input event buffer size is set 30.

Static Variation reported when variation 0 requested: **3 (32-Bit Analog Input w/o Flag), 4 (16-Bit Analog Input w/o Flag)** Change Event Variation reported when variation 0 requested: **1 (32-Bit Analog Change Event w/o Time)**						
Point Index	Name/Description	Default Class	Default Static Object 30 Variation	Default Event Object 32 Variation	Multiplier	Deadband
0	Frequency (Hz)	3	2	4	100	1
1	V Primary (kV)	3	2	4	0.001	1000
2	Voltage Secondary	3	2	4	100	1
3	Voltage Nominal	3	2	4	100	1
4	Operate Ia	3	2	4	100	1
5	Operate Ib	3	2	4	100	1
6	Operate Ic	3	2	4	100	1
7	Restrain Ia	3	2	4	100	1
8	Restrain Ib	3	2	4	100	1
9	Restrain Ic	3	2	4	100	1
10	W1 2nd Harmonic Ia	3	2	4	100	1
11	W1 2nd Harmonic Ib	3	2	4	100	1
12	W1 2nd Harmonic Ic	3	2	4	100	1
13	W2 2nd Harmonic Ia	3	2	4	100	1
14	W2 2nd Harmonic Ib	3	2	4	100	1
15	W2 2nd Harmonic Ic	3	2	4	100	1
16	Primary Ig-1	3	2	4	100	1
17	Secondary Ig-1	3	2	4	100	1
18	Nominal Ig-1	3	2	4	100	1
19	Primary Ig-2	3	2	4	100	1
20	Secondary Ig-2	3	2	4	100	1
21	Nominal Ig-2	3	2	4	100	1
22	V/f V	3	2	4	100	1
23	V/f	3	2	4	100	1
24	V/f 24IT	3	2	4	100	1
25	Thermal Status Ph A	3	2	4	100	1
26	Thermal Status Ph B	3	2	4	100	1
27	Thermal Status Ph C	3	2	4	100	1
28	W1 Primary Ia	3	2	4	0.001	1000
29	W1 Primary Ib	3	2	4	0.001	1000
30	W1 Primary Ic	3	2	4	0.001	1000
31	W1 Secondary Ia	3	2	4	100	1
32	W1 Secondary Ib	3	2	4	100	1
33	W1 Secondary Ic	3	2	4	100	1
34	W1 Nominal Ia	3	2	4	100	1
35	W1 Nominal Ib	3	2	4	100	1
36	W1 Nominal Ic	3	2	4	100	1
37	W1 Line Ia	3	2	4	100	1
38	W1 Line Ib	3	2	4	100	1
39	W1 Line Ic	3	2	4	100	1
40	W1 Relay Ia	3	2	4	100	1

Static Variation reported when variation 0 requested: **3 (32-Bit Analog Input w/o Flag), 4 (16-Bit Analog Input w/o Flag)** Change Event Variation reported when variation 0 requested: **1 (32-Bit Analog Change Event w/o Time)**						
Point Index	Name/Description	Default Class	Default Static Object 30 Variation	Default Event Object 32 Variation	Multiplier	Deadband
41	W1 Relay Ib	3	2	4	100	1
42	W1 Relay Ic	3	2	4	100	1
43	W2 Primary Ia	3	2	4	0.001	1000
44	W2 Primary Ib	3	2	4	0.001	1000
45	W2 Primary Ic	3	2	4	0.001	1000
46	W2 Secondary Ia	3	2	4	100	1
47	W2 Secondary Ib	3	2	4	100	1
48	W2 Secondary Ic	3	2	4	100	1
49	W2 Nominal Ia	3	2	4	100	1
50	W2 Nominal Ib	3	2	4	100	1
51	W2 Nominal Ic	3	2	4	100	1
52	W2 Line Ia	3	2	4	100	1
53	W2 Line Ib	3	2	4	100	1
54	W2 Line Ic	3	2	4	100	1
55	W2 Relay Ia	3	2	4	100	1
56	W2 Relay Ib	3	2	4	100	1
57	W2 Relay Ic	3	2	4	100	1
73	Fault Records	3	2	4	1	1
74	Event Records	3	2	4	1	1
75	Waveform Records	3	2	4	1	1
76	W1 I Phase A Max	3	2	4	100	1
77	W1 I Phase B Max	3	2	4	100	1
78	W1 I Phase C Max	3	2	4	100	1
79	W2 I Phase A Max	3	2	4	100	1
80	W2 I Phase B Max	3	2	4	100	1
81	W2 I Phase C Max	3	2	4	100	1

Data Type	**Static Variant**	**Description**
DT1	3	Data is sent as a 32 bit integer in fixed point to 3 decimal places format. E.g. a value of 1023 = 1.023
DT2	4	Data is sent as a 16 bit integer.

Section 6: 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.

6.1.1 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.

Where two DCE devices e.g. the modem and the fibre-optic converter are being connected together 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.

6.1.2 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.

6.1.3 Connecting to the Remote Modem

Once the remote modem has been configured correctly, it should be possible to make connection to the relay.

Where a 'dial-up' modem system is installed the settings on the remote modem are fixed so the local modem should negotiate with it on connection, choosing suitable matching settings. Where this is not possible the local modem should be set with settings equivalent to those of the remote modem as described above.

Section 7: 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.