7SR224 Recloser Controller
Overcurrent Relay

Document Release History

This document is issue **2010/09.** The list of revisions up to and including this issue is:

2008/03	First Issue
2008/11	Second Issue
2009/09	Third Issue
2010/04	Fourth Issue
2010/05	Fifth Issue. Document reformatted due to rebrand.
2010/09	Sixth issue. Addition of IEC60870-5-101 communication protocol.

Software Revision History

2008/03	2435H80011R2d-1a	First Release
2008/06	2435H80011R3d-2b	Demand Records, DNP3.0 data comms Loss of Voltage Loop Automation
2008/10	2435H80011R4-3	Single/triple ARC
2009/09	2435H80011R4c-3b	Maintenance Release
2010/04	2435H80011R4d-4	Check Sync
2010/09	2435H80011R4f-4b	IEC60870-5-101 communication protocol

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Section 1: Introduction

The relay data communication facility is compatible with control and automation systems, PCs running Reydisp software, can 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 available. 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 one 'Front' USB communication interface (Com2) located on the fascia and one RS485 (Com1) located on the 'Rear' with optional Fibre optic, RS232 and additional RS485 ports also located on the rear. Access to the communication settings for the USB port is only available from the relay front fascia via the key pad setting menu **COMMUNICATIONS MENU.** The communication settings for the other ports are available from the relay front fascia via the key pad setting menu or through Reydisp via the USB connection.

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, DNP-3, MODBUS RTU or IEC60870-5-101 communications to a substation SCADA or integrated control system or engineer remote access.

3. Com3/Com4: Optional RS232, dual fibre optic or additional RS485 ports located on the rear of the relay can be used for IEC60870-5-103, DNP3, MODBUS RTU or IEC60870-5-101 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, DNP3, MODBUS RTU or IEC60870-5-101 protocol at any one time, protocols available will depend upon relay model.

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 DNP 3.0 Settings

The following relay settings are provided for configuration of the DNP 3.0 implementation when available and are common to all ports using this protocol.

Setting name	Range	Default	Setting	Notes
Unsolicited Mode	DISABLED ENABLED	DISABLED	As Required	Setting is only visible when a port Protocol is set to DNP3
Destination Address	0 … 65534	0	As Required	Setting is only visible when a port Protocol is set to DNP3
DNP3 Application Timeout	5, 6 ... 299, 300	10s	As Required	Setting is only visible when a port Protocol is set to DNP3

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2.1.2 IEC60870-5-101 Settings

The following relay settings are provided for configuration of the IEC60870-5-101 implementation when available and are common to all ports using this protocol.

Setting name	Range	Default	Setting	Notes
I101 Link Mode	Balanced, Unbalanced	Unbalanced	As Required	Balanced transmission is used for point to point connection to one device. The controlled station (slave) may send link messages at any time. Unbalanced transmission is used for multi-drop connection, e.g. RS485, to one or more devices. The controlling station (master) send class 1 and 2 polls to each slave station.
I101 Link Address Field	Not Present, 1 Octet, 2 Octets	1 Octet	As Required	Size of link address in octets. Not Present – Only used with balanced transmission. 1 octet address range 0 – 254 2 octets address range 0 - 65534
I101 Common Address of ASDU	1 Octet, 2 Octets	2 Octet	As Required	Size of common address in octets. 1 octet address range 0 – 254 2 octets address range 0 - 65534
I101 Cause of Trans (COT)	1 Octet, 2 Octets	1 Octet	As Required	Size of cause of transmission in octets. 1 octet – COT code 2 octets – COT code + originator address or 0.
I101 Info Obj Add (IOA)	1 Octet, 2 Octets, 3 Octets	2 Octet	As Required	Size of Info Object address in octets. 1 octet address range 1 – 255 2 octets address range 1 – 65535 3 octets used to generate structured address format.
I101 ASDU Address	0 .. 65535	3	As Required	Address to use to identify ASDU layer
I101 Cyclic Period	Off, 1 ..3600 seconds	60 Seconds	As Required	Period device will generate cyclic data. Set to Off to disable generating of cyclic data. Only data points with the cyclic flag set will be generated cyclically.

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Setting name	Range	Default	Setting	Notes
I101 Background Period	Off, 1 ..1500 minutes	Off	As Required	Period device will generate background data. Set to Off to disable generating of background data. Only data points with the background flag set will be generated in the background.

2.1.3   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. When connecting to Reydisp using this connection the default settings can be used without the need to first change any settings, otherwise the Com 2 port must be set to IEC60870-5-103 (the relay address and baud rate do not need to be set).

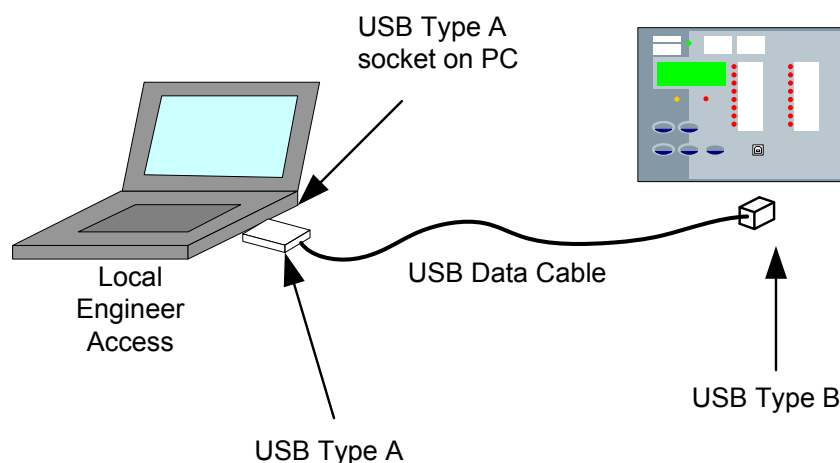| Setting name	Range	Default	Setting	Notes
Station Address	1 … 254	0	1-254	An address between 1 and 254 must be given to identify the relay
COM2-USB Protocol	OFF, IEC60870-5-103, DNP3.0 or IEC60870-5-101, MODBUS-RTU, ASCII	IEC60870-5-103	IEC60870-5-103	Reydisp software uses IEC60870-5-103 to communicate.
COM2 Mode	Local, Remote, Local Or Remote	Local	Local	Selects port mode

Figure 2-1   Communication to Front USB Port

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2.1.4 RS485 Interface

An 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. This can be done via the internal 120 ohm terminating resistor, which can be connected between 14 (A) and 18 (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 RS485 data comms link will be broken for that particular relay element if it is withdrawn from the case but the chain of communication to the other relays is maintained.

An additional RS485 port is available as an ordering option. This port is wired to a dedicated terminal block at the relay rear.

The following settings must be configured via the relay fascia or Reydisp when using the RS485 interface. The shaded settings are only visible when DNP3.0 is selected.

Setting name	Range	Default	Setting	Notes
Station Address	1 – 254 for IEC60870-5-103 or IEC60870-5-101 0 – 247 for Modbus RTU 0 – 65534 for DNP3.0	1 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 or IEC60870-5-101	IEC60870-5-103	As Required	Sets the protocol used to communicate on the 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 same RS485 bus 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 same RS485 bus must be the same and in accordance with the master device.
COM1 Mode	Local, Remote, Local Or Remote	Remote	Remote	Selects port mode
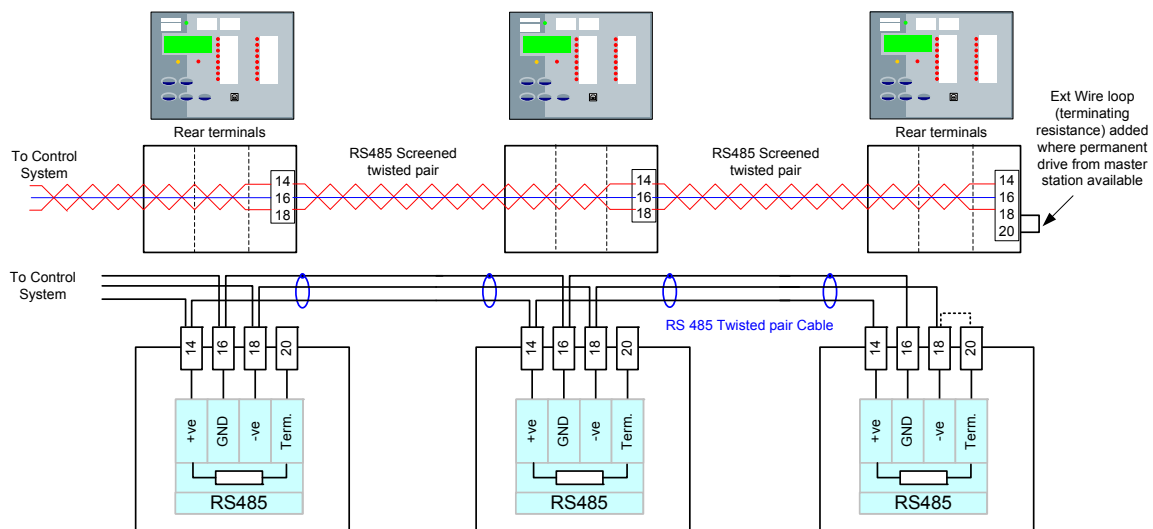
Figure 2-2   Communication to Multiple Devices from Control System using RS485

2.1.5   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^{TM} (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 Argus 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

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

Transmitter launch power.

Attenuation, based on light frequency, fibre material and fibre diameter. (Consult fibre manufacturers' data for actual values of fibre attenuation).

Number of intermediate connectors and splices. 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. Typical losses at splices are <0.3dB. (Consult fibre manufacturers' data for actual values).

Receiver sensitivity. The light power at the receiver must be above the sensitivity of the receiver in order that effective communication can occur.

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 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	

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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 fibre optic 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 or IEC60870-5-101 0 – 247 for Modbus RTU 0 – 65520 for DNP3.0	1 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 or IEC60870-5-101	IEC60870-5-103	As Required	Sets the protocol used to communicate on the fibre optic connection – Com3
COM3 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400 57600	57600	As Required	The baud rate set on all of the relays connected to the same 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 same fibre optic 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.
COM3 Mode	Local, Remote, Local Or Remote	Remote	Remote	Selects port mode
COM4 Protocol	OFF, IEC60870-5-103, MODBUS-RTU, DNP3.0 or IEC60870-5-101	IEC60870-5-103	As Required	Sets the protocol used to communicate on the fibre optic 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 same system must be the same as the one set on the master device.

Setting name	Range	Default	Setting	Notes
COM4 Parity	NONE, ODD, EVEN	EVEN	As Required	The parity set on all of the relays connected to the same fibre optic 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.
COM4 Mode	Local, Remote, Local Or Remote	Remote	Remote	Selects port mode
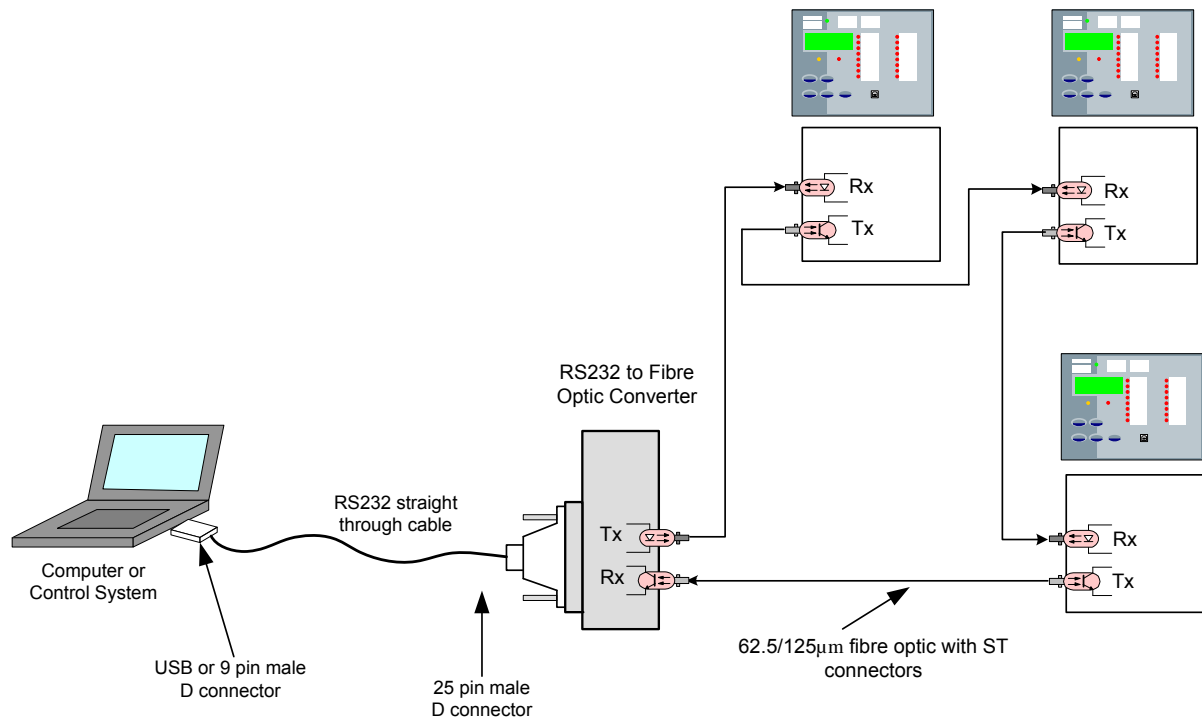
Figure 2-3   Communication to Multiple Devices using Fibre-optic Ring Network
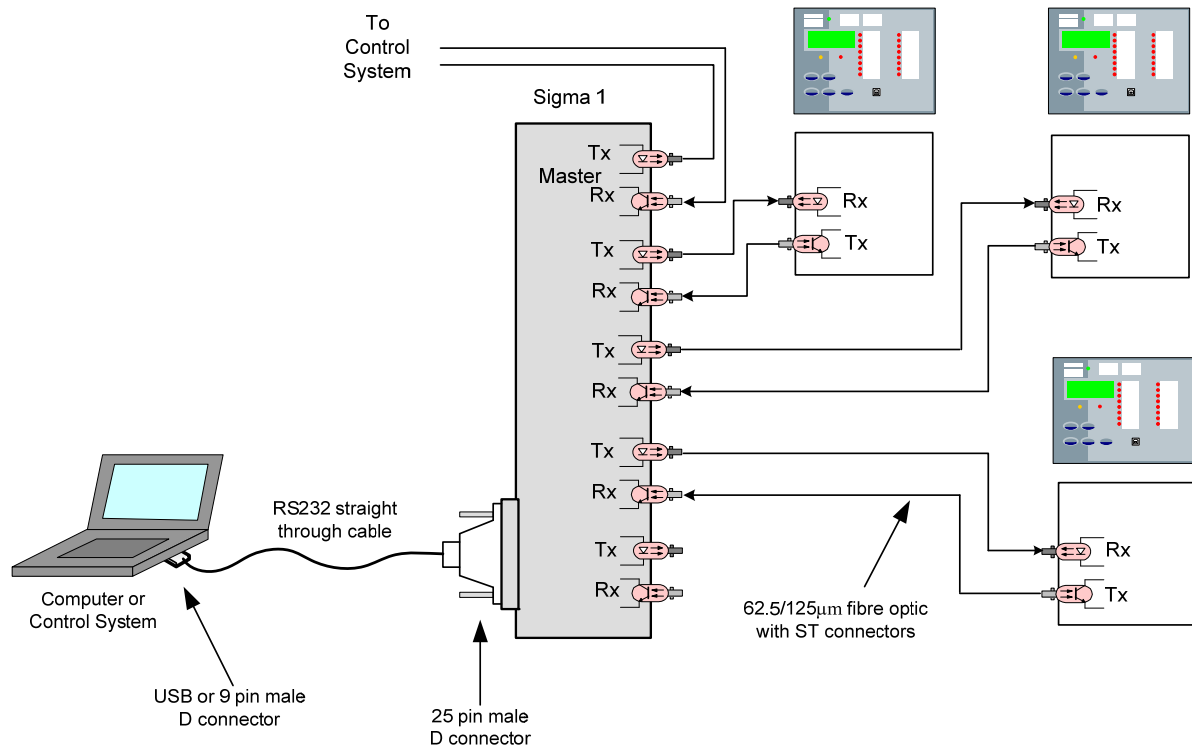
Figure 2-4   Communication to Multiple Devices from Control System and Laptop using Fibre-optic Star Network

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 RS232 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*. 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	0	Data Lost	1	SE
60	4	Remote Mode	1	SE, GI,
			20	Ack, Nak
60	5	Out of Service Mode	1	SE, GI,
			20	Ack, Nak
60	6	Local Mode	1	SE, GI,
			20	Ack, Nak
60	7	Local & Remote Mode	1	SE, GI,
			20	Ack, Nak
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	Reset Demand metering	1	SE, GI
			20	Ack, Nak
60	141	27 Sag SARFI	1	SE, GI,
60	142	59Swell SARFI	1	SE, GI,
60	143	Reset SagSwell Count	1	SE
60	150	Battery Test Pass	1	SE
60	151	Battery Test Fail	1	SE
60	152	Battery Ohms High	1	SE
60	153	Battery Volts Low	1	SE, GI,
60	154	Battery Volts High	1	SE, GI,
60	155	Battery Healthy	1	SE, GI,
60	156	Battery Recovery Fail	1	SE
60	157	Battery Test	1	SE, GI,
			20	Ack, Nak
60	160	Capacitor Ready	1	SE, GI,
60	161	Capacitor Test Pass	1	SE
60	162	Capacitor Test Fail	1	SE
60	163	Capacitor Recovery Fail	1	SE
60	164	Capacitor Test	1	SE
			20	Ack, Nak
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,

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Function	Information Number	Description	Function Type	Cause of Transmission
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,
60	197	Quick Logic E16	1	SE, GI,
60	214	Function Key 1	1	SE
60	215	Function Key 2	1	SE
60	216	Function Key 3	1	SE
60	217	Function Key 4	1	SE
60	218	Function Key 5	1	SE
60	219	Function Key 6	1	SE
60	220	Function Key 7	1	SE
60	221	Function Key 8	1	SE
60	222	Function Key 9	1	SE
60	223	Function Key 10	1	SE
60	224	Function Key 11	1	SE
60	225	Function Key 12	1	SE
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,
70	20	Binary Input 20	1	SE, GI,

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Function	Information Number	Description	Function Type	Cause of Transmission
70	21	Binary Input 21	1	SE, GI,
70	22	Binary Input 22	1	SE, GI,
70	23	Binary Input 23	1	SE, GI,
70	24	Binary Input 24	1	SE, GI,
70	25	Binary Input 25	1	SE, GI,
70	26	Binary Input 26	1	SE, GI,
70	27	Binary Input 27	1	SE, GI,
70	28	Binary Input 28	1	SE, GI,
70	29	Binary Input 29	1	SE, GI,
70	30	Binary Input 30	1	SE, GI,
70	31	Binary Input 31	1	SE, GI,
70	32	Binary Input 32	1	SE, GI,
70	33	Binary Input 33	1	SE, GI,
70	34	Binary Input 34	1	SE, GI,
70	35	Binary Input 35	1	SE, GI,
70	36	Binary Input 36	1	SE, GI,
70	37	Binary Input 37	1	SE, GI,
70	38	Binary Input 38	1	SE, GI,
70	39	Binary Input 39	1	SE, GI,
70	40	Binary Input 40	1	SE, GI,
70	41	Binary Input 41	1	SE, GI,
70	42	Binary Input 42	1	SE, GI,
70	43	Binary Input 43	1	SE, GI,
70	44	Binary Input 44	1	SE, GI,
70	45	Binary Input 45	1	SE, GI,
70	46	Binary Input 46	1	SE, GI,
70	47	Binary Input 47	1	SE, GI,
70	48	Binary Input 48	1	SE, GI,
70	49	Binary Input 49	1	SE, GI,
70	50	Binary Input 50	1	SE, GI,
70	51	Binary Input 51	1	SE, GI,
70	52	Binary Input 52	1	SE, GI,
70	53	Binary Input 53	1	SE, GI,
70	54	Binary Input 54	1	SE, GI,
70	55	Binary Input 55	1	SE, GI,
70	56	Binary Input 56	1	SE, GI,
70	57	Binary Input 57	1	SE, GI,
70	58	Binary Input 58	1	SE, GI,
70	59	Binary Input 59	1	SE, GI,
70	60	Binary Input 60	1	SE, GI,
70	61	Binary Input 61	1	SE, GI,
70	62	Binary Input 62	1	SE, GI,
70	63	Binary Input 63	1	SE, GI,
70	64	Binary Input 64	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

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Function	Information Number	Description	Function Type	Cause of Transmission
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
80	15	Binary Output 15	1	SE, GI,
			20	Ack, Nak
80	16	Binary Output 16	1	SE, GI,
			20	Ack, Nak
80	17	Binary Output 17	1	SE, GI,
			20	Ack, Nak
80	18	Binary Output 18	1	SE, GI,
			20	Ack, Nak
80	19	Binary Output 19	1	SE, GI,
			20	Ack, Nak
80	20	Binary Output 20	1	SE, GI,
			20	Ack, Nak
80	21	Binary Output 21	1	SE, GI,
			20	Ack, Nak
80	22	Binary Output 22	1	SE, GI,
			20	Ack, Nak
80	23	Binary Output 23	1	SE, GI,
			20	Ack, Nak
80	24	Binary Output 24	1	SE, GI,
			20	Ack, Nak
80	25	Binary Output 25	1	SE, GI,
			20	Ack, Nak
80	26	Binary Output 26	1	SE, GI,
			20	Ack, Nak
80	27	Binary Output 27	1	SE, GI,
			20	Ack, Nak
80	28	Binary Output 28	1	SE, GI,
			20	Ack, Nak

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Function	Information Number	Description	Function Type	Cause of Transmission
80	29	Binary Output 29	1	SE, GI,
			20	Ack, Nak
80	30	Binary Output 30	1	SE, GI,
			20	Ack, Nak
80	31	Binary Output 31	1	SE, GI,
			20	Ack, Nak
80	32	Binary Output 32	1	SE, GI,
			20	Ack, Nak
160	0	Time Synchronisation	6	Time Synchronisation
160	0	GI End	8	End of GI
160	2	Reset FCB	5	Reset FCB
160	3	Reset CU	5	Reset CU
160	4	Start/Restart	5	Start/Restart
160	5	Power On	5	SE
160	16	Auto-reclose active (In/Out)	1	SE, GI
			20	Ack, Nak
160	19	LEDs reset (Reset Flag & Outputs)	1	SE
			20	Ack, Nak
160	22	Settings changed	1	SE
160	23	Settings Group 1 Select	1	SE, GI
			20	Ack, Nak
160	24	Settings Group 2 Select	1	SE, GI
			20	Ack, Nak
160	25	Settings Group 3 Select	1	SE, GI
			20	Ack, Nak
160	26	Settings Group 4 Select	1	SE, GI
			20	Ack, Nak
160	27	Binary Input 1	1	SE, GI
160	28	Binary Input 2	1	SE, GI
160	29	Binary Input 3	1	SE, GI
160	30	Binary Input 4	1	SE, GI
160	36	Trip circuit fail	1	SE, GI
160	38	VT Fuse Failure	1	SE, GI
160	51	Earth Fault Forward/Line	1	SE, GI
160	52	Earth Fault Reverse/Busbar	1	SE, GI
160	64	Starter/Pick Up L1	1	SE, GI
160	65	Starter/Pick Up L2	1	SE, GI
160	66	Starter/Pick Up L3	1	SE, GI
160	67	Starter/Pick Up N	1	SE, GI
160	68	General Trip	2	SE
160	69	Trip L1	2	SE
160	70	Trip L2	2	SE
160	71	Trip L3	2	SE
160	74	Fault Forward/Line	1	SE, GI
160	75	Fault Reverse/Busbar	1	SE, GI
160	84	General Starter/Pick Up	1	SE, GI
160	85	Circuit breaker fail	2	SE
160	90	Trip I>	2	SE
160	91	Trip I>>	2	SE
160	92	Trip In>	2	SE

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Function	Information Number	Description	Function Type	Cause of Transmission
160	93	Trip In>>	2	SE
160	128	CB on by auto reclose	1	SE, GI
183	0	Data Lost	1	SE
183	10	51-1	2	SE, GI
183	11	50-1	2	SE, GI
183	14	51G-1	2	SE, GI
183	15	50G-1	2	SE, GI
183	16	51-2	2	SE, GI
183	17	50-2	2	SE, GI
183	20	51G-2	2	SE, GI
183	21	50G-2	2	SE, GI
183	22	51-3	2	SE, GI
183	23	50-3	2	SE, GI
183	26	51G-3	2	SE, GI
183	27	50G-3	2	SE, GI
183	28	51-4	2	SE, GI
183	29	50-4	2	SE, GI
183	32	51G-4	2	SE, GI
183	33	50G-4	2	SE, GI
183	34	50BF Stage 2	2	SE, GI
183	35	Thermal Alarm	2	SE, GI
183	36	Thermal Trip	2	SE, GI
183	40	CT Supervision	2	SE, GI
183	41	51SEF-1	2	SE, GI
183	42	50SEF-1	2	SE, GI
183	43	51SEF-2	2	SE, GI
183	44	50SEF-2	2	SE, GI
183	45	51SEF-3	2	SE, GI
183	46	50SEF-3	2	SE, GI
183	47	51SEF-4	2	SE, GI
183	48	50SEF-4	2	SE, GI
183	49	SEF Out/In	2	SE.GI
			20	Ack,Nak
183	50	46IT	2	SE, GI
183	51	46DT	2	SE, GI
183	52	64H	2	SE, GI
183	53	EF Out/In	1	SE, GI
			20	Ack,Nak
183	54	SEF Forward/Line	2	SE, GI
183	55	SEF Reverse/Busbar	2	SE, GI
183	60	47-1	2	SE, GI
183	61	47-2	2	SE, GI
183	62	37-1	2	SE, GI
183	63	37-2	2	SE, GI
183	70	46BC	2	SE, GI
183	81	27/59-1	2	SE, GI
183	82	27/59-2	2	SE, GI
183	83	27/59-3	2	SE, GI
183	84	27/59-4	2	SE, GI
183	85	59NIT	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
183	86	59NDT	2	SE, GI
183	87	Vx27/59	2	SE, GI
183	90	81-1	2	SE, GI
183	91	81-2	2	SE, GI
183	92	81-3	2	SE, GI
183	93	81-4	2	SE, GI
183	101	Trip Circuit Fail 1	1	SE, GI
183	102	Trip Circuit Fail 2	1	SE, GI
183	103	Trip Circuit Fail 3	1	SE, GI
183	110	Settings Group 5 Selected	1	SE, GI
			20	Ack, Nak
183	111	Settings Group 6 Selected	1	SE, GI
			20	Ack, Nak
183	112	Settings Group 7 Selected	1	SE, GI
			20	Ack, Nak
183	113	Settings Group 8 Selected	1	SE, GI
			20	Ack, Nak
183	114	Close CB Failed	1	SE
183	115	Open CB Failed	1	SE
183	116	Reclaim	1	SE, GI
183	117	Lockout	1	SE, GI
183	119	Successful DAR Close	1	SE
183	120	Successful Man Close	1	SE
183	121	Hotline Working	1	SE,GI
			20	Ack, Nak
183	122	Inst Protection Out	1	SE,GI
			20	Ack, Nak
183	123	CB Total Trip Count	1	SE, GI
183	124	CB Delta Trip Count	1	SE, GI
183	125	CB Count to AR Block	1	SE, GI
183	126	Reset CB Trip Count Maint	1	SE
			20	Ack, Nak
183	127	Reset CB Trip Count Delta	1	SE
			20	Ack, Nak
183	128	Reset CB Trip Count Lockout	1	SE
			20	Ack, Nak
183	129	I^2t CB Wear	1	SE, GI
183	130	Reset I^2t CB Wear	1	SE
			20	Ack, Nak
183	131	79 AR In Progress	1	SE, GI
183	132	CB Frequent Ops Count	1	SE, GI
183	133	Reset CB Frequent Ops Count	1	SE
			20	Ack, Nak
183	134	CB LO Handle Ops Count	1	SE,
183	135	Reset CB LO Handle Ops Count	1	SE
			20	Ack, Nak
183	136	CB On by Manual Close	1	SE,G!
183	140	Cold Load Active	1	SE,GI
183	141	P/F Inst Protection Inhibited	1	SE, GI
183	142	E/F Inst Protection Inhibited	1	SE, GI

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Function	Information Number	Description	Function Type	Cause of Transmission
183	143	SEF Inst Protection Inhibited	1	SE, GI
183	144	Ext Inst Protection Inhibited	1	SE, GI
183	150	LOV Primed	1	SE, GI
183	151	LOV Trip	1	SE, GI
183	152	LOV Close	1	SE, GI
183	153	LOV Inhibit Fast Protection	1	SE, GI
183	154	LOV Force Fast Protection	1	SE, GI
183	155	LOV In Progress	1	SE, GI
183	156	LOV Backfeed Fail	1	SE
183	157	LOV Successful	1	SE
183	158	LOV 1x Trip and Lockout	1	SE, GI
183	159	LOV Fail	1	SE
183	160	LOV-A Live	1	SE, GI
183	161	LOV-X Live	1	SE, GI
183	162	LOV Out	1	SE, GI
			20	Ack, Nak
183	163	Trip Time Alarm	1	SE, GI
183	164	Close Circuit Fail 1	1	SE
183	165	Close Circuit Fail 2	1	SE
183	166	Close Circuit Fail 3	1	SE
183	167	Close Circuit Fail	1	SE
183	168	Distance To Fault	1	SE, GI
183	169	Distance To Fault %	1	SE, GI
183	170	Fault Reactance	1	SE, GI
183	172	Act Energy Exp	1	SE
183	173	Act Energy Imp	1	SE
183	174	React Energy Exp	1	SE
183	175	React Energy Imp	1	SE
183	176	Reset Energy Meters	1	SE
			20	Ack, Nak
183	177	Active Exp Meter Reset	1	SE
183	178	Active Imp Meter Reset	1	SE
183	179	Reactive Exp Meter Reset	1	SE
183	180	Reactive Imp Meter Reset	1	SE
183	181	CB Total Trip Count	1	SE
183	182	CB Delta Trip Count	1	SE
183	183	CB Count To AR Block	1	SE
183	184	CB Freq Ops Count	1	SE
183	185	LOV A Live	1	SE, GI
183	186	LOV B Live	1	SE, GI
183	187	LOV C Live	1	SE, GI
183	188	LOV X Live	1	SE, GI
183	189	LOV Y Live	1	SE, GI
183	190	LOV Z Live	1	SE, GI
183	191	LOV A	1	SE, GI
183	192	LOV B	1	SE, GI
183	193	LOV C	1	SE, GI
183	194	LOV X	1	SE, GI
183	195	LOV Y	1	SE, GI
183	196	LOV Z	1	SE, GI

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Function	Information Number	Description	Function Type	Cause of Transmission
183	197	CB LO Handle Ops Count	1	SE
183	198	25 Check Sync	1	SE, GI
183	199	25 System Sync	1	SE, GI
183	200	25 Close On Zero	1	SE, GI
183	201	25 System Split	1	SE, GI
183	202	25 Live Line	1	SE, GI
183	203	25 Live Bus	1	SE, GI
183	204	25 Line U/V	1	SE, GI
183	205	25 Bus U/V	1	SE, GI
183	206	25 Voltage Dif >	1	SE, GI
183	207	25 CS Slip Freq >	1	SE, GI
183	208	25 SS Slip Freq >	1	SE, GI
183	209	25 COZ Slip Freq >	1	SE, GI
183	210	25 In Sync	1	SE, GI
183	211	25 CS In Progress	1	SE, GI
183	212	25 SS In Progress	1	SE, GI
183	213	25 COZ In Progress	1	SE, GI
183	214	25 System Split LO	1	SE, GI
183	215	60VTF-Bus	1	SE, GI
183	217	Man Override Sync	1	SE, GI
			20	Ack, Nak
183	218	79 Override Sync	1	SE, GI
			20	Ack, Nak
183	219	Dead Line Close	1	SE, GI
183	220	Dead Bus Close	1	SE, GI
183	239	In Fault Current	4	SE
183	240	Ia Fault Current	4	SE
183	241	Ib Fault Current	4	SE
183	242	Ic Fault Current	4	SE
183	243	Ig Fault Current	4	SE
183	244	Isef Fault Current	4	SE
183	245	Va Fault Current	4	SE
183	246	Vb Fault Current	4	SE
183	247	Vc Fault Current	4	SE
184	1	Close CB-A Failed	1	SE
184	2	Open CB-A Failed	1	SE
184	3	CB-A Reclaim	1	SE, GI
184	4	CB-A Lockout	1	SE, GI
184	5	CB-A Successful Close	1	SE
184	6	CB-A Successful DAR Close	1	SE
184	7	CB-A Successful Man Close	1	SE
184	8	CB-A Total Trip Count	1	SE, GI
184	9	CB-A Delta Trip Count	1	SE, GI
184	10	CB-A Count To AR Block	1	SE, GI
184	11	Reset CB-A Total Trip Count	1	SE
			20	Ack, Nak
184	12	Reset CB-A Delta Trip Count	1	SE
			20	Ack, Nak
184	13	Reset CB-A Count to AR Block	1	SE
			20	Ack, Nak
184	14	CB-A I^2t Wear	1	SE, GI
184	15	Reset CB-A I^2t Wear	1	SE
			20	Ack, Nak

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Function	Information Number	Description	Function Type	Cause of Transmission
184	16	CB-A 79 AR In progress	1	SE, GI
184	17	CB-A Frequent Ops Count	1	SE, GI
184	18	Reset CB-A Frequent Ops Count	1	SE
			20	Ack, Nak
184	19	CB-A LO Handle Ops Count	1	SE, GI
184	20	Reset CB-A LO Handle Ops Count	1	SE
			20	Ack, Nak
184	21	PhA Inst Protection Inhibited	1	SE, GI
184	22	CB-A Blocked By Interlocking	1	SE, GI
184	23	CB-A on by auto reclose	1	SE
184	24	CB-A Trip & Reclose	1	SE
184	25	50BF-1 Pole A	1	SE, GI
184	26	50BF-2 Pole A	1	SE, GI
184	27	CB-A Trip & Lockout	1	SE
			20	Ack, Nak
184	28	Cap-A Ready	1	SE, GI
184	29	Cap-A Test Pass	1	SE
184	30	Cap-A Test Fail	1	SE
184	31	Cap-A Recovery Fail	1	SE
184	32	Cap-A Test	1	SE, GI
184	33	CB-A Deadtime Running	1	SE, GI
184	51	Close CB-B Failed	1	SE
184	52	Open CB-B Failed	1	SE
184	53	CB-B Reclaim	1	SE, GI
184	54	CB-B Lockout	1	SE, GI
184	55	CB-B Successful Close	1	SE
184	56	CB-B Successful DAR Close	1	SE
184	57	CB-B Successful Man Close	1	SE
184	58	CB-B Total Trip Count	1	SE, GI
184	59	CB-B Delta Trip Count	1	SE, GI
184	60	CB-B Count To AR Block	1	SE, GI
184	61	Reset CB-B Total Trip Count	1	SE
			20	Ack, Nak
184	62	Reset CB-B Delta Trip Count	1	SE
			20	Ack, Nak
184	63	Reset CB-B Count to AR Block	1	SE
			20	Ack, Nak
184	64	CB-B I^2t Wear	1	SE, GI
184	65	Reset CB-B I^2t Wear	1	SE
			20	Ack, Nak
184	66	CB-B 79 AR In progress	1	SE, GI
184	67	CB-B Frequent Ops Count	1	SE, GI
184	68	Reset CB-B Frequent Ops Count	1	SE
			20	Ack, Nak
184	69	CB-B LO Handle Ops Count	1	SE, GI
184	70	Reset CB-B LO Handle Ops Count	1	SE
			20	Ack, Nak
184	71	PhB Inst Protection Inhibited	1	SE, GI
184	72	CB-B Blocked By Interlocking	1	SE, GI
184	73	CB-B on by auto reclose	1	SE
184	74	CB-B Trip & Reclose	1	SE
184	75	50BF-1 Pole B	1	SE, GI
184	76	50BF-2 Pole B	1	SE, GI
184	77	CB-B Trip & Lockout	1	SE
			20	Ack, Nak
184	78	Cap-B Ready	1	SE, GI
184	79	Cap-B Test Pass	1	SE

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Function	Information Number	Description	Function Type	Cause of Transmission
184	80	Cap-B Test Fail	1	SE
184	81	Cap-B Recovery Fail	1	SE
184	82	Cap-B Test	1	SE, GI
184	83	CB-B Deadtime Running	1	SE, GI
184	101	Close CB-C Failed	1	SE
184	102	Open CB-C Failed	1	SE
184	103	CB-C Reclaim	1	SE, GI
184	104	CB-C Lockout	1	SE, GI
184	105	CB-C Successful Close	1	SE
184	106	CB-C Successful DAR Close	1	SE
184	107	CB-C Successful Man Close	1	SE
184	108	CB-C Total Trip Count	1	SE, GI
184	109	CB-C Delta Trip Count	1	SE, GI
184	110	CB-C Count To AR Block	1	SE, GI
184	111	Reset CB-C Total Trip Count	1	SE
			20	Ack, Nak
184	112	Reset CB-C Delta Trip Count	1	SE
			20	Ack, Nak
184	113	Reset CB-C Count to AR Block	1	SE
			20	Ack, Nak
184	114	CB-C I^2t Wear	1	SE, GI
184	115	Reset CB-C I^2t Wear	1	SE
			20	Ack, Nak
184	116	CB-C 79 AR In progress	1	SE, GI
184	117	CB-C Frequent Ops Count	1	SE, GI
184	118	Reset CB-C Frequent Ops Count	1	SE
			20	Ack, Nak
184	119	CB-C LO Handle Ops Count	1	SE, GI
184	120	Reset CB-C LO Handle Ops Count	1	SE
			20	Ack, Nak
184	121	PhC Inst Protection Inhibited	1	SE, GI
184	122	CB-C Blocked By Interlocking	1	SE, GI
184	123	CB-C on by auto reclose	1	SE
184	124	CB-C Trip & Reclose	1	SE
184	125	50BF-1 Pole C	1	SE, GI
184	126	50BF-2 Pole C	1	SE, GI
184	127	CB-C Trip & Lockout	1	SE
			20	Ack, Nak
184	128	Cap-C Ready	1	SE, GI
184	129	Cap-C Test Pass	1	SE
184	130	Cap-C Test Fail	1	SE
184	131	Cap-C Recovery Fail	1	SE
184	132	Cap-C Test	1	SE, GI
184	134	CB-C Deadtime Running	1	SE, GI
184	133	Pole Discrepancy	1	SE, GI
184	150	Three Pole Trip Select	1	SE, GI
184	151	Force 3Pole Trip	1	SE, GI
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	11	CB-A	1	SE, GI
			20	Ack, Nak
200	12	CB-B	1	SE, GI
			20	Ack, Nak
200	13	CB-C	1	SE, GI
			20	Ack, Nak
200	200	CB 1 Trip & Reclose	1	SE

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Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
200	201	CB 1 Trip & Lockout	1	SE
			20	Ack, Nak
200	252	Mode A - 3PTrip3PLO	1	SE, GI
			20	Ack, Nak
200	253	Mode B - 1PTrip3PLO	1	SE, GI
			20	Ack, Nak
200	254	Mode C - 1PTrip1PLO	1	SE, GI
			20	Ack, Nak
200	255	Blocked by Interlocking	1	SE,GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	GI Initiation	7	End of GI
255	0	End of GI	8	End of GI

Measurand

Function	Information Number	Description	Function Type	Cause of Transmission
183	148	Measurand $I_{L1,2,3}$, $V_{L1,2,3}$, P, Q, F, $V_{L1-2,L2-3,L3-1}$ I_{L1} (2.4 x) I_{L2} (2.4 x) I_{L3} (2.4 x) V_{L1} (1.2 x) V_{L2} (1.2 x) V_{L3} (1.2 x) P (2.4 x) Q (2.4 x) F (1.2 x) V_{L1-2}(1.2 x) V_{L2-3}(1.2 x) V_{L3-1}(1.2 x)	9	Cyclic – Refresh rate 5 seconds or value change greater than 1%
183	216	Measurand Vx, Bus Freq, Phase Diff, Diff Volts and Slip Freq (1.2 x) Note – Phase difference is stored as -1 to +1 as a multiple of 180deg nominal	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	V1
183	2	V2
183	3	V3
183	4	Vx
183	5	Ia
183	6	Ib
183	7	Ic
183	8	Ig1
183	9	Not Used
183	10	Vy
183	11	Vz

V1, V2 and V3 are dependent on *Phase Voltage Config* setting and represent Van, Vbn, Vcn or Vab, Vbc, V0 or Va, Vb, Vc

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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, RS232 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*. 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
00015	Binary Output 15
00016	Binary Output 16
00017	Binary Output 17
00018	Binary Output 18
00019	Binary Output 19
00020	Binary Output 20
00021	Binary Output 21
00022	Binary Output 22
00023	Binary Output 23
00024	Binary Output 24
00025	Binary Output 25
00026	Binary Output 26
00027	Binary Output 27
00028	Binary Output 28
00029	Binary Output 29
00030	Binary Output 30
00031	Binary Output 31
00032	Binary Output 32
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	Circuit Breaker 1

Address	Description
00110	CB 1 Trip & Reclose (Write only location)
00111	CB 1 Trip & Lockout (Write only location)
00112	Auto-reclose on/off
00113	Hot Line Working on/off
00114	E/F off/on
00115	SEF off/on
00116	Inst Protection off/on
00117	LOV off/on
00118	Reset CB Total Trip Count (write only location)
00119	Reset CB Delta Trip Count (write only location)
00120	Reset CB Count To AR Block (write only location)
00121	Reset CB Frequent Ops Count (write only location)
00122	Reset CB LO Handle Ops Count (write only location)
00123	Reset I^2t CB Wear (write only location)
00124	Battery Test (write only location)
00125	Capacitor Test (write only location)
00126	Reset Demand Metering (write only location)
00127	CB-A
00128	CB-B
00129	CB-C
00130	CB-A Trip & Lockout
00131	CB-B Trip & Lockout
00132	CB-C Trip & Lockout
00133	Mode A - 3PTrip3PLO
00134	Mode B - 1PTrip3PLO
00135	Mode C - 1PTrip1PLO
00136	Reset CB-A Total Trip Count
00137	Reset CB-B Total Trip Count
00138	Reset CB-C Total Trip Count
00139	Reset CB-A Delta Trip Count
00140	Reset CB-B Delta Trip Count
00141	Reset CB-C Delta Trip Count
00142	Reset CB-A Count To AR Block
00143	Reset CB-B Count To AR Block
00144	Reset CB-C Count To AR Block
00145	Reset CB-A Frequent Ops Count
00146	Reset CB-B Frequent Ops Count
00147	Reset CB-C Frequent Ops Count
00148	Reset CB-A LO Handle Ops Count
00149	Reset CB-B LO Handle Ops Count
00150	Reset CB-C LO Handle Ops Count
00151	Reset CB-A I^2t Wear
00152	Reset CB-B I^2t Wear
00153	Reset CB-C I^2t Wear
00154	Reset Energy Metering (write only location)
00155	Remote Mode
00156	Service Mode
00157	Local Mode
00158	Local & Remote
00159	Manual Override Synchronising On/Off
00160	79 Override Synchronising On/Off

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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
10020	Binary Input 20
10021	Binary Input 21
10022	Binary Input 22
10023	Binary Input 23
10024	Binary Input 24
10025	Binary Input 25
10026	Binary Input 26
10027	Binary Input 27
10028	Binary Input 28
10029	Binary Input 29
10030	Binary Input 30
10031	Binary Input 31
10032	Binary Input 32
10033	Binary Input 33
10034	Binary Input 34
10035	Binary Input 35
10036	Binary Input 36
10037	Binary Input 37
10038	Binary Input 38
10039	Binary Input 39
10040	Binary Input 40
10041	Binary Input 41
10042	Binary Input 42
10043	Binary Input 43
10044	Binary Input 44
10045	Binary Input 45
10046	Binary Input 46
10047	Binary Input 47
10048	Binary Input 48
10049	Binary Input 49
10050	Binary Input 50
10102	Remote mode
10103	Service mode
10104	Local mode
10105	Local & Remote mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10117	Earth Fault Forward/Line
10118	Earth Fault Reverse/Busbar

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Address	Description
10119	Start/Pick Up N
10120	Fault Forward/Line
10121	Fault Reverse/Busbar
10122	51-1
10123	50-1
10126	51G-1
10127	50G-1
10128	51-2
10129	50-2
10132	51G-2
10133	50G-2
10134	51-3
10135	50-3
10138	51G-3
10139	50G-3
10140	51-4
10141	50-4
10144	51G-4
10145	50G-4
10146	50BF Stage 2
10147	49 Alarm
10148	49 Trip
10149	60 CTS
10150	46IT
10151	46DT
10152	47-1
10153	47-2
10154	46BC
10155	27/59-1
10156	27/59-2
10157	27/59-3
10158	27/59-4
10159	59NIT
10160	59NDT
10161	81-1
10162	81-2
10163	81-3
10164	81-4
10167	64H
10168	37-1
10169	37-2
10170	Vx27/59
10171	AR Active
10172	CB on by AR
10173	Reclaim
10174	Lockout
10175	Hot Line Working
10176	Inst Protection Out
10177	CB Trip Count Maint
10178	CB Trip Count Delta
10179	CB Trip Count Lockout
10180	I^2t CB Wear
10181	79 AR In Progress
10182	Cold Load Active
10183	E/F Protection Out
10184	P/F Inst Protection Inhibited
10185	E/F Inst Protection Inhibited
10186	SEF Inst Protection Inhibited
10187	Ext Inst Protection Inhibited
10189	Battery Test Pass
10190	Battery Test Fail
10191	Battery Ohms High

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Address	Description
10192	Battery Volts Low
10193	Battery Volts High
10194	Battery Healthy
10195	Battery Recovery Fail
10196	Battery Test
10197	Capacitor Ready
10198	Capacitor Test Pass
10199	Capacitor Test Fail
10200	Capacitor Recovery Fail
10201	Capacitor Test
10202	51SEF-1
10203	50SEF-1
10204	51SEF-2
10205	50SEF-2
10206	51SEF-3
10207	50SEF-3
10208	51SEF-4
10209	50SEF-4
10210	SEF Out
10211	Trip Circuit Fail 1
10212	Trip Circuit Fail 2
10213	Trip Circuit Fail 3
10214	CB Total Trip Count
10215	CB Delta Trip Count
10216	CB Count to AR Block
10217	CB Frequent Ops Count
10218	I^2t CB Wear
10219	CB Open
10220	CB Closed
10221	CB-A Reclaim
10222	CB-A Lockout
10223	CB-A Total Trip Count
10224	CB-A Delta Trip Count
10225	CB-A Count To AR Block
10226	CB-A I^2t Wear
10227	CB-A Frequent Ops Count
10228	CB-A LO Handle Ops Count
10229	CB-A 79 AR In progress
10230	PhA Inst Protection Inhibited
10231	50BF-1 Pole A
10232	50BF-2 Pole A
10233	Cap-A Ready
10234	Cap-A Test Pass
10235	Cap-A Test Fail
10236	Cap-A Recovery Fail
10237	Cap-A Test
10238	CB-A Open
10239	CB-A Closed
10240	CB-B Reclaim
10241	CB-B Lockout
10242	CB-B Total Trip Count
10243	CB-B Delta Trip Count
10244	CB-B Count To AR Block
10245	CB-B I^2t Wear
10246	CB-B Frequent Ops Count
10247	CB-B LO Handle Ops Count
10248	CB-B 79 AR In progress
10249	PhB Inst Protection Inhibited
10250	50BF-1 Pole B
10251	50BF-2 Pole B

Address	Description
10252	Cap-B Ready
10253	Cap-B Test Pass
10254	Cap-B Test Fail
10255	Cap-B Recovery Fail
10256	Cap-B Test
10257	CB-B Open
10258	CB-B Closed
10259	CB-C Reclaim
10260	CB-C Lockout
10261	CB-C Total Trip Count
10262	CB-C Delta Trip Count
10263	CB-C Count To AR Block
10264	CB-C I^2t Wear
10265	CB-C Frequent Ops Count
10266	CB-C LO Handle Ops Count
10267	CB-C 79 AR In progress
10268	PhC Inst Protection Inhibited
10269	50BF-1 Pole C
10270	50BF-2 Pole C
10271	Cap-C Ready
10272	Cap-C Test Pass
10273	Cap-C Test Fail
10274	Cap-C Recovery Fail
10275	Cap-C Test
10276	CB-C Open
10277	CB-C Closed
10278	Pole Discrepancy
10279	LOV Primed
10280	LOV Trip
10281	LOV Close
10282	LOV In Progress
10288	SEF Forward/Line
10289	SEF Reverse/Busbar
10290	General Alarm 1
10291	General Alarm 2
10292	General Alarm 3
10293	General Alarm 4
10294	General Alarm 5
10295	General Alarm 6
10296	General Alarm 7
10297	General Alarm 8
10298	General Alarm 9
10299	General Alarm 10
10300	General Alarm 11
10301	General Alarm 12
10302	Quick Logic E1
10303	Quick Logic E2
10304	Quick Logic E3
10305	Quick Logic E4
10306	Quick Logic E5
10307	Quick Logic E6
10308	Quick Logic E7
10309	Quick Logic E8
10310	Quick Logic E9
10311	Quick Logic E10
10312	Quick Logic E11
10313	Quick Logic E12
10314	Quick Logic E13
10315	Quick Logic E14
10316	Quick Logic E15
10317	Quick Logic E16
10340	LOV A Live

Address	Description
10341	LOV B Live
10342	LOV C Live
10343	LOV X Live
10344	LOV Y Live
10345	LOV Z Live
10346	LOV A
10347	LOV B
10348	LOV C
10349	LOV X
10350	LOV Y
10351	LOV Z
10352	25 System Split
10353	25 Live Line
10354	25 Live Bus
10355	25 Line U/V
10356	25 Bus U/V
10357	25 Voltage Dif >
10358	25 CS Slip Freq >
10359	25 SS Slip Freq >
10360	25 COZ Slip Freq >
10361	25 In Sync
10362	25 CS In Progress
10363	25 SS In Progress
10364	25 COZ In Progress
10365	25 System Split LO
10366	60VTF-Bus

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Event Record	8 Registers[3]	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30034	Phase ab Nominal Volt	FP_32BITS_3DP[1]	Vab Degrees
30036	Phase bc Nominal Volt	FP_32BITS_3DP[1]	Vbc Degrees
30038	Phase ca Nominal Volt	FP_32BITS_3DP[1]	Vca Degrees
30040	Phase a Nominal Volt	FP_32BITS_3DP[1]	Va Degrees
30042	Phase b Nominal Volt	FP_32BITS_3DP[1]	Vb Degrees
30044	Phase c Nominal Volt	FP_32BITS_3DP[1]	Vc Degrees
30048	Vzps	FP_32BITS_3DP[1]	Vzps xVnom
30050	Vpps	FP_32BITS_3DP[1]	Vpps xVnom
30052	Vnps	FP_32BITS_3DP[1]	Vnps xVnom
30054	Vzps	FP_32BITS_3DP[1]	Vzps Degrees
30056	Vpps	FP_32BITS_3DP[1]	Vpps Degrees
30058	Vnps	FP_32BITS_3DP[1]	Vnps Degrees
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30076	Phase A Nominal	FP_32BITS_3DP[1]	Ia x Inom
30078	Phase B Nominal	FP_32BITS_3DP[1]	Ib x Inom
30080	Phase C Nominal	FP_32BITS_3DP[1]	Ic x Inom

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Address	Name	Format	Description
30082	Phase A Nominal	FP_32BITS_3DP[1]	Ia Degrees
30084	Phase B Nominal	FP_32BITS_3DP[1]	Ib Degrees
30086	Phase C Nominal	FP_32BITS_3DP[1]	Ic Degrees
30088	In Primary	FP_32BITS_3DP[1]	IN kA
30090	In Secondary	FP_32BITS_3DP[1]	IN A
30092	In Nominal	FP_32BITS_3DP[1]	IN xInom
30094	Ig Primary	FP_32BITS_3DP[1]	IG kA
30096	Ig Secondary	FP_32BITS_3DP[1]	IG A
30098	Ig Nominal	FP_32BITS_3DP[1]	IG xInom
30100	Izps Nominal	FP_32BITS_3DP[1]	Izps xIn
30102	Ipps Nominal	FP_32BITS_3DP[1]	Ipps xIn
30104	Inps Nominal	FP_32BITS_3DP[1]	Inps xIn
30106	Izps Nominal	FP_32BITS_3DP[1]	Izps Degrees
30108	Ipps Nominal	FP_32BITS_3DP[1]	Ipps Degrees
30110	Inps Nominal	FP_32BITS_3DP[1]	Inps Degrees
30112	Active Power A	FP_32BITS_3DP[1]	A Phase MW
30114	Active Power B	FP_32BITS_3DP[1]	B Phase MW
30116	Active Power C	FP_32BITS_3DP[1]	C Phase MW
30118	3P Power	FP_32BITS_3DP[1]	3 Phase MW
30120	Reactive Power A	FP_32BITS_3DP[1]	A Phase MVAr
30122	Reactive Power B	FP_32BITS_3DP[1]	B Phase MVAr
30124	Reactive Power C	FP_32BITS_3DP[1]	C Phase MVAr
30126	3P Reactive Power Q	FP_32BITS_3DP[1]	3 Phase MVAr
30128	Apparent Power A	FP_32BITS_3DP[1]	A Phase MVA
30130	Apparent Power B	FP_32BITS_3DP[1]	B Phase MVA
30132	Apparent Power C	FP_32BITS_3DP[1]	C Phase MVA
30134	3P Apparent Power	FP_32BITS_3DP[1]	3 Phase MVA
30136	Power Factor A	FP_32BITS_3DP[1]	Phase A
30138	Power Factor B	FP_32BITS_3DP[1]	Phase B
30140	Power Factor C	FP_32BITS_3DP[1]	Phase C
30142	3P Power Factor	FP_32BITS_3DP[1]	3 Phase
30144	Active Energy Export	FP_32BITS_3DP[1]	3 Phase MWh
30146	Active Energy Import	FP_32BITS_3DP[1]	3 Phase MWh
30148	Reactive Energy Export	FP_32BITS_3DP[1]	3 Phase MWh
30150	Reactive Energy Import	FP_32BITS_3DP[1]	3 Phase MWh
30152	Thermal Status Ph A	UINT16[2]	%
30153	Thermal Status Ph B	UINT16[2]	%
30154	Thermal Status Ph C	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30169	Waveform Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V
30176	VN Primary	FP_32BITS_3DP[1]	VN kV
30178	VN Secondary	FP_32BITS_3DP[1]	VN V
30180	VN Secondary	FP_32BITS_3DP[1]	VN Degrees
30182	Vx Primary	FP_32BITS_3DP[1]	Vx kV
30184	Vx Secondary	FP_32BITS_3DP[1]	Vx V
30186	Vx Secondary	FP_32BITS_3DP[1]	Vx Degrees
30193	Ia Max Demand	FP_32BITS_3DP[1]	Ia kA
30194	Ib Max Demand	FP_32BITS_3DP[1]	Ib kA
30195	Ic Max Demand	FP_32BITS_3DP[1]	Ic kA
30196	Power Max Demand	FP_32BITS_3DP[1]	3 Phase MW
30197	VARs Max Demand	FP_32BITS_3DP[1]	3 Phase MVAr
30213	Fault Distance Percent	FP_32BITS_3DP	Fault Distance Percent
30215	Fault Reactance	FP_32BITS_3DP	Fault Reactance
30217	Vy Primary	FP_32BITS_3DP	Vy kV
30219	Vy Secondary	FP_32BITS_3DP	Vy V
30223	Vz Primary	FP_32BITS_3DP	Vz kV
30225	Vz Secondary	FP_32BITS_3DP	Vz V
30229	Vxy Primary	FP_32BITS_3DP	Vxy kV

Address	Name	Format	Description
30231	Vyz Primary	FP_32BITS_3DP	Vyz kV
30233	Vzx Primary	FP_32BITS_3DP	Vzx kV
30241	CB Total Trip Count	UINT32	CB Total Trip Count
30243	CB Delta Trip Count	UINT32	CB Delta Trip Count
30245	CB Count To AR Block	UINT32	CB Count To AR Block
30247	CB Frequent Ops Count	UINT32	CB Frequent Ops Count
30249	CB LO Handle Ops	UINT32	CB LO Handle Ops
30251	Sag SIARFI Pole1	UINT32	Sag SIARFI Pole1
30253	Sag SMARFI Pole1	UINT32	Sag SMARFI Pole1
30255	Sag STARFI Pole1	UINT32	Sag STARFI Pole1
30257	Sag SIARFI Pole2	UINT32	Sag SIARFI Pole2
30259	Sag SMARFI Pole2	UINT32	Sag SMARFI Pole2
30261	Sag STARFI Pole2	UINT32	Sag STARFI Pole2
30263	Sag SIARFI Pole3	UINT32	Sag SIARFI Pole3
30265	Sag SMARFI Pole3	UINT32	Sag SMARFI Pole3
30267	Sag STARFI Pole3	UINT32	Sag STARFI Pole3
30269	Interrupt Pole1	UINT32	P1 Interrupts
30271	Interrupt Pole2	UINT32	P2 Interrupts
30273	Interrupt Pole3	UINT32	P3 Interrupts
30275	Swell SIARFI Pole1	UINT32	Swell SIARFI Pole1
30277	Swell SMARFI Pole1	UINT32	Swell SMARFI Pole1
30279	Swell STARFI Pole1	UINT32	Swell STARFI Pole1
30281	Swell SIARFI Pole2	UINT32	Swell SIARFI Pole2
30283	Swell SMARFI Pole2	UINT32	Swell SMARFI Pole2
30285	Swell STARFI Pole2	UINT32	Swell STARFI Pole2
30287	Swell SIARFI Pole3	UINT32	Swell SIARFI Pole3
30289	Swell SMARFI Pole3	UINT32	Swell SMARFI Pole3
30291	Swell STARFI Pole3	UINT32	Swell STARFI Pole3
30293	Bus Freq	FP_32BITS_3DP	Vx Frequency
30295	Phase Diff	FP_32BITS_3DP	25 Phase Diff
30297	Slip Freq	FP_32BITS_3DP	25 Slip Freq
30299	Voltage Diff	FP_32BITS_3DP	25 Voltage Diff

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 and the Point List Tables provided should provide a complete configuration/interoperability guide for communicating with a device implementing the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library.

DNP V3.0 DEVICE PROFILE DOCUMENT (Also see the DNP 3.0 Implementation Table Section 5.2.)	
Vendor Name: **Siemens Protection Devices Ltd.**	
Device Name: 7SR224 **, using the Triangle MicroWorks, Inc. DNP3 Slave Source Code Library, Version 3.**	

Highest DNP Level Supported:
 	
   For Requests: **Level 3**
   For Responses: **Level 3**
	Device Function:
	
	  ☐ Master
	  ☒ **Slave**

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.**	

Maximum Data Link Frame Size (octets):
 	
   Transmitted: **256**
   Received   **256**
	Maximum Application Fragment Size (octets):
	
	   Transmitted: **2048**
	   Received **2048**

Maximum Data Link Re-tries:
 	
  ☐ None
  ☒ **Fixed (3)**
  ☐ Configurable from 0 to 65535
	Maximum Application Layer Re-tries:
	
	  ☒ **None**
	  ☐ Configurable

Requires Data Link Layer Confirmation:
 	
  ☒ **Never**
  ☐ Always
  ☐ Sometimes
  ☐ Configurable as: Never, Only for multi-frame messages, or Always	

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."	

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DNP V3.0
DEVICE PROFILE DOCUMENT
(Also see the DNP 3.0 Implementation Table Section 5.2.)

Timeouts while waiting for:

Data Link Confirm:	☐ None	☒ Fixed at 2sec		Variable	Configurable**.**
Complete Appl. Fragment:	☒ **None**	Fixed at ____		Variable	Configurable
Application Confirm:	None	☒ Fixed at 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:	Reports time-tagged Binary Input Change Events when no specific variation requested:
Never Only time-tagged Only non-time-tagged ☒ **Configurable to send one or the other**	Never Binary Input Change With Time Binary Input Change With Relative Time ☒ **Configurable**
Sends Unsolicited Responses:	Sends Static Data in Unsolicited Responses:
Never ☒ **Configurable** Only certain objects Sometimes (attach explanation) ☒ **ENABLE/DISABLE UNSOLICITED Function codes supported**	☒ **Never** When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation:	Counters Roll Over at:
☒ **No Counters Reported** Configurable Default Object Default Variation: Point-by-point list attached	☒ **No Counters Reported** Configurable (attach explanation) 16 Bits 32 Bits Other Value: _____ Point-by-point list attached

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DNP V3.0
DEVICE PROFILE DOCUMENT
(Also see the DNP 3.0 Implementation Table Section 5.2.)

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**		

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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-stop) 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-stop) 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)		
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-stop) 17, 28 (index – see note 1)
			1 (write)	00, 01 (start-stop)		

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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	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-stop) 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
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-stop) 17, 28 (index – see note 2)

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	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-stop) 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-stop) 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-stop) 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-stop) 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-stop) 17, 28 (index – see note 1)
32	0	Analog Change Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1 (default – see note 1)	32-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	5	short floating point Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 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)
32	6	long floating point Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	7	short floating point Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	8	long floating point Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
50	0	Time and Date				
50	1 (default – see note 1)	Time and Date	1 (read) 2 (write)	07, (limited qty = 1) 07 (limited qty = 1)	129 (response)	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 = 1)
51	2	Unsychronised Time and Date CTO			129 (response) 130 (unsol. Resp)	07 (limited qty = 1)
52	1	Time Delay Coarse			129 (response)	07 (limited qty = 1)
52	2	Time Delay Fine			129 (response)	07 (limited 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) 20 (enbl. unsol.) 21 (dab. unsol.) 22 (assign class)	06 (no range, or all) 07, 08 (limited qty) 06 (no range, or all)		
60	3	Class 2 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		

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)
			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 (response)	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			

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)

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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.

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

Binary Input Points

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

Binary Input Points Static (Steady-State) Object Number:　**1** Change Event Object Number:　**2** Default Static Variation reported when variation 0 requested:　**2 (Binary Input with flags)** Default Change Event Variation reported when variation 0 requested:　**2 (Binary Input with absolute time)**		
Point Index	Name/Description	Default Change Event Assigned Class (1, 2, 3 or none)
1	Binary Input 1	2
2	Binary Input 2	2
3	Binary Input 3	2
4	Binary Input 4	2
5	Binary Input 5	2
6	Binary Input 6	2
7	Binary Input 7	2
8	Binary Input 8	2
9	Binary Input 9	2
10	Binary Input 10	2
11	Binary Input 11	2
12	Binary Input 12	2
13	Binary Input 13	2
14	Binary Input 14	2
15	Binary Input 15	2
16	Binary Input 16	2
17	Binary Input 17	2
18	Binary Input 18	2
19	Binary Input 19	2
20	Binary Input 20	2
21	Binary Input 21	2
22	Binary Input 22	2
23	Binary Input 23	2
24	Binary Input 24	2
25	Binary Input 25	2
26	Binary Input 26	2
27	Binary Input 27	2
28	Binary Input 28	2
29	Binary Input 29	2
30	Binary Input 30	2
31	Binary Input 31	2
32	Binary Input 32	2
33	Binary Input 33	2
35	Remote mode	2
36	Service mode	2
37	Local mode	2
38	Local & Remote	2

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Default Static Variation reported when variation 0 requested: **2 (Binary Input with flags)**
Default Change Event Variation reported when variation 0 requested: **2 (Binary Input with absolute time)**

Point Index	Name/Description	Default Change Event Assigned Class (1, 2, 3 or none)
41	Trip Circuit Fail	2
42	A-Starter	2
43	B-Starter	2
44	C-Starter	2
45	General Starter	2
46	VTS Alarm	2
47	Earth Fault Forward/Line	2
48	Earth Fault Reverse/Busbar	2
49	Start/Pick-up N	2
50	Fault Forward/Line	2
51	Fault Reverse/Busbar	2
52	51-1	2
53	50-1	2
56	51G-1	2
57	50G-1	2
58	51-2	2
59	50-2	2
62	51G-2	2
63	50G-2	2
64	CTS Alarm	2
65	46IT	2
66	46DT	2
67	47-1	2
68	47-2	2
69	46BC	2
70	27/59-1	2
71	27/59-2	2
72	27/59-3	2
73	27/59-4	2
74	59NIT	2
75	59NDT	2
76	81-1	2
77	81-2	2
78	81-3	2
79	81-4	2
80	Auto-reclose active	2
81	CB on by auto reclose	2
82	Reclaim	2
83	Lockout	2
86	51-3	2
87	50-3	2
90	51G-3	2
91	50G-3	2
92	51-4	2
93	50-4	2

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Default Static Variation reported when variation 0 requested: **2 (Binary Input with flags)**
Default Change Event Variation reported when variation 0 requested: **2 (Binary Input with absolute time)**

Point Index	Name/Description	Default Change Event Assigned Class (1, 2, 3 or none)
		2
96	51G-4	2
97	50G-4	2
98	Cold Load Active	2
99	E/F Protection Out	2
100	P/F Inst Protection Inhibited	2
101	E/F Inst Protection Inhibited	2
102	SEF Inst Protection Inhibited	2
103	Ext Inst Protection Inhibited	2
105	Battery Test Pass	2
106	Battery Test Fail	2
107	Battery Ohms High	2
108	Battery Volts Low	2
109	Battery Volts High	2
110	Battery Healthy	2
112	Capacitor Ready	2
117	51SEF-1	2
118	50SEF-1	2
119	51SEF-2	2
120	50SEF-2	2
121	51SEF-3	2
122	50SEF-3	2
123	51SEF-4	2
124	50SEF-4	2
125	SEF Out	2
126	Trip Circuit Fail 1	2
127	Trip Circuit Fail 2	2
128	Trip Circuit Fail 3	2
129	CB Total Trip Count	2
130	CB Delta Trip Count	2
131	CB Count To AR Block	2
132	CB Frequent Ops Count	2
133	I^2t CB Wear	2
134	CB-A Reclaim	2
135	CB-A Lockout	2
136	CB-A Total Trip Count	2
137	CB-A Delta Trip Count	2
138	CB-A Count To AR Block	2
139	CB-A I^2t Wear	2
140	CB-A Frequent Ops Count	2
141	CB-A LO Handle Ops Count	2
142	CB-A 79 AR In progress	2
143	PhA Inst Protection Inhibited	2
144	50BF-1 Pole A	2

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Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Default Static Variation reported when variation 0 requested: **2 (Binary Input with flags)**
Default Change Event Variation reported when variation 0 requested: **2 (Binary Input with absolute time)**

Point Index	Name/Description	Default Change Event Assigned Class (1, 2, 3 or none)
145	50BF-2 Pole A	2
146	Cap-A Ready	2
147	Cap-A Test Pass	2
148	Cap-A Test Fail	2
149	Cap-A Recovery Fail	2
150	Cap-A Test	2
151	CB-B Reclaim	2
152	CB-B Lockout	2
153	CB-B Total Trip Count	2
154	CB-B Delta Trip Count	2
155	CB-B Count To AR Block	2
156	CB-B I^2t Wear	2
157	CB-B Frequent Ops Count	2
158	CB-B LO Handle Ops Count	2
159	CB-B 79 AR In progress	2
160	PhB Inst Protection Inhibited	2
161	50BF-1 Pole B	2
162	50BF-2 Pole B	2
163	Cap-B Ready	2
164	Cap-B Test Pass	2
165	Cap-B Test Fail	2
166	Cap-B Recovery Fail	2
167	Cap-B Test	2
168	CB-C Reclaim	2
169	CB-C Lockout	2
170	CB-C Total Trip Count	2
171	CB-C Delta Trip Count	2
172	CB-C Count To AR Block	2
173	CB-C I^2t Wear	2
174	CB-C Frequent Ops Count	2
175	CB-C LO Handle Ops Count	2
176	CB-C 79 AR In progress	2
177	PhC Inst Protection Inhibited	2
178	50BF-1 Pole C	2
179	50BF-2 Pole C	2
180	Cap-C Ready	2
181	Cap-C Test Pass	2
182	Cap-C Test Fail	2
183	Cap-C Recovery Fail	2
184	Cap-C Test	2
185	Pole Discrepancy	2
186	LOV Primed	2
187	LOV Trip	2
188	LOV Close	2
189	LOV In Progress	2
190	BI 34	2
191	BI 35	2
192	BI 36	2

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Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Default Static Variation reported when variation 0 requested: **2 (Binary Input with flags)**
Default Change Event Variation reported when variation 0 requested: **2 (Binary Input with absolute time)**

Point Index	Name/Description	Default Change Event Assigned Class (1, 2, 3 or none)
193	BI 37	2
194	BI 38	2
195	BI 39	2
196	BI 40	2
197	BI 41	2
198	BI 42	2
199	BI 43	2
200	BI 44	2
201	BI 45	2
202	BI 46	2
203	BI 47	2
204	BI 48	2
205	BI 49	2
206	BI 50	2
207	Close Circuit Fail 1	2
208	Close Circuit Fail 2	2
209	Close Circuit Fail 3	2
210	Close Circuit Fail	2
211	50BF-1	2
212	50BF-2	2
213	49-Alarm	2
214	49-Trip	2
215	64H	2
216	Vx27/59	2
217	37-1	2
218	37-2	2
219	Cold Load Active	2
220	CB LO Handle Ops Count	2
221	Battery Recovery Fail	2
222	Trip Time Alarm	2
223	SEF Forward/Line	2
224	SEF Reverse/Busbar	2
225	General Alarm 1	2
226	General Alarm 2	2
227	General Alarm 3	2
228	General Alarm 4	2
229	General Alarm 5	2
230	General Alarm 6	2
231	General Alarm 7	2
232	General Alarm 8	2
233	General Alarm 9	2
234	General Alarm 10	2
235	General Alarm 11	2
236	General Alarm 12	2
237	Quick Logic E1	2
238	Quick Logic E2	2
239	Quick Logic E3	2
240	Quick Logic E4	2

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Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Default Static Variation reported when variation 0 requested: **2 (Binary Input with flags)**
Default Change Event Variation reported when variation 0 requested: **2 (Binary Input with absolute time)**

Point Index	Name/Description	Default Change Event Assigned Class (1, 2, 3 or none)
241	Quick Logic E5	2
242	Quick Logic E6	2
243	Quick Logic E7	2
244	Quick Logic E8	2
245	Quick Logic E9	2
246	Quick Logic E10	2
247	Quick Logic E11	2
248	Quick Logic E12	2
249	Quick Logic E13	2
250	Quick Logic E14	2
251	Quick Logic E15	2
252	Quick Logic E16	2
375	LOV A Live	2
376	LOV B Live	2
377	LOV C Live	2
378	LOV X Live	2
379	LOV Y Live	2
380	LOV Z Live	2
381	LOV A	2
382	LOV B	2
383	LOV C	2
384	LOV X	2
385	LOV Y	2
386	LOV Z	2
387	25 System Split	2
388	25 Live Line	2
389	25 Live Bus	2
390	25 Line U/V	2
391	25 Bus U/V	2
392	25 Voltage Dif >	2
393	25 CS Slip Freq >	2
394	25 SS Slip Freq >	2
395	25 COZ Slip Freq >	2
396	25 In Sync	2
397	25 CS In Progress	2
398	25 SS In Progress	2
399	25 COZ In Progress	2
400	25 System Split LO	2
401	60VTF-Bus	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 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.

Binary Output Status Points
  Static Object Number: **10**
  Change Event Object Number: **11**
  Default Variation reported when variation 0 requested: **2 (Binary Output with flags)**
  Default Change Event variation 0 requested: **2 (Binary Output absolute time)**
Control Relay Output Blocks
  Object Number: **12**
 All objects are default class 2

Point Index	Name/Description	Supported Control Relay Output Block Fields
1	Binary Output 1	Pulse On/Latch On
2	Binary Output 2	Pulse On/Latch On
3	Binary Output 3	Pulse On/Latch On
4	Binary Output 4	Pulse On/Latch On
5	Binary Output 5	Pulse On/Latch On
6	Binary Output 6	Pulse On/Latch On
7	Binary Output 7	Pulse On/Latch On
8	Binary Output 8	Pulse On/Latch On
9	Binary Output 9	Pulse On/Latch On
10	Binary Output 10	Pulse On/Latch On
11	Binary Output 11	Pulse On/Latch On
12	Binary Output 12	Pulse On/Latch On
13	Binary Output 13	Pulse On/Latch On
14	Binary Output 14	Pulse On/Latch On
15	Binary Output 15	Pulse On/Latch On
16	Binary Output 16	Pulse On/Latch On
17	Binary Output 17	Pulse On/Latch On
18	Binary Output 18	Pulse On/Latch On
19	Binary Output 19	Pulse On/Latch On
20	Binary Output 20	Pulse On/Latch On
21	Binary Output 21	Pulse On/Latch On
22	Binary Output 22	Pulse On/Latch On
23	Binary Output 23	Pulse On/Latch On
24	Binary Output 24	Pulse On/Latch On
25	Binary Output 25	Pulse On/Latch On

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Binary Output Status Points
  Static Object Number: **10**
  Change Event Object Number: **11**
  Default Variation reported when variation 0 requested: **2 (Binary Output with flags)**
  Default Change Event variation 0 requested: **2 (Binary Output absolute time)**
Control Relay Output Blocks
  Object Number: **12**
  All objects are default class 2

Point Index	Name/Description	Supported Control Relay Output Block Fields
26	Binary Output 26	Pulse On/Latch On
27	Binary Output 27	Pulse On/Latch On
28	Binary Output 28	Pulse On/Latch On
29	Binary Output 29	Pulse On/Latch On
30	Binary Output 30	Pulse On/Latch On
31	Binary Output 31	Pulse On/Latch On
32	Binary Output 32	Pulse On/Latch On
33	LED reset	Pulse On/Latch On
34	Settings Group 1	Pulse On/Latch On
35	Settings Group 2	Pulse On/Latch On
36	Settings Group 3	Pulse On/Latch On
37	Settings Group 4	Pulse On/Latch On
38	Settings Group 5	Pulse On/Latch On
39	Settings Group 6	Pulse On/Latch On
40	Settings Group 7	Pulse On/Latch On
41	Settings Group 8	Pulse On/Latch On
42	Auto-reclose on/off	Pulse On / Pulse Off / Latch On / Latch Off
43	Hot Line Working on/off	Pulse On / Pulse Off / Latch On / Latch Off
44	E/F off/on	Pulse On / Pulse Off / Latch On / Latch Off
45	SEF off/on	Pulse On / Pulse Off / Latch On / Latch Off
46	Inst Protection off/on	Pulse On / Pulse Off / Latch On / Latch Off
47	LOV off/on	Pulse On / Pulse Off / Latch On / Latch Off
48	Reset CB Total Trip Count	Pulse On/Latch On
49	Reset CB Delta Trip Count	Pulse On/Latch On
50	Reset CB Count To AR Block	Pulse On/Latch On
51	Reset CB Frequent Ops Count	Pulse On/Latch On
52	Reset CB LO Handle Ops Count	Pulse On/Latch On
53	Reset I^2t CB Wear	Pulse On/Latch On
54	CB 1	Pulse On / Pulse Off / Latch On / Latch Off
55	CB 1 Trip & Reclose	Pulse On/Latch On
56	CB 1 Trip & Lockout	Pulse On/Latch On
57	Battery Test	Pulse On/Latch On
58	Capacitor Test	Pulse On/Latch On
59	Demand metering reset	Pulse On/Latch On
60	CB-A	Pulse On / Pulse Off / Latch On / Latch Off
61	CB-B	Pulse On / Pulse Off / Latch On / Latch Off
62	CB-C	Pulse On / Pulse Off / Latch On / Latch Off
63	CB-A Trip & Lockout	Pulse On/Latch On
64	CB-B Trip & Lockout	Pulse On/Latch On
65	CB-C Trip & Lockout	Pulse On/Latch On
66	Mode A - 3PTrip3PLO	Pulse On/Latch On
67	Mode B - 1PTrip3PLO	Pulse On/Latch On
68	Mode C - 1PTrip1PLO	Pulse On/Latch On
69	Reset CB-A Total Trip Count	Pulse On/Latch On
70	Reset CB-B Total Trip Count	Pulse On/Latch On
71	Reset CB-C Total Trip Count	Pulse On/Latch On

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Binary Output Status Points
  Static Object Number: **10**
  Change Event Object Number: **11**
  Default Variation reported when variation 0 requested: **2 (Binary Output with flags)**
  Default Change Event variation 0 requested: **2 (Binary Output absolute time)**
Control Relay Output Blocks
  Object Number: **12**
 All objects are default class 2

Point Index	Name/Description	Supported Control Relay Output Block Fields
72	Reset CB-A Delta Trip Count	Pulse On/Latch On
73	Reset CB-B Delta Trip Count	Pulse On/Latch On
74	Reset CB-C Delta Trip Count	Pulse On/Latch On
75	Reset CB-A Count To AR Block	Pulse On/Latch On
76	Reset CB-B Count To AR Block	Pulse On/Latch On
77	Reset CB-C Count To AR Block	Pulse On/Latch On
78	Reset CB-A Frequent Ops Count	Pulse On/Latch On
79	Reset CB-B Frequent Ops Count	Pulse On/Latch On
80	Reset CB-C Frequent Ops Count	Pulse On/Latch On
81	Reset CB-A LO Handle Ops Count	Pulse On/Latch On
82	Reset CB-B LO Handle Ops Count	Pulse On/Latch On
83	Reset CB-C LO Handle Ops Count	Pulse On/Latch On
84	Reset CB-A I^2t Wear	Pulse On/Latch On
85	Reset CB-B I^2t Wear	Pulse On/Latch On
86	Reset CB-C I^2t Wear	Pulse On/Latch On
87	Reset Energy Meters	Pulse On/Latch On
88	Remote Mode	Pulse On/Latch On
89	Service Mode	Pulse On/Latch On
90	Local Mode	Pulse On/Latch On
91	Local & Remote	Pulse On/Latch On
92	Man Override Sync on/off	Pulse On / Pulse Off / Latch On / Latch Off
93	79 Override Sync on/off	Pulse On / Pulse Off / Latch On / Latch Off

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Analogue Inputs

The following table lists Analogue Inputs (Object 30). It is important to note that 16-bit and 32-bit variations of Analogue Inputs, Analogue Output Control Blocks, and Analogue 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 analogue 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 analogue input event buffer size is set 30.

Analog Inputs
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Default Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input with Flag)**
Default Change Event Variation reported when variation 0 requested: **4 (16-Bit Analog Change Event with Time)**

Point Index	Name/Description	Scaling Factor	Deadband	Def. Class	Def. Static Object	Def/ Event Object
0	Frequency (Hz)	100.0	1	3	2	4
1	Vab Primary (kV)	0.001	1000	3	2	4
2	Vbc Primary (kV)	0.001	1000	3	2	4
3	Vca Primary (kV)	0.001	1000	3	2	4
4	Va Primary (kV)	0.001	1000	3	2	4
5	Vb Primary (kV)	0.001	1000	3	2	4
6	Vc Primary (kV)	0.001	1000	3	2	4
7	Va Secondary (V)	100.0	1	3	2	4
8	Vb Secondary (V)	100.0	1	3	2	4
9	Vc Secondary (V)	100.0	1	3	2	4
21	Vzps Magnitude (V)	100.0	1	3	2	4
22	Vpps Magnitude (V)	100.0	1	3	2	4
23	Vnps Magnitude (V)	100.0	1	3	2	4
31	Ia Primary (kA)	0.001	1000	3	2	4
32	Ib Primary (kA)	0.001	1000	3	2	4
33	Ic Primary (kA)	0.001	1000	3	2	4
34	Ia Secondary (A)	100.0	1	3	2	4
35	Ib Secondary (A)	100.0	1	3	2	4
36	Ic Secondary (A)	100.0	1	3	2	4
37	Ia Nominal Magnitude (xIn)	100.0	1	3	2	4
38	Ib Nominal Magnitude (xIn)	100.0	1	3	2	4
39	Ic Nominal Magnitude (xIn)	100.0	1	3	2	4
43	In Primary (kA)	0.001	1000	3	2	4
44	In Secondary (A)	100.0	1	3	2	4
45	In Nominal (xIn)	100.0	1	3	2	4
46	Ig Primary (kA)	0.001	1000	3	2	4
47	Ig Secondary (A)	100.0	1	3	2	4
48	Ig Nominal (xIn)	100.0	1	3	2	4
51	Izps Nominal Magnitude (xIn)	100.0	1	3	2	4
52	Ipps Nominal Magnitude (xIn)	100.0	1	3	2	4
53	Inps Nominal Magnitude (xIn)	100.0	1	3	2	4
57	Active Power A Phase W	0.000001	1000000	3	2	4
58	Active Power B Phase W	0.000001	1000000	3	2	4
59	Active Power C Phase W	0.000001	1000000	3	2	4
60	3 Phase Real Power (P) (MW)	0.000001	100000	3	2	4
61	Reactive Power A Phase VAr	0.000001	1000000	3	2	4
62	Reactive Power B Phase VAr	0.000001	1000000	3	2	4
63	Reactive Power C Phase VAr	0.000001	1000000	3	2	4
64	3 Phase Reactive Power (Q) (MVAr)	0.000001	100000	3	2	4
65	Apparent Power A Phase VA	0.000001	1000000	3	2	4

Analog Inputs
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Default Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input with Flag)**
Default Change Event Variation reported when variation 0 requested: **4 (16-Bit Analog Change Event with Time)**

Point Index	Name/Description	Scaling Factor	Deadband	Def. Class	Def. Static Object	Def/ Event Object
66	Apparent Power B Phase VA	0.000001	1000000	3	2	4
67	Apparent Power C Phase VA	0.000001	1000000	3	2	4
68	3 Phase Apparent Power (S) (MVA)	0.000001	100000	3	2	4
71	Power Factor(PhA) (Cos θ)	1.0	5	3	2	4
72	Power Factor(PhB) (Cos θ)	1.0	5	3	2	4
73	Power Factor(PhC) (Cos θ)	1.0	5	3	2	4
74	Power Factor(3P) (Cos θ)	1.0	5	3	2	4
75	Act Energy Exp (MWh)	0.001	1000	3	2	4
76	Act Energy Imp (MWh)	0.001	1000	3	2	4
77	React Energy Exp (MWh)	0.001	1000	3	2	4
78	React Energy Imp (MWh)	0.001	1000	3	2	4
81	Thermal Status Ph A (%)	100.0	1	3	2	4
82	Thermal Status Ph B (%)	100.0	1	3	2	4
83	Thermal Status Ph C (%)	100.0	1	3	2	4
99	Vab Secondary (V)	100.0	1	3	2	4
100	Vbc Secondary (V)	100.0	1	3	2	4
101	Vca Secondary (V)	100.0	1	3	2	4
102	Vn Primary (kV)	0.001	1000	3	2	4
103	Vn Secondary (V)	100.0	1	3	2	4
105	Vx Primary (kV)	0.001	1000	3	2	4
106	Vx Secondary Magnitude (V)	100.0	1	3	2	4
108	Ia Max Demand (kA)	100.0	1	3	2	4
109	Ib Max Demand (kA)	100.0	1	3	2	4
110	Ic Max Demand (kA)	100.0	1	3	2	4
111	Power Max Demand (MW)	100.0	1	3	2	4
112	VARs Max Demand (VAr)	100.0	1	3	2	4
120	Vy Primary	0.001	1000	3	2	4
121	Vy Secondary	100.0	1	3	2	4
123	Vz Primary	0.001	1000	3	2	4
124	Vz Secondary	100.0	1	3	2	4
126	Vxy Primary	0.001	1000	3	2	4
127	Vyz Primary	0.001	1000	3	2	4
128	Vzx Primary	0.001	1000	3	2	4
129	Vxy Secondary	100.0	1	3	2	4
130	Vyz Secondary	100.0	1	3	2	4
131	Vzx Secondary	100.0	1	3	2	4
135	CB Total Trip Count	1	1	3	2	4
136	CB Delta Trip Count	1	1	3	2	4
137	CB Count To AR Block	1	1	3	2	4
138	CB Frequent Ops Count	1	1	3	2	4
139	CB LO Handle Ops	1	1	3	2	4
140	Sag SIARFI Pole1	1	1	3	2	4
141	Sag SMARFI Pole1	1	1	3	2	4
142	Sag STARFI Pole1	1	1	3	2	4
143	Sag SIARFI Pole2	1	1	3	2	4
144	Sag SMARFI Pole2	1	1	3	2	4

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Analog Inputs
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Default Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input with Flag)**
Default Change Event Variation reported when variation 0 requested: **4 (16-Bit Analog Change Event with Time)**

Point Index	Name/Description	Scaling Factor	Deadband	Def. Class	Def. Static Object	Def/ Event Object
145	Sag STARFI Pole2	1	1	3	2	4
146	Sag SIARFI Pole3	1	1	3	2	4
147	Sag SMARFI Pole3	1	1	3	2	4
148	Sag STARFI Pole3	1	1	3	2	4
149	Interrupt Pole1	1	1	3	2	4
150	Interrupt Pole2	1	1	3	2	4
151	Interrupt Pole3	1	1	3	2	4
152	Swell SIARFI Pole1	1	1	3	2	4
153	Swell SMARFI Pole1	1	1	3	2	4
154	Swell STARFI Pole1	1	1	3	2	4
155	Swell SIARFI Pole2	1	1	3	2	4
156	Swell SMARFI Pole2	1	1	3	2	4
157	Swell STARFI Pole2	1	1	3	2	4
158	Swell SIARFI Pole3	1	1	3	2	4
159	Swell SMARFI Pole3	1	1	3	2	4
160	Swell STARFI Pole3	1	1	3	2	4
162	Phase Diff	100	1	3	2	4
163	Slip Freq	100	1	3	2	4
164	Voltage Diff	100	1	3	2	4
165	Ia Fault Last Trip	1	0	3	1	3
166	Ib Fault Last Trip	1	0	3	1	3
167	Ic Fault Last Trip	1	0	3	1	3
168	Va Fault Last Trip	1	0	3	1	3
169	Vb Fault Last Trip	1	0	3	1	3
170	Vc Fault Last Trip	1	0	3	1	3
171	In Fault Last Trip	1	0	3	1	3
172	Ig Fault Last Trip	1	0	3	1	3
173	Isef Fault Last Trip	1	0	3	1	3

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5.4 IEC60870-5-101 Introduction

This section describes the IEC 60870-5-101 protocol implementation in the relays.   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.

This protocol can be set to use any or all of the relays hardware interfaces (USB, Fibre Optic, RS232 and RS485).

Cause of Transmission
Shaded boxes are not required.

Blank = function or ASDU is not used.

Mark type identification/cause of transmission combinations:

"**X**" if used only in the standard direction

The cause of transmission (COT) for each information object type is listed below.

		periodic, cyclic	background scan	spontaneous	initialized	request or requested	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	return info caused by a remote cmd	return info caused by a local cmd	file transfer	interrogated by group \<number\>	request by group \<n\> counter request	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
\<1\>	M_SP_NA_1		X	X		X						X	X		X					
\<2\>	M_SP_TA_1			X		X						X	X							
\<3\>	M_DP_NA_1		X	X		X						X	X		X					
\<4\>	M_DP_TA_1			X		X						X	X							
\<5\>	M_ST_NA_1		X	X		X						X	X		X					
\<6\>	M_ST_TA_1			X		X						X	X							
\<7\>	M_BO_NA_1		X	X		X									X					
\<8\>	M_BO_TA_1			X		X														
\<9\>	M_ME_NA_1	X	X	X		X									X					
\<10\>	M_ME_TA_1			X		X														
\<11\>	M_ME_NB_1	X	X	X		X									X					
\<12\>	M_ME_TB_1			X		X														
\<13\>	M_ME_NC_1	X	X	X		X									X					
\<14\>	M_ME_TC_1			X		X														
\<15\>	M_IT_NA_1			X												X				
\<16\>	M_IT_TA_1			X												X				
\<17\>	M_EP_TA_1			X																
\<18\>	M_EP_TB_1			X																
\<19\>	M_EP_TC_1			X																
\<21\>	M_ME_ND_1	X	X	X		X									X					
\<30\>	M_SP_TB_1			X		X						X	X							
\<31\>	M_DP_TB_1			X		X						X	X							

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		periodic, cyclic	background scan	spontaneous	initialized	request or requested	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	return info caused by a remote cmd	return info caused by a local cmd	file transfer	interrogated by group <number>	request by group <n> counter request	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<32>	M_ST_TB_1			X		X						X	X							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1			X		X														
<35>	M_ME_TE_1			X		X														
<36>	M_ME_TF_1			X		X														
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1			X																
<40>	M_EP_TF_1			X																
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1						X	X	X	X	X						X	X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X	X	X	X						X	X	X	X
<101>	C_CI_NA_1						X	X			X						X	X	X	X
<102>	C_RD_NA_1					X											X	X	X	X
<103>	C_CS_NA_1			X			X	X									X	X	X	X
<104>	C_TS_NA_1						X	X									X	X	X	X
<105>	C_RP_NA_1						X	X									X	X	X	X
<106>	C_CD_NA_1			X			X	X									X	X	X	X

Definitions

Process Information Object Type in Monitor Direction

Abbreviation	Description
M_SP_NA_1	Single point information
M_SP_TA_1	Single point information with time tag
M_DP_NA_1	Double point information
M_DP_TA_1	Double point information with time tag
M_ST_NA_1	Step position information
M_ST_TA_1	Step position information with time tag
M_BO_NA_1	Bit string of 32 bit
M_BO_TA_1	Bit string of 32 bit with time tag
M_ME_NA_1	Measured value, normalized value
M_ME_TA_1	Measured value, normalized value with time tag

M_ME_NB_1	Measured value, scaled value
M_ME_TB_1	Measured value, scaled value with time tag
M_ME_NC_1	Measured value, short floating point number
M_ME_TC_1	Measured value, short floating point number with time tag
M_IT_NA_1	Integrated totals
M_IT_TA_1	Integrated totals with time tag
M_EP_TA_1	Event of protection equipment with time tag
M_EP_TB_1	Packed start of events of protection equipment with time tag
M_EP_TC_1	Packed output circuit information of protection equipment with time tag
M_ME_ND_1	Measured value, normalized value without quality descriptor
M_SP_TB_1	Single point information with time tag CP56Time2A
M_DP_TB_1	Double point information with time tag CP56Time2A
M_ST_TB_1	Step position information with time tag CP56Time2A
M_BO_TB_1	Bit string of 32 bit with time tag CP56Time2A
M_ME_TD_1	Measured value, normalized value with time tag CP56Time2A
M_ME_TE_1	Measured value, scaled value with time tag CP56Time2A
M_ME_TF_1	Measured value, short floating point number with time tag CP56Time2A
M_IT_TB_1	Integrated totals with time tag CP56Time2A
M_EP_TD_1	Packed start of events of protection equipment with time tag CP56Time2A
M_EP_TE_1	Packed output circuit information of protection equipment with time tag CP56Time2A
M_EP_TF_1	Event of protection equipment with time tag CP56Time2A

Process Information Object Type in the Control Direction

Abbreviation	Description
C_SC_NA_1	Single command
C_DC_NA_1	Double command
C_RC_NA_1	Regulating step command

System Information Object Type in the Monitor Direction

Abbreviation	Description
ME_EI_NA_1	End of initialization

System Information Object Type in the Control Direction

Abbreviation	Description
C_IC_NA_1	Interrogation command
C_CI_NA_1	Counter interrogation
C_RD_NA_1	Read command
C_CS_NA_1	Clock Synchronisation command
C_TS_NB_1	Test command
C_RP_NC_1	Reset process command
C_CD_NA_1	Delay acquisition command

Information Object Addresses (IOA)

The following table lists information object address (IOA) definitions together with a description of the message and default function type of that message. Definitions with shaded area are not available on all relay models.

The Default type is given below but all items are user configurable.

IOA	Description	Default Type
1	Data Lost	M_SP_TB_1
4	Remote Mode	M_SP_TB_1 C_SC_NA_1
5	Service Mode	M_SP_TB_1 C_SC_NA_1
6	Local Mode	M_SP_TB_1 C_SC_NA_1
7	Local & Remote Mode	M_SP_TB_1 C_SC_NA_1
12	Control Received	M_SP_TB_1
13	Command Received	M_SP_TB_1
14	Cold Start	M_SP_TB_1
15	Warm Start	M_SP_TB_1
16	Re-start	M_SP_TB_1
17	Trigger Storage	M_SP_TB_1
18	Clear Waveform Records	M_SP_TB_1
19	Clear Fault Records	M_SP_TB_1
20	Clear Event Records	M_SP_TB_1
21	Reset Demand metering	M_SP_TB_1 C_SC_NA_1
22	27 Sag SARFI	M_SP_TB_1
23	59Swell SARFI	M_SP_TB_1
24	Reset SagSwell Count	M_SP_TB_1
25	Battery Test Pass	M_SP_TB_1
26	Battery Test Fail	M_SP_TB_1
27	Battery Ohms High	M_SP_TB_1
28	Battery Volts Low	M_SP_TB_1
29	Battery Volts High	M_SP_TB_1
30	Battery Healthy	M_SP_TB_1
31	Battery Recovery Fail	M_SP_TB_1
32	Battery Test	M_SP_TB_1 C_SC_NA_1
33	Capacitor Ready	M_SP_TB_1
34	Capacitor Test Pass	M_SP_TB_1
35	Capacitor Test Fail	M_SP_TB_1
36	Capacitor Recovery Fail	M_SP_TB_1
37	Capacitor Test	M_SP_TB_1 C_SC_NA_1
38	General Alarm 1	M_SP_TB_1
39	General Alarm 2	M_SP_TB_1
40	General Alarm 3	M_SP_TB_1
41	General Alarm 4	M_SP_TB_1

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IOA	Description	Default Type
42	General Alarm 5	M_SP_TB_1
43	General Alarm 6	M_SP_TB_1
44	General Alarm 7	M_SP_TB_1
45	General Alarm 8	M_SP_TB_1
46	General Alarm 9	M_SP_TB_1
47	General Alarm 10	M_SP_TB_1
48	General Alarm 11	M_SP_TB_1
49	General Alarm 12	M_SP_TB_1
50	Quick Logic E1	M_SP_TB_1
51	Quick Logic E2	M_SP_TB_1
52	Quick Logic E3	M_SP_TB_1
53	Quick Logic E4	M_SP_TB_1
54	Quick Logic E5	M_SP_TB_1
55	Quick Logic E6	M_SP_TB_1
56	Quick Logic E7	M_SP_TB_1
57	Quick Logic E8	M_SP_TB_1
58	Quick Logic E9	M_SP_TB_1
59	Quick Logic E10	M_SP_TB_1
60	Quick Logic E11	M_SP_TB_1
61	Quick Logic E12	M_SP_TB_1
62	Quick Logic E13	M_SP_TB_1
63	Quick Logic E14	M_SP_TB_1
64	Quick Logic E15	M_SP_TB_1
65	Quick Logic E16	M_SP_TB_1
66	Quick Logic E17	M_SP_TB_1
67	Quick Logic E18	M_SP_TB_1
68	Quick Logic E19	M_SP_TB_1
69	Quick Logic E20	M_SP_TB_1
70	Quick Logic E21	M_SP_TB_1
71	Quick Logic E22	M_SP_TB_1
72	Quick Logic E23	M_SP_TB_1
73	Quick Logic E24	M_SP_TB_1
74	Quick Logic E25	M_SP_TB_1
75	Quick Logic E26	M_SP_TB_1
76	Quick Logic E27	M_SP_TB_1
77	Quick Logic E28	M_SP_TB_1
78	Quick Logic E29	M_SP_TB_1
79	Quick Logic E30	M_SP_TB_1
80	Quick Logic E31	M_SP_TB_1
81	Quick Logic E32	M_SP_TB_1
82	Function Key 1	M_SP_TB_1
83	Function Key 2	M_SP_TB_1
84	Function Key 3	M_SP_TB_1
85	Function Key 4	M_SP_TB_1
86	Function Key 5	M_SP_TB_1
87	Function Key 6	M_SP_TB_1
88	Function Key 7	M_SP_TB_1
89	Function Key 8	M_SP_TB_1
90	Function Key 9	M_SP_TB_1
91	Function Key 10	M_SP_TB_1
92	Function Key 11	M_SP_TB_1
93	Function Key 12	M_SP_TB_1
94	Function Key 13	M_SP_TB_1
95	Function Key 14	M_SP_TB_1

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IOA	Description	Default Type
96	Function Key 15	M_SP_TB_1
97	Function Key 16	M_SP_TB_1
98	Function Key 17	M_SP_TB_1
99	Function Key 18	M_SP_TB_1
100	Function Key 19	M_SP_TB_1
101	Function Key 20	M_SP_TB_1
102	Function Key 21	M_SP_TB_1
103	Function Key 22	M_SP_TB_1
104	Function Key 23	M_SP_TB_1
105	Function Key 24	M_SP_TB_1
106	Function Key 25	M_SP_TB_1
107	Function Key 26	M_SP_TB_1
108	Function Key 27	M_SP_TB_1
109	Binary Input 1	M_SP_TB_1
110	Binary Input 2	M_SP_TB_1
111	Binary Input 3	M_SP_TB_1
112	Binary Input 4	M_SP_TB_1
113	Binary Input 5	M_SP_TB_1
114	Binary Input 6	M_SP_TB_1
115	Binary Input 7	M_SP_TB_1
116	Binary Input 8	M_SP_TB_1
117	Binary Input 9	M_SP_TB_1
118	Binary Input 10	M_SP_TB_1
119	Binary Input 11	M_SP_TB_1
120	Binary Input 12	M_SP_TB_1
121	Binary Input 13	M_SP_TB_1
122	Binary Input 14	M_SP_TB_1
123	Binary Input 15	M_SP_TB_1
124	Binary Input 16	M_SP_TB_1
125	Binary Input 17	M_SP_TB_1
126	Binary Input 18	M_SP_TB_1
127	Binary Input 19	M_SP_TB_1
128	Binary Input 20	M_SP_TB_1
129	Binary Input 21	M_SP_TB_1
130	Binary Input 22	M_SP_TB_1
131	Binary Input 23	M_SP_TB_1
132	Binary Input 24	M_SP_TB_1
133	Binary Input 25	M_SP_TB_1
134	Binary Input 26	M_SP_TB_1
135	Binary Input 27	M_SP_TB_1
136	Binary Input 28	M_SP_TB_1
137	Binary Input 29	M_SP_TB_1
138	Binary Input 30	M_SP_TB_1
139	Binary Input 31	M_SP_TB_1
140	Binary Input 32	M_SP_TB_1
141	Binary Input 33	M_SP_TB_1
142	Binary Input 34	M_SP_TB_1
143	Binary Input 35	M_SP_TB_1

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IOA	Description	Default Type
144	Binary Input 36	M_SP_TB_1
145	Binary Input 37	M_SP_TB_1
146	Binary Input 38	M_SP_TB_1
147	Binary Input 39	M_SP_TB_1
148	Binary Input 40	M_SP_TB_1
149	Binary Input 41	M_SP_TB_1
150	Binary Input 42	M_SP_TB_1
151	Binary Input 43	M_SP_TB_1
152	Binary Input 44	M_SP_TB_1
153	Binary Input 45	M_SP_TB_1
154	Binary Input 46	M_SP_TB_1
155	Binary Input 47	M_SP_TB_1
156	Binary Input 48	M_SP_TB_1
157	Binary Input 49	M_SP_TB_1
158	Binary Input 50	M_SP_TB_1
159	Binary Input 51	M_SP_TB_1
160	Binary Input 52	M_SP_TB_1
161	Binary Input 53	M_SP_TB_1
162	Binary Input 54	M_SP_TB_1
163	Binary Input 55	M_SP_TB_1
164	Binary Input 56	M_SP_TB_1
165	Binary Input 57	M_SP_TB_1
166	Binary Input 58	M_SP_TB_1
167	Binary Input 59	M_SP_TB_1
168	Binary Input 60	M_SP_TB_1
169	Binary Input 61	M_SP_TB_1
170	Binary Input 62	M_SP_TB_1
171	Binary Input 63	M_SP_TB_1
172	Binary Input 64	M_SP_TB_1
173	Binary Output 1	M_SP_TB_1 C_SC_NA_1
174	Binary Output 2	M_SP_TB_1 C_SC_NA_1
175	Binary Output 3	M_SP_TB_1 C_SC_NA_1
176	Binary Output 4	M_SP_TB_1 C_SC_NA_1
177	Binary Output 5	M_SP_TB_1 C_SC_NA_1
178	Binary Output 6	M_SP_TB_1 C_SC_NA_1
179	Binary Output 7	M_SP_TB_1 C_SC_NA_1
180	Binary Output 8	M_SP_TB_1 C_SC_NA_1
181	Binary Output 9	M_SP_TB_1 C_SC_NA_1
182	Binary Output 10	M_SP_TB_1 C_SC_NA_1

IOA	Description	Default Type
183	Binary Output 11	M_SP_TB_1 C_SC_NA_1
184	Binary Output 12	M_SP_TB_1 C_SC_NA_1
185	Binary Output 13	M_SP_TB_1 C_SC_NA_1
186	Binary Output 14	M_SP_TB_1 C_SC_NA_1
187	Binary Output 15	M_SP_TB_1 C_SC_NA_1
188	Binary Output 16	M_SP_TB_1 C_SC_NA_1
189	Binary Output 17	M_SP_TB_1 C_SC_NA_1
190	Binary Output 18	M_SP_TB_1 C_SC_NA_1
191	Binary Output 19	M_SP_TB_1 C_SC_NA_1
192	Binary Output 20	M_SP_TB_1 C_SC_NA_1
193	Binary Output 21	M_SP_TB_1 C_SC_NA_1
194	Binary Output 22	M_SP_TB_1 C_SC_NA_1
195	Binary Output 23	M_SP_TB_1 C_SC_NA_1
196	Binary Output 24	M_SP_TB_1 C_SC_NA_1
197	Binary Output 25	M_SP_TB_1 C_SC_NA_1
198	Binary Output 26	M_SP_TB_1 C_SC_NA_1
199	Binary Output 27	M_SP_TB_1 C_SC_NA_1
200	Binary Output 28	M_SP_TB_1 C_SC_NA_1
201	Binary Output 29	M_SP_TB_1 C_SC_NA_1
202	Binary Output 30	M_SP_TB_1 C_SC_NA_1
203	Binary Output 31	M_SP_TB_1 C_SC_NA_1
204	Binary Output 32	M_SP_TB_1 C_SC_NA_1
205	Reset FCB	M_SP_TB_1
206	Reset CU	M_SP_TB_1
207	Start/Restart	M_SP_TB_1
208	Power On	M_SP_TB_1
209	Auto-reclose active (In/Out)	M_SP_TB_1 C_SC_NA_1
210	LEDs reset (Reset Flag & Outputs)	M_SP_TB_1 C_SC_NA_1
211	Settings changed	M_SP_TB_1

IOA	Description	Default Type
212	Settings Group 1 Select	M_SP_TB_1 C_SC_NA_1
213	Settings Group 2 select	M_SP_TB_1 C_SC_NA_1
214	Settings Group 3 Select	M_SP_TB_1 C_SC_NA_1
215	Settings Group 4 Select	M_SP_TB_1 C_SC_NA_1
216	Settings Group 5 Selected	M_SP_TB_1 C_SC_NA_1
217	Settings Group 6 Selected	M_SP_TB_1 C_SC_NA_1
218	Settings Group 7 Selected	M_SP_TB_1 C_SC_NA_1
219	Settings Group 8 Selected	M_SP_TB_1 C_SC_NA_1
220	Trip circuit fail	M_EP_TD_1
221	VT Fuse Failure	M_EP_TD_1
222	Earth Fault Forward/Line	M_EP_TD_1
223	Earth Fault Reverse/Busbar	M_EP_TD_1
224	Starter/Pick Up L1	M_EP_TD_1
225	Starter/Pick Up L2	M_EP_TD_1
226	Starter/Pick Up L3	M_EP_TD_1
227	Starter/Pick Up N	M_EP_TD_1
228	General Trip	M_EP_TD_1
229	Trip L1	M_EP_TD_1
230	Trip L2	M_EP_TD_1
231	Trip L3	M_EP_TD_1
232	Fault Impedance	M_EP_TD_1
233	Fault Forward/Line	M_EP_TD_1
234	Fault Reverse/Busbar	M_EP_TD_1
235	General Starter/Pick Up	M_EP_TD_1
236	Circuit breaker fail	M_EP_TD_1
237	Trip I>	M_EP_TD_1
238	Trip I>>	M_EP_TD_1
239	Trip In>	M_EP_TD_1
240	Trip In>>	M_EP_TD_1
241	CB on by auto reclose	M_EP_TD_1
242	Reclose blocked	M_EP_TD_1
243	51-1	M_EP_TD_1
244	50-1	M_EP_TD_1
245	51N-1	M_EP_TD_1
246	50N-1	M_EP_TD_1
247	51G-1	M_EP_TD_1
248	50G-1	M_EP_TD_1
249	51-2	M_EP_TD_1
250	50-2	M_EP_TD_1
251	51N-2	M_EP_TD_1
252	50N-2	M_EP_TD_1

IOA	Description	Default Type
253	51G-2	M_EP_TD_1
254	50G-2	M_EP_TD_1
255	51-3	M_EP_TD_1
256	50-3	M_EP_TD_1
257	51N-3	M_EP_TD_1
258	50N-3	M_EP_TD_1
259	51G-3	M_EP_TD_1
260	50G-3	M_EP_TD_1
261	51-4	M_EP_TD_1
262	50-4	M_EP_TD_1
263	51N-4	M_EP_TD_1
264	50N-4	M_EP_TD_1
265	51G-4	M_EP_TD_1
266	50G-4	M_EP_TD_1
267	50BF Stage 2	M_EP_TD_1
268	49 Thermal Alarm	M_EP_TD_1
269	49 Thermal Trip	M_EP_TD_1
270	51V-PhA	M_EP_TD_1
271	51V-PhB	M_EP_TD_1
272	51V-PhC	M_EP_TD_1
273	60 CT Supervision	M_EP_TD_1
274	51SEF-1	M_EP_TD_1
275	50SEF-1	M_EP_TD_1
276	51SEF-2	M_EP_TD_1
277	50SEF-2	M_EP_TD_1
278	51SEF-3	M_EP_TD_1
279	50SEF-3	M_EP_TD_1
280	51SEF-4	M_EP_TD_1
281	50SEF-4	M_EP_TD_1
282	SEF Out/In	M_SP_TB_1 C_SC_NA_1
283	46IT	M_EP_TD_1
284	46DT	M_EP_TD_1
285	64H	M_EP_TD_1
286	EF Out/In	M_SP_TB_1 C_SC_NA_1
287	SEF Forward/Line	M_EP_TD_1
288	SEF Reverse/Busbar	M_EP_TD_1
289	47-1	M_EP_TD_1
290	47-2	M_EP_TD_1
291	37-1	M_EP_TD_1
292	37-2	M_EP_TD_1
293	37G-1	M_EP_TD_1
294	37G-2	M_EP_TD_1
295	37SEF-1	M_EP_TD_1
296	37SEF-2	M_EP_TD_1
297	46BC	M_EP_TD_1
298	27/59-1	M_EP_TD_1
299	27/59-2	M_EP_TD_1

IOA	Description	Default Type
300	27/59-3	M_EP_TD_1
301	27/59-4	M_EP_TD_1
302	59NIT	M_EP_TD_1
303	59NDT	M_EP_TD_1
304	Vx27/59	M_EP_TD_1
305	81-1	M_EP_TD_1
306	81-2	M_EP_TD_1
307	81-3	M_EP_TD_1
308	81-4	M_EP_TD_1
309	81-5	M_EP_TD_1
310	81-6	M_EP_TD_1
311	81HBL2	M_EP_TD_1
312	Trip Circuit Fail 1	M_EP_TD_1
313	Trip Circuit Fail 2	M_EP_TD_1
314	Trip Circuit Fail 3	M_EP_TD_1
319	Close CB Failed	M_SP_TB_1
320	Open CB Failed	M_SP_TB_1
321	Reclaim	M_SP_TB_1
322	Lockout	M_SP_TB_1
323	Successful Close	M_SP_TB_1
324	Successful DAR Close	M_SP_TB_1
325	Successful Man Close	M_SP_TB_1
326	Hotline Working	M_SP_TB_1 C_SC_NA_1
327	Inst Protection Out	M_SP_TB_1 C_SC_NA_1
328	CB Total Trip Count	M_SP_TB_1
329	CB Delta Trip Count	M_SP_TB_1
330	CB Count to AR Block	M_SP_TB_1
331	Reset CB Trip Count Maint	M_SP_TB_1 C_SC_NA_1
332	Reset CB Trip Count Delta	M_SP_TB_1 C_SC_NA_1
333	Reset CB Trip Count Lockout	M_SP_TB_1 C_SC_NA_1
334	I^2t CB Wear	M_SP_TB_1
335	Reset I^2t CB Wear	M_SP_TB_1 C_SC_NA_1
336	79 AR In Progress	M_SP_TB_1
337	CB Frequent Ops Count	M_SP_TB_1
338	Reset CB Frequent Ops Count	M_SP_TB_1 M_SC_NA_1
339	CB LO Handle Ops Count	M_SP_TB_1
340	Reset CB LO Handle Ops Count	M_SP_TB_1 C_SC_NA_1
341	CB On By Manual Close	M_SP_TB_1
342	Cold Load Active	M_SP_TB_1
343	P/F Inst Protection Inhibited	M_EP_TD_1
344	E/F Inst Protection Inhibited	M_EP_TD_1
345	SEF Inst Protection Inhibited	M_EP_TD_1

IOA	Description	Default Type
346	Ext Inst Protection Inhibited	M_EP_TD_1
348	LOV Primed	M_SP_TB_1
349	LOV Trip	M_SP_TB_1
350	LOV Close	M_SP_TB_1
351	LOV Inhibit Fast Protection	M_SP_TB_1
352	LOV Force Fast Protection	M_SP_TB_1
353	LOV In Progress	M_SP_TB_1
354	LOV Backfeed Fail	M_SP_TB_1
355	LOV Successful	M_SP_TB_1
356	LOV 1x Trip and Lockout	M_SP_TB_1
357	LOV Fail	M_SP_TB_1
358	LOV-A Live	M_SP_TB_1
359	LOV-X Live	M_SP_TB_1
360	LOV Out	M_SP_TB_1 C_SC_NA_1
361	Trip Time Alarm	M_SP_TB_1
362	Close Circuit Fail 1	M_SP_TB_1
363	Close Circuit Fail 2	M_SP_TB_1
364	Close Circuit Fail 3	M_SP_TB_1
365	Close Circuit Fail	M_SP_TB_1
366	Distance To Fault	M_SP_TB_1
367	Distance To Fault %	M_SP_TB_1
368	Fault Reactance	M_SP_TB_1
369	60 CTS-I	M_SP_TB_1
370	Act Energy Exp	M_SP_TB_1
371	Act Energy Imp	M_SP_TB_1
372	React Energy Exp	M_SP_TB_1
373	React Energy Imp	M_SP_TB_1
374	Reset Energy Meters	M_SP_TB_1 C_SC_NA_1
375	Active Exp Meter Reset	M_SP_TB_1
376	Active Imp Meter Reset	M_SP_TB_1
377	Reactive Exp Meter Reset	M_SP_TB_1
378	Reactive Imp Meter Reset	M_SP_TB_1
379	CB Total Trip Count	M_SP_TB_1
380	CB Delta Trip Count	M_SP_TB_1
381	CB Count To AR Block	M_SP_TB_1
382	CB Freq Ops Count	M_SP_TB_1
383	LOV A Live	M_SP_TB_1
384	LOV B Live	M_SP_TB_1
385	LOV C Live	M_SP_TB_1
386	LOV X Live	M_SP_TB_1
387	LOV Y Live	M_SP_TB_1
388	LOV Z Live	M_SP_TB_1
389	LOV A	M_SP_TB_1
390	LOV B	M_SP_TB_1
391	LOV C	M_SP_TB_1
392	LOV X	M_SP_TB_1
393	LOV Y	M_SP_TB_1
394	LOV Z	M_SP_TB_1
395	CB LO Handle Ops Count	M_SP_TB_1
396	25 Check Sync	M_SP_TB_1
397	25 System Sync	M_SP_TB_1

IOA	Description	Default Type
398	25 Close On Zero	M_SP_TB_1
399	25 System Split	M_SP_TB_1
400	25 Live Line	M_SP_TB_1
401	25 Live Bus	M_SP_TB_1
402	25 Line U/V	M_SP_TB_1
403	25 Bus U/V	M_SP_TB_1
404	25 Voltage Dif >	M_SP_TB_1
405	25 CS Slip Freq >	M_SP_TB_1
406	25 SS Slip Freq >	M_SP_TB_1
407	25 COZ Slip Freq >	M_SP_TB_1
408	25 In Sync	M_SP_TB_1
409	25 CS In Progress	M_SP_TB_1
410	25 SS In Progress	M_SP_TB_1
411	25 COZ In Progress	M_SP_TB_1
412	25 System Split LO	M_SP_TB_1
413	60VTF-Bus	M_SP_TB_1
415	Man Override Sync	M_SP_TB_1
416	79 Override Sync	M_SP_TB_1
417	Dead Line Close	M_SP_TB_1
418	Dead Bus Close	M_SP_TB_1
419	Wattmetric Po>	M_SP_TB_1
420	Close CB-A Failed	M_SP_TB_1
421	Open CB-A Failed	M_SP_TB_1
422	CB-A Reclaim	M_SP_TB_1
423	CB-A Lockout	M_SP_TB_1
424	CB-A Successful Close	M_SP_TB_1
425	CB-A Successful DAR Close	M_SP_TB_1
426	CB-A Successful Man Close	M_SP_TB_1
427	CB-A Total Trip Count	M_SP_TB_1
428	CB-A Delta Trip Count	M_SP_TB_1
429	CB-A Count To AR Block	M_SP_TB_1
430	Reset CB-A Total Trip Count	M_SP_TB_1 C_SC_NA_1
431	Reset CB-A Delta Trip Count	M_SP_TB_1 C_SC_NA_1
432	Reset CB-A Count to AR Block	M_SP_TB_1 C_SC_NA_1
433	CB-A I^2t Wear	M_SP_TB_1
434	Reset CB-A I^2t Wear	M_SP_TB_1 C_SC_NA_1
435	CB-A 79 AR In progress	M_SP_TB_1
436	CB-A Frequent Ops Count	M_SP_TB_1
437	Reset CB-A Frequent Ops Count	M_SP_TB_1 C_SC_NA_1
438	CB-A LO Handle Ops Count	M_SP_TB_1
439	Reset CB-A LO Handle Ops Count	M_SP_TB_1 C_SC_NA_1
440	PhA Inst Protection Inhibited	M_SP_TB_1
441	CB-A Blocked By Interlocking	M_SP_TB_1
442	CB-A on by auto reclose	M_SP_TB_1
443	CB-A Trip & Reclose	M_SP_TB_1
444	50BF-1 Pole A	M_SP_TB_1
445	50BF-2 Pole A	M_SP_TB_1

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IOA	Description	Default Type
446	CB-A Trip & Lockout	M_SP_TB_1 C_SC_NA_1
447	Cap-A Ready	M_SP_TB_1
448	Cap-A Test Pass	M_SP_TB_1
449	Cap-A Test Fail	M_SP_TB_1
450	Cap-A Recovery Fail	M_SP_TB_1
451	Cap-A Test	M_SP_TB_1
452	CB-A Deadtime Running	M_SP_TB_1
453	Close CB-B Failed	M_SP_TB_1
454	Open CB-B Failed	M_SP_TB_1
455	CB-B Reclaim	M_SP_TB_1
456	CB-B Lockout	M_SP_TB_1
457	CB-B Successful Close	M_SP_TB_1
458	CB-B Successful DAR Close	M_SP_TB_1
459	CB-B Successful Man Close	M_SP_TB_1
460	CB-B Total Trip Count	M_SP_TB_1
461	CB-B Delta Trip Count	M_SP_TB_1
462	CB-B Count To AR Block	M_SP_TB_1
463	Reset CB-B Total Trip Count	M_SP_TB_1 C_SC_NA_1
464	Reset CB-B Delta Trip Count	M_SP_TB_1 C_SC_NA_1
465	Reset CB-B Count to AR Block	M_SP_TB_1 C_SC_NA_1
466	CB-B I^2t Wear	M_SP_TB_1
467	Reset CB-B I^2t Wear	M_SP_TB_1 C_SC_NA_1
468	CB-B 79 AR In progress	M_SP_TB_1
469	CB-B Frequent Ops Count	M_SP_TB_1
470	Reset CB-B Frequent Ops Count	M_SP_TB_1 C_SC_NA_1
471	CB-B LO Handle Ops Count	M_SP_TB_1
472	Reset CB-B LO Handle Ops Count	M_SP_TB_1 C_SC_NA_1
473	PhB Inst Protection Inhibited	M_SP_TB_1
474	CB-B Blocked By Interlocking	M_SP_TB_1
475	CB-B on by auto reclose	M_SP_TB_1
476	CB-B Trip & Reclose	M_SP_TB_1
477	50BF-1 Pole B	M_SP_TB_1
478	50BF-2 Pole B	M_SP_TB_1
479	CB-B Trip & Lockout	M_SP_TB_1 C_SC_NA_1
480	Cap-B Ready	M_SP_TB_1
481	Cap-B Test Pass	M_SP_TB_1
482	Cap-B Test Fail	M_SP_TB_1
483	Cap-B Recovery Fail	M_SP_TB_1
484	Cap-B Test	M_SP_TB_1
485	CB-B Deadtime Running	M_SP_TB_1
486	Close CB-C Failed	M_SP_TB_1
487	Open CB-C Failed	M_SP_TB_1
488	CB-C Reclaim	M_SP_TB_1
489	CB-C Lockout	M_SP_TB_1
490	CB-C Successful Close	M_SP_TB_1
491	CB-C Successful DAR Close	M_SP_TB_1

IOA	Description	Default Type
492	CB-C Successful Man Close	M_SP_TB_1
493	CB-C Total Trip Count	M_SP_TB_1
494	CB-C Delta Trip Count	M_SP_TB_1
495	CB-C Count To AR Block	M_SP_TB_1
496	Reset CB-C Total Trip Count	M_SP_TB_1 C_SC_NA_1
497	Reset CB-C Delta Trip Count	M_SP_TB_1 C_SC_NA_1
498	Reset CB-C Count to AR Block	M_SP_TB_1 C_SC_NA_1
499	CB-C I^2t Wear	M_SP_TB_1
500	Reset CB-C I^2t Wear	M_SP_TB_1 C_SC_NA_1
501	CB-C 79 AR In progress	M_SP_TB_1
502	CB-C Frequent Ops Count	M_SP_TB_1
503	Reset CB-C Frequent Ops Count	M_SP_TB_1 C_SC_NA_1
504	CB-C LO Handle Ops Count	M_SP_TB_1
505	Reset CB-C LO Handle Ops Count	M_SP_TB_1 C_SC_NA_1
506	PhC Inst Protection Inhibited	M_SP_TB_1
507	CB-C Blocked By Interlocking	M_SP_TB_1
508	CB-C on by auto reclose	M_SP_TB_1
509	CB-C Trip & Reclose	M_SP_TB_1
510	50BF-1 Pole C	M_SP_TB_1
511	50BF-2 Pole C	M_SP_TB_1
512	CB-C Trip & Lockout	M_SP_TB_1 C_SC_NA_1
513	Cap-C Ready	M_SP_TB_1
514	Cap-C Test Pass	M_SP_TB_1
515	Cap-C Test Fail	M_SP_TB_1
516	Cap-C Recovery Fail	M_SP_TB_1
517	Cap-C Test	M_SP_TB_1
518	CB-C Deadtime Running	M_SP_TB_1
519	Pole Discrepancy	M_SP_TB_1
520	Three Pole Trip Select	M_SP_TB_1
521	Force 3Pole Trip	M_SP_TB_1
522	CB 1	M_DP_TB_1 C_DC_NA_1
527	CB-A	M_DP_TB_1 C_DC_NA_1
528	CB-B	M_DP_TB_1 C_DC_NA_1
529	CB-C	M_DP_TB_1 C_DC_NA_1
550	CB 1 Trip & Reclose	M_SP_TB_1 C_SC_NA_1
551	CB 1 Trip & Lockout	M_SP_TB_1 C_SC_NA_1
552	Mode A - 3PTrip3PLO	M_SP_TB_1 C_SC_NA_1
553	Mode B - 1PTrip3PLO	M_SP_TB_1 C_SC_NA_1

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IOA	Description	Default Type
554	Mode C - 1PTrip1PLO	M_SP_TB_1 C_SC_NA_1
555	Blocked by Interlocking	M_SP_TB_1
556	50BF-1	M_SP_TB_1
557	37-PhA	M_SP_TB_1
558	37-PhB	M_SP_TB_1
559	37-PhC	M_SP_TB_1
560	50 LC-1	M_SP_TB_1
561	50 LC-2	M_SP_TB_1
562	50G LC-1	M_SP_TB_1
563	50G LC-2	M_SP_TB_1
564	50SEF LC-1	M_SP_TB_1
565	50SEF LC-2	M_SP_TB_1
566	50BF-PhA	M_SP_TB_1
567	50BF-PhB	M_SP_TB_1
568	50BF-PhC	M_SP_TB_1
569	50BF-EF	M_SP_TB_1
570	79 Last Trip Lockout	M_SP_TB_1
571	Auto-reclose active	M_SP_TB_1
572	CB on by auto reclose	M_SP_TB_1
573	Battery Test Pass	M_SP_TB_1
574	Battery Test Fail	M_SP_TB_1
575	Battery Ohms High	M_SP_TB_1
576	Capacitor Test Pass	M_SP_TB_1
577	Capacitor Test Fail	M_SP_TB_1
578	Capacitor Recovery Fail	M_SP_TB_1
590	Ia Fault	M_ME_NC_1
591	Ib Fault	M_ME_NC_1
592	Ic Fault	M_ME_NC_1
593	Va Fault	M_ME_NC_1
594	Vb Fault	M_ME_NC_1
595	Vc Fault	M_ME_NC_1
596	In Fault	M_ME_NC_1
597	Ig Fault	M_ME_NC_1
597	Isef Fault	M_ME_NC_1
601	Frequency	M_ME_NB_1
602	Vab Primary	M_ME_NB_1
603	Vbc Primary	M_ME_NB_1
604	Vca Primary	M_ME_NB_1
605	Va Primary	M_ME_NB_1
606	Vb Primary	M_ME_NB_1
607	Vc Primary	M_ME_NB_1
608	Va Secondary	M_ME_NB_1
609	Vb Secondary	M_ME_NB_1
610	Vc Secondary	M_ME_NB_1
621	Vzps	M_ME_NB_1
622	Vpps	M_ME_NB_1
623	Vnps	M_ME_NB_1

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IOA	Description	Default Type
627	Ia Primary	M_ME_NB_1
628	Ib Primary	M_ME_NB_1
629	Ic Primary	M_ME_NB_1
630	Ia Secondary	M_ME_NB_1
631	Ib Secondary	M_ME_NB_1
632	Ic Secondary	M_ME_NB_1
633	Ia Nominal	M_ME_NB_1
634	Ib Nominal	M_ME_NB_1
635	Ic Nominal	M_ME_NB_1
639	In Primary	M_ME_NB_1
640	In Secondary	M_ME_NB_1
641	In Nominal	M_ME_NB_1
642	Ig Primary	M_ME_NB_1
643	Ig Secondary	M_ME_NB_1
644	Ig Nominal	M_ME_NB_1
645	Izps Nominal	M_ME_NB_1
646	Ipps Nominal	M_ME_NB_1
647	Inps Nominal	M_ME_NB_1
651	Active Power A	M_ME_NB_1
652	Active Power B	M_ME_NB_1
653	Active Power C	M_ME_NB_1
654	P (3P)	M_ME_NB_1
655	Reactive Power A	M_ME_NB_1
656	Reactive Power B	M_ME_NB_1
657	Reactive Power C	M_ME_NB_1
658	Q (3P)	M_ME_NB_1
659	Apparent Power A	M_ME_NB_1
660	Apparent Power B	M_ME_NB_1
661	Apparent Power C	M_ME_NB_1
662	S (3P)	M_ME_NB_1
663	Power Factor A	M_ME_NB_1
664	Power Factor B	M_ME_NB_1
665	Power Factor C	M_ME_NB_1
666	Power Factor(3P)	M_ME_NB_1
667	Act Energy Exp	M_ME_NB_1
668	Act Energy Imp	M_ME_NB_1
669	React Energy Exp	M_ME_NB_1
670	React Energy Imp	M_ME_NB_1
671	Thermal Status Ph A	M_ME_NB_1
672	Thermal Status Ph B	M_ME_NB_1
673	Thermal Status Ph C	M_ME_NB_1
674	Fault Records	M_IT_TB_1
675	Event Records	M_IT_TB_1
676	Waveform Records	M_IT_TB_1
677	Vab Secondary	M_ME_NB_1
678	Vbc Secondary	M_ME_NB_1
679	Vca Secondary	M_ME_NB_1
680	Vn Primary	M_ME_NB_1
681	Vn Secondary	M_ME_NB_1

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IOA	Description	Default Type
683	Vx Primary	M_ME_NB_1
684	Vx Secondary	M_ME_NB_1
686	I Phase A Max	M_ME_NB_1
687	I Phase B Max	M_ME_NB_1
688	I Phase C Max	M_ME_NB_1
689	P 3P Max	M_ME_NB_1
690	Q 3P Max	M_ME_NB_1
691	Ig Max	M_ME_NB_1
692	Isef Max	M_ME_NB_1
693	Isef Primary	M_ME_NB_1
694	Isef Secondary	M_ME_NB_1
695	Isef Nominal	M_ME_NB_1
696	Fault Distance Percent	M_ME_NB_1
697	Fault Reactance	M_ME_NB_1
698	Vy Primary	M_ME_NB_1
699	Vy Secondary	M_ME_NB_1
701	Vz Primary	M_ME_NB_1
702	Vz Secondary	M_ME_NB_1
704	Vxy Primary	M_ME_NB_1
705	Vyz Primary	M_ME_NB_1
706	Vzx Primary	M_ME_NB_1
707	Vxy Secondary	M_ME_NB_1
708	Vyz Secondary	M_ME_NB_1
709	Vzx Secondary	M_ME_NB_1
713	CB Total Trip Count	M_ME_NB_1
714	CB Delta Trip Count	M_ME_NB_1
715	CB Count To AR Block	M_ME_NB_1
716	CB Frequent Ops Count	M_ME_NB_1
717	CB LO Handle Ops	M_ME_NB_1
718	Sag SIARFI Pole1	M_ME_NB_1
719	Sag SMARFI Pole1	M_ME_NB_1
720	Sag STARFI Pole1	M_ME_NB_1
721	Sag SIARFI Pole2	M_ME_NB_1
722	Sag SMARFI Pole2	M_ME_NB_1
723	Sag STARFI Pole2	M_ME_NB_1
724	Sag SIARFI Pole3	M_ME_NB_1
725	Sag SMARFI Pole3	M_ME_NB_1
726	Sag STARFI Pole3	M_ME_NB_1
727	Interrupt Pole1	M_ME_NB_1
728	Interrupt Pole2	M_ME_NB_1
729	Interrupt Pole3	M_ME_NB_1
730	Swell SIARFI Pole1	M_ME_NB_1
731	Swell SMARFI Pole1	M_ME_NB_1
732	Swell STARFI Pole1	M_ME_NB_1
733	Swell SIARFI Pole2	M_ME_NB_1
734	Swell SMARFI Pole2	M_ME_NB_1
735	Swell STARFI Pole2	M_ME_NB_1
736	Swell SIARFI Pole3	M_ME_NB_1
737	Swell SMARFI Pole3	M_ME_NB_1

IOA	Description	Default Type
738	Swell STARFI Pole3	M_ME_NB_1
739	Bus Freq	M_ME_NB_1
740	Phase Diff	M_ME_NB_1
741	Slip Freq	M_ME_NB_1
742	Voltage Diff	M_ME_NB_1
743	Ia Last Trip	M_ME_NB_1
744	Ib Last Trip	M_ME_NB_1
745	Ic Last Trip	M_ME_NB_1
746	Va Last Trip	M_ME_NB_1
747	Vb Last Trip	M_ME_NB_1
748	Vc Last Trip	M_ME_NB_1
749	In Last Trip	M_ME_NB_1
750	Ig Last Trip	M_ME_NB_1
751	Isef Last Trip	M_ME_NB_1
801	Binary Inputs 1-8	M_BO_TB_1
802	Binary Inputs 9-16	M_BO_TB_1
803	Binary Inputs 17-24	M_BO_TB_1
804	Binary Inputs 25-32	M_BO_TB_1
805	Binary Outputs 1-8	M_BO_TB_1
806	Binary Outputs 9-16	M_BO_TB_1
807	Binary Outputs 17-24	M_BO_TB_1
808	Binary Outputs 25-32	M_BO_TB_1

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. 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.

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 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.

Section 7: 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, IEC60870-5-101 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.

IEC60870-5-101

The tool will allow:

· Data Points to be enabled or disabled.

· Changing the Information Object Address (IOA) and information type returned by each point.

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 8: 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.