

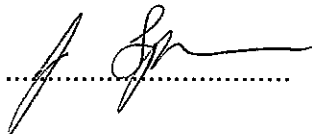
TECHNICAL REPORT

TECHNICAL MANUAL

IEC60870-5-103 Communications Interface

Report No.: 434/TM/5/17

Prepared By: RP/RD/J. Sprague



Approved By: RP/RD/P. Mudditt



Date:

13 MAR 2007

Siemens Protection Devices Ltd.
Management: Martin Bell, Alec Ramsay

Postal address:
Siemens Protection Devices Ltd.
PO Box No. 8
Hebburn
Tyne & Wear
NE31 1TZ

Office address:
Siemens Protection Devices Ltd.
North Farm Road
Hebburn
Tyne & Wear
NE31 1LX

Siemens Protection Devices Ltd: Martin Bell, Alec Ramsay, Ron Smith, Gary Weir, Armin Bruck
Registered No. 3724899 Registered office: Siemens House, Oldbury, Bracknell, Berkshire, RG12 8FZ, England

CIRCULATION APPROVED

REVISION HISTORY

ISSUE 12

Throughout document changed IEC870 to IEC60870.

Throughout document changed company name to VA Tech Reyrolle ACP Ltd.

Throughout document minor clarifications and corrections, formatting and style changes.

2.1.1 Changed Fibre-Optic cable requirement to reference table.

2.1.2 Added reference to Sigma products.

2.2.1 Defined Modular II relays.

2.2.2 Defined Modular II communications settings in more detail.

3.4.2 Defined additional function code.

3.7.9 Additional examples.

3.7.10 Added an example using Solkor-N to improve description of Type 4 measurand.

Appendix A COT abbreviations removed.

Appendix B Event List

The event list has been split from one contiguous list into sub lists for each product family, e.g. Argus or Omega. Additional lists have been added describing commands and the disturbance recorder channels. In addition the following changes have been made to the stated sections.

7.1 Argus 1 - 6	168, 12, E-Delayed Trip
FUN, INF Description	168, 13, A-HS1 trip
160, 148 Measurand added	168, 14, B-HS1 trip
164, 42 CB Slow Close Event Removed.	168, 15, C-HS1 trip
164, 70 Trip count alarm measurand added	168, 16, E-HS1 trip
164, 71 CB maintenance alarm measurand added	168, 17, A-HS2 trip
164, 79 Voltage block event added	168, 18, B-HS2 trip
164, 92 Power on counter alarm added	168, 19, C-HS2 trip
164, 127 ... 129 General alarm events removed	168, 20, E-HS2 trip
164, 131 Va/Vab starter event added	168, 21, SEF/REF starter1
164, 132 Vb/Vbc starter event added	168, 22, SEF/REF starter2
164, 133 Vc/Vca starter event added	168, 24, SEF/REF trip1
164, 170 V starter event added	168, 25, SEF/REF trip2
164, 182 V trip starter event added	168, 26, A-HS1 starter
164, 190 Voltage memory A event added	168, 27, B-HS1 starter
164, 191 Voltage memory B event added	168, 28, C-HS1 starter
164, 192 Voltage memory C event added	168, 29, E-HS1 starter
164, 100 Cold load pickup event added to commands list.	168, 30, A-HS2 starter
Added disturbance recorder channels list for Argus 2 - 500 variant.	168, 31, B-HS2 starter
7.2 Argus 7	168, 32, C-HS2 starter
FUN, INF Description	168, 33, E-HS2 starter
166, 148 Measurand added	168, 34, CB Opened
Added commands list.	168, 39, Circuit breaker fail 2
7.3 Argus 8	168, 40, MeasE/F-general trip
FUN, INF Description	168, 41, CB Close Fail
167, 18 External trip event added	168, 43, CB DBI state
167, 20 Trip circuit fail event added	168, 44, A-Forward
167, 33 Trip count alarm event and measurand added.	168, 45, A-Reverse
167, 58 ... 61 Output 8 ... 11 events added.	168, 46, B-Forward
167, 92, Power on counter alarm added.	168, 47, B-Reverse
167, 130 ... 160 Removed unused events.	168, 48, C-Forward
167, 148 Measurand added	168, 49, C-Reverse
Added command list	168, 50, E/F-Forward
167, 33 Trip counter reset command added to command list.	168, 51, E/F-Reverse
167, 58 ... 61 Energise output relay 8 ... 11 events added.	168, 52, V Element 1 Starter
Added disturbance recorder channels list.	168, 53, V Element 2 Starter
7.4 Delta	168, 54, V Element 3 Starter
Added Events	168, 55, V Element 4 Starter
FUN, INF, Description	168, 56, V Element 1 Trip
60, 3, Front Port OverRide	168, 57, V Element 2 Trip
60, 8, Real Time Clock Set	168, 58, V Element 3 Trip
60, 9, Real Time Clock Drift Corrected	168, 59, V Element 4 Trip
60, 10, Real Time Clock Not Synchronised	168, 60, SEF-Forward
60, 11, Real Time Clock Synchronised	168, 61, SEF-Reverse
168, 0, Data lost	168, 62, NPS-lowset starter
168, 1, A-lowset starter	168, 63, NPS-lowset trip
168, 2, B-lowset starter	168, 64, NPS-HS1 trip
168, 3, C-lowset starter	168, 65, NPS-HS2 trip
168, 4, E-lowset starter	168, 66, NPS-HS1 starter
168, 5, A-lowset trip	168, 67, NPS-HS2 starter
168, 6, B-lowset trip	168, 68, NPS-general trip
168, 7, C-lowset trip	168, 69, Group Switched - External
168, 8, E-lowset trip	168, 70, Trip count alarm
168, 9, A-Delayed Trip	168, 73, Delta Trip count alarm
168, 10, B-Delayed Trip	168, 74, Trip count overflowed
168, 11, C-Delayed Trip	168, 75, Delta count overflowed
	168, 76, A Broken Conductor
	168, 77, B Broken Conductor
	168, 78, C Broken Conductor
	168, 80, Waveform stored
	168, 82, Trip And Lockout

168, 84, Trip And Reclose	176, 65, Start/Pick-up L2
168, 85, Circuit breaker closed	176, 66, Start/Pick-up L3
168, 91, Thermal Capacity Alarm	176, 67, Start/Pick-up N
168, 92, Load Increase Alarm	176, 90, Trip I >
168, 93, Thermal Overload Alarm	176, 91, Trip I >>
168, 94, Phase A CT Failed	176, 92, Trip In >
168, 95, Phase B CT Failed	176, 93, Trip In >>
168, 96, Phase C CT Failed	178, 34, W1 Phase Fault
168, 98, Successful Close	178, 35, W1 Residual Earth Fault
168, 102, Line check trip	178, 36, W1 Earth Fault
168, 103, Live Line	178, 37, Restricted Earth Fault
168, 104, Live Bus	178, 38, Earth Fault
168, 105, In Sync	178, 39, W34 Restricted Earth Fault
168, 106, External trip block	178, 48, W2 Residual Earth Fault
168, 107, System Split	178, 49, W2 Earth Fault
168, 135, VT Failed	178, 57, W2 Phase Fault Stage 1
168, 185, 3Vo Element 1 Starter	178, 58, W2 Phase Fault Stage 2
168, 186, 3Vo Element 2 Starter	178, 59, W3 Phase Fault Stage 1
168, 187, 3Vo Element 1 Trip	178, 67, W34 Phase Fault
168, 188, 3Vo Element 2 Trip	178, 68, W34 Residual Earth Fault
168, 201, 3PAvEnergy	178, 69, W3 Phase Fault Stage 2
168, 202, 3PReacEnergy	178, 70, Voltage Stage 1
168, 238, P/F Idmtl on/off	178, 71, Voltage Stage 2
168, 239, E/F Idmtl on/off	178, 72, Voltage Stage 3
168, 240, P/F Lowset on/off	178, 73, Voltage Stage 4
168, 241, P/F Highset 1 on/off	178, 74, Overfluxing Dtl Stage 1
168, 242, P/F Highset 2 on/off	178, 75, Overfluxing Dtl Stage 2
168, 243, E/F Lowset on/off	178, 76, Overfluxing Idmtl
168, 244, E/F Highset 1 on/off	178, 77, W1 Breaker Fail ReTrip
168, 245, E/F Highset 2 on/off	178, 78, W1 Breaker Fail BackTrip
168, 246, SEF1 on/off	178, 79, W3 Residual Earth Fault
168, 247, SEF2 on/off	178, 80, Thermal Alarm
168, 248, Thermal O/L on/off	178, 81, Thermal Trip
168, 249, Broken Conductor on/off	178, 82, W2 Breaker Fail ReTrip
168, 250, Cold Load on/off	178, 83, W2 Breaker Fail BackTrip
168, 251, CT Supervision on/off	178, 85, Standby E/F Stage 1
168, 252, Trip Cct Supervision on/off	178, 86, Standby E/F Stage 2
200, 41, Earth Switch 1	178, 87, W3 Breaker Fail ReTrip
200, 42, Earth Switch 2	178, 88, W3 Breaker Fail BackTrip
200, 43, Earth Switch 3	178, 89, W3 Earth Fault
200, 44, Earth Switch 4	178, 90, Frequency Stage 1
200, 45, Earth Switch 5	178, 91, Frequency Stage 2
200, 121, CB 1 Service Position	178, 92, Frequency Stage 3
200, 122, CB 2 Service Position	178, 93, Frequency Stage 4
200, 123, CB 3 Service Position	178, 94, W1 Standby E/F Stage 1
200, 124, CB 4 Service Position	178, 95, W1 Standby E/F Stage 2
200, 125, CB 5 Service Position	178, 96, W2 Standby E/F Stage 1
200, 255, Blocked By Interlocking	178, 97, W2 Standby E/F Stage 2
Added Measurand	178, 100, W2 Earth Fault Stage 1
168, 200, Measurand	178, 101, W2 Earth Fault Stage 2
Added Commands	178, 102, W3 Earth Fault Stage 1
168, 238, P/F Idmtl on/off	178, 103, W3 Earth Fault Stage 2
168, 239, E/F Idmtl on/off	178, 110, Setting G5 selected
168, 240, P/F Lowset on/off	178, 111, Setting G6 selected
168, 241, P/F Highset 1 on/off	178, 112, Setting G7 selected
168, 242, P/F Highset 2 on/off	178, 113, Setting G8 selected
168, 243, E/F Lowset on/off	
168, 244, E/F Highset 1 on/off	7.6 Iota
168, 245, E/F Highset 2 on/off	Added Events
168, 246, SEF1 on/off	FUN, INF, Description
168, 247, SEF2 on/off	60, 1, IEC870 Active Com1
168, 248, Thermal O/L on/off	60, 2, IEC870 Active Com2
168, 249, Broken Conductor on/off	60, 3, Front Port OverRide
168, 250, Cold Load on/off	60, 8, Real Time Clock Set
168, 251, CT Supervision on/off	60, 9, Real Time Clock Drift Corrected
168, 252, Trip Cct Supervision on/off	60, 10, Real Time Clock Not Synchronised
Added disturbance recorder channels list.	60, 11, Real Time Clock Synchronised
7.5 Duobias-M	200, 41, Earth Switch 1
Added Events	200, 42, Earth Switch 2
FUN, INF, Description	200, 43, Earth Switch 3
60, 1, IEC870 Active Com1	200, 44, Earth Switch 4
60, 2, IEC870 Active Com2	200, 45, Earth Switch 5
60, 3, Front Port OverRide	200, 121, CB 1 Service Position
60, 8, Real Time Clock Set	200, 122, CB 2 Service Position
60, 9, Real Time Clock Drift Corrected	200, 123, CB 3 Service Position
60, 10, Real Time Clock Not Synchronised	200, 124, CB 4 Service Position
60, 11, Real Time Clock Synchronised	200, 125, CB 5 Service Position
176, 36, Trip Circuit Fail	200, 255, Blocked By Interlocking
176, 64, Start/Pick-up L1	
	7.7 MicroTAPP
	Added Events

FUN, INF, Description
 60, 8, Real Time Clock Set
 60, 9, Real Time Clock Drift Corrected
 60, 10, Real Time Clock Not Synchronised
 60, 11, Real Time Clock Synchronised
 179, 2, Reset FCB
 179, 3, Reset CU
 179, 4, Start/restart
 179, 5, Power on
 179, 19, LED Reset
 179, 21, Test Mode
 179, 22, Settings changed
 179, 122, VT fuse failure alarm
 255, 27, Status Input 1
 255, 28, Status Input 2
 255, 29, Status Input 3
 255, 30, Status Input 4
 Added Measurands
 FUN, INF, Description
 179, 108, Delta tap-change count alarm
 179, 109, Today's tap count
 179, 110, Total tap count
 179, 111, Delta sum of I² alarm

7.8 MSCDN

Added Section

7.9 Ohmega

Split list in 3xx and 4xx variants.

Added Events (3xx and 4xx)

FUN, INF, Description

60, 3, Front Port Override

128, 68, General Trip

130, 72, Aided Distance Trip

Added Events (4xx only)

FUN, INF, Description

128, 64, Start/Pick-up L1 (4xx Only)

128, 65, Start/Pick-up L2 (4xx Only)

128, 66, Start/Pick-up L3 (4xx Only)

128, 67, Start/Pick-up N (4xx Only)

130, 38, 3Ph V Chk Alarm

130, 41, TCS Alarm 1

130, 42, TCS Alarm 2

130, 43, TCS Alarm 3

130, 48, Phase Fault L12

130, 49, Phase Fault L23

130, 50, Phase Fault L31

130, 71, SOTF Trip

130, 73, Fault Impedance (%Z1)

130, 74, Distance To Fault

130, 84, Power Swing Blocking

130, 85, Zone 1 Start

130, 86, Zone 2 Start

130, 87, Zone 3 Start

130, 88, Zone 4 Start

130, 90, Thermal Overload Trip

130, 91, Thermal Capacity Alarm

130, 92, Load Increase Alarm

130, 93, Thermal Overload Alarm

Added disturbance recorder channels list.

7.10 Rho 3

FUN, INF Description

165, 130 Maximum demand reset event added

165, 131 Last start info reset event added

165, 132 Motor run time reset event added

Added commands list.

7.11 Solkor-N

FUN, INF Description

196, 70 Trip count alarm measurand event added

196, 71 CB maintenance alarm measurand event added

196, 92 Power on counter alarm event added

196, 132 ... 134 Guard events added

Added commands list

192, 19 Reset flag and outputs command added.

192, 23 ... 26 Select settings group commands added.

Added disturbance recorder channels list.

7.12 Tau

Added Events

FUN, INF, Description

70, 5 ... 43, Status input events added

80, 1 ... 45, Plant control events added

210, 0, Data lost

210, 6, Fx One In Service

210, 7, Fx Two In Service

210, 8, Tx One In Service

210, 9, Tx Two In Service

210, 10, Fx One OutOfService

210, 11, Fx Two OutOfService

210, 12, Tx One OutOfService

210, 13, Tx Two OutOfService

210, 23, Setting G1 selected

210, 24, Setting G2 selected

210, 25, Setting G3 selected

210, 26, Setting G4 selected

210, 225, Successful Close

210, 226, External A/R Start

210, 227, Manual Close

210, 228, Reset Lockout

210, 229, A/R Out

210, 230, A/R In

210, 231, In Sync Output

210, 232, Live Bus

210, 233, Live Line

210, 234, Trip

210, 235, Starter

210, 236, Reclose Lockout

210, 237, Trip And Reclose Input

210, 238, CB Pole Discrepancy

210, 239, Reclaim

210, 240, Ext Group Change

210, 241, Ext Group Back

210, 242, Manual Sync Override

210, 243, Intertrip Receive

210, 244, AutoIsolation Complete I/P

210, 245, Inhibit Seq Isolation

210, 246, Persistent Intertrip

210, 247, AutoIsolation Fail

210, 250, CB 'on' by MC

210, 251, A/R In Progress

210, 252, Total CB Count Reset

210, 253, Delta CB Count Reset

Added commands

FUN, INF, Description

210, 16, Auto-reclose on/off

210, 23, Settings Group 1 Select

210, 24, Settings Group 2 Select

210, 25, Settings Group 3 Select

210, 26, Settings Group 4 Select

210, 252, Reset Total CB Count

210, 253, Reset Delta CB Count

ISSUE 13**Section 7.1**

Measurands with relative time added to Argus section. Numbers all are Function Type (FUN) 164, Information (INF) numbers 240-248.

New General commands added to Argus section, FUN = 164 and INF = 129, 130.

New event 'CT Failure' added to Argus section. FUN = 164, INF = 97.

Updated Argus measurand numbers FUN=160, INF = 144, 148.

Updated Argus event 'CB on by auto-reclose' to make it double point.

Updated Argus table of Actual Channel (ACC) numbers for the disturbance recorder.

Section 7.5

The tables for Duobias-M containing event and command numbers have been updated. A table of Actual Channel numbers has been added.

ISSUE 14**Section 7.9**

Events numbers 128, 73 and 130, 73-74 used by Ohmega corrected the type to 4.

ISSUE 15

Updated section 2.1 for MODBUS and RS485.

Section 7.13 DAD-N codes added.

Section 7.14 IOTA 212 codes added.

Section 7.15 Reyrolle TAU codes added.

Issue 12 revision history added.

Updated Fibre Optic Data.

ISSUE 16

Section 7.7 **MicroTAPP** 179, 112 event added.

Section 7.5 **Duobias-M** LEDs reset event FUN 160 corrected to 176. Updated Events and Actual Channels Lists.

ISSUE 17

Title page removed logo and changed company details.

Throughout document changed company name to Siemens Protection Devices Ltd.

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GLOSSARY

ASDU	Application Service Data Unit
Baud Rate	See <i>bits per second</i> .
Bit	The smallest measure of computer data.
Bits Per Second (BPS)	Measurement of data transmission speed.
Byte	Series of <i>bits</i> , usually eight.
'C'	High Level Computer Programming Language.
Checksum	Used for error detection. Value calculated over a range of data by the transmitter and sent with the data. The receiver calculates the same value and compares the two.
Class 1 Data	High Priority Data.
Class 2 Data	Low Priority Data.
Data Bits	A number of <i>bits</i> containing the data. Sent after the <i>start bit</i> .
Frame	A block of information to be transmitted. Includes the destination address and error correction information.
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.
Least Significant Bit (LSB)	In a Byte, octet etc. the bit of least numerical value.
Master Station	See <i>primary station</i> .
Modem	MOdulator / DEModulator device for connecting computer equipment to a telephone line.
Most Significant Bit (MSB)	In a byte, octet etc. the bit of most numerical value.
Octet	Series of <i>bits</i> , exactly eight. In most cases, identical to a <i>byte</i> .
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	<i>Bit</i> used for implementing parity checking. Sent after the <i>data bits</i> .
Primary Station	The device controlling the communication.
RS232C	Serial Communications Standard. Electronic Industries Association Recommended Standard Number 232, Revision C.
Secondary Station	The device being communicated with.
Slave Station	See <i>secondary station</i> .
Start Bit	<i>Bit</i> (logical 0) sent to signify the start of a byte during data transmission.
Stop Bit	<i>Bit</i> (logical 1) sent to signify the end of a byte during data transmission.

1 INTRODUCTION

This document describes the informative communication interface, its features, how it is accessed and provides guidance for writing software to utilise it. The interface complies with [1] IEC60870-5-103.

The features are in two distinct types. Firstly standard features, for example, Events, Metering and General Interrogation as defined in [1] IEC60870-5-103. Secondly private commands to access additional features, for example, waveform data records and altering the settings database.

The document is split into the following sections. Section 2 describes how the relay is physically connected to the control system. Section 3 describes the protocol requirements of the link layer as defined in [1] IEC60870-5-103. Section 4 describes the private commands and the data they return. Section 5 describes the Reyrolle Protection Settings Description Language. The appendices contain information referenced throughout the document, including codes defined by [1] IEC60870-5-103.

2 CONNECTION SPECIFICATION AND RELAY SETTINGS

2.1 Argus Type Relays

2.1.1 Connection Interface

2.1.1.1 Fibre Optic - Recommended fibre optic cable

Argus relays are fitted with a fibre optic interface as standard. Selection of fibre optic cable is critical. Fibres should be terminated with 9mm SMA connectors, or ST connectors depending on the type fitted to the Relay.

Fibre-optic transmission distances vary with transmitter, receiver and type of fibre. The tables in section 14 show the achievable distances between Reyrolle devices with different types of fibre cable.

2.1.1.2 Electrical RS485 - Recommended cable

Argus relays can optionally be fitted with an RS485 electrical interface. The RS485 interface can be connected using 120 ohm screened twisted pair wire, for example, Belden 9841 or equivalent. Note, the RS485 master must support and use the Auto Device Enable (ADE) feature.

2.1.2 Communication Settings

COMMS INTERFACE MENU.											
Setting	Range	Default	Description								
Comms Protocol	IEC60870-5-103, MODBUS-RTU	103	Later releases of software allow selection of either the IEC60870-5-103 or MODBUS communications protocol. Details of the MODBUS protocol are given in a separate document.								
Class 2 Update Period	Instantaneous, 1,2 ...60 seconds	Inst	When using the IEC60870-5-103 protocol this setting sets the period the class 2 measurands will be updated. The range is from instantaneous to every 60 seconds in steps of 1 second. This setting is only visible when the protocol is set to IEC60870-5-103.								
IEC Class 2 Scaling	1.2x or 2.4x	1.2x	When using the IEC60870-5-103 protocol this setting sets the scaling of the class 2 measurands. The same scaling factor applies to all the measurands returned. Either of the options (1.2 or 2.4 times) defined by the standard can be set. This setting is only visible when the protocol is set to IEC60870-5-103.								
Comms Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200	19200	Communications speed defined in bits per second (BPS). Only 19200 and 9600 BPS are defined in [1] IEC60870-5-103, the additional rates are provided for local or modem communications. This setting applies to whichever interface, fibre optic or electrical RS485, is fitted.								
Comms Parity	None, Even	Even	[1] IEC60870-5-103 defines the method of transmission as using Even Parity. However, in some configurations the parity needs to be None. This setting applies to whichever interface, fibre optic or electrical RS485, is fitted.								
Relay Address	0 ... 254	0	The address of the relay must be set to a value between 1 and 254 before communication. Setting the address to zero disables communications to the relay. All relays on a network, for example, as illustrated in section 13, must have a unique address. Address 255 is reserved as a global broadcast address. This setting applies to whichever protocol, IEC60870-5-103 or MODBUS, is selected.								
Line Idle	Light Off Light On	Light Off	[1] IEC60870-5-103 defines the line idle state as Light On. This setting allows an alternative of Light Off to be selected. When using the RS485 electrical interface this setting must be set to OFF . The line idle setting must be set to be compatible with the hardware connected to the relay. The Sigma range of products for connecting to the fibre-optic ports on the relays support either Light ON or OFF. All sigma units are supplied Light Off. Sigma 1 has internal switches to set the condition for each fibre optic channel, Sigma 3 and 4 have an internal jumper to set the state of their fibre optic channel. Refer to section 13 DIAGRAMS. The table to the left shows the line-idle settings for use with the Honeywell type HFM5500 fibre-optic to RS232 converters.								
<table border="1"> <thead> <tr> <th>Device</th> <th>Setting</th> </tr> </thead> <tbody> <tr> <td>HFM5500-AAM, HFM5500-AAF</td> <td>Light Off</td> </tr> <tr> <td>HFM5500-BAM, HFM5500-BAF</td> <td>Light On</td> </tr> <tr> <td>Sigma 1, 3, 4</td> <td>Settable</td> </tr> </tbody> </table>		Device	Setting	HFM5500-AAM, HFM5500-AAF	Light Off	HFM5500-BAM, HFM5500-BAF	Light On	Sigma 1, 3, 4	Settable		
Device	Setting										
HFM5500-AAM, HFM5500-AAF	Light Off										
HFM5500-BAM, HFM5500-BAF	Light On										
Sigma 1, 3, 4	Settable										
Data Echo	Off On	Off	Fibre optic communication networks can be connected in star or ring format. Ring connections require data to be passed from relay to relay. When using this configuration all relays in the ring must have Data Echo set to ON. Otherwise it should, and must when using the RS485 electrical interface or the MODBUS protocol, be set to OFF . Figure 2 to Figure 6 illustrate a number of network arrangements.								

2.2 Modular II Type Relays

2.2.1 Recommended fibre optic cable

Selection of fibre optic cable is critical. Fibres should be terminated with 9mm SMA connectors, or ST connectors depending on the type fitted to the relay.

Modular II relays are based on a common platform; these include Ohmega Distance Protection, MicroTAPP Transformer Voltage Control, Delta Feeder Manager, Duobias-M Transformer Protection, TAU Autoreclose and Iota I/O unit.

The Modular II relay is optimised to use either a 50/125 µm or 62.5/125 µm glass fibre optic cable. Fibre-optic transmission distances vary with transmitter, receiver and type of fibre. The tables in section 14 show the achievable distances between Reyrolle devices.

2.2.2 Communication Settings

COMMUNICATIONS MENU											
Setting	Range	Default	Description								
Station Address	0 ... 254	0	The address of the relay must be set to a value between 1 and 254 before communication. Setting the address to zero disables communications to the relay. All relays on a network, for example, as illustrated in section 13, must have a unique address. Address 255 is reserved as a global broadcast address.								
IEC870 on port	Com1, Com2, Auto, None	Com1	The port to which the IEC60870 protocol is directed. The Auto option enables detection of the active port. This option can be used if redundancy is required and both channels are connected to the same source. The option None switches all communications off. This option has been superseded in newer software, refer protocol setting below.								
Com1 Protocol Com2 Protocol	OFF, ASCII, IEC60870-5-103, MODBUS-RTU,	103 ASCII	Select the communications protocol active on each port. The standard protocols IEC60870-5-103 and MODBUS-RTU are supported along with an ASCII terminal mode. On some devices this is only available on Com2. To disable communications on a port set the protocol to OFF. Details of the MODBUS protocol are given in separate documents.								
Line Switch Time	1 ... 60 seconds	30	If the Auto option is set in the IEC870 on port setting (see above) this is the amount of time the device waits after communications has ceased on a channel before switching channels. This option has been removed in newer software, due to implementation of the different protocols.								
Com1 Baud Rate Com2 Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	19200 19200	Communications speed defined in bits per second (BPS) for each port. Only 19200 and 9600 BPS are defined in [1] IEC60870-5-103, the additional rates are provided for local or modem communications.								
Com1 Parity Com2 Parity	None, Even, Odd	Even None	Parity setting for each port. [1] IEC60870-5-103 defines the method of transmission as using Even Parity. However, in some configurations the parity needs to be None.								
Com1 Line Idle Com2 Line Idle	Light Off, Light On	Light Off Light Off	Idle state setting for each port. [1] IEC60870-5-103 defines the line idle state as Light On. This setting allows an alternative of Light Off to be selected. The line idle setting must be set to be compatible with the hardware connected to the relay. The Sigma range of products for connecting to the fibre-optic ports on the relays support either Light ON or OFF. All sigma units are supplied Light Off. Sigma 1 has internal switches to set the condition for each fibre optic channel, Sigma 3 and 4 have an internal jumper to set the state of their fibre optic channel. Refer to section 13 DIAGRAMS. The table to the left shows the line-idle settings for use with the Honeywell type HFM5500 fibre-optic to RS232 converters.								
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Device	Setting										
HFM5500-AAM, HFM5500-AAF	Light Off										
HFM5500-BAM, HFM5500-BAF	Light On										
Sigma 1, 3, 4	Settable										
Com1 Data Echo Com2 Data Echo	Off, On	Off Off	Echo mode setting for each port. Communication networks can be connected in star or optical ring format (not when using MODBUS). The Optical Ring architecture requires data to be passed from relay to relay. When using this configuration all relays in the ring must have Data Echo set to ON. Otherwise (and when using MODBUS) this setting should OFF. Figure 2 to Figure 5 illustrate a number of network arrangements								
Com2 Direction	Auto-Detect Front Port Rear Port	Auto-Detect	A Modular II relay has two Com2 ports, a pair of fibre optic connectors on the rear; and a 25 way female D-Type socket on the front fascia. This setting specifies which Com2 port will be active. Choosing <i>front</i> or <i>rear</i> forces that port active. Choose <i>Auto-Detect</i> and the rear port will be active until a device is connected to the front port, which then becomes active. When the device is removed the Rear port will again activate.								

2.3 Modems

The communications interface has been designed to allow data transfer over a telephone system via modems. Information concerning using and installing modems is detailed in the document [7] Reyrolle Technical Information Report - 434tir007.

3 LINK LAYER

3.1 Introduction

This protocol uses Frame Type FT1.2 as defined by [2] IEC60870-5-1. These frames consist of octets (8 bits) transmitted least significant bit first, without any idle time between bits. Unbalanced transmission is used i.e. communication can only be initiated from the Primary (Master) Station, for example, a Control System or Remote Access Point communication program, never from the Secondary (Slave i.e. the relay). Sections 5.2 "Unbalanced transmission services" and 5.3 "Unbalanced transmission procedures" of [3] IEC60870-5-2 fully apply. The Application Service Data Units (ASDU) are taken from [1] IEC60870-5-103. Two types of frame are used; one of fixed length 5 octets and a variable length frame of up to 256 octets, both are described below. Note the following description will use hexadecimal notation to denote some constants, for example 10h (equal to decimal 16). Numbers without the 'h' suffix are decimal.

3.2 Fixed Length Message Frame

Start	Information Field		Checksum	End
	Control	Address		
10h	c	A	x	16h

A fixed length frame contains 5 octets. It begins with a Start octet of 10h and is terminated by an End octet of 16h. The octet immediately preceding the End is the Checksum. The Information Field comprising two octets, Control, as defined in [3] IEC60870-5-2 section 5.12 and section 3.4, and Address, is located between the Start Flag and the Checksum field. The Checksum is calculated by performing modulo 256 addition of the octets in the Information Field. A modulo 256 addition involves adding all the octets and then taking the remainder after dividing by 256.

3.3 Variable Length Message Frame

Start	Length	Length	Start	Information Field	Checksum	End
68h	LL	LL	68h		x	16h

A variable length frame begins with a Start octet of 68h and is terminated by an End octet of 16h. The Start octet is followed by an octet indicating the number of octets in the Information Field, which is then repeated in the following octet. The frame header is completed by a second Start octet. The octet immediately preceding the End octet is a Checksum, again calculated by performing modulo 256 addition of the octets in the Information Field. The Information Field is located between the second Start octet and the Checksum, and has a maximum length of 250 octets, which corresponds to a maximum frame length of 256 octets.

Information Field								
Control	Address	Data Unit Identifier				Object Identifier		Data Field
c	a	Type	Var. ID	COT	ASDU	Type	Address	

The information field of a variable length frame starts with a Control Octet followed by an Address Octet. These serve the same purpose as those in the fixed length frame. Then there are 4 octets that constitute the Data Unit Identifier, as defined in [4] IEC60870-5-3. These octets are Type Identification, Variable Structure Identifier, Cause of Transmission, and Common Address of ASDU. Two octets comprising the Information Object Identifier, whose octets are respectively Information Object Type (Function Type) and Information Object Address (Information Number) follow the Data Unit Identifier. The contents of the Data Field are dependent on the type of frame. The octets of the Data Unit Identifier, Object Identifier and Data Field constitute the ASDU. They are selected from a set of Application Information Elements as defined in [5] IEC60870-5-4. The types used are defined below. The Data Field is totally transparent and the information can have any form and contain any binary bit combination.

3.4 Control Octet

MSB				Bit Number				LSB
7	6	5	4	3	2	1	0	
Control Code				Function Code				

For either type of frame the most significant 4 bits of this octet contain the control code and the least significant 4 bits the function code. They are defined in [3] IEC60870-5-2, section 5.1.2 and [1] IEC60870-5-103, section 6.3, and described below.

3.4.1 Control Codes

MSB		Bit Number				LSB	
7	6	5	4	3	2	1	0
Reserved	Primary Direction =1	Frame Count Bit	Frame Count Bit Valid	Function Code			

In the primary direction i.e. from the primary to the secondary, the Control codes shown above apply.

MSB		Bit Number				LSB	
7	6	5	4	3	2	1	0
Reserved	Primary Direction =0	Access Demand	Data Flow Control	Function Code			

In the secondary direction i.e. from the secondary to the primary, the Control codes shown above apply.

Control Bit Definitions	Description
Reserved	Not used.
Primary Direction (PRM)	Signifies which station generated the frame. If generated by the Primary station this bit is set (=1), if the secondary it is clear (=0).
Frame Count Bit (FCB)	The purpose of the Frame Count Bit (FCB) is to allow the secondary station to detect when a frame is being retransmitted. For the majority of data exchanges the Master station alternates the value of the FCB in the Control Octets of the frames. In the case of a missing or corrupted response from the Secondary the Master sends the same frame with the same value of FCB. When the Relay sees a frame with the same value of FCB as the previous frame it assumes that the previous response frame it sent has been corrupted or lost and will transmit the previous frame again even if there is already a new message in the output buffer. After a predefined maximum number of attempts (usually 5) have failed the Master indicates a communication link failure and ceases transmission. The secondary station only tests this bit if the Frame Count Valid (FCV) bit is set. Refer below. Initially, or after a reset, the secondary station expects the first frame sent by the Master to have the FCB set.
Frame Count Valid (FCV)	Set by the primary station if the value of Frame Count Bit is to be tested.
Access Demand Bit (ACD)	Set by the secondary station if it has a Data Class 1 frame available for downloading.
Data Flow Control (DFC)	Set by the secondary station when it is processing a command. It cannot process any further commands, and will ignore any sent while it is set.

3.4.2 Function Codes

The function code occupies the lower 4 bits of the control octet. It should be treated as a 4-bit integer. These function codes and the responses to them are defined in [3] IEC60870-5-2. Note that all codes will generate a response, either a confirmation or data, from the secondary station except for code 4. Code 4 would usually be used with global broadcast commands.

Primary Function Codes (PRM=1)	Value	Type	Description
Reset Communications Unit	0	Send	Resets the communications unit, Frame Count Bit and all buffers. Relay expects next frame's FCB bit to be set
Send / Confirm Expected	3	Send	Send data, secondary station to confirm receipt.
Send / NO Confirm Expected	4	Send	Send data, no confirmation from secondary station
Reset Frame Count Bit	7	Send	Only Resets the Frame Count Bit. Relay expects next frame's FCB bit to be set
Link Status Request	9	Request	Request of Link Status
Data Class 1 Request	10	Request	Request application data Class 1
Data Class 2 Request	11	Request	Request application data Class 2

Secondary Function Code (PRM=0)	Value	Type	Description
Positive Confirm To Send	0	Confirm	Positive acknowledgement
Negative Confirm To Send	1	Confirm	Negative acknowledgement (data could not be processed - interface busy)
Positive Confirm To Request	8	Confirm	Application data
Negative Confirm To Request	9	Confirm	Requested data not available
Response for link status	11	Respond	Link Status OK
Link service not functioning	14	Respond	Malfunction, cannot process primary function code
Link service not implemented	15	Respond	Unknown primary function code received

Possible Function Codes sent by the secondary station in response to a request from the primary							
Function Code From Primary	0	3	4	7	9	10	11
Possible Function Codes in Response From Secondary	0	0,1		0	11	8,9	8,9

3.5 Address Octet

The address octet contains the address that the relay was set in its active setting table. See section 2.1.2 or 2.2.2.

3.6 Frames in the Control Direction (Control System to Relay)

The following section describes the link layer frames to transmit to the secondary station for the instructions described above. Beside each frame is a description of which bit fields and function codes are in the control octet. The descriptions 3.6.1 to 3.6.5 use the short frame as described in section 3.2, the remainder the variable length frame from section 3.3 the control codes are from section 3.4. Some of the variable length frames are of predefined types that carry out specific tasks, for example, time synchronisation; they are defined in detail. APPENDIX A - IEC60870 CODE DEFINITIONS defines the IEC60870 control codes that are used in these frames.

3.6.1 Request for Communication Unit Reset

10h	40h	1h	41h	16h	Control = PRM = 40h
-----	-----	----	-----	-----	---------------------

The first access of the relay after start/restart or hardware/software reset must be with a Request for Communication Unit reset or Request for Frame Count Bit reset. The relay will not respond to any message even if correctly addressed unless either has been successfully executed. On successful reception of this command the relay will acknowledge it, see 3.7.1, and prepare an initialisation response, see 3.7.11.

3.6.2 Request for Frame Count Bit Reset

10h	47h	1h	48h	16h	Control = PRM + Reset Frame Count Bit = 47h
-----	-----	----	-----	-----	---

The relay will acknowledge this request, see 3.7.1, and prepare an initialisation response, see 3.7.11.

3.6.3 Request for Link Status

10h	49h	1h	4Ah	16h	Control = PRM + Link Status Request = 49h
-----	-----	----	-----	-----	---

The relay will respond with a Link Status Acknowledge message, see section 3.7.5.

3.6.4 Request for Data Class 1

10h	7Ah	1h	7Bh	16h	Control = PRM + FCB + FCV + Data Class 1 Request = 7Ah
-----	-----	----	-----	-----	--

10h	5Ah	1h	5Bh	16h	Control = PRM + FCV + Data Class 1 Request = 5Ah
-----	-----	----	-----	-----	--

The relay will respond with the next class 1 message if available, or a Data Not Available message, see 3.7.4.

3.6.5 Request for Data Class 2

10h	7Bh	1h	7Ch	16h	Control = PRM + FCB + FCV + Data Class 2 Request = 7Bh
-----	-----	----	-----	-----	--

10h	5Bh	1h	5Ch	16h	Control = PRM + FCV + Data Class 2 Request = 5Bh
-----	-----	----	-----	-----	--

The relay will respond with the next class 2 message if available, or a Data Not Available message, see 3.7.4.

3.6.6 Time Synchronisation - ASDU Type 6

Octet No.	Value Global	Value Individual	Description
1	68h	68h	Start flag
2	15	15	Length of Information field
3	15	15	Repeated length of Information field
4	68h	68h	Start flag
5	44h	73h	Control field
6	255	a	Station address
7	6	6	Frame Type identification
8	81h	81h	Variable structure identifier
9	8	8	Cause of transmission
10	255	a	Common address of ASDU
11	255	255	Function Type
12	0	0	Information number
13	30h	30h	Milliseconds - low octet
14	75h	75h	Milliseconds - high octet
15	1Bh	1Bh	Minutes + MSB = Invalid Flag
16	8Ah	8Ah	Hours + MSB = SU Summer time Flag
17	4	4	Days
18	6	6	Months
19	97	97	Years
20			Checksum
21	16h	16h	End flag

The time synchronise command sent by the primary station to the secondary complies with that defined [1] IEC60870-5-103 section 7.4.2 Time Synchronisation. It comprises the information shown in the above table within a variable length frame of type 6.

Usually, the time synchronise command is used to synchronise all secondary devices on a network. To achieve this we set the destination address to be Global (255), and the control field to **PRM + Send / NO Confirm Expected = 44h** signifying we do not want replies from the secondary stations.

You can also use the time synchronise command to set the time of an individual secondary station. In this case the address of the secondary station (e.g. 1) is used and the control field typically set to **PRM + FCB (alternating) + FCV + Send / Confirm Expected = 73h or 53h**. An acknowledgement, see 3.7.1, from the secondary is followed by a time synchronise confirmation message, see 3.7.12.

Some typical values for the fields are shown in the above table in respectively the value global and value individual columns. The example time in the above table is 10:27:30.000 and the date the 4th June 1997, it is encoded as follows. The seconds are stored as a number of milliseconds, 0 to 59,999, in a 16-bit word. This is split into a low octet and a high octet, for example, in this case milliseconds = 30,000 = 7530h, therefore low = 30h and high 75h.

The minutes, 0 to 59, are set in a single octet. In this example minutes = 27 = 1Bh. Note, the Most Significant Bit (MSB) of the minutes octet is used to signify the status of the invalid flag, however in this instance as we are sending a time it is irrelevant.

The invalid flag, 0 represents valid, 1 invalid, is used to signify whether the time has been set within the last 23 hours. Frames from the secondary device that have a time stamp include the invalid flag. After 23 hours have elapsed since the last setting of the time, the secondary station sets the invalid flag to signify the time may be invalid. When the time is synchronised this flag is cleared allowing an invalid time to be detected.

The hours, 0 to 23, are set in a single octet. Note, the Most Significant Bit (MSB) is used to hold the summer time flag. In this example with the summer time flag cleared hours = 10 = 0Ah, with it set the octet would be set to 80h + 0Ah = 8Ah. The table shows the summer time flag set.

The summertime flag, 0 represents normal time and 1 that daylight saving time is in operation. When the time is synchronised this flag is set or cleared depending on the value of this bit. Frames from the secondary device that have a time stamp include the summer time flag.

The octets containing the date are simply set to the numeric value of the content, i.e. day = 1 to 31. Month 1 (January) to 12 (December) and years without the century, therefore, for the above example Day = 4, Month = 6 and year = 97.

The following shows the values in a typical global time synchronise frame, note the summer time flag is set.

Example Frame
68h Fh Fh 68h 44h FFh 6h 81h 8h FFh FFh 0h 30h 75h 1Bh 8Ah 4h 6h 61h 85h 16h

3.6.7 General Interrogation Initialisation - ASDU Type 7

Octet	Value	Description
1	68h	Start flag
2	9	Length of Information field
3	9	Repeated length of Information field
4	68h	Start flag
5	73h or 53h	Control field
6		Station address (1 - 254)
7	7	Frame Type identification
8	81h	Variable structure identifier
9	9	Cause of transmission
10		Common address of ASDU (1 - 254)
11	255	Function Type
12	0	Information number
13		Scan Number (0 - 255)
14		Checksum (sum of fields 5 to 13 modulo 256)
15	16h	End flag

The General Interrogation procedure complies with that defined in [1] IEC60870-5-103, Section 7.4.3 - General Interrogation. General Interrogation is used to retrieve the state of certain events at the time of the interrogation. A General Interrogation Cycle is initiated by sending an Initialisation of General Interrogation ASDU of type 7, shown above, to the address of the station to interrogate. The scan number, octet 13 above, is an arbitrary number (0 to 255) sent by the control system, which is copied to the response message by the relay and thus used to tie a response to the request.

Each event is in the form of type 1 or 2 ASDU, see 3.7.7 or 3.7.8. The completion of a general interrogation cycle will be signified by a General Interrogation Termination message, frame type 8, see 3.7.13. These frames are retrieved in response to a request for class 1 data; therefore after initialisation of general interrogation the relay should be polled for class 1 data, see 3.6.4.

If you sent a General Interrogation Initialisation during a General Interrogation cycle, the present cycle will be aborted, without the termination message and a new one started.

A General Interrogation will typically be sent after a system reset to obtain the present state of the events.

The following shows the values in a typical General Interrogation Initialisation Frame.

Example Frame
68h 9h 9h 68h 73h 1h 7h 81h 9h 1h FFh 0h C8h CDh 16h

3.6.8 General Command - ASDU Type 20

Octet	Value	Description
1	68h	Start flag
2	10	Length of Information field
3	10	Repeated length of Information field
4	68h	Start flag
5	73h or 53h	Control field
6		Station address (1 - 254)
7	20	Frame Type identification
8	81h	Variable structure identifier
9	20	Cause of transmission
10		Common address of ASDU (1 - 254)
11		Function type
12		Command number
13		Double Command Information
14		Return Information Identifier (0 - 255)
15		Checksum (sum of fields 5 to 14 modulo 256)
16	16h	End flag (16h)

A General Command comprises the information shown in the above table within a variable length frame containing an ASDU type 20. The command number is defined by [1] IEC60870-5-103 section 7.2.5 Table 17 and by Reyrolle. A command is either double (turns an item on or off, for example an auto-recloser), or single (turns an item on, for example, a characteristic) action. The Double Command Information used with certain commands is either OFF (1) or ON (2), for single action commands this should be set to ON (2).

Double Command Information	Description (Refer to [1] IEC60870-5-103 section 7.2.6.4)
0	Not Used
1	OFF
2	ON
3	Not Used

Table Showing permitted Double Command Information Numbers

Return Information Identifier, octet 14 above, is an arbitrary number sent by the control system. It is copied to the response message and thus used to tie responses to commands.

The response is with a Command Acknowledge Message in a Type 1 Frame, see 3.7.7.

Information about general commands can be obtained via the "IG" command, see section 4.10.3.

The following shows the values in a typical General Command.

Example Frame
68h Ah Ah 68h 73h 1h 14h 81h 14h 1h FFh 13h 2h 2Ah 5Ch 16h

3.6.9 Order for disturbance data transmission - Frame Type 24

Octet	Value	Description
1	68h	Start flag
2	13	Length of Information field
3	13	Repeated length of Information field
4	68h	Start flag
5	73h or 53h	Control field
6		Station address (1 - 254)
7	24	Frame Type identification
8	81h	Variable structure identifier
9	31	Cause of transmission
10		Common address of ASDU (1 - 254)
11		Function type
12		Not Used
13		Type of Order (TOO)
14		Type of Disturbance Values (TOV)
15		Fault Number (FAN) - low octet
16		Fault Number (FAN) – high octet
17		Actual Channel (ACC)
18		Checksum (sum of fields 5 to 14 modulo 256)
19	16h	End flag (16h)

An order for disturbance data transmission comprises the information shown in the above table within a variable length frame of type 24. The disturbance data is transmitted in several parts. Each part is requested in this type of frame. The Type of order number for each part is defined by [1] IEC60870-5-103 section 7.2.6.26, The subset of TOO codes used in a type 24 frame are shown below.

Type of Order Code	Description
1	Selection of fault
2	Request for disturbance data
3	Abortion of disturbance data
4..7	Reserved
8	Request for channel
9	Abortion of channel
10...15	Reserved
16	Request for tags
17	Abortion of tags
18...23	Reserved
24	Request for list of recorded disturbances
25...31	Reserved

The type of value parameter is defined by [1] IEC60870-5-103 section 7.2.6.27 and shown below.

Type of Order Code	Description
0	Not Used
1	Instantaneous Values
2...255	Not Used

The fault number is supplied by the relay in a List of Recorded Disturbances - Frame Type 23, see 3.7.15. Frame type 23 is generated by the relay when a fault is stored, or after an order for disturbance data request with TOO = 24.

The actual channel numbers are defined by [1] IEC60870-5-103, section 7.2.6.1 and Reyrolle and are shown in APPENDIX B- PUBLIC AND PRIVATE CODES.

The following shows the values in an order for disturbance data request with TOO = 24.

Example Frame
68h dh dh 68h 73h 1h 18h 81h 1fh 1h a0h 0h 18h 1h 0h 0h 0h 50h 16h

3.6.10 Acknowledgement for disturbance data transmission - Frame Type 25

Octet	Value	Description
1	68h	Start flag
2	13	Length of Information field
3	13	Repeated length of Information field
4	68h	Start flag
5	73h or 53h	Control field
6		Station address (1 - 254)
7	25	Frame Type identification
8	81h	Variable structure identifier
9	31	Cause of transmission
10		Common address of ASDU (1 - 254)
11		Function type
12		Not Used
13		Type of Order (TOO)
14		Type of Disturbance Values (TOV)
15		Fault Number (FAN) - low octet
16		Fault Number (FAN) – high octet
17		Actual Channel (ACC)
18		Checksum (sum of fields 5 to 14 modulo 256)
19	16h	End flag (16h)

An acknowledgement of disturbance data transmission comprises the information shown in the above table within a variable length frame of type 25. The disturbance data is transmitted in several parts. Each part is acknowledged in this type of frame. The type of order number for each part is defined by [1] IEC60870-5-103 section 7.2.6.26, The subset of TOO codes used in a type 25 frame are shown below.

Type of Order Code	Description
32	End of disturbance data transmission without abortion
33	End of disturbance data transmission with abortion by control system
34	End of disturbance data transmission with abortion by protection equipment
35	End of channel transmission without abortion
36	End of channel transmission with abortion by control system
37	End of channel transmission with abortion by protection equipment
38	End of tag transmission without abortion
39	End of tag transmission with abortion by control system
40	End of tag transmission with abortion by protection equipment
41...63	Reserved

The type of value, fault number and actual channel parameters are copied from the frames being acknowledged.

The following shows the values in an acknowledgement of disturbance data request with TOO = 32.

Example Frame
68h dh dh 68h 73h 1h 19h 81h 1fh 1h a0h 0h 20h 1h 40h 5h 0h 34h 16h

3.6.11 Send Private Data to Relay Frame Types 254 and 255

Octet	Value	Description
1	68h	Start flag
2	$n + 3$	Length of Information field
3	$n + 3$	Repeated length of Information field
4	68h	Start flag
5	73h or 53h	Control field
6		Station address (1 - 254)
7	254 or 255	Frame Type identification
		n (Max 247) octets of User Data
$8 + n$		Checksum (sum of fields 5 to 14 modulo 256)
$9 + n$	16h	End flag (16h)

This section describes how private data is sent, using variable length frames, to the relay. Typically this data will be one of the Reyrolle private commands described in section 4. Unlike the other variable length frames defined, these frames do not have the 4 byte Data Unit Identifier or the Object Identifier described in section 3.3. Instead they have a single Type Identifier octet defined as either 255 (FFh) or 254 (FEh), respectively the last segment of data and not the last segment of data. This allows data to be sent to the relay that will occupy multiple frames i.e. more than the maximum 247 octets per frame of data. All the frames excluding the last one are marked as type 254, with the last, signifying the data is now complete as type 255.

Each frame sent to the relay is acknowledged, see section 3.7.1. After the acknowledgement is received the next data frame can be transmitted. After sending the last data frame, the relay should be polled for class 1 data to retrieve any response messages.

The following show examples of a single data frame being sent. The data sent is the string HELP, ASCII characters 48h, 45h, 4Ch and 50h. As it is the only frame it is marked last frame ffh.

Example Frame with Control Octet = PRM + FCB + FCV + Send / Confirm Expected
68h 7h 7h 68h 73h 1h ffh 48h 45h 4Ch 50h 9Ch 16h

Example Frame with Control Octet = PRM + FCV + Send / Confirm Expected
68h 7h 7h 68h 53h 1h ffh 48h 45h 4Ch 50h 7Ch 16h

3.7 Frames in the Monitoring Direction (Relay to Control System)

These responses are only sent when the relay has received a frame that it can process, or as the data in response to a request for data. For this to happen the integrity of the frame must be correct, i.e. tests on the checksum, length, predefined fields etc. must have been passed. If the integrity of the frame is incorrect the relay will not respond. The primary station must time how long it is before the response arrives, the relay should respond within 50 milliseconds, if it is significantly outside this the primary station can assume an error and retransmit the frame.

The control code in the response frame from the relay is dependent on the state of the ACD and DFC bits at the time of transmission. Refer also section 3.4.1. The following codes are possible.

Code Value	Description
0	Neither DFC nor ACD is set.
1	Only DFC is set.
2	Only ACD is set.
3	Both DFC and ACD are set.

3.7.1 Positive acknowledgement (confirm) of data received by relay

Sent by the relay in response to a data frame to signify the data has been processed, it is a short frame with the function Code of 0. As an alternative to this message the Negative Acknowledgement frame, see section 3.7.2, may be sent. Examples of a positive acknowledgement are shown below.

No ACD or DFC
10h 0h 1h 1h 16h

ACD
10h 20h 1h 21h 16h

ACD and DFC
10h 30h 1h 31h 16h

3.7.2 Negative acknowledgement (confirm) of data received by relay

Sent by the relay in response to a data frame to signify the data has not been processed, it is a short frame with the function Code of 1. This will be either because the frame type is not recognised, or the relay presently has the DFC bit set. An example of a negative acknowledgement is shown below.

10h	01h	1h	02h	16h
-----	-----	----	-----	-----

3.7.3 Positive acknowledgement (confirm) of request received by relay, requested data available

The function code 8 is sent by the relay in the data frame containing the requested data. The data frame will be one of the types listed below in section 3.7.7 onwards. Note if the ACD bit is set to accompany this response there is more class 1 data ready in the relay for which you can poll immediately.

3.7.4 Negative acknowledgement (confirm) of request received by relay, requested data not available

The function code 9 is sent in a short frame to signify that the requested class 1 or 2 data is not available. If you are expecting this data to be available, for example, as the response to a command, then the relay may not have had time to produce it yet and you should continue polling. An example is shown below.

10h	09h	1h	0Ah	16h
-----	-----	----	-----	-----

3.7.5 Link Status Acknowledge

Sent by the relay in response to a link status request. A short frame with the function Code of 11. An example of a link status acknowledgement is shown below.

10h	0Bh	1h	0Ch	16h
-----	-----	----	-----	-----

3.7.6 Response for unknown function code

Sent by the relay in response to an unknown link layer function code, see section 3.4.2, it is a short frame with the function code of 15. An example of an unknown function code acknowledgement is shown below.

10h	0Fh	1h	10h	16h
-----	-----	----	-----	-----

3.7.7 Time Tagged Message, Frame Type 1

Octet	Value	Description
1	68h	Start flag
2	14	Length of Information field
3	14	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	1	Frame Type Identification
8	81h	Variable structure identifier
9		Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11		Function type
12		Information number
13		Double Point Information - IEC371-02-08 (1 - OFF or 2 - ON)
14		Milliseconds - low octet
15		Milliseconds - high octet
16		Minutes + MSB = Invalid Flag
17		Hours + MSB = Summer Time Flag
18		Supplementary Information
19		Checksum (sum of fields 5 to 18 modulo 256)
20	16h	End Flag

Time tagged frame used to return Events, General Interrogation and General Command Responses, as defined in [1] IEC60870-5-103, section 7.3.1.1. They are extracted as the response to a request for class 1 data, see section 3.6.4. The type of information being returned can be determined by checking the cause of transmission (COT) octet, the supplementary information octet is dependent on the COT octet, see table below.

Description	COT	Supplementary Information
Spontaneous Events	1	0
General Interrogation	9	GI Scan Number from GI Initialisation Message
Command Acknowledgement Positive	20	Return Information Identifier from Command Message
Command Acknowledgement Negative	21	Return Information Identifier from Command Message

Table Showing Cause of Transmission and Supplementary Information value for various events

Double Point Information	Description (Refer to [1] IEC60870-5-103 section 7.2.6.5)
0	Travelling (Transitional)
1	OFF
2	ON
3	Invalid

Table Showing permitted Double Point Information values

For Spontaneous Events and General Interrogation messages the function type and information number are from the Function Type and Event Codes shown in APPENDIX A - IEC60870 CODE DEFINITIONS and APPENDIX B- PUBLIC AND PRIVATE CODES. The Double Point Information (DPI) octet is set to the actual state of the corresponding event; it is not relevant for command acknowledgements. For the command acknowledgements the function type and information number (command code) are defined in APPENDIX B- PUBLIC AND PRIVATE CODES.

An example of a spontaneous event frame is shown below; the function type is 160, event LED Reset information number is 19 and time 9:34:27.950 with the summer time flag set.

Example Frame

68h Eh Eh 68h 08h 1h 1h 81h 1h 1h A0h 13h 2h 2Eh 6Dh 22h 89h 0h 88h 16h

3.7.8 Time Tagged Message with Relative Time, Frame Type 2

Octet	Value	Description
1	68h	Start flag
2	18	Length of Information field
3	18	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	2	Type identification
8	81h	Variable structure identifier
9		Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11		Function type
12		Information number
13		Double Point Information - IEC60870-5-103 (1 - OFF or 2 - ON)
14		Relative Time - Low Octet
15		Relative Time - High Octet
16		Fault Number - Low Octet
17		Fault Number - High Octet
18		Milliseconds - low octet
19		Milliseconds - high octet
20		Minutes + MSB = Invalid Flag
21		Hours + MSB = Summer Time Flag
22		Supplementary Information
23		Checksum (sum of fields 5 to 22 modulo 256)
24	16h	End Flag

Time tagged frame with relative time, extracted as the response to a request for class 1 data, see section 3.6.4. The structure and meaning are basically the same as for Type 1 frames except for additional 4 octets between the DPI information and the milliseconds low octets. The relative time is relative to the start/pickup of the protection equipment and is given in milliseconds. The fault number is used to tag events giving a relationship between events and faults. The fault number will be incremented each time a new fault occurs. Relative time and the Fault Number are not relevant for general interrogation. Any general interrogation responses that are returned in this type of frame will have these values set to zero. No Command responses will be returned in this type of frame. An example of a spontaneous event type 2 frame is shown below, the function code is 160, event A-Starter 64, the Relative Time Stamp is 5 milliseconds, the fault number is 3 and time 9:34:27.950 with the summer time flag set.

Example Frame

68h 12h 12h 68h 08h 1h 2h 81h 1h 1h A0h 40h 2h 5h 0h 3h 0h 2Eh 6Dh 22h 89h 0h BEh 16h

3.7.9 Measurands 1- Frame Type 3

Octet	Value	Description
1	68h	Start flag
2	$8 + (2 * m)$	Length of Information field
3	$8 + (2 * m)$	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	3	Type identification
8	n	Variable structure identifier
9	2	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	ft	Function type
12	inf	Information number
$13 + ((m - 1) * 2)$		Measurand - low octet
$14 + ((m - 1) * 2)$		Measurand - high octet
$15 + ((m - 1) * 2)$		Checksum (sum of fields 5 to 14 + $((m - 1) * 2)$ modulo 256)
$16 + ((m - 1) * 2)$	16h	End flag (16h)

Type 3 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.3, provide groups of measured values. The Function Type and the Information Number (INF) define the type of measurand. The number of values in a measurand is given by the Variable Structure Identifier (VSI) octet. The public measurands returned in this type of frame are defined in [1] IEC60870-5-103 section 7.2.5.2 table 14, and are duplicated below.

Information Number (inf)	Variable Structure Identifier (VSI)	Description
144	1	Measurand I
145	2	Measurands I, V
146	4	Measurands I, V, P, Q
147	2	Measurands I_N , V_{EN}

Octet	Value	Description
13		Measurand I low octet
14		Measurand I high octet
15		Checksum (sum of fields 5 to 14 modulo 256)
16	16h	End flag (16h)

The table above shows the measurand octets and the end of a frame when the INF is 144 and the VSI 1.

Octet	Value	Description
13		Measurand I low octet
14		Measurand I high octet
15		Measurand V low octet
16		Measurand V high octet
17		Checksum (sum of fields 5 to 14 modulo 256)
18	16h	End flag (16h)

The table above shows the measurand octets at the end of a frame when the INF 145 and the VSI 2.

If available, a type 3 measurand is extracted from the relay by means of the Request Data Class 2 command, see section 3.6.5. The Measurands Returned depend on the type of the relay. APPENDIX B- PUBLIC AND PRIVATE CODES shows the measurands returned for the specific types of relays.

High Octet								Low Octet							
Sign	V12	V11	V10	V9	V8	V7	V6	V5	V4	V3	V2	V1	RES	ERR	OV

Each measurand is returned as two octets, low then high, that are combined to form the 16 bit word as shown above. It is defined in [1] IEC60870-5-103 section 7.2.6.8. Bits V1 to V12 comprise the 12 bit normalised value, which uses 2's complement format, RES is a reserved bit, ERR is an error bit and OV is the overflow bit. The definition also states the maximum normalised value as being 1.2x or 2.4x the rated value of the relay. If the value exceeds this maximum the overflow bit will be set and the value will be the maximum that can be represented, i.e. for positive values bits V1 to V12 are set, for negative values the sign bit is set and bits V1 to V12 cleared. Whether the relay uses 1.2x or 2.4x must either be settable, or declared for a particular relay. By default Reyrolle relays use 1.2x.

The relay calculates the Normalised value as follows

$$NormalisedValue = \frac{MeasuredValue * 2^{12}}{RatedValue * 1.2}$$

The example below shows a frame containing a single measurand, information number 150 (96h), and Variable structure identifier 1. The value of the measurand is 3413 (hex = d55) placed in positions V1 to V12. The flags Sign, RES, ERR, OV are cleared as follows:

High Octet								Low Octet							
Sign	V12	V11	V10	V9	V8	V7	V6	V5	V4	V3	V2	V1	RES	ERR	OV
0	1	1	0	1	0	1	0	1	0	1	0	1	0	0	0
0	d				5				5				0	0	0
6				A				A				8			

The following frame shows this example, note the measurand octets reversed for transmission.

Example Frame
68h Ah Ah 68h 08h 1h 3h 1h 2h 1h A0h 96h A8h 6Ah 58h 16h

The next example shows the same measurand with a value of -3413.

The 2's complement of 3413 for 12 bits is $2^{12} - 3413 = 683(2ABh)$

Placing this in position and setting the sign bit, with the other bits cleared as follows:

High Octet								Low Octet							
Sign	V12	V11	V10	V9	V8	V7	V6	V5	V4	V3	V2	V1	RES	ERR	OV
1	0	0	1	0	1	0	1	0	1	0	1	1	0	0	0
1	2				A				B				0	0	0
9				5				5				8			

The following frame shows this example, note the measurand octets reversed for transmission.

Example Frame
68h Ah Ah 68h 08h 1h 3h 1h 2h 1h A0h 96h 58h 95h 2Dh 16h

3.7.10 Time-tagged measurands with relative time - Frame Type 4

Octet	Value	Description
1	68h	Start flag
2	20	Length of Information field
3	20	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	4	Type identification
8	81h	Variable structure identifier
9		Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	<i>Inf</i>	Information number
13		Measurand – least significant octet
14		
15		
16		Measurand – most significant octet
17		Relative Time - Low Octet
18		Relative Time - High Octet
19		Fault Number - Low Octet
20		Fault Number - High Octet
21		Milliseconds - low octet
22		Milliseconds - high octet
23		Minutes + MSB = Invalid Flag
24		Hours + MSB = Summer Time Flag
25		Checksum (sum of fields 5 to 14 + ((m - 1) * 2) modulo 256)
26	16h	End flag (16h)

Type 4 data frames provide measurands as defined in [1] IEC60870-5-103 section 7.3.1.4. The Function Type and the Information Number define the type of measurand. There is only 1 measurand per frame. The public measurands returned in this type of frame are defined in [1] IEC60870-5-103 section 7.2.5.2 table 12, and are duplicated below.

Information Number	Description
73	Fault location X in ohms

This ASDU is also used to send events with a real value. For example, the description shown below is taken from the Solkor-N events list in section 7.11; it shows two Trip count alarm events. The TYP column shows the type of ASDU used to send the event. ASDU 1 is used to send the event when the alarm is raised or cleared; this would be after a threshold has been reached. ASDU 4 is used to send the count each time it changes. In this example, both are also sent during a GI sequence.

FUN	INF	Description	GI / COM	TYP	COT	DIR	
196	70	Trip count alarm	x	1	1, 9	RC	
196	70	Trip count alarm	x	4	1, 9	M	

3.7.11 Identification Message - Frame Type 5

Octet	Value	Description
1	68h	Start flag
2	21	Length of Information field
3	21	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	5	Type identification
8	81h	Variable structure identifier
9		Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	<i>Inf</i>	Information number
13	2	Compatibility Level
14	82	'R'
15	69	'E'
16	89	'Y'
17	82	'R'
18	79	'O'
19	76	'L'
20	76	'L'
21	69	'E'
22	<i>id</i>	Manufacturers Internal Software Identifier 1
23	<i>id</i>	Manufacturers Internal Software Identifier 2
24	<i>id</i>	Manufacturers Internal Software Identifier 3
25	<i>id</i>	Manufacturers Internal Software Identifier 4
26		Checksum (sum of fields 5 to 25 modulo 256)
27	16h	End flag

Type 5 data frames provide identification messages as defined in [1] IEC60870-5-103 section 7.3.1.5. These messages are returned in response to the events Reset Communications Unit refer section 3.6.1, and Reset Frame Count Bit refer section 3.6.2 and a Start Restart of the relay. They are extracted as the response to a request for class 1 data, see section 3.6.4.

FUN	INF	Description	GI / COM	TYP	COT		
?	2	Reset Frame Count Bit	-	5	3		
?	3	Reset Communication Unit	-	5	4		
?	4	Start / Restart	-	5	5		
?	5	Power On	-	5	6		

Table Showing Cause of Transmission and Information Number values for the events described above.

Compatibility Level	Description (Refer to [1] IEC60870-5-103 section 7.2.6.3)
2	Generic Services Not Supported
3	Generic Services Supported

Table Showing Compatibility Levels.

After the initial reset command to the relay it will prepare two events in type 5 frames, which will be the initial class 1 responses. The first will have COT = 4, INF = 3 if the command was a Reset Communications Unit, otherwise

COT = 3, INF = 2 if a Reset Frame Check Bit. The second frame will always have COT = 5, INF = 4, signifying a restart. This procedure complies with [1] IEC60870-5-103 Section 7.4.1 - Initialisation Procedure.

When the user or control system requests Reset Communications Unit or Reset Frame Count a single type 5 response frame will be generated with COT and INF as described above for the respective commands. Again these have to be extracted with a request for class 1 data, see section 3.6.4

The following frame shows an example of a type 5 frame with cause of transmission Reset Frame Count Bit.

Example Frame
68h 15h 15h 68h 08h 1h 5h 81h 3h 1h A0h 2h 2h 52h 45h 59h 52h 4Fh 4Ch 4Ch 45h 0h 0h 0h 0h A5h 16h

3.7.12 Time Synchronise Confirmation - Frame Type 6

This is the response frame generated by the relay when it receives a time synchronisation message which it is asked to confirm, i.e. it is addressed individually rather than globally, see section 3.6.6. This procedure complies with [1] IEC60870-5-103 Section 7.4.2 - Time Synchronisation. The frame is identical to that described in section 3.6.6 except that the Control field will signify it is being sent by the secondary station, i.e. its value is 08h optionally ACD + DFC and the Invalid flag of the minutes octet is now relevant. This type of frame is extracted as the response to a request for class 1 data, see section 3.6.4.

3.7.13 General Interrogation Termination - Frame Type 8

Octet	Value	Description
1	68h	Start flag
2	9	Length of Information field
3	9	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	8	Type identification
8	81h	Variable structure identifier
9	10	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	255	Function type
12	0	Information number
13		Scan Number (0 - 255)
14		Checksum (sum of fields 5 to 13 modulo 256)
15	16h	End flag

The last frame sent from the relay in one general interrogation scan. This frame has a Data Unit Type Identification of 8 and a Cause of Transmission of 10. The Scan Number is copied from the GI initialisation frame, refer section 3.6.7, and is the only data added to the standard application header in this frame. Again this type of frame is extracted as the response to a request for class 1 data, see section 3.6.4.

An example of a type 8 frame is shown below, the scan number is F5h.

Example Frame
68h 09h 09h 68h 08h 01h 08h 81h 0Ah 01h FFh 00h F5h 91h 16h

3.7.14 Measurands 2- Frame Type 9

Octet	Value	Description
1	68h	Start flag
2	$8 + (2 * m)$	Length of Information field
3	$8 + (2 * m)$	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	9	Type identification
8	n	Variable structure identifier
9	2	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	ft	Function type
12	inf	Information number
$13 + ((m - 1) * 2)$		Measurand - low octet
$14 + ((m - 1) * 2)$		Measurand - high octet
$15 + ((m - 1) * 2)$		Checksum (sum of fields 5 to $14 + ((m - 1) * 2)$ modulo 256)
$16 + ((m - 1) * 2)$	16h	End flag (16h)

Type 9 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.8, provide groups of measured values. The Function Type and the Information Number define the type of measurand. The number of values in a measurand is given by the Variable Structure Identifier (VSI) octet. The public measurands returned in this type of frame are defined in [1] IEC60870-5-103 section 7.2.5.2 table 14, and are duplicated below.

Information Number	Var. Structure ID	Description
148	9	Measurand $I_{L1,2,3}, V_{L1,2,3}, P, Q, f$

Type 9 data frames are very similar to type 3, see section 3.7.9, except that not all the measurands need be sent. By specifying the exact number of measurands being sent in the variable structure identifier octet and always starting at I_{L1} the measurands can be truncated, for example, 4 would mean we are sending $I_{L1,2,3}, V_{L1}$. The length of frame byte would be correspondingly shortened, in this case to 16. See example below.

Example Frame
68h 10h 10h 68h 8h 1h 9h 4h 2h 1h 80h 94h 10h 0h 10h 0h 10h 0h 20h 0h 7Dh 16h

The values of the measurands are encoded as for a type 3 frame, see section 3.7.9, and like that frame, if available type 9 frames are extracted from the relay by means of the Request Data Class 2, refer section 3.6.5.

3.7.15 List of Recorded Disturbances - Frame Type 23

Octet	Value	Description
1	68h	Start flag
2	$8 + (2 * m)$	Length of Information field
3	$8 + (2 * m)$	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	23	Type identification
8	R	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	ft	Function type
12	0	Not Used
		Fault Number - low octet
		Fault Number - high octet
		Status of Fault (SOF)
	30h	Milliseconds - low octet
	75h	Milliseconds - high octet
	1Bh	Minutes + MSB = Invalid Flag
	8Ah	Hours + MSB = SU Summer time Flag
	4	Days
	6	Months
	97	Years
$13 + (r * 10)$		Checksum (sum of fields 5 to 14 + $((m - 1) * 2)$ modulo 256)
$14 + (r * 10)$	16h	End flag (16h)

Type 23 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.11, list the disturbance records held in the device. These frames are prepared either automatically when a new record is stored, or after a request by the controller using an ASDU 24 frame (section 3.6.9), with TOO = 24. They are extracted using class 1 data requests (section 3.6.4). The Variable Structure Identifier octet states how many records are stored in the device. This can be up to 8 and can also be zero. If there are records available, their details are listed from octet 13. Each record's details occupy 10 octets, and consist of a 2 octet fault number, a status of fault octet and a standard seven octet time stamp. The fault number corresponds to that sent by the events in type 2 frames, refer section 3.7.8. The status of fault uses bit notation as follows.

8	7	6	5	4	3	2	1
Reserved				OFEV	TEST	TM	TP

Mnemonic	Value	Description
TP	0	Recorded fault without trip
	1	Recorded fault with trip
TM	0	Disturbance data waiting for transmission
	1	Disturbance data currently being transmitted
TEST	0	Disturbance data recorded during normal operation
	1	Disturbance data recorded during test mode
OFEV	0	Disturbance data recording initiated by start / pickup
	1	Disturbance data recording initiated by other events

Example Frame

68h 12h 12h 68h 8h 1h 17h 1h 1Fh 1h A0h 0h 27h 01h 9h 30h 75h 1bh 8ah 4h 6h 61h adh 16h

3.7.16 Ready For Transmission of Disturbance Data - Frame Type 26

Octet	Value	Description
1	68h	Start flag
2	23	Length of Information field
3	23	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	26	Type identification
8	81h	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	ft	Function type
12	0	Not Used
13	0	Not Used
14	1	Type of Values (TOV)
15		Fault Number – low octet
16		Fault Number – high octet
17		Number of grid faults (NOF) – low octet
18		Number of grid faults (NOF) – high octet
19		Number of Channels (NOC)
20		Number of information elements per channel (NOE) – low octet
21		Number of information elements per channel (NOE) – high octet
22		Interval between information elements (INT) – low octet
23		Interval between information elements (INT) – high octet
24	30h	Milliseconds – low octet
25	75h	Milliseconds – high octet
26	1Bh	Minutes + MSB = Invalid Flag
27	8Ah	Hours + MSB = SU Summer time Flag
28		Checksum (sum of fields 5 to 14 + ((m - 1) * 2) modulo 256)
29	16h	End flag (16h)

Type 26 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.12, announce that a disturbance record file is ready for requesting. These are prepared in response to a request for data in an ASDU 24 message (section 3.6.9) with TOO = 1, and are extracted using class 1 data requests (section 3.6.4). Information in this frame states constants that apply to the whole data record. The interval between information elements (INT) states the time between samples in microseconds. The number of information elements per channel (NOE) and the number of analogue channels (NOC). The number of grid faults (NOF) is used to indicate when a grid fault causes several faults to occur. For each fault the fault number will increase the grid fault would remain constant.

Example Frame

68h 17h 17h 68h 8h 1h 1ah 81h 1Fh 1h A0h 0h 0h 1h 9h 30h 10h 31h 4h 20h 3h 9ch 4h 30h 75h 1bh 8ah f0h 16h

3.7.17 Ready for Transmission of a Channel - Frame Type 27

Octet	Value	Description
1	68h	Start flag
2	25	Length of Information field
3	25	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	27	Type identification
8	81h	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	0	Not Used
13	0	Not Used
14	1	Type of Values (TOV)
15		Fault Number (FAN) – low octet
16		Fault Number (FAN) – high octet
17		Actual Channel (ACC)
18		Rated Primary Value (RPV) – least significant octet
19		Rated Primary Value (RPV) – 2 nd octet
20		Rated Primary Value (RPV) – 3 rd octet
21		Rated Primary Value (RPV) – most significant octet
22		Rated Secondary Value (RSV) – least significant octet
23		Rated Secondary Value (RSV) – 2 nd octet
24		Rated Secondary Value (RSV) – 3 rd octet
25		Rated Secondary Value (RSV) – most significant octet
26		Reference Factor (RFA) – least significant octet
27		Reference Factor (RFA) – 2 nd octet
28		Reference Factor (RFA) – 3 rd octet
29		Reference Factor (RFA) – most significant octet
30		Checksum (sum of fields 5 to 14 + ((<i>m</i> - 1) * 2) modulo 256)
31	16h	End flag (16h)

A Type 27 data frame, as defined in [1] IEC60870-5-103 section 7.3.1.13, announces a disturbance record analogue channel is available. This is initially prepared after the tags have been acknowledged (ASDU 25, TOO=68) or aborted (ASDU 25, TOO=69). After each analogue channel has been acknowledged (ASDU 25, TOO=66) or aborted (ASDU 25, 67) further ASDU 27's are prepared to announce any remaining channels. Again they are extracted using class 1 data requests (section 3.6.4).

Information in this frame states constants that apply to the channel. The Rated Primary Value (RPV), Rated Secondary Value (RSV) and Reference Factor (RFA) are all sent as 32 bit (4 octet) floating point values, conforming to the standard 23 bit mantissa, 8 bit exponent and 1 bit sign format. The relationship between these values and the sample point *x* is shown below.

$$\text{SecondaryValue} = \frac{x}{RFA} \qquad \text{PrimaryValue} = \text{SecondaryValue} \times \frac{RPV}{RSV}$$

The following example frame shows a type 27 ASDU when the RPV = 300.0, RSV = 1.0 and the RFA = 600.0

Example Frame
68h 19h 19h 68h 8h 1h 1b 81h 1fh 1h a8h 0h 0h 1h 0h 0h 1h 0h 0h 96h 43h 0h 0h 80h 3fh 0h 0h 16h 44h 25h 16h

3.7.18 Ready For Transmission of Tags - Frame Type 28

Octet	Value	Description
1	68h	Start flag
2	12	Length of Information field
3	12	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	28	Type identification
8	81h	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	0	Not Used
13	0	Not Used
14	0	Not Used
15		Fault Number (FAN) – low octet
16		Fault Number (FAN) – high octet
17		Checksum (sum of fields 5 to 14 + $((m - 1) * 2)$ modulo 256)
18	16h	End flag (16h)

Type 28 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.14, announce that tags are ready for requesting. These are sent in response to a request for data in an ASDU 24 message, refer section 3.6.9, and are extracted using class 1 data requests (section 3.6.4).

Example Frame
68h ch ch 68h 8h 1h 1ch 81h 1fh 1h a0h 0h 0h 0h 27h 6h 93h 16h

3.7.19 Transmission of Tags - Frame Type 29

Octet	Value	Description
1	68h	Start flag
2	$13 + (t * 3)$	Length of Information field
3	$13 + (t * 3)$	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	29	Type identification
8	81h	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	0	Not Used
13		Fault Number (FAN) – low octet
14		Fault Number (FAN) – high octet
15	<i>t</i>	Number of Tags (NOT)
16		Tag At Position (TAP) – low octet
17		Tag At Position (TAP) – high octet
		Tag 1 Function Type
		Tag 1 Information Number
		Tag 1 Double Point Information
$18 + (t * 3)$		Checksum (sum of fields 5 to 14 + $((m - 1) * 2)$ modulo 256)
$19 + (t * 3)$	16h	End flag (16h)

Type 29 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.15, indicate the status of the tags. These are sent in response to a request for data in an ASDU 24 message, refer section 3.6.9, and are extracted using class 1 data requests (section 3.6.4). Each Tag consists of three octets, a Function Type, Information Number and DPI State. The number of tags (NOT) octet specifies the number of tags in the ASDU, up to a maximum of 25 per ASDU. The Tag at Position (TAP) value gives the position of the tags in the disturbance record. An ASDU only holds tags at one position. Initially the state of all tags at TAP position zero is transmitted. Subsequently only tags that change state in the disturbance record are transmitted. The following example shows a frame with three tags at position 96.

Example Frame
68h 16h 16h 68h 8h 1h 1dh 81h 1fh 1h a0h 0h 27h 1h 3h 60h 0h a4h 33h 1h a4h 35h 2h a4 3bh 2h 86h 16h

3.7.20 Transmission of Disturbance Values - Frame Type 30

Octet	Value	Description
1	68h	Start flag
2	$16 + (n * 2)$	Length of Information field
3	$16 + (n * 2)$	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	30	Type identification
8	81h	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	0	Not Used
13	0	Not Used
14	1	Type of Values (TOV)
15		Fault Number (FAN) – low octet
16		Fault Number (FAN) – high octet
17		Actual Channel (ACC)
18	<i>n</i>	Number of Disturbance Values (NDV)
19		Number of First Element (NFE) – low octet
20		Number of First Element (NFE) – high octet
		Value 1 – low octet
		Value 1 – High octet
		...
		...
		Value <i>n</i> – low octet
		Value <i>n</i> – High octet
$21 + (n * 2)$		Checksum (sum of fields 5 to 14 + $((m - 1) * 2)$ modulo 256)
$22 + (n * 2)$	16h	End flag (16h)

Type 30 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.16, provide the raw disturbance values. These are sent in response to a request for data in an ASDU 24 message, refer section 3.6.9, and are extracted using class 1 data requests (section 3.6.4).

Each data value is a 16 bit fixed point number, transmitted as low octet followed by high octet. The number of disturbance values (NDV) octet specifies the number of values in the ASDU, up to a maximum of 25 per ASDU. Each channel is transmitted in several ASDU 30's. The Number of First Element (NFE) value gives the index of the first data value in the channel of the disturbance record. The following example shows a frame with four values with a starting position of 500 (1f4).

Example Frame
68h 18h 18h 68h 8h 1h 1eh 81h 1fh 1h a0h 0h 0h 1h 27h 1h 2h 4h f4h 1h 0h 0h 9h 0h 1bh 0h 2ah 0h 71h 16h

3.7.21 End of Transmission - Frame Type 31

Octet	Value	Description
1	68h	Start flag
2	13	Length of Information field
3	13	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	31	Type identification
8	81h	Variable structure identifier (0...8)
9	31	Cause of transmission
10		Common address of ASDU (1 - 254 - identical to octet 6)
11	<i>ft</i>	Function type
12	0	Not Used
13		Type of Order (TOO)
14	1	Type of Values (TOV)
15		Fault Number (FAN) – low octet
16		Fault Number (FAN) – high octet
17		Actual Channel (ACC)
18		Checksum (sum of fields 5 to 14 + $((m - 1) * 2)$ modulo 256)
19	16h	End flag (16h)

Type 31 data frames, as defined in [1] IEC60870-5-103 section 7.3.1.17, signify the end of a transmission stage, whether it was successful or unsuccessful. These are sent in response to a request for data in an ASDU 24 message, refer section 3.6.9, and are extracted using class 1 data requests (section 3.6.4). The Type of order number for each stage is defined by [1] IEC60870-5-103 section 7.2.6.26. The subset of TOO codes used in a type 31 message are shown below.

Type of Order Code	Description
64	Disturbance data transmitted successfully (positive)
65	Disturbance data transmitted not successfully (negative)
66	Channel transmitted successfully (positive)
67	Channel transmitted not successfully (negative)
68	Tags transmitted successfully (positive)
69	Tags transmitted not successfully (negative)
70...255	Reserved

The following example shows a frame with a TOO code of 64 (40h).

Example Frame
68h dh dh 68h 8h 1h 1fh 81h 1fh 1h a0h 0h 40h 1h 27h 1h 4h d6h 16h

3.7.22 Response With Private Data From Relay Frame Types 254 and 255

These frames are identical to those to send private data described in section 3.6.11, except that the Control field will signify it is being sent by the secondary station, i.e. its value is 08h optionally ACD + DFC. The Frames are extracted as the response to a request for class 1 data, see section 3.6.4. The resultant data may occupy several frames i.e. multiple frames of type 254 then one of 255. You must concatenate this user data together until you receive the final frame. Single frame responses are type 255. Section 4 describes the data received. The frames might not be contiguous they may be interrupted by frames of a higher priority, see section 3.8.

3.7.23 Termination of Private Data Response Frame Type 253

Octet	Value	Description
1	68h	Start flag
2	3 + n	Length of Information field
3	3 + n	Repeated length of Information field
4	68h	Start flag
5		Control field (08h optionally ACD + DFC)
6		Station address (1 - 254)
7	253	Type identification
		n User data. Maximum 247 octets of optional Response Message.
8 + n		Checksum (sum of fields 5 to 10 + n modulo 256)
9 + n	16h	End flag (16h)

This frame is sent by the relay when data transmission has been terminated before completion. It is an addition to the private data frames of 254 and 255. An example of when it would be sent is if the data being downloaded becomes unavailable due to a new record being stored. If this frame is sent the download is complete, i.e. there will be no more 254 or 255 frames. Any user data already received in 254 type frames should be discarded, as it will be incomplete. Only the user data sent in this frame should be returned.

Example Frame
68h 3h 3h 68h 8h 1h FDh 06h 16h

3.8 Priorities

As there are several forms of class 1 data, for example, events, general interrogation and private data, there may be several types waiting to be downloaded, therefore they have been prioritised, see table below.

Priority	Description	Frame Type	Refer To Section
Highest	Initialisation Response	5	3.7.11
	Event	1, 2	3.7.7, 3.7.8
	General Interrogation Response	1, 2, 8	3.7.7, 3.7.8, 3.7.13
	General Command Response	1	3.7.7
	Time Synchronise Response	6	3.7.12
Lowest	Private Data	253, 254, 255	3.7.22, 3.7.23

Thus if there is an event and a general interrogation response waiting to be downloaded when you request class 1 data you will get the event. The next time you request class 1 data you will get the general interrogation response. However, if an event occurs between the first and second polls, that event will be returned as the response to the second poll.

3.9 Philosophy

The informative interface complying with [1] IEC60870-5-103 is designed for automatic interrogation by a control system, or manually with user intervention. With a control system the standard format frames, all except types 253, 254 and 255, will be used. For a control system to use the private commands (see section 4) issued and received in frames 253, 254 and 255, requires software in addition to that for the standard [1] IEC60870-5-103 usage. Manual interrogation involves a user driving a communications application, for example, Reydisp Evolution, which has the ability to download and process the information produced by the private commands.

All communication is initiated by the primary station i.e. the control system or user, never the secondary i.e. the relay. In either case, before a conversation can take place the defined communication protocol initialisation procedure, [1] IEC60870-5-103 Section 7.4.1 has to be completed. This requires sending either Reset Communication Unit (see section 3.6.1) or Reset Frame Count Bit (see section 3.6.2). Once this is complete the relay can be polled for data.

The two types of data which can be polled by the primary station are class 1 (see section 3.6.4) and class 2 (see section 3.6.5). Class 2 is the measurands, frame type 3 (see section 3.7.9) and 9 (see section 3.7.14), all the others are class 1. Polling is performed cyclically at time intervals of for example, 50 milliseconds. This interval

should be as short as is practicable as you should download events in as close to real time as is possible. There are two ways you can poll. Firstly you can poll for class 1 data (see section 3.6.4) if any is available it will be returned as described above, if not the negative acknowledgement (data not available) will be returned (see section 3.7.4). Alternately, you can poll for class 2 data (see section 3.6.5) and test if the ACD bit of the control code in the returned frame is set. If it is you should now poll for any class 1 data before returning to poll for class 2. If the ACD bit is set in a class 1 response frame, you can immediately poll again for class 1 without waiting for the cyclical polling period. This will speed up the response time of your communications.

Note, if the relay is connected to a control system and you wish to access the data manually there must be a method of excluding the relay (s) from being polled by the control system, for example, a passive substation switch. It is beyond the scope of this document to discuss this further.

4 PRIVATE COMMAND DESCRIPTION

4.1 Introduction

This section describes the private commands and the responses from them. The commands are sent and received via the private data ASDU's as described in sections 3.6.11 and 3.7.22 respectively and terminated via that described in 3.7.23. If an unknown command is received or if there is an attempt to use password protected commands without the correct password, then the text string "ERROR" is transmitted as response to the command. If a command is being used incorrectly, for example, incorrect parameters, or there is no data stored then the text string beginning "NAK" is transmitted. An optional message giving details of the problem may be appended to the "NAK" string, for example, "NAKInvalid Settings Group Number". The "NAKxxxx" string is also returned as the user data of the Termination of Private Data Response Frame, see 3.7.23. If the command is processed correctly then either the data requested or the text string "OK" is returned if the command is not associated with any data.

The following notation is used in the description:-

<CR, LF>	End of line (ASCII characters 0Ah and 0Dh).
<FF>	Form Feed (ASCII character 0Ch).
<EOF>	End Of File Marker (ASCII 1Ah).
<Relay Type>	Specifies the type of the relay. E.g. DCD3P+E(D)
<User Defined Identifier>	User programmable name (16 characters).
<Time Stamp – name>	Time stamp of <i>name</i> with format of <i>dd/mm/yy hh:mi:ss.ssss</i>
<i>n</i>	Digit (0-9)
<i>X</i>	Character

4.2 Information Commands

4.2.1 Help Command

Command	HELP[xx]
Description	<p>HELP.</p> <p>This command provides help about all user commands within the relay. For a summary of the commands use HELP on its own. To get extra help about a specific command use HELPx where xx is the name of the command. E.g. to get help on the Adjust Time function use HELPAT.</p>
See Also	
Security	NONE
Response	<p>Using HELP</p> <p>A list of all commands with a short explanation of each. Commands prefixed by * are password protected.</p> <p>Using HELPx</p> <p>A more detailed explanation of how to use the command xx.</p>
Example	

4.2.2 System Information Command

Command	SI
Description	<p>Send relay Identifier.</p> <p>This command returns information about the relay type, software article number, boot block article number, and also the number of waveforms, settings groups, status inputs and output relays the relay has. It also contains a user programmable name for the relay.</p>
See Also	
Security	NONE
Response	<Relay Type> SnnnnHnnnnRn BnnnnHnnnnRn nW nG nI nO <User Defined Identifier>
Example	DCD3P+E(D) S2434H80018R1 B2434H80017R1 5W 8G 7I 11O HEBBURN 1 FEEDER

4.3 Security Commands

4.3.1 Password (Login) Command

Command	PWxxxx
----------------	--------

Description	PassWord. This command enables the user to log in to the relay so all protected commands can be used. Xxxx is the password to use. E.g. PWTEST - log in using TEST as the password.
See Also	LO
Security	NONE
Response	OK
Example	OK

4.3.2 Logout Command

Command	LO
Description	LogOut. This command logs the user out of the relay and disables access to all protected commands.
See Also	PWxxxx
Security	NONE
Response	OK
Example	OK

4.4 Settings Commands

4.4.1 Information About Settings Command

Command	IS
Description	Information about Settings . This command returns information about each setting in the form of the Reyrolle Protection Settings Description Language (RPSDL), see section 5, which contains the setting text strings, information on how the setting is edited, and the storage format of the setting. These descriptors enable internal setting values to be converted to real setting values. Using this information it is possible to build a database of internal setting values that can be then sent to the relay by means of command USn<data> .
See Also	PSn, SSn, USn
Security	NONE
Response	For each setting: <FF><Setting Text><Setting Descriptor><Setting Dependency (Optional)>
Example	

4.4.2 Send Settings Command

Command	SSn
Description	Send Settings for group n. This command returns the internal setting values for all the settings of group n. The relay sends a number of octets for each setting. Usually a setting is stored as a 16-bit word that is sent as 2 octets (Low Octet, High Octet). Exceptions to this are the Password setting (sent as 4 octets), Relay Identifier String (16 octets), and the Status Group Select setting (1 octet per status input fitted). The exact order and data lengths of the all the settings are obtained in response to the Information about Settings command (IS).
See Also	PSn, IS, USn
Security	NONE
Response	<Low Set. 1><Hign Set. 1><Low Set. 2><Hign Set. 2>...<Low Set. Last><Hign Set Last>
Example	<01h><00h><07h><03h>...<05h><01h>

4.4.3 Upload Settings Command

Command	USn<Setting Number><Setting Value>[...<Setting Number><Setting Value>]
Description	Upload Settings to group n, where n = 1 to 8. This command allows one or more settings to be uploaded into the relay. The <Setting Number> and <Setting Value> fields are in binary format.

	<p><Setting Number> The setting number to change (2 octets – low octet, high octet)</p> <p><Setting Value> The new value for the setting. The number of octets this field occupies is dependent on the setting type (usually 2). See SSn for information on the number of octets per setting.</p>
See Also	PSn, IS, USn, PWxxxx
Security	Password Protected.
Response	OK
Example	OK

4.4.4 Print Settings Group Command

Command	PSn
Description	Print Settings group n. This command returns all relay settings and values for group n in ASCII format.
See Also	IS, SSn, USn
Security	NONE
Response	For each relay setting: <Text String For The Setting><CR, LF>
Example	

4.4.5 Send Active Setting Group Command

Command	SG
Description	Send active setting Group. This command returns the currently active setting group.
See Also	CG
Security	NONE
Response	ACTIVE SETTINGS GROUP = n where $n = 1$ to <i>maximum .number settings groups</i>
Example	ACTIVE SETTINGS GROUP = 3

4.4.6 Change Active Setting Group Command

Command	CGn
Description	Change active setting Group. This command sets the active setting group of the relay to n.
See Also	SG, PWxxxx
Security	Password Protected
Response	OK
Example	OK

4.5 Event Commands

4.5.1 Information about Events Command

Command	IE
Description	Information about Events. This command returns information about all events, which are used within the relay. It consists of the event name, event number, type of event, and the direction the event can happen in. On the basis of this information the controlling device can recognise event codes received as part of spontaneous event data packets and/or as the response data for the SE command, and display appropriate text strings.
Superseded	This command has been superseded by the "XIE" command. Applications should check that "XIE" command is implemented in the relay and if so use it.
See Also	SE, RE, XSE, XIE
Security	NONE

Response	For each event: <Event Name>,<Event Number>,<Type>[,<Direction>]<CR, LF> where <Type> Specifies if the event is an IEC event (0) or a private event (1). <Direction> 1 if the event can be raised and cleared. If this optional field is missing then the event can only be raised.
Example	Phase A Starter,64,0,1<CR><LF> Waveform Stored,80,1<CR><LF>

4.5.2 Send Events Command

Command	SE
Description	Send Events. This command returns all currently stored events.
Superseded	This command has been superseded by the "XSE" command. Applications should check that "XSE" command is implemented in the relay and if so use it.
See Also	IE, RE, XSE, XIE
Security	NONE
Response	For each evaluation period the octet format of the events are: Octet Description 1 Number of events in this evaluation period - n (1 octet) 2e Number of the e-th event - e = 1 ... n (1 octet) 2e+1 Attribute of the e-th event (bit 0 = CLEARED, bit 1 = RAISED, bit 7 = PRIVATE_CODE) (1 octet) 2e+2 Lower octet of ms absolute time tag (1 octet) 2e+3 Higher octet of ms absolute time tag (1 octet) 2e+4 Minutes of absolute time tag (1 octet) 2e+5 Hours of absolute time tag (1 octet) 2e+6 Days of absolute time tag (1 octet) 2e+7 Months of absolute time tag (1 octet) 2e+8 Years of absolute time tag (1 octet) Note: See Appendices C & D for meanings of individual event codes.
Example	The following hex dump shows a response <02><33><82><FD><82><05><00><00><00><01><01><50> <01><59><82><23><00><00><00><01><01><50> <01><59><81><B9><0F><00><00><01><01><50>

4.5.3 Reset Event Store Command

Command	RE
Description	Reset Event storage. This command erases all stored events in the relay.
See Also	IE, SE, XSE, XIE, PWxxxx
Security	Password Protected.
Response	OK
Example	OK

4.5.4 Extended Information about Events Command

Command	XIE
Description	Extended Information about Events. This command returns information about all events, which are used within the relay. It returns the same information as the "IE" command and some additions. First there are descriptions of

	the function types used, in the form #number, description. Then there are descriptions of the events, consisting of the function type, event number, the direction and the event name. On the basis of this information the controlling device can recognise event codes received as part of spontaneous event data packets and / or as the response data for the SE or XSE commands, and display appropriate text strings.
See Also	IE, SE, RE, XSE
Security	NONE
Response	<p>If this command does not exist the response will be "ERROR", otherwise,</p> <p>The descriptions of the function types:</p> <p>#<Function Type>,<Description><CR, LF></p> <p>where</p> <p><Function Type> Specifies the type of relay the event is from, in the range 0-255.</p> <p><Description > Text string describing the function type.</p> <p>Then for each event:</p> <p><Function Type>,<Event Number>,<Direction>,<Event Name><CR, LF></p> <p>where</p> <p><Function Type> Specifies the type of relay the event is from, in the range 0-255.</p> <p><Event Number> Specifies the number of the event, in the range 0 –255.</p> <p><Direction> 1 if the event can be raised and cleared. 0 if it can only be raised.</p> <p><Event Name> Text string describing the event.</p>
Example	<pre>#160,Overcurrent<CR><LF> #164,Reyrolle Overcurrent<CR><LF> #166,Reyrolle GCB Synchronising<CR><LF> 160,68,0,General Trip<CR><LF> 164,80,1,Waveform Stored<CR><LF></pre>

4.5.5 Extended Send Events Command

Command	XSE																										
Description	<p>Extended Send Events.</p> <p>This command returns all currently stored events.</p>																										
See Also	IE, SE, RE, XIE																										
Security	NONE																										
Response	<p>If this command does not exist the response will be "ERROR", otherwise,</p> <p>For each evaluation period the octet format of the events are:</p> <table border="0"> <tr> <td>Octet</td> <td>Description</td> </tr> <tr> <td>1</td> <td>Number of events in this evaluation period - n (1 octet)</td> </tr> <tr> <td>2e</td> <td>Function Type of the event</td> </tr> <tr> <td>2e+1</td> <td>Number of the e-th event - e = 1 ... n (1 octet)</td> </tr> <tr> <td>2e+2</td> <td>Attribute of the e-th event, 0 = Travelling, 1 = Cleared, 2 = Raised, 3 = Error Detected</td> </tr> <tr> <td>2e+3</td> <td>Lower octet of ms absolute time tag (1 octet)</td> </tr> <tr> <td>2e+4</td> <td>Higher octet of ms absolute time tag (1 octet)</td> </tr> <tr> <td>2e+5</td> <td>Minutes of absolute time tag (1 octet)</td> </tr> <tr> <td>2e+6</td> <td>Hours of absolute time tag (1 octet)</td> </tr> <tr> <td>2e+7</td> <td>Days of absolute time tag (1 octet)</td> </tr> <tr> <td>2e+8</td> <td>Months of absolute time tag (1 octet)</td> </tr> <tr> <td>2e+9</td> <td>Lower octet of Years of absolute time tag (1 octet)</td> </tr> <tr> <td>2e+10</td> <td>Higher octet of Years of absolute time tag (1 octet)</td> </tr> </table> <p>Note: See Appendices C & D for meanings of individual event codes.</p>	Octet	Description	1	Number of events in this evaluation period - n (1 octet)	2e	Function Type of the event	2e+1	Number of the e-th event - e = 1 ... n (1 octet)	2e+2	Attribute of the e-th event, 0 = Travelling, 1 = Cleared, 2 = Raised, 3 = Error Detected	2e+3	Lower octet of ms absolute time tag (1 octet)	2e+4	Higher octet of ms absolute time tag (1 octet)	2e+5	Minutes of absolute time tag (1 octet)	2e+6	Hours of absolute time tag (1 octet)	2e+7	Days of absolute time tag (1 octet)	2e+8	Months of absolute time tag (1 octet)	2e+9	Lower octet of Years of absolute time tag (1 octet)	2e+10	Higher octet of Years of absolute time tag (1 octet)
Octet	Description																										
1	Number of events in this evaluation period - n (1 octet)																										
2e	Function Type of the event																										
2e+1	Number of the e-th event - e = 1 ... n (1 octet)																										
2e+2	Attribute of the e-th event, 0 = Travelling, 1 = Cleared, 2 = Raised, 3 = Error Detected																										
2e+3	Lower octet of ms absolute time tag (1 octet)																										
2e+4	Higher octet of ms absolute time tag (1 octet)																										
2e+5	Minutes of absolute time tag (1 octet)																										
2e+6	Hours of absolute time tag (1 octet)																										
2e+7	Days of absolute time tag (1 octet)																										
2e+8	Months of absolute time tag (1 octet)																										
2e+9	Lower octet of Years of absolute time tag (1 octet)																										
2e+10	Higher octet of Years of absolute time tag (1 octet)																										
Example	The following hex dump shows a response																										

	<pre><02><A8><33><02><A8><FD><02><05><00><00><00><01><01><BC><07> <01><A8><59><02><23><00><00><00><01><01><BC><07> <01><A8><59><01><B9><0F><00><00><01><01><BC><07></pre>
--	---

4.6 Data Storage Commands

4.6.1 Trigger Storage Command

Command	TS
Description	Trigger Storage. This command causes a waveform record to be stored.
See Also	DD, SDn, RS, PWxxxx
Security	Password Protected
Response	OK
Example	OK

4.6.2 Reset Storage Command

Command	RS
Description	Reset waveform Storage. This command erases all waveform records.
See Also	DD, SDn, TS, PWxxxx
Security	Password Protected
Response	OK
Example	OK

4.6.3 Data Directory Command

Command	DD
Description	Data Directory. This command returns information about all currently stored waveform records. Each record is numbered and has an associated time and date stamp.
See Also	SDn, RS, TS
Security	NONE
Response	For each waveform record stored. <i><Number Of Waveform>. <Time Stamp - Trigger Point><CR,LF></i>
Example	<pre>5. 11/01/96 10:08:02.1800 4. 24/06/96 23:18:13.1450 3. 03/12/96 04:34:45.1550 2. 01/02/97 00:01:03.2050 1. 12/03/97 22:59:38.5400</pre>

4.6.4 Send Waveform Data Command

Command	SDn
Description	Send waveform Data record n where n = 1 to last data record. Record 1 is always the newest.
See Also	DD, RS, TS
Security	NONE
Response	Relay sends the requested waveform record in the format below. <i><Relay Type> <User Defined Identifier>,<Station Address><CR, LF></i> <i><Total Channels>,<Analogue Channels>A,<Digital Channels>D<CR, LF></i> For each analogue channel: <i><Channel Number>,,<Channel Name>,,<Units>,<Multiplication Factor>,,,<CR, LF></i> For each digital channel:

	<p style="text-align: center;"><Channel Number>,<Channel Name>,<Normal State><CR, LF></p> <p><Line Frequency><CR, LF></p> <p><Number Of Sample Rates In Record><CR, LF></p> <p>For each sample rate:</p> <p style="padding-left: 40px;"><Sample Rate>,<Number Of Samples At Rate><CR, LF></p> <p><Time Stamp - First Sample><CR, LF></p> <p><Time Stamp - Trigger Point><CR, LF></p> <p>BINARY - PHASE BY PHASE<CR, LF><EOF></p> <p>For each analogue channel:</p> <p style="padding-left: 40px;"><Analogue Channel Data></p> <p>For each group of 16 digital channels:</p> <p style="padding-left: 40px;"><Packed Digital Data></p> <p>where :</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-left: 20px;"><Total Channels></td> <td>Number of channels stored in record.</td> </tr> <tr> <td style="padding-left: 20px;"><Analogue Channels></td> <td>Number of analogue channels stored.</td> </tr> <tr> <td style="padding-left: 20px;"><Digital Channels></td> <td>Number of digital channels stored.</td> </tr> <tr> <td style="padding-left: 20px;"><Multiplication Factor></td> <td>Multiplication factor for the analogue channel. This converts the stored data into real data of type <Units>. i.e. Real data = Stored Data * <Multiplication Factor></td> </tr> <tr> <td style="padding-left: 20px;"><Normal State></td> <td>Normal state of the digital channel (0 or 1).</td> </tr> <tr> <td style="padding-left: 20px;"><Analogue Channel Data></td> <td>Data for one analogue channel. Each sample consists of two octets in low octet, high octet format.</td> </tr> <tr> <td style="padding-left: 20px;"><Packed Digital Data></td> <td>Compressed digital data for 16 channels at a time. Bit 0 = digital channel 1, Bit 15 = digital channel 16. Unused digital channels are set to 0. Sent Low octet, High octet.</td> </tr> </table>	<Total Channels>	Number of channels stored in record.	<Analogue Channels>	Number of analogue channels stored.	<Digital Channels>	Number of digital channels stored.	<Multiplication Factor>	Multiplication factor for the analogue channel. This converts the stored data into real data of type <Units>. i.e. Real data = Stored Data * <Multiplication Factor>	<Normal State>	Normal state of the digital channel (0 or 1).	<Analogue Channel Data>	Data for one analogue channel. Each sample consists of two octets in low octet, high octet format.	<Packed Digital Data>	Compressed digital data for 16 channels at a time. Bit 0 = digital channel 1, Bit 15 = digital channel 16. Unused digital channels are set to 0. Sent Low octet, High octet.
<Total Channels>	Number of channels stored in record.														
<Analogue Channels>	Number of analogue channels stored.														
<Digital Channels>	Number of digital channels stored.														
<Multiplication Factor>	Multiplication factor for the analogue channel. This converts the stored data into real data of type <Units>. i.e. Real data = Stored Data * <Multiplication Factor>														
<Normal State>	Normal state of the digital channel (0 or 1).														
<Analogue Channel Data>	Data for one analogue channel. Each sample consists of two octets in low octet, high octet format.														
<Packed Digital Data>	Compressed digital data for 16 channels at a time. Bit 0 = digital channel 1, Bit 15 = digital channel 16. Unused digital channels are set to 0. Sent Low octet, High octet.														
<p>Example</p>	<p>DCD2P+E Hebburn1 ,6</p> <p>19,3A,16D</p> <p>1,,A,,A,1.10193,,,,</p> <p>2,,C,,A,1.12340,,,,</p> <p>3,,E,,A,1.11115,,,,</p> <p>4,INPUT1,0</p> <p>5,INPUT2,0</p> <p>6,INPUT3,0</p> <p>7,INPUT4,0</p> <p>8,INPUT5,0</p> <p>9,OUTPUT1,1</p> <p>10,OUTPUT2,1</p> <p>11,OUTPUT3,1</p> <p>12,OUTPUT4,1</p> <p>13,OUTPUT5,1</p> <p>14,OUTPUT6,0</p> <p>15,OUTPUT7,0</p> <p>16,OUTPUT8,0</p> <p>17,OUTPUT9,0</p> <p>18,OUTPUT10,0</p> <p>19,OUTPUT11,0</p> <p>50</p> <p>1</p> <p>800,800</p>														

	11/18/95,07:45:32.672500 11/18/95,07:45:32.685000 BINARY - PHASE BY PHASE <Analogue Channel 1> <Analogue Channel 2> <Analogue Channel 3> <Packed Digital 1> <Packed Digital 2>
--	---

4.7 Measurand Commands

4.7.1 Information About Measurands Command

Command	IM
Description	Information about Measurands. This command returns information about all measurands that are present in the relay. Each measurand is described by one line of text consisting of the measurand number, name, units and the type.
See Also	SMn
Security	NONE
Response	For each measurand: <i><Measurand Number></i> , <i><Measurand Name></i> , <i><Units></i> , <i><Type Of Measurand></i> <CR, LF> where <i><Type Of Measurand></i> consists of: Bit 0 : measurand is reserved. Bit 1 : analogue measurand (e.g current). Bit 2 : digital measurand (e.g. status inputs). Bit 3 : integer measurand (e.g trip counter). Bit 4 : complex string measurand (e.g. time or date).
Example	0,IA (PRIMARY),A,2 5,la (SECONDARY),A,2 10,la (xIn),xIn,2 27,Time,,16 28,Date,,16

4.7.2 Send Measurand Command

Command	SMn
Description	Send Measurand n; where n is the number of the measurand to send. This command returns the measurand requested. To find the numbers of a particular measurand use the IM command.
See Also	IM
Security	NONE
Response	Relay sends the requested measurand in ASCII format as a text string.
Example	The response for the time measurand will be in the form 08:15:26

4.8 Output Relay Commands

4.8.1 Select Output Relay Command

Command	SOn
Description	Select Output relay n. This command causes selection of output relay n for subsequent energisation by the CO _n

	command.
See Also	CO_n, PWxxxx
Security	Password Protected
Response	OK
Example	OK

4.8.2 Close Output Relay Command

Command	CO_n
Description	Close Output relay n. This command causes output relay n to be closed for 100ms provided the output relay was selected by SO _n less than 20 seconds previously.
See Also	SO_n, PWxxxx
Security	Password Protected
Response	OK
Example	OK

4.9 Time Commands

4.9.1 Send Relay Time Command

Command	ST
Description	Send relay Time. This command returns the relay's time and date.
See Also	ATddmmyyhhmi
Security	NONE
Response	DATE <i>dd/mml/yy</i> , TIME <i>hh:mm:ss</i>
Example	DATE 27/03/97, TIME 08:15:26

4.9.2 Adjust Relay Time Command

Command	ATddmmyyhhmi
Description	Adjust relay Time. This command sets the relay clock to the time and date specified. This command will reset the seconds to zero. If the command AT has been applied the invalid flag will be set (see 3.6.6).
See Also	ST, PWxxx
Security	Password Protected
Response	OK
Example	OK

4.10 Miscellaneous Commands

4.10.1 Send Fault Information Command

Command	SF
Description	Send Fault information. This command returns all currently stored fault records in ASCII format.
See Also	
Security	NONE
Response	For each fault record. <Fault Number> <Time Stamp> <Fault Information><CR,LF>
Example	FAULT 2 04/01/94 23:29:20.8200 PHASE A LS IDMTL HS1 IA=22.85xIn PHASE B LS IDMTL HS1 IB=44.19xIn PHASE C LS IDMTL HS1 IC=43.46xIn FAULT 1 04/01/94 23:29:21.0300 PHASE A LS IDMTL HS1 IA=31.45xIn PHASE B LS IDMTL HS1 IB=60.96xIn PHASE C LS IDMTL HS1 IC=59.58xIn

4.10.2 Reset Flags Command

Command	RF
Description	Reset Flags. This command resets the fascia LEDs and any latched output relays.
See Also	PWxxxx
Security	Password Protected
Response	OK
Example	OK

4.10.3 Information About General Commands

Command	IG
Description	Information about General commands This command returns all currently available general commands, see appendix E.
See Also	
Security	NONE
Response	First Line <First Protection Code>[, <Second Protection Code>]...[,<Last Protection Code>]<CR,LF> then for each command. <Description>, <Protection Code>, <Command Number>, <Action (1= single, 2= double)><CR,LF>
Example	160,164 Reset Flag & Outputs,160,19,1 Trigger waveform Storage,164,80,1

5 SETTINGS DESCRIPTION LANGUAGE

5.1 Introduction

The Reyrolle Protection Settings Description Language enables machine readable relay settings to be converted into human readable settings. This chapter defines:

- Settings which are read only
- Settings which can be displayed and edited
- Settings which are hidden

5.2 Settings Structure

The information downloaded from the relay, in response to the “IS” command, consists of three parts, Setting Text Display, Setting Value Description and Setting Display Condition, as follows:

Setting Text Display	Setting Value Description	Setting Display Condition
Setting 1 Text Display	Setting 1 Value Description	Setting 1 Display Condition.
Setting 2 Text Display	Setting 2 Value Description	Setting 2 Display Condition.
.		
Setting n Text Display	Setting n Value Description	Setting n Display Condition.

5.2.1 Setting Text Display

This part of the setting descriptor contains the textual information equivalent to the corresponding lines on the LCD display and includes all control characters. There can be any number of lines. The text display for the setting consists of the following basic format. A start code of character 12 (0Ch) is followed by the first line of the text. Each subsequent (optional) line is then preceded by a line feed character 10 (0Ah) followed by the text for that line, thus

```
0Ch<first line of text>[0Ah<second line of text>] ... [0Ah<last line of text>]
```

Each text line can consist of a combination of text and field codes. These field codes specify where the editable fields for the setting are to be displayed, i.e. if the line is <Description><Field><Unit> the field specifies the setting is to be displayed between the description and the unit. The format for the field code is as follows; a start character 7 followed by a character denoting the field number. Then the text presently displayed in the field followed by a terminating character again 7, thus

```
07h 01h <field text 1> 07h <Displayable Text> 07h 02h <field text 2> 07h <Displayable Text>
```

Examples of Setting Text Display	
Setting	Will be sent as
Active Settings Group = 1	0ChActive Settings 0AhGroup = 07h 01h1 07h
Set Identifier DCD	0ChSet Identifier 0Ah07h 01hDCD 07h
Calendar - Set Date = 03/07/96	0ChCalendar Set 0AhDate = 07h 01h03 07h//07h 02h07 07h//07h 03h96 07h
Gn P/F Charact. Setting= 0.15xIn	0ChGn P/F Charact. 0AhSetting =07h 01h 0.15 07h x n

The end of a setting text display is determined by the start of the setting value description, which is always an opening square bracket '['.

5.2.2 Setting Value Description

The Setting Value Description is used for converting machine-readable settings into human readable settings. It consists of a set of square braces containing information about one or more editable fields, each of which are also enclosed in square braces. An optional '@' before the first field indicating that the setting is read-only - i.e. it can be interpreted and displayed but not modified

```
[<@>[Field 1]<[Field 2]...[Field n]>]
```

A field consists of the following format

Field Format	Description
-	An optional minus sign '-' which, if present, signifies that the units information should be suppressed for this field.
[ww]	An optional field width, enclosed within square brackets "[]", representing the number of bits used to store the field value. This is only required on multiple field settings, otherwise a default value of 16 applies.
Setting Type	The format of the rest of the field depends on the type of setting, see next table.

and therefore can appear as follows,

[-[ww]<Setting Type>]

Setting Type	Description
String	A dollar sign '\$' followed by a number representing the maximum length of the string. A double-quoted string within a set of braces follows the number "{ }". The quoted string contains all allowable characters in the string. Example, showing a string of 8 upper case characters A-Z. \$8{"ABCDEFGHJKLMNOPQRSTUVWXYZ"} Examples 2, a string of 16 characters consisting of A-Z, 0-9, minus, plus, slash and space. \$16{"ABCDEFGHJKLMNOPQRSTUVWXYZ0123456789-+/"}
Bit mask	A hash sign '#' followed by a value representing the number of bit fields within the mask. These bits are continuous starting with the least significant bit. A hexadecimal number enclosed within square brackets, which is a mask representing the bit positions that can be modified follows this value. Labels for all bit positions follow it. The labels are double-quoted strings within a set of braces, similar to those of a string setting value description. The first label corresponds to the least significant bit. For example, a bit mask setting consisting of 5 bit fields labelled Status1 to Status5. The mask of 1C (11100 in binary) means that the value of the last two bit fields (Status4 and Status5) should not be modified. #5[1C]["Status1"]["Status2"]["Status3"]["Status4"]["Status5"]
Sub-menu title	[MENU]
Calendar date	[DATE]
Clock time	[TIME]
Password	[PASSWORD]
Non-editable	The body of the field is empty, i.e. []
All other	One or more range descriptions. A range description consists of a number followed by either a label (in the same format as a bit-field label) or a reverse-polish setting value description contained within a set of braces. The number represents the maximum internal value of the setting for which this range description is applicable. See Appendix H for a description of the reverse polish notation.

Examples of Setting Value Descriptors:

[[]]	The simplest description: the setting cannot be modified or displayed.
[@[DATE]]	The setting is a calendar date. The '@' symbol means the setting is read only, i.e. the date cannot be changed.
[[0{"E/F"}1{"P/F"}]]	All internal values up to and including zero (i.e. just the value zero), represent the label "E/F", and all values greater than zero but less than or equal to one (i.e. just the value 1) represent the label "P/F". All other values are invalid.

Internal value of setting	0	1	> 1
Value Displayed	E/F	P/F	invalid

[[0{"OFF"}10{?10*}]]	All internal values up to and including zero (i.e. just the value zero), represent the label "OFF" and all values greater than zero but less than or equal to 10 (i.e. the values 1 to 10) are converted using the reverse polish formula ?10* - which would simply multiply the internal value by 10. All internal values greater than 10 are invalid, see below :
----------------------	--

Internal value of setting	0	1	2	3	4	5	6	7	8	9	10	> 10
Value Displayed	OFF	10	20	30	40	50	60	70	80	90	100	invalid

[[48{?2+20/}]] One field and one range. An internal value from 0 to 48 is translated using the formula '2+20/'. Values greater than 48 are invalid. The formula simply adds 2 to the internal value then divides the result by 20, i.e.

Internal value of setting	0	1	2	3	...	46	47	48	> 48
Value Displayed	0.1	0.15	0.2	0.25	...	2.4	2.45	2.5	<i>invalid</i>

[-0{"INST"}60{?}]] One field and two ranges. An internal value of 0 represents 'INST'. Internal values from 1 to 60 inclusive represent actual values of 1-60. Internal values greater than 60 are invalid. This setting is actually used for the relay reset delay, where values can range from 'INST' then '1 sec' to '60 sec'. The minus sign in front of the first range is used to ensure that 'INST' would be displayed and not 'INST sec'.

Internal value of setting	0	1	2	..	59	60	> 60
Value Displayed	INST	1	2	..	59	60	<i>invalid</i>

[@{0{75}1{110}9{2?2-^150*}]] One field and three ranges. An internal value of zero represents 75. An internal value of 1 represents 110. Internal values from 2 to 9 are converted using the formula '2?2-^150*', or in standard infix notation: $2^{n-2} \times 150$ where n represents the internal setting value, giving :

Internal value of setting	0	1	2	3	4	5	6	7	8	9	> 9
Value Displayed	75	110	150	300	600	1200	2400	4800	9600	19200	<i>invalid</i>

[[#3{7}{ "STA" } { "P/F" } { "E/F" }]] One bit mask field consisting of 3 bit fields named "STA", "P/F" and "E/F". The mask of 7 (111 in binary) means that all bit fields can be edited.

Internal value of setting	0	1	2	3	4	5	6	7	> 7
Value Displayed		STA	P/F	STA+P/F	E/F	STA+E/F	P/F+E/F	STA+P/F+E/F	<i>invalid</i>

[[{15}1999{?1+5*}][{1}1{?4*1+}]] Two fields each with only one range. The first field occupies the highest 15 bits of the word and the second field occupies the final (i.e. the least significant) bit. In the first field, all values from zero to 1999 are converted by adding one to the internal value then multiplying the result by five. In the second field, the values zero and one are converted by multiplying the internal value by four then adding one to the result. This would give :

Internal value of setting	0	1	2	3	...	3997	3998	3999	> 3999							
Values Displayed (f1 f2)	5	1	5	5	10	1	10	5	...	9995	5	10000	1	10000	5	<i>invalid</i>

Further examples are shown in appendix G and the complete reverse polish described in appendix H.

5.2.3 Setting Display Condition

The Setting Display Condition is a logical expression that determines whether the setting should be displayed for the present configuration of the relay. For example, a Highset Time Delay setting should not be displayed if the Highset Setting is turned off

The Setting Display Condition consists of a set of square brackets containing a reverse polish logical expression that is evaluated to give TRUE or FALSE, respectively display or do not display the setting. See appendix J.

The logical expression is able to compare settings with other settings or with constant values. The letter S immediately followed by the index of the setting represents the setting. The letter V immediately followed by the constant number represents a value.

The following ANSI 'C' logical operators are supported			
&&	And		Or
==	Equals	!=	Not Equal To
>=	Greater Than Or Equal To	<=	Less Than Or Equal To

>	Greater Than	<	Less Than
---	--------------	---	-----------

Examples of Setting Display Condition	
[S20 V0 ==]	Display setting if setting number 20 equals 0.
[S20 S21 ==]	Display setting if setting number 20 equals setting number 21.
[S20 S21 == S27 V50 >= S27 V60 <= &&]	Display setting if setting number 20 equals setting number 21 or setting number 27 is between 50 and 60 inclusive.
[]	Always display this setting.

6 APPENDIX A - IEC60870 CODE DEFINITIONS

Function Type	Description (Refer to [1] IEC60870-5-103 section 7.2.5.1)
60	Reyrolle Modular II
70	Reyrolle Status Inputs
80	Reyrolle Plant Controls
90	Reyrolle LED Codes
128	IEC Distance Protection
130	Reyrolle Distance Protection
132	Reyrolle Distance Protection
160	IEC Overcurrent Protection
164	Reyrolle Overcurrent Protection
165	Reyrolle FHA Motor Protection Relay (Rho)
166	Reyrolle GCB Synchronising Relay (Argus 7)
167	Reyrolle DBB Voltage Relay (Argus 8)
168	Reyrolle DGA Feeder Manager (Delta)
176	IEC Transformer Differential Protection
178	Reyrolle Transformer Protection (Delta)
179	Reyrolle Voltage Control (MicroTAPP)
180	Reyrolle Capacitor Protection (MSCDN)
181	Reyrolle High Impedance Differential Protection (DAD-N)
182	Reyrolle Delta-Lite
192	IEC Line Differential Protection
196	Reyrolle FDF Line Differential (Solkor-N)
197	Reyrolle FDD Line Differential (Microphase-PCM)
200	Reyrolle Control Commands
210	Reyrolle GAE Autoreclose (Tau)
211	Reyrolle IOTA
212	Reyrolle IOTA 210
213	Reyrolle TAU
254	IEC Generic
255	IEC Global

Table Showing Function Type Numbers Used

Cause of Transmission (COT)	Description (Refer to [1] IEC60870-5-103 section 7.2.3)
1	Spontaneous Events
2	Cyclic
3	Reset Frame Count Bit (FCB)
4	Reset Communication Unit (CU)
5	Start Restart
6	Power On
7	Test Mode
8	Time Synchronisation
9	General Interrogation
10	Termination of General Interrogation
11	Local Operation
12	Remote Operation
20	Positive Command Acknowledge
21	Negative Command Acknowledge
31	Transmission of Disturbance Data

Table Showing Permitted Cause of Transmission Numbers

7 APPENDIX B- PUBLIC AND PRIVATE CODES

This section contains the event, measurand and command codes defined in [1] IEC60870-5-103 section 7.2.5.2 and by Reyrolle in appendix B. The commands are listed in a separate table after the events. Please note all codes do not apply to all models.

FUN	INF	Description	TYP	GI / COM	COT	DIR
		Event Codes				
		Measurand Codes				

KEY

FUN Function Type (defined in [1] IEC60870-5-103 section 7.2.5.1) and by Reyrolle in appendix A
INF Information Number (defined in [1] IEC60870-5-103 section 7.2.5.2) and by Reyrolle for each relay in appendix B
TYP ASDU Type (defined in [1] IEC60870-5-103 sections 7.3.1 and 7.3.2)
GI Event supports General Interrogation x = supported (defined in [1] IEC60870-5-103 section 7.2.5.2) and by Reyrolle in appendix B
COM Type of command single (ON only) or double (ON/OFF) (defined in [1] IEC60870-5-103 section 7.2.5.2) and by Reyrolle in appendix B
COT Cause of Transmission (defined in [1] IEC60870-5-103 section 7.2.3, table 5)
DIR Direction of event Raised Only (RO), Raised / Cleared (RC) or Double Point Travelling, Cleared, Raised or Unknown (DP)
x Supported, - Not supported.

7.1 ARGUS 1 - 6

FUN	INF	Description	GI	TYP	COT	DIR	Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
160	2	Reset FCB	-	5	3	RO	x	x	x
160	3	Reset CU	-	5	4	RO	x	x	x
160	4	Start/Restart	-	5	5	RO	x	x	x
160	5	Power On	-	5	6	RO	x	x	x
160	16	ARC in progress	x	1	1, 9, 12, 20, 21	RC	-	-	x
160	19	LEDs reset	-	1	1, 7, 11, 12, 20, 21	RO	x	x	x
160	21	Trip Test	x	1	1, 9	RC	x	x	x
160	22	Settings changed	x	1	1, 9, 11, 12	RC	x	x	x
160	23	Setting G1 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
160	24	Setting G2 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
160	25	Setting G3 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
160	26	Setting G4 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
160	27	Input 1	x	1	1, 9	RC	x	x	x
160	28	Input 2	x	1	1, 9	RC	x	x	x
160	29	Input 3	x	1	1, 9	RC	x	x	x
160	30	Input 4	x	1	1, 9	RC	x	x	x
160	36	Trip circuit fail	x	1	1, 9	RC	x	x	x
160	46	Group Warning	x	1	1, 9	RC			x
160	47	Alarm	x	1	1, 9	RO			x
160	64	A-starter	x	2	1, 9	RC	x	x	x

FUN	INF	Description	GI	TYP	COT	DIR	Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
160	65	B-starter	x	2	1, 9	RC	x	x	x
160	66	C-starter	x	2	1, 9	RC	x	x	x
160	67	E-starter	x	2	1, 9	RC	x	x	x
160	68	General trip	-	2	1	RO	x	x	x
160	69	A-general trip	-	2	1	RO	x	x	x
160	70	B-general trip	-	2	1	RO	x	x	x
160	71	C-general trip	-	2	1	RO	x	x	x
160	84	General starter	x	2	1, 9	RC	x	x	x
160	85	Circuit breaker fail 1	-	2	1	RO	x	x	x
160	91	P/F-general HS trip	-	2	1	RO	x	x	x
160	92	E/F-general trip	-	2	1	RO	x	x	x
160	93	E/F-general HS trip	-	2	1	RO	x	x	x
160	128	CB on by auto reclose	-	1	1	DP			x
160	130	Reclose blocked	x	1	1, 9	RC			x
160	144	Measurand I ⁱ	-	3.1	2,7	-	x	x	x
160	148	Measurand I _{L1,2,3} , V _{L1,2,3} , P, Q, F	-	9	2,7	-	x	x	x
164	0	Data lost	-	1	1	RO	x	x	x
164	1	A-lowset starter	-	2	1	RC	x	x	x
164	2	B-lowset starter	-	2	1	RC	x	x	x
164	3	C-lowset starter	-	2	1	RC	x	x	x
164	4	E-lowset starter	-	2	1	RC	x	x	x
164	5	A-lowset trip	-	2	1	RO	x	x	x
164	6	B-lowset trip	-	2	1	RO	x	x	x
164	7	C-lowset trip	-	2	1	RO	x	x	x
164	8	E-lowset trip	-	2	1	RO	x	x	x
164	9	A-delayed trip	-	2	1	RO	x	x	x
164	10	B-delayed trip	-	2	1	RO	x	x	x
164	11	C-delayed trip	-	2	1	RO	x	x	x
164	12	E-delayed trip	-	2	1	RO	x	x	x
164	13	A-HS1 trip	-	2	1	RO	x	x	x
164	14	B-HS1 trip	-	2	1	RO	x	x	x
164	15	C-HS1 trip	-	2	1	RO	x	x	x
164	16	E-HS1 trip	-	2	1	RO	x	x	x
164	17	A-HS2 trip	-	2	1	RO	x	x	x

ⁱ One of Ia, Ib, Ic, Id depending on relay type

FUN	INF	Description	GI	TYP	COT	DIR	Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
164	18	B-HS2 trip	-	2	1	RO	x	x	x
164	19	C-HS2 trip	-	2	1	RO	x	x	x
164	20	E-HS2 trip	-	2	1	RO	x	x	x
164	21	SEF/REF starter	x	2	1, 9	RC	x	x	x
164	23	SEF/REF lowset trip	-	2	1	RC	x	x	x
164	24	SEF/REF stage 1 trip	-	2	1	RC	x	x	x
164	25	SEF/REF stage 2 trip	-	2	1	RC	x	x	x
164	26	A-HS1 starter	-	2	1	RC	x	x	x
164	27	B-HS1 starter	-	2	1	RC	x	x	x
164	28	C-HS1 starter	-	2	1	RC	x	x	x
164	29	E-HS1 starter	-	2	1	RC	x	x	x
164	30	A-HS2 starter	-	2	1	RC	x	x	x
164	31	B-HS2 starter	-	2	1	RC	x	x	x
164	32	C-HS2 starter	-	2	1	RC	x	x	x
164	33	E-HS2 starter	-	2	1	RC	x	x	x
164	34	Circuit breaker open	x	1	1, 9	RO			x
164	35	Setting G5 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
164	36	Setting G6 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
164	37	Setting G7 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
164	38	Setting G8 selected	x	1	1, 9, 11, 12, 20, 21	RC	x	x	x
164	39	Circuit breaker fail 2	-	2	1	RO	x	x	x
164	41	CB close fail	x	1	1, 9	RO			x
164	43	CB DBI state	x	1	1, 9	RO			x
164	44	External Trip	-	2	1	RO	x	x	x
164	45	Input 5	x	1	1, 9	RC	x	x	x
164	46	Input 6	x	1	1, 9	RC	x	x	x
164	47	Input 7	x	1	1, 9	RC	x	x	x
164	48	Input 8	x	1	1, 9	RC	x	x	x
164	49	Input 9	x	1	1, 9	RC	x	x	x
164	51	Output 1	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	52	Output 2	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	53	Output 3	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	54	Output 4	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	55	Output 5	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	56	Output 6	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	57	Output 7	x	1	1, 9, 12, 20, 21	RC	x	x	x
164	58	Output 8	x	1	1, 9, 12, 20, 21	RC	x	x	
164	59	Output 9	x	1	1, 9, 12, 20, 21	RC	x	x	

FUN	INF	Description	GI	TYP	COT	DIR	Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
164	60	Output 10	x	1	1, 9, 12, 20, 21	RC	x	x	
164	61	Output 11	x	1	1, 9, 12, 20, 21	RC	x	x	
164	62	Forward A	x	2	1, 9	RC	x	x	x
164	63	Reverse A	x	2	1, 9	RC	x	x	x
164	64	Forward B	x	2	1, 9	RC	x	x	x
164	65	Reverse B	x	2	1, 9	RC	x	x	x
164	66	Forward C	x	2	1, 9	RC	x	x	x
164	67	Reverse C	x	2	1, 9	RC	x	x	x
164	68	Forward E	x	2	1, 9	RC	x	x	x
164	69	Reverse E	x	2	1, 9	RC	x	x	x
164	70	Trip count alarm	x	1	1, 9	RC	x	x	x
164	70	Trip count alarm	x	4	1, 9	-		x	
164	71	CB maintenance alarm	x	1	1, 9	RC	x	x	x
164	71	CB maintenance alarm	x	4	1, 9	-		x	
164	72	Frequent operations exceeded	x	1	1, 9	RC			x
164	73	Delta Trip Counter Alarm	x	1	1, 9	RC			x
164	79	Voltage Block	x	1	1, 9	RC		x	
164	80	Waveform stored	-	1	1, 12, 20, 21	RO	x	x	x
164	81	Remote control interrupted	-	1	1	RO	x	x	x
164	82	Trip and Lockout	-	1	1, 12, 20, 21	RO	-	-	x
164	83	Close and Reclaim	-	1	1, 12, 20, 21	RO			x
164	84	Trip And Reclose	-	1	1, 12, 20, 21	RO			x
164	85	Circuit breaker closed	x	1	1, 9	RO			x
164	86	Close And Lockin	-	1	1, 12, 20, 21	RO			x
164	87	Reclose delay	x	1	1, 9	RC			x
164	88	Reclaim	x	1	1, 9	RC			x
164	89	Lockout	x	1	1, 9	RC			x
164	90	Forward SEF	x	2	1, 9	RC	x		x
164	91	Reverse SEF	x	2	1, 9	RC	x		x
164	92	Power On Counter Alarm	x	1	1, 9	RC	x	x	x
164	97	CT Failure	x	1	1, 9	RC	x	x	x
164	100	Cold load pickup	x	1	1, 9, 12, 20, 21	RC			x
164	101	Cold load trip	-	2	1	RO			x
164	102	Line check trip	-	2	1	RO			x
164	103	ARC start A	x	1	1, 9	RC			x
164	104	A backup time	-	1	1	RC			x
164	105	A backup trip	-	1	1	RC			x
164	106	External trip block	x	1	1, 9	RC			x

FUN	INF	Description	GI	TYP	COT	DIR	Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
164	110	SEF off	x	1	1, 9, 12, 20, 21	RC			x
164	111	All ARC off	x	1	1, 9	RC			x
164	112	P/F ARC off	x	1	1, 9, 12, 20, 21	RC			x
164	113	E/F ARC off	x	1	1, 9, 12, 20, 21	RC			x
164	114	SEF ARC off	x	1	1, 9, 12, 20, 21	RC			x
164	115	All inst off	x	1	1, 9, 12, 20, 21	RC			x
164	116	P/F inst off	x	1	1, 9, 12, 20, 21	RC			x
164	117	E/F inst off	x	1	1, 9, 12, 20, 21	RC			x
164	118	SEF inst off	x	1	1, 9, 12, 20, 21	RC			x
164	119	Hot line working	x	1	1, 9, 12, 20, 21	RC			x
164	120	Scada Control	x	1	1, 9	RC			x
164	121	General alarm 1	x	1	1, 9	RC	x	x	x
164	122	General alarm 2	x	1	1, 9	RC	x	x	x
164	123	General alarm 3	x	1	1, 9	RC	x	x	x
164	124	General alarm 4	x	1	1, 9	RC	x	x	x
164	125	General alarm 5	x	1	1, 9	RC	x	x	x
164	131	Va/Vab starter	x	2	1, 9	RC		x	
164	132	Vb/Vbc starter	x	2	1, 9	RC		x	
164	133	Vc/Vca starter	x	2	1, 9	RC		x	
164	170	V starter	x	2	1, 9	RC		x	
164	182	V trip	-	2	1	RO		x	
164	190	Voltage Memory A	x	1	1, 9	RC		x	
164	191	Voltage Memory B	x	1	1, 9	RC		x	
164	192	Voltage Memory C	x	1	1, 9	RC		x	
164	240	Ia Fault Current	x	4	1, 9	-	x	x	x
164	241	Ib Fault Current	x	4	1, 9	-	x	x	x
164	242	Ic Fault Current	x	4	1, 9	-	x	x	x
164	243	Ie Fault Current	x	4	1, 9	-	x	x	x
164	244	Isef Fault Current	x	4	1, 9	-	x	x	x
164	245	Va Fault Voltage	x	4	1, 9	-		x	
164	246	Vb Fault Voltage	x	4	1, 9	-		x	
164	247	Vc Fault Voltage	x	4	1, 9	-		x	
164	248	Vn Fault Voltage	x	4	1, 9	-		x	
255	0	Time Synchronisation	-	6	8	-	x	x	x
255	0	Initiate General Interrogation	-	7	9	-	x	x	x
255	0	End of General Interrogation	-	8	10	-	x	x	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
160	16	Auto-recloser ON/OFF	ON/OFF	20	20		-	-	x
160	19	Reset Flag & Outputs	ON	20	20		x	x	x
160	23	Settings Group 1 Select	ON	20	20		x	x	x
160	24	Settings Group 2 Select	ON	20	20		x	x	x
160	25	Settings Group 3 Select	ON	20	20		x	x	x
160	26	Settings Group 4 Select	ON	20	20		x	x	x
164	35	Settings Group 5 Select	ON	20	20		x	x	x
164	36	Settings Group 6 Select	ON	20	20		x	x	x
164	37	Settings Group 7 Select	ON	20	20		x	x	x
164	38	Settings Group 8 Select	ON	20	20		x	x	x
164	51	Energise Output 1	ON	20	20		x	x	x
164	52	Energise Output 2	ON	20	20		x	x	x
164	53	Energise Output 3	ON	20	20		x	x	x
164	54	Energise Output 4	ON	20	20		x	x	x
164	55	Energise Output 5	ON	20	20		x	x	x
164	56	Energise Output 6	ON	20	20		x	x	x
164	57	Energise Output 7	ON	20	20		x	x	x
164	58	Energise Output 8	ON	20	20		x	x	
164	59	Energise Output 9	ON	20	20		x	x	
164	60	Energise Output 10	ON	20	20		x	x	
164	61	Energise Output 11	ON	20	20		x	x	
164	80	Trigger Waveform Storage	ON	20	20		x	x	x
164	82	Trip and Lockout	ON	20	20		-	-	x
164	83	Close and Reclaim	ON	20	20		-	-	x
164	84	Trip And Reclose	ON	20	20		-	-	x
164	86	Close And Lockin	ON/OFF	20	20		-	-	x
164	100	Cold load pickup	ON/OFF	20	20		-	-	x
164	110	SEF	ON/OFF	20	20		-	-	x
164	112	P/F ARC Inhibit	ON/OFF	20	20		-	-	x
164	113	E/F ARC Inhibit	ON/OFF	20	20		-	-	x
164	114	SEF ARC Inhibit	ON/OFF	20	20		-	-	x
164	115	Instantaneous	ON/OFF	20	20		-	-	x

FUN	INF	Description	COM	TYP	COT		Argus 1 & 2	Argus 2 - 500	Argus 3 - 6
164	116	P/F Instantaneous	ON/OFF	20	20		-	-	x
164	117	E/F Instantaneous	ON/OFF	20	20		-	-	x
164	118	SEF Instantaneous	ON/OFF	20	20		-	-	x
164	119	Hot line working	ON/OFF	20	20		-	-	x
164	129	Reset Energy Meters	ON/OFF	20	20			x	
164	130	Reset Maximum Demand	ON/OFF	20	20		x	x	x
255	0	Time Synchronisation	-	6	8		x	x	x

Table Showing Command Information (INF) Numbers

The following table shows the Actual Channel Numbers used for each configuration of relay. The abbreviated used are nP number of standard poles, E earth fault pole, SEF sensitive earth fault pole. For example, a 4 pole relay may be a 2P + E + SEF.

FUN	ACC	Argus 1 - 6 (Except AG2-5xx)								AG2-5xx		
		1P	1E	3P	2P+E	2P+SEF	2P+E+SEF	3P+E	3P+SEF	3P+E	3P+SEF	2P+E+SEF
164	1	l	l	la	la	la	la	la	la	la	la	la
164	2			lb	le	lb	le	lb	lb	lb	lb	lc
164	3			lc	lc	lse	lc	lc	lc	lc	lc	le
164	4						lse	le	lse	le	lsef	lsef
164	5									Va	Va	Va
164	6									Vb	Vb	Vb
164	7									Vc	Vc	Vc
164	8									Vn	Vn	Vn
164	9									Vab	Vab	Vab
164	10									Vbc	Vbc	Vbc
164	11									Vca	Vca	Vca

Table Showing Disturbance Recorder Actual Channel (ACC) Numbers

7.2 ARGUS 7

FUN	INF	Description	GI	TYP	COT	DIR	Argus 7
166	0	Data lost	-	1	1	RO	x
166	2	Reset FCB	-	5	3	RO	x
166	3	Reset CU	-	5	4	RO	x
166	4	Start/Restart	-	5	5	RO	x
166	5	Power On	-	5	6	RO	x
166	19	LEDs reset	-	1	1, 7, 11, 12, 20, 21	RO	x
166	21	Trip Test	-	1	0	RC	x
166	22	Settings changed	-	1	1, 11, 12	RC	x
166	23	Setting G1 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	24	Setting G2 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	25	Setting G3 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	26	Setting G4 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	27	Input 1	x	1	1, 9	RC	x
166	28	Input 2	x	1	1, 9	RC	x
166	29	Input 3	x	1	1, 9	RC	x
166	30	Input 4	x	1	1, 9	RC	x
166	35	Setting G5 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	36	Setting G6 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	37	Setting G7 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	38	Setting G8 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
166	51	Output 1	x	1	1, 9, 11, 12, 20, 21	RC	x
166	52	Output 2	x	1	1, 9, 11, 12, 20, 21	RC	x
166	53	Output 3	x	1	1, 9, 11, 12, 20, 21	RC	x
166	54	Output 4	x	1	1, 9, 11, 12, 20, 21	RC	x
166	55	Output 5	x	1	1, 9, 11, 12, 20, 21	RC	x
166	56	Output 6	x	1	1, 9, 11, 12, 20, 21	RC	x
166	57	Output 7	x	1	1, 9, 11, 12, 20, 21	RC	x
166	80	Waveform stored	-	1	1, 12, 20, 21	RO	x
166	81	Remote control interrupted	-	1	1	RO	x
166	83	Lockout	-	1	1	RC	x
166	84	Reset Lockout Mode	-	1	1	RO	x
166	90	Check Sync Start	x	1	1, 9	RC	x
166	91	System Sync Start	x	1	1, 9, 12, 20, 21	RC	x
166	92	Check Sync Inhibit	x	1	1, 9	RC	x
166	93	System Sync Inhibit	x	1	1, 9	RC	x
166	94	Sync Bypass	x	1	1, 9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Argus 7
166	96	Check Sync Close	x	1	1, 9	RC	x
166	97	System Sync Close	x	1	1, 9	RC	x
166	98	Bypass Close	x	1	1, 9	RC	x
166	99	Slip In Sync	x	1	1, 9	RC	x
166	100	Phase In Sync	x	1	1, 9	RC	x
166	101	Live Line	x	1	1, 9	RC	x
166	102	Live Bus	x	1	1, 9	RC	x
166	103	Bus U/V Detector	x	1	1, 9	RC	x
166	104	Line U/V Detector	x	1	1, 9	RC	x
166	105	Volts Differential	x	1	1, 9	RC	x
166	106	System Split	x	1	1, 9	RC	x
166	121	Alarm 1	x	1	1, 9	RC	x
166	122	Alarm 2	x	1	1, 9	RC	x
166	123	Alarm 3	x	1	1, 9	RC	x
166	124	Alarm 4	x	1	1, 9	RC	x
166	148	Measurand $I_{L1,2,3}, V_{L1,2,3}, P, Q, F^{ii}$	-	9	2,7	-	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT	Argus 7
166	19	Reset Flag & Outputs	ON	20	20	x
166	23	Settings Group 1 Select	ON	20	20	x
166	24	Settings Group 2 Select	ON	20	20	x
166	25	Settings Group 3 Select	ON	20	20	x
166	26	Settings Group 4 Select	ON	20	20	x
166	35	Settings Group 5 Select	ON	20	20	x
166	36	Settings Group 6 Select	ON	20	20	x
166	37	Settings Group 7 Select	ON	20	20	x
166	38	Settings Group 8 Select	ON	20	20	x
166	51	Energise Output 1 for 100 ms	ON	20	20	x
166	52	Energise Output 2 for 100 ms	ON	20	20	x
166	53	Energise Output 3 for 100 ms	ON	20	20	x
166	54	Energise Output 4 for 100 ms	ON	20	20	x
166	55	Energise Output 5 for 100 ms	ON	20	20	x
166	56	Energise Output 6 for 100 ms	ON	20	20	x

ⁱⁱ Only VL1, VL2, and F are valid, all other fields returned as zero.

FUN	INF	Description	COM	TYP	COT		Argus 7
166	57	Energise Output 7 for 100 ms	ON	20	20		x
166	80	Trigger Waveform Storage	ON	20	20		x
166	91	Start System Sync	ON/OFF	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

7.3 ARGUS 8

FUN	INF	Description	GI	TYP	COT	DIR	Argus 8
167	0	Data lost	-	1	1	RO	x
167	2	Reset FCB	-	5	3	RO	x
167	3	Reset CU	-	5	4	RO	x
167	4	Start/Restart	-	5	5	RO	x
167	5	Power On	-	5	6	RO	x
167	18	External Trip	-	2	1	RO	x
167	19	LEDs reset	-	1	1, 7, 11, 12, 20, 21	RO	x
167	20	Trip circuit fail	x	1	1, 9	RC	x
167	21	Trip Test	-	1	1	RC	x
167	22	Settings changed	-	1	1, 11, 12	RC	x
167	23	Setting G1 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	24	Setting G2 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	25	Setting G3 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	26	Setting G4 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	27	Input 1	x	1	1, 9	RC	x
167	28	Input 2	x	1	1, 9	RC	x
167	29	Input 3	x	1	1, 9	RC	x
167	30	Input 4	x	1	1, 9	RC	x
167	33	Trip count alarm	x	1	1, 9, 12, 20, 21	RC	x
167	33	Trip count alarm	x	4	1, 9	-	x
167	35	Setting G5 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	36	Setting G6 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	37	Setting G7 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	38	Setting G8 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
167	45	Input 5	x	1	1, 9	RC	x
167	46	Input 6	x	1	1, 9	RC	x
167	47	Input 7	x	1	1, 9	RC	x
167	48	Input 8	x	1	1, 9	RC	x
167	49	Input 9	x	1	1, 9	RC	x
167	51	Output 1	x	1	1, 9, 12, 20, 21	RC	x
167	52	Output 2	x	1	1, 9, 12, 20, 21	RC	x
167	53	Output 3	x	1	1, 9, 12, 20, 21	RC	x
167	54	Output 4	x	1	1, 9, 12, 20, 21	RC	x
167	55	Output 5	x	1	1, 9, 12, 20, 21	RC	x
167	56	Output 6	x	1	1, 9, 12, 20, 21	RC	x
167	57	Output 7	x	1	1, 9, 12, 20, 21	RC	x
167	58	Output 8	x	1	1, 9, 12, 20, 21	RC	x
167	59	Output 9	x	1	1, 9, 12, 20, 21	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Argus 8
167	60	Output 10	x	1	1, 9, 12, 20, 21	RC	x
167	61	Output 11	x	1	1, 9, 12, 20, 21	RC	x
167	79	Voltage Block	x	1	1, 9	RC	x
167	80	Waveform stored	-	1	1, 12, 20, 21	RO	x
167	81	Remote control interrupted	-	1	1	RO	x
167	92	Power On Counter Alarm	x	1	1, 9	RC	x
167	121	General Alarm 1	x	1	1, 9	RC	x
167	122	General Alarm 2	x	1	1, 9	RC	x
167	123	General Alarm 3	x	1	1, 9	RC	x
167	124	General Alarm 4	x	1	1, 9	RC	x
167	125	General Alarm 5	x	1	1, 9	RC	x
167	126	General Alarm 6	x	1	1, 9	RC	x
167	127	General Alarm 7	x	1	1, 9	RC	x
167	128	General Alarm 8	x	1	1, 9	RC	x
167	129	General Alarm 9	x	1	1, 9	RC	x
167	148	Measurand $I_{L1,2,3}, V_{L1,2,3}, P, Q, F^{iii}$	-	9	2,7	-	x
167	170	V Element 1 starter	x	1	1, 9	RC	x
167	171	V Element 2 starter	x	1	1, 9	RC	x
167	172	V Element 3 starter	x	1	1, 9	RC	x
167	173	V Element 4 starter	x	1	1, 9	RC	x
167	174	F Element 1 starter	x	1	1, 9	RC	x
167	175	F Element 2 starter	x	1	1, 9	RC	x
167	176	F Element 3 starter	x	1	1, 9	RC	x
167	177	F Element 4 starter	x	1	1, 9	RC	x
167	178	3Vo Element 1 starter	x	1	1, 9	RC	x
167	179	3Vo Element 2 starter	x	1	1, 9	RC	x
167	180	V2 Element 1 starter	x	1	1, 9	RC	x
167	181	V2 Element 2 starter	x	1	1, 9	RC	x
167	182	V Element 1 trip	-	1	1	RO	x
167	183	V Element 2 trip	-	1	1	RO	x
167	184	V Element 3 trip	-	1	1	RO	x
167	185	V Element 4 trip	-	1	1	RO	x
167	186	F Element 1 trip	-	1	1	RO	x
167	187	F Element 2 trip	-	1	1	RO	x
167	188	F Element 3 trip	-	1	1	RO	x
167	189	F Element 4 trip	-	1	1	RO	x
167	190	3Vo Element 1 trip	-	1	1	RO	x
167	191	3Vo Element 2 trip	-	1	1	RO	x

ⁱⁱⁱ Only VL1, VL2, VL3 and F are valid, all other fields returned as zero.

FUN	INF	Description	GI	TYP	COT	DIR	Argus 8
167	192	V2 Element 1 trip	-	1	1	RO	x
167	193	V2 Element 2 trip	-	1	1	RO	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT	DIR	Argus 8
167	19	Reset Flag & Outputs	ON	20	20	-	x
167	23	Settings Group 1 Select	ON	20	20	-	x
167	24	Settings Group 2 Select	ON	20	20	-	x
167	25	Settings Group 3 Select	ON	20	20	-	x
167	26	Settings Group 4 Select	ON	20	20	-	x
167	33	Trip counter reset	ON	20	20	-	x
167	35	Settings Group 5 Select	ON	20	20	-	x
167	36	Settings Group 6 Select	ON	20	20	-	x
167	37	Settings Group 7 Select	ON	20	20	-	x
167	38	Settings Group 8 Select	ON	20	20	-	x
167	51	Energise Output 1	ON	20	20	-	x
167	52	Energise Output 2	ON	20	20	-	x
167	53	Energise Output 3	ON	20	20	-	x
167	54	Energise Output 4	ON	20	20	-	x
167	55	Energise Output 5	ON	20	20	-	x
167	56	Energise Output 6	ON	20	20	-	x
167	57	Energise Output 7	ON	20	20	-	x
167	58	Energise Output 8	ON	20	20	-	x
167	59	Energise Output 9	ON	20	20	-	x
167	60	Energise Output 10	ON	20	20	-	x
167	61	Energise Output 11	ON	20	20	-	x
167	80	Trigger Waveform Storage	ON	20	20	-	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	Initiate General Interrogation	-	7	9	-	x

Table Showing Command Information (INF) Numbers

Variant (AG8 x01 - x03)					
FUN	ACC	2 Phase - Phase	Phase-Neutral + NVD	Phase-Phase + NVD	2 Systems A / B
167	1	Vab	Va	Vab	Va
167	2	Vbc	V0	V0	Vb
167	3	Vca			

Variant (AG8 x04 - x12)				
FUN	ACC	3 Phase - Phase	2 Phase-Phase + NVD	3 Phase-Neutral + NVD
167	1	Vab	Vab	Va
167	2	Vbc	Vbc	Vb
167	3	Vca	V0	Vc

Tables Showing Disturbance Recorder Actual Channel (ACC) Numbers

7.4 DELTA

FUN	INF	Description	GI	TYP	COT	DIR	Delta
60	1	IEC870 Active Com 1	x	1	1	RC	x
60	2	IEC870 Active Com 2	x	1	1	RC	x
60	3	Front Port OverRide	x	1	1	RC	x
60	128	Cold Start	-	1	0	RO	x
60	129	Warm Start	-	1	0	RO	x
60	130	Re-Start	-	1	0	RO	x
60	135	Trigger Storage	-	1	0	RO	x
60	136	Clear Waveform Records	-	1	0	RO	x
60	137	Clear Fault Records	-	1	0	RO	x
60	138	Clear Event Records	-	1	0	RO	x
70	5	Status Input 5	x	1	1	RC	x
70	6	Status Input 6	x	1	1	RC	x
70	7	Status Input 7	x	1	1	RC	x
70	8	Status Input 8	x	1	1	RC	x
70	9	Status Input 9	x	1	1	RC	x
70	10	Status Input 10	x	1	1	RC	x
70	11	Status Input 11	x	1	1	RC	x
70	12	Status Input 12	x	1	1	RC	x
70	13	Status Input 13	x	1	1	RC	x
70	14	Status Input 14	x	1	1	RC	x
70	15	Status Input 15	x	1	1	RC	x
70	16	Status Input 16	x	1	1	RC	x
70	17	Status Input 17	x	1	1	RC	x
70	18	Status Input 18	x	1	1	RC	x
70	19	Status Input 19	x	1	1	RC	x
70	20	Status Input 20	x	1	1	RC	x
70	21	Status Input 21	x	1	1	RC	x
70	22	Status Input 22	x	1	1	RC	x
70	23	Status Input 23	x	1	1	RC	x
70	24	Status Input 24	x	1	1	RC	x
70	25	Status Input 25	x	1	1	RC	x
70	26	Status Input 26	x	1	1	RC	x
70	27	Status Input 27	x	1	1	RC	x
70	28	Status Input 28	x	1	1	RC	x
70	29	Status Input 29	x	1	1	RC	x
70	30	Status Input 30	x	1	1	RC	x
70	31	Status Input 31	x	1	1	RC	x
70	32	Status Input 32	x	1	1	RC	x
80	1	Plant Control Relay 1	x	1	1	RC	x
80	2	Plant Control Relay 2	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Delta
80	3	Plant Control Relay 3	x	1	1	RC	x
80	4	Plant Control Relay 4	x	1	1	RC	x
80	5	Plant Control Relay 5	x	1	1	RC	x
80	6	Plant Control Relay 6	x	1	1	RC	x
80	7	Plant Control Relay 7	x	1	1	RC	x
80	8	Plant Control Relay 8	x	1	1	RC	x
80	9	Plant Control Relay 9	x	1	1	RC	x
80	10	Plant Control Relay 10	x	1	1	RC	x
80	11	Plant Control Relay 11	x	1	1	RC	x
80	12	Plant Control Relay 12	x	1	1	RC	x
80	13	Plant Control Relay 13	x	1	1	RC	x
80	14	Plant Control Relay 14	x	1	1	RC	x
80	15	Plant Control Relay 15	x	1	1	RC	x
80	16	Plant Control Relay 16	x	1	1	RC	x
80	17	Plant Control Relay 17	x	1	1	RC	x
80	18	Plant Control Relay 18	x	1	1	RC	x
80	19	Plant Control Relay 19	x	1	1	RC	x
80	20	Plant Control Relay 20	x	1	1	RC	x
80	21	Plant Control Relay 21	x	1	1	RC	x
80	22	Plant Control Relay 22	x	1	1	RC	x
80	23	Plant Control Relay 23	x	1	1	RC	x
80	24	Plant Control Relay 24	x	1	1	RC	x
80	25	Plant Control Relay 25	x	1	1	RC	x
80	26	Plant Control Relay 26	x	1	1	RC	x
80	27	Plant Control Relay 27	x	1	1	RC	x
80	28	Plant Control Relay 28	x	1	1	RC	x
80	29	Plant Control Relay 29	x	1	1	RC	x
80	30	Plant Control Relay 30	x	1	1	RC	x
80	31	Plant Control Relay 31	x	1	1	RC	x
80	32	Plant Control Relay 32	x	1	1	RC	x
160	2	Reset FCB	-	2	3	RO	x
160	3	Reset CU	-	2	4	RO	x
160	4	Start/Restart	-	2	5	RO	x
160	16	Auto-reclose active	x	1	1, 20, 21	RC	x
160	19	LEDs reset	-	1	1, 20, 21	RO	x
160	21	Trip Test	x	1	1	RC	x
160	22	Settings changed	-	1	1	RC	x
160	23	Setting G1 selected	x	1	1, 20, 21	RC	x
160	24	Setting G2 selected	x	1	1, 20, 21	RC	x
160	25	Setting G3 selected	x	1	1, 20, 21	RC	x
160	26	Setting G4 selected	x	1	1, 20, 21	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Delta
160	27	Status Input 1	x	1	1	RC	x
160	28	Status Input 2	x	1	1	RC	x
160	29	Status Input 3	x	1	1	RC	x
160	30	Status Input 4	x	1	1	RC	x
160	36	Trip circuit fail	x	1	1	RC	x
160	64	A-Delayed Starter	x	2	1	RC	x
160	65	B-Delayed Starter	x	2	1	RC	x
160	66	C-Delayed Starter	x	2	1	RC	x
160	67	E-Delayed Starter	x	2	1	RC	x
160	68	General Trip	-	2	1	RO	x
160	69	A-general trip	-	2	1	RO	x
160	70	B-general trip	-	2	1	RO	x
160	71	C-general trip	-	2	1	RO	x
160	84	General Starter	x	2	1	RC	x
160	85	Circuit breaker fail 1	-	2	1	RO	x
160	91	P/F-general HS trip	-	2	1	RO	x
160	92	E/F-general trip	-	2	1	RO	x
160	93	E/F-general HS trip	-	2	1	RO	x
160	128	CB on by auto reclose	-	1	1	RO	x
160	130	Reclose blocked	x	1	1	RC	x
160	148	Measurand $I_{L1,2,3}, V_{L1,2,3}, P, Q, F^{iv}$	-	9	2,7	-	x
168	0	Data lost	-	1	1	RO	x
168	1	A-lowset starter	-	2	1	RC	x
168	2	B-lowset starter	-	2	1	RC	x
168	3	C-lowset starter	-	2	1	RC	x
168	4	E-lowset starter	-	2	1	RC	x
168	5	A-lowset trip	-	2	1	RO	x
168	6	B-lowset trip	-	2	1	RO	x
168	7	C-lowset trip	-	2	1	RO	x
168	8	E-lowset trip	-	2	1	RO	x
168	9	A-Delayed Trip	-	2	1	RO	x
168	10	B-Delayed Trip	-	2	1	RO	x
168	11	C-Delayed Trip	-	2	1	RO	x
168	12	E-Delayed Trip	-	2	1	RO	x
168	13	A-HS1 trip	-	2	1	RO	x

^{iv} The voltages returned are phase to neutral.

FUN	INF	Description	GI	TYP	COT	DIR	Delta
168	14	B-HS1 trip	-	2	1	RO	x
168	15	C-HS1 trip	-	2	1	RO	x
168	16	E-HS1 trip	-	2	1	RO	x
168	17	A-HS2 trip	-	2	1	RO	x
168	18	B-HS2 trip	-	2	1	RO	x
168	19	C-HS2 trip	-	2	1	RO	x
168	20	E-HS2 trip	-	2	1	RO	x
168	21	SEF/REF starter1	-	2	1	RC	x
168	22	SEF/REF starter2	-	2	1	RC	x
168	24	SEF/REF trip1	-	2	1	RO	x
168	25	SEF/REF trip2	-	2	1	RO	x
168	26	A-HS1 starter	-	2	1	RC	x
168	27	B-HS1 starter	-	2	1	RC	x
168	28	C-HS1 starter	-	2	1	RC	x
168	29	E-HS1 starter	-	2	1	RC	x
168	30	A-HS2 starter	-	2	1	RC	x
168	31	B-HS2 starter	-	2	1	RC	x
168	32	C-HS2 starter	-	2	1	RC	x
168	33	E-HS2 starter	-	2	1	RC	x
168	34	CB Opened	x	1	1	RO	x
168	39	Circuit breaker fail 2	-	2	1	RO	x
168	40	MeasE/F-general trip	-	2	1	RO	x
168	41	CB Close Fail	x	1	1	RO	x
168	43	CB DBI state	x	1	1	RC	x
168	44	A-Forward	x	2	1	RC	x
168	45	A-Reverse	x	2	1	RC	x
168	46	B-Forward	x	2	1	RC	x
168	47	B-Reverse	x	2	1	RC	x
168	48	C-Forward	x	2	1	RC	x
168	49	C-Reverse	x	2	1	RC	x
168	50	E/F-Forward	x	2	1	RC	x
168	51	E/F-Reverse	x	2	1	RC	x
168	52	V Element 1 Starter	x	2	1	RC	x
168	53	V Element 2 Starter	x	2	1	RC	x
168	54	V Element 3 Starter	x	2	1	RC	x
168	55	V Element 4 Starter	x	2	1	RC	x
168	56	V Element 1 Trip	-	2	1	RO	x
168	57	V Element 2 Trip	-	2	1	RO	x
168	58	V Element 3 Trip	-	2	1	RO	x
168	59	V Element 4 Trip	-	2	1	RO	x
168	60	SEF-Forward	x	2	1	RC	x
168	61	SEF-Reverse	x	2	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Delta
168	62	NPS-lowset starter	-	2	1	RC	x
168	63	NPS-lowset trip	-	2	1	RO	x
168	64	NPS-HS1 trip	-	2	1	RO	x
168	65	NPS-HS2 trip	-	2	1	RO	x
168	66	NPS-HS1 starter	-	2	1	RC	x
168	67	NPS-HS2 starter	-	2	1	RC	x
168	68	NPS-general trip	-	2	1	RO	x
168	69	Group Switched - External	x	1	1	RC	x
168	70	Trip count alarm	x	1	1	RC	x
168	71	CB maintenance alarm	x	1	1	RC	x
168	73	Delta Trip count alarm	x	1	1	RC	x
168	74	Trip count overflowed	-	1	1	RO	x
168	75	Delta count overflowed	-	1	1	RO	x
168	76	A Broken Conductor	-	1	1	RC	x
168	77	B Broken Conductor	-	1	1	RC	x
168	78	C Broken Conductor	-	1	1	RC	x
168	79	Broken Conductor	-	1	1	RO	x
168	80	Waveform stored	-	1	1	RO	x
168	82	Trip And Lockout	-	1	1	RO	x
168	84	Trip And Reclose	-	1	1	RO	x
168	85	Circuit breaker closed	x	1	1	RO	x
168	88	Reclaim	x	1	1	RC	x
168	89	Lockout	x	1	1	RC	x
168	90	Thermal Overload Trip	-	1	1	RO	x
168	91	Thermal Capacity Alarm	-	1	1	RC	x
168	92	Load Increase Alarm	-	1	1	RC	x
168	93	Thermal Overload Alarm	-	1	1	RC	x
168	94	Phase A CT Failed	-	1	1	RC	x
168	95	Phase B CT Failed	-	1	1	RC	x
168	96	Phase C CT Failed	-	1	1	RC	x
168	97	CT Failed	-	1	1	RC	x
168	98	Successful Close	x	1	1	RO	x
168	100	Cold Load Pickup	x	2	1	RC	x
168	101	Cold Load Trip	-	2	1	RO	x
168	102	Line check trip	-	2	1	RO	x
168	103	Live Line	x	2	1	RC	x
168	104	Live Bus	x	2	1	RC	x
168	105	In Sync	x	2	1	RC	x
168	106	External trip block	x	1	1	RC	x
168	107	System Split	x	2	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Delta
168	135	VT Failed	x	2	1	RC	x
168	171	LS Trip	-	2	1	RO	x
168	172	Delayed Trip	-	2	1	RO	x
168	173	HS1 Trip	-	2	1	RO	x
168	174	HS2 Trip	-	2	1	RO	x
168	175	Setting G5 selected	x	1	1, 20, 21	RC	x
168	176	Setting G6 selected	x	1	1, 20, 21	RC	x
168	177	Setting G7 selected	x	1	1, 20, 21	RC	x
168	178	Setting G8 selected	x	1	1, 20, 21	RC	x
168	179	Trip count reset	-	1	1, 20, 21	RO	x
168	180	Delta trip count reset	-	1	1, 20, 21	RO	x
168	181	I ² t count reset	-	1	1, 20, 21	RO	x
168	182	Remote Mode	x	1	1	RC	x
168	183	Service Mode	x	1	1	RC	x
168	184	Local Mode	x	1	1	RC	x
168	185	3Vo Element 1 Starter	x	2	1	RC	x
168	186	3Vo Element 2 Starter	x	2	1	RC	x
168	187	3Vo Element 1 Trip	-	2	1	RO	x
168	188	3Vo Element 2 Trip	-	2	1	RO	x
168	200	Measurand $I_{L1,2,3}$, $V_{L1,2,3}$, $V_{L1-2,L2-3,L3-1}$, P, Q, F, Sync Angle	-	9	2,7	-	x
168	201	3PAvEnergy	-	1	2	RO	x
168	202	3PRacEnergy	-	1	2	RO	x
168	238	P/F Idmtl on/off	-	1	1, 20, 21	RC	x
168	239	E/F Idmtl on/off	-	1	1, 20, 21	RC	x
168	240	P/F Lowset on/off	-	1	1, 20, 21	RC	x
168	241	P/F Highset 1 on/off	-	1	1, 20, 21	RC	x
168	242	P/F Highset 2 on/off	-	1	1, 20, 21	RC	x
168	243	E/F Lowset on/off	-	1	1, 20, 21	RC	x
168	244	E/F Highset 1 on/off	-	1	1, 20, 21	RC	x
168	245	E/F Highset 2 on/off	-	1	1, 20, 21	RC	x
168	246	SEF1 on/off	-	1	1, 20, 21	RC	x
168	247	SEF2 on/off	-	1	1, 20, 21	RC	x
168	248	Thermal O/L on/off	-	1	1, 20, 21	RC	x
168	249	Broken Conductor on/off	-	1	1, 20, 21	RC	x
168	250	Cold Load on/off	-	1	1, 20, 21	RC	x
168	251	CT Supervision on/off	-	1	1, 20, 21	RC	x
168	252	Trip Cct Supervision on/off	-	1	1, 20, 21	RC	x
168	253	Cold Start	-	1	1	RO	x
168	254	Warm Start	-	1	1	RO	x
168	255	Re-Start	-	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Delta
200	1	CB 1	x	1	1, 20, 21	DP	x
200	2	CB 2	x	1	1, 20, 21	DP	x
200	3	CB 3	x	1	1, 20, 21	DP	x
200	4	CB 4	x	1	1, 20, 21	DP	x
200	5	CB 5	x	1	1, 20, 21	DP	x
200	21	Iso 1	x	1	1, 20, 21	DP	x
200	22	Iso 2	x	1	1, 20, 21	DP	x
200	23	Iso 3	x	1	1, 20, 21	DP	x
200	24	Iso 4	x	1	1, 20, 21	DP	x
200	25	Iso 5	x	1	1, 20, 21	DP	x
200	41	Earth Switch 1	x	1	1, 20, 21	DP	x
200	42	Earth Switch 2	x	1	1, 20, 21	DP	x
200	43	Earth Switch 3	x	1	1, 20, 21	DP	x
200	44	Earth Switch 4	x	1	1, 20, 21	DP	x
200	45	Earth Switch 5	x	1	1, 20, 21	DP	x
200	101	Control Item 1	x	1	1, 20, 21	DP	x
200	102	Control Item 2	x	1	1, 20, 21	DP	x
200	103	Control Item 3	x	1	1, 20, 21	DP	x
200	104	Control Item 4	x	1	1, 20, 21	DP	x
200	105	Control Item 5	x	1	1, 20, 21	DP	x
200	121	CB 1 Service Position	x	1	1	DP	x
200	122	CB 2 Service Position	x	1	1	DP	x
200	123	CB 3 Service Position	x	1	1	DP	x
200	124	CB 4 Service Position	x	1	1	DP	x
200	125	CB 5 Service Position	x	1	1	DP	x
200	255	Blocked By Interlocking	-	1	1	RO	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		Delta
160	16	Auto-recloser	ON/OFF	20	20		x
160	19	Reset Flag & Outputs	ON	20	20		x
160	23	Settings Group 1 Select	ON	20	20		x
160	24	Settings Group 2 Select	ON	20	20		x
160	25	Settings Group 3 Select	ON	20	20		x
160	26	Settings Group 4 Select	ON	20	20		x
168	175	Settings Group 5 Select	ON	20	20		x
168	176	Settings Group 6 Select	ON	20	20		x
168	177	Settings Group 7 Select	ON	20	20		x
168	178	Settings Group 8 Select	ON	20	20		x
168	179	Reset Trip Count	ON	20	20		x
168	180	Reset Delta Trip Count	ON	20	20		x
168	181	Reset I ² t count	ON	20	20		x
168	238	P/F Idmtl on/off	ON/OFF	20	20		x
168	239	E/F Idmtl on/off	ON/OFF	20	20		x
168	240	P/F Lowset on/off	ON/OFF	20	20		x
168	241	P/F Highset 1 on/off	ON/OFF	20	20		x
168	242	P/F Highset 2 on/off	ON/OFF	20	20		x
168	243	E/F Lowset on/off	ON/OFF	20	20		x
168	244	E/F Highset 1 on/off	ON/OFF	20	20		x
168	245	E/F Highset 2 on/off	ON/OFF	20	20		x
168	246	SEF1 on/off	ON/OFF	20	20		x
168	247	SEF2 on/off	ON/OFF	20	20		x
168	248	Thermal O/L on/off	ON/OFF	20	20		x
168	249	Broken Conductor on/off	ON/OFF	20	20		x
168	250	Cold Load on/off	ON/OFF	20	20		x
168	251	CT Supervision on/off	ON/OFF	20	20		x
168	252	Trip Cct Supervision on/off	ON/OFF	20	20		x
200	1	CB 1	ON/OFF	20	20		x
200	2	CB 2	ON/OFF	20	20		x
200	3	CB 3	ON/OFF	20	20		x
200	4	CB 4	ON/OFF	20	20		x
200	5	CB 5	ON/OFF	20	20		x
200	21	Iso 1	ON/OFF	20	20		x
200	22	Iso 2	ON/OFF	20	20		x
200	23	Iso 3	ON/OFF	20	20		x
200	24	Iso 4	ON/OFF	20	20		x

FUN	INF	Description	COM	TYP	COT		Delta
200	25	Iso 5	ON/OFF	20	20		x
200	41	Earth Switch 1	ON/OFF	20	20		x
200	42	Earth Switch 2	ON/OFF	20	20		x
200	43	Earth Switch 3	ON/OFF	20	20		x
200	44	Earth Switch 4	ON/OFF	20	20		x
200	45	Earth Switch 5	ON/OFF	20	20		x
200	101	Control Item 1	ON/OFF	20	20		x
200	102	Control Item 2	ON/OFF	20	20		x
200	103	Control Item 3	ON/OFF	20	20		x
200	104	Control Item 4	ON/OFF	20	20		x
200	105	Control Item 5	ON/OFF	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

FUN	ACC	Description	Delta
168	0	Global	Ü
168	1	Ia	Ü
168	2	Ib	Ü
168	3	Ic	Ü
168	4	Ie	Ü
168	5	Ix	Ü
168	6	Va	Ü
168	7	Vb	Ü
168	8	Vc	Ü
168	9	Vx	Ü

Table Showing Actual Channel (ACC) Numbers

7.5 Duobias-M

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
60	1	IEC870 Active Com1	x	1	1	RC	x
60	2	IEC870 Active Com2	x	1	1	RC	x
60	3	Front Port OverRide	x	1	1	RC	x
60	4	Remote Mode	x	1	1	RC	x
60	5	Service Mode	x	1	1	RC	x
60	6	Local Mode	x	1	1	RC	x
60	7	Local & Remote	x	1	1	RC	x
60	12	Control Received	-	1	1	RO	x
60	13	Command Received	-	1	1	RO	x
60	136	Clear Waveform Records	-	1	1	RO	x
60	137	Clear Fault Records	-	1	1	RO	x
60	138	Clear Event Records	-	1	1	RO	x
176	2	Reset FCB	-	5	3	RO	x
176	3	Reset CU	-	5	4	RO	x
176	4	Start/Restart	-	5	5	RO	x
176	5	Power On	-	5	6	RO	x
176	19	LEDs reset	-	1	1, 20, 21	RO	x
176	22	Settings changed	-	1	1	RO	x
176	23	Setting G1 selected	x	1	1	RC	x
176	24	Setting G2 selected	x	1	1	RC	x
176	25	Setting G3 selected	x	1	1	RC	x
176	26	Setting G4 selected	x	1	1	RC	x
176	27	Status Input 1	x	1	1	RC	x
176	28	Status Input 2	x	1	1	RC	x
176	29	Status Input 3	x	1	1	RC	x
176	30	Status Input 4	x	1	1	RC	x
176	36	Trip Circuit Fail	x	1	1	RC	x
176	64	Start/Pick-up L1	x	2	1	RC	x
176	65	Start/Pick-up L2	x	2	1	RC	x
176	66	Start/Pick-up L3	x	2	1	RC	x
176	67	Start/Pick-up N	x	2	1	RC	x
176	68	General Trip	-	2	1	RO	x
176	69	Trip L1	-	2	1	RO	x
176	70	Trip L2	-	2	1	RO	x
176	71	Trip L3	-	2	1	RO	x
176	84	General Start/Pick-up	x	2	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
176	90	Trip I >	-	2	1	RO	x
176	91	Trip I >>	-	2	1	RO	x
176	92	Trip In >	-	2	1	RO	x
176	93	Trip In >>	-	2	1	RO	x
178	1	Biased Differential A	-	2	1	RO	x
178	2	Biased Differential B	-	2	1	RO	x
178	3	Biased Differential C	-	2	1	RO	x
178	4	Differential Highset A	-	2	1	RO	x
178	5	Differential Highset B	-	2	1	RO	x
178	6	Differential Highset C	-	2	1	RO	x
178	7	Biased Differential	-	2	1	RO	x
178	8	Differential Highset	-	2	1	RO	x
178	9	W1 Restricted Earth Fault	-	2	1	RO	x
178	10	W2 Restricted Earth Fault	-	2	1	RO	x
178	11	W2 Restricted Earth Fault	-	2	1	RO	x
178	12	W3 Restricted Earth Fault	-	2	1	RO	x
178	13	W4 Restricted Earth Fault	-	2	1	RO	x
178	14	W1 Phase Fault Stage 1	-	2	1	RO	x
178	15	W1 Phase Fault Stage 2	-	2	1	RO	x
178	16	W2 Phase Fault	-	2	1	RO	x
178	17	W2 Phase Fault	-	2	1	RO	x
178	18	W3 Phase Fault	-	2	1	RO	x
178	19	W4 Phase Fault	-	2	1	RO	x
178	20	W1 Phase Fault Inhibit	x	2	1	RC	x
178	21	W1 Phase Fault Starter A	x	2	1	RC	x
178	22	W1 Phase Fault Starter B	x	2	1	RC	x
178	23	W1 Phase Fault Starter C	x	2	1	RC	x
178	24	W1 Phase Fault Stage 1 A	-	2	1	RO	x
178	25	W1 Phase Fault Stage 1 B	-	2	1	RO	x
178	26	W1 Phase Fault Stage 1 C	-	2	1	RO	x
178	27	W1 Phase Fault Stage 2 A	-	2	1	RO	x
178	28	W1 Phase Fault Stage 2 B	-	2	1	RO	x
178	29	W1 Phase Fault Stage 2 C	-	2	1	RO	x
178	30	W1 Earth Fault Inhibit	x	2	1	RC	x
178	31	W1 Earth Fault Starter	x	2	1	RC	x
178	32	W1 Earth Fault Stage 1	-	2	1	RO	x
178	33	W1 Earth Fault Stage 2	-	2	1	RO	x
178	34	W1 Phase Fault	-	2	1	RO	x
178	35	W1 Residual Earth Fault	-	2	1	RO	x
178	36	W1 Earth Fault	-	2	1	RO	x
178	37	Restricted Earth Fault	-	2	1	RO	x
178	38	Earth Fault	-	2	1	RO	x
178	39	W34 Restricted Earth Fault	-	2	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
178	40	W2 Phase Fault Inhibit	x	2	1	RC	x
178	41	W2 Phase Fault Starter A	x	2	1	RC	x
178	42	W2 Phase Fault Starter B	x	2	1	RC	x
178	43	W2 Phase Fault Starter C	x	2	1	RC	x
178	44	W2 Phase Fault A	-	2	1	RO	x
178	45	W2 Phase Fault B	-	2	1	RO	x
178	46	W2 Phase Fault C	-	2	1	RO	x
178	48	W2 Residual Earth Fault	-	2	1	RO	x
178	49	W2 Earth Fault	-	2	1	RO	x
178	50	W2 Phase Fault Inhibit	x	2	1	RC	x
178	51	W2 Phase Fault Starter A	x	2	1	RC	x
178	52	W2 Phase Fault Starter B	x	2	1	RC	x
178	53	W2 Phase Fault Starter C	x	2	1	RC	x
178	54	W2 Phase Fault A	-	2	1	RO	x
178	55	W2 Phase Fault B	-	2	1	RO	x
178	56	W2 Phase Fault C	-	2	1	RO	x
178	57	W2 Phase Fault Stage 1	-	2	1	RO	x
178	58	W2 Phase Fault Stage 2	-	2	1	RO	x
178	59	W3 Phase Fault Stage 1	-	2	1	RO	x
178	60	W3 Phase Fault Inhibit	x	2	1	RC	x
178	61	W3 Phase Fault Starter A	x	2	1	RC	x
178	62	W3 Phase Fault Starter B	x	2	1	RC	x
178	63	W3 Phase Fault Starter C	x	2	1	RC	x
178	64	W3 Phase Fault A	-	2	1	RO	x
178	65	W3 Phase Fault B	-	2	1	RO	x
178	66	W3 Phase Fault C	-	2	1	RO	x
178	67	W34 Phase Fault	-	2	1	RO	x
178	68	W34 Residual Earth Fault	-	2	1	RO	x
178	69	W3 Phase Fault Stage 2	-	2	1	RO	x
178	70	Voltage Stage 1	-	2	1	RO	x
178	71	Voltage Stage 2	-	2	1	RO	x
178	72	Voltage Stage 3	-	2	1	RO	x
178	73	Voltage Stage 4	-	2	1	RO	x
178	74	Overfluxing Dtl Stage 1	-	2	1	RO	x
178	75	Overfluxing Dtl Stage 2	-	2	1	RO	x
178	76	Overfluxing Idmtl	-	2	1	RO	x
178	77	W1 Breaker Fail ReTrip	-	2	1	RO	x
178	78	W1 Breaker Fail BackTrip	-	2	1	RO	x
178	79	W3 Residual Earth Fault	-	2	1	RO	x
178	80	Thermal Alarm	-	2	1	RO	x
178	81	Thermal Trip	-	2	1	RO	x
178	82	W2 Breaker Fail ReTrip	-	2	1	RO	x
178	83	W2 Breaker Fail BackTrip	-	2	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
178	85	Standby E/F Stage 1	-	2	1	RO	x
178	86	Standby E/F Stage 2	-	2	1	RO	x
178	87	W3 Breaker Fail ReTrip	-	2	1	RO	x
178	88	W3 Breaker Fail BackTrip	-	2	1	RO	x
178	89	W3 Earth Fault	-	2	1	RO	x
178	90	Frequency Stage 1	-	2	1	RO	x
178	91	Frequency Stage 2	-	2	1	RO	x
178	92	Frequency Stage 3	-	2	1	RO	X
178	93	Frequency Stage 4	-	2	1	RO	X
178	94	W1 Standby E/F Stage 1	-	2	1	RO	X
178	95	W1 Standby E/F Stage 2	-	2	1	RO	X
178	96	W2 Standby E/F Stage 1	-	2	1	RO	X
178	97	W2 Standby E/F Stage 2	-	2	1	RO	X
178	98	W1 NPS Overcurrent	-	2	1	RO	X
178	99	W2 NPS Overcurrent	-	2	1	RO	X
178	100	W2 Earth Fault Stage 1	-	2	1	RO	X
178	101	W2 Earth Fault Stage 2	-	2	1	RO	X
178	102	W3 Earth Fault Stage 1	-	2	1	RO	X
178	103	W3 Earth Fault Stage 2	-	2	1	RO	X
178	104	Standby E/F 1 Stage 1	-	2	1	RO	X
178	105	Standby E/F 1 Stage 2	-	2	1	RO	X
178	106	Standby E/F 2 Stage 1	-	2	1	RO	X
178	107	Standby E/F 2 Stage 2	-	2	1	RO	X
178	108	Standby E/F 1 Stage 3	-	2	1	RO	X
178	109	Standby E/F 2 Stage 3	-	2	1	RO	X
178	110	Setting G5 selected	x	1	1	RC	X
178	111	Setting G6 selected	x	1	1	RC	X
178	112	Setting G7 selected	x	1	1	RC	X
178	113	Setting G8 selected	x	1	1	RC	X
178	114	Phase Fault 1	-	2	1	RO	X
178	115	Phase Fault 2	-	2	1	RO	X
178	116	Phase Fault 3	-	2	1	RO	X
178	117	W4 Phase Fault	-	2	1	RO	X
178	118	W4 Residual Earth Fault	-	2	1	RO	X
178	119	Residual Earth Fault 1	-	2	1	RO	X
178	120	Residual Earth Fault 2	-	2	1	RO	X
178	121	Residual Earth Fault 3	-	2	1	RO	X
178	122	W4 Breaker Fail ReTrip	-	2	1	RO	X
178	123	W4 Breaker Fail BackTrip	-	2	1	RO	X
178	124	Restricted Earth Fault 1	-	2	1	RO	X
178	125	Restricted Earth Fault 2	-	2	1	RO	X
178	126	Restricted Earth Fault 3	-	2	1	RO	X
178	128	Cold Start	-	1	1	RO	X

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
178	129	Warm Start	-	1	1	RO	X
178	130	Re-Start	-	1	1	RO	X
178	135	Trigger Storage	-	1	1	RO	X
178	145	Status Input 5	x	1	1	RC	x
178	146	Status Input 6	x	1	1	RC	x
178	147	Status Input 7	x	1	1	RC	x
178	148	Status Input 8	x	1	1	RC	x
178	149	Status Input 9	x	1	1	RC	x
178	150	Status Input 10	x	1	1	RC	x
178	151	Status Input 11	x	1	1	RC	x
178	152	Status Input 12	x	1	1	RC	x
178	153	Status Input 13	x	1	1	RC	x
178	154	Status Input 14	x	1	1	RC	x
178	155	Status Input 15	x	1	1	RC	x
178	156	Status Input 16	x	1	1	RC	x
178	157	Status Input 17	x	1	1	RC	x
178	158	Status Input 18	x	1	1	RC	x
178	159	Status Input 19	x	1	1	RC	x
178	160	Status Input 20	x	1	1	RC	x
178	161	Status Input 21	x	1	1	RC	x
178	162	Status Input 22	x	1	1	RC	x
178	163	Status Input 23	x	1	1	RC	x
178	164	Status Input 24	x	1	1	RC	x
178	165	Status Input 25	x	1	1	RC	x
178	166	Status Input 26	x	1	1	RC	x
178	167	Status Input 27	x	1	1	RC	x
178	168	Status Input 28	x	1	1	RC	x
178	169	Status Input 29	x	1	1	RC	x
178	170	Status Input 30	x	1	1	RC	x
178	171	Status Input 31	x	1	1	RC	x
178	172	Status Input 32	x	1	1	RC	x
178	181	Plant Control Relay 1	x	1	1	RC	x
178	182	Plant Control Relay 2	x	1	1	RC	x
178	183	Plant Control Relay 3	x	1	1	RC	x
178	184	Plant Control Relay 4	x	1	1	RC	x
178	185	Plant Control Relay 5	x	1	1	RC	x
178	186	Plant Control Relay 6	x	1	1	RC	x
178	187	Plant Control Relay 7	x	1	1	RC	x
178	188	Plant Control Relay 8	x	1	1	RC	x
178	189	Plant Control Relay 9	x	1	1	RC	x
178	190	Plant Control Relay 10	x	1	1	RC	x
178	191	Plant Control Relay 11	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
178	192	Plant Control Relay 12	x	1	1	RC	x
178	193	Plant Control Relay 13	x	1	1	RC	x
178	194	Plant Control Relay 14	x	1	1	RC	x
178	195	Plant Control Relay 15	x	1	1	RC	x
178	196	Plant Control Relay 16	x	1	1	RC	x
178	197	Plant Control Relay 17	x	1	1	RC	x
178	198	Plant Control Relay 18	x	1	1	RC	x
178	199	Plant Control Relay 19	x	1	1	RC	x
178	200	Plant Control Relay 20	x	1	1	RC	x
178	201	Plant Control Relay 21	x	1	1	RC	x
178	202	Plant Control Relay 22	x	1	1	RC	x
178	203	Plant Control Relay 23	x	1	1	RC	x
178	204	Plant Control Relay 24	x	1	1	RC	x
178	205	Plant Control Relay 25	x	1	1	RC	x
178	206	Plant Control Relay 26	x	1	1	RC	x
178	207	Plant Control Relay 27	x	1	1	RC	x
178	208	Plant Control Relay 28	x	1	1	RC	x
178	209	Plant Control Relay 29	x	1	1	RC	x
178	210	Plant Control Relay 30	x	1	1	RC	x
178	211	Plant Control Relay 31	x	1	1	RC	x
178	212	Plant Control Relay 32	x	1	1	RC	x
178	220	Measurand V _{(1,2x), f_(1,2x)}	-	9	2,7	-	x
178	230	Measurand Winding 1 I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	231	Measurand Winding 2 I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	232	Measurand Winding 3 I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	233	Measurand Winding 4 I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	234	Measurand Winding 5 I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	240	Measurand O/C 1 Winding Group Currents I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	241	Measurand O/C 2 Winding Group Currents I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	242	Measurand O/C 3 Winding Group Currents I _{L1,2,3 (all 2,4x)}	-	9	2,7	-	x
178	244	Trip Circuit Fail 1	x	1	1	RC	x
178	245	Trip Circuit Fail 2	x	1	1	RC	x
178	246	Trip Circuit Fail 3	x	1	1	RC	x
178	247	Trip Circuit Fail 4	x	1	1	RC	x
178	248	Trip Circuit Fail 5	x	1	1	RC	x
178	249	Trip Circuit Fail 6	x	1	1	RC	x
178	250	Trip Circuit Fail 7	x	1	1	RC	x
178	251	Trip Circuit Fail 8	x	1	1	RC	x
178	252	Trip Circuit Fail 9	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Duobias-M
178	253	Trip Circuit Fail 10	x	1	1	RC	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		Duobias-M
176	19	Reset Flag & Outputs	ON	20	20		x
176	23	Settings Group 1 Select	ON	20	20		x
176	24	Settings Group 2 Select	ON	20	20		x
176	25	Settings Group 3 Select	ON	20	20		x
176	26	Settings Group 4 Select	ON	20	20		x
178	110	Settings Group 5 Select	ON	20	20		x
178	111	Settings Group 6 Select	ON	20	20		x
178	112	Settings Group 7 Select	ON	20	20		x
178	113	Settings Group 8 Select	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

FUN	ACC	Description	Duobias-M
178	0	Global	ü
178	1	W1 Ia	ü
178	2	W1 Ib	ü
178	3	W1 Ic	ü
178	4	W1 EF	ü
178	5	W2 Ia	ü
178	6	W2 Ib	ü
178	7	W2 Ic	ü
178	8	W2 EF	ü
178	9	W3 Ia	ü
178	10	W3 Ib	ü
178	11	W3 Ic	ü
178	12	W3 EF	ü
178	13	W4 Ia	ü
178	14	W4 Ib	ü
178	15	W4 Ic	ü
178	16	W4 EF	ü
178	17	W5 Ia	ü
178	18	W5 Ib	ü
178	19	W5 Ic	ü
178	20	W5 EF	ü
178	24	Standby Ie	ü

FUN	ACC	Description	Duobias-M
178	25	V	ü
178	26	EF	ü

Table Showing Actual Channel (ACC) Numbers

7.6 Iota

FUN	INF	Description	GI	TYP	COT	DIR	Iota
60	1	IEC870 Active Com1	x	1	1	RC	x
60	2	IEC870 Active Com2	x	1	1	RC	x
60	3	Front Port OverRide	x	1	1	RC	x
60	4	Remote Mode	x	1	1	RC	x
60	5	Service Mode	x	1	1	RC	x
60	6	Local Mode	x	1	1	RC	x
60	7	Local & Remote	x	1	1	RC	x
60	128	Cold Start	-	1	0	RO	x
60	129	Warm Start	-	1	0	RO	x
60	130	Re-Start	-	1	0	RO	x
60	135	Trigger Storage	-	1	0	RO	x
60	136	Clear Waveform Records	-	1	0	RO	x
60	137	Clear Fault Records	-	1	0	RO	x
60	138	Clear Event Records	-	1	0	RO	x
70	1	Status Input 1	x	1	1	RC	x
70	2	Status Input 2	x	1	1	RC	x
70	3	Status Input 3	x	1	1	RC	x
70	4	Status Input 4	x	1	1	RC	x
70	5	Status Input 5	x	1	1	RC	x
70	6	Status Input 6	x	1	1	RC	x
70	7	Status Input 7	x	1	1	RC	x
70	8	Status Input 8	x	1	1	RC	x
70	9	Status Input 9	x	1	1	RC	x
70	10	Status Input 10	x	1	1	RC	x
70	11	Status Input 11	x	1	1	RC	x
70	12	Status Input 12	x	1	1	RC	x
70	13	Status Input 13	x	1	1	RC	x
70	14	Status Input 14	x	1	1	RC	x
70	15	Status Input 15	x	1	1	RC	x
70	16	Status Input 16	x	1	1	RC	x
70	17	Status Input 17	x	1	1	RC	x
70	18	Status Input 18	x	1	1	RC	x
70	19	Status Input 19	x	1	1	RC	x
70	20	Status Input 20	x	1	1	RC	x
70	21	Status Input 21	x	1	1	RC	x
70	22	Status Input 22	x	1	1	RC	x
70	23	Status Input 23	x	1	1	RC	x
70	24	Status Input 24	x	1	1	RC	x
70	25	Status Input 25	x	1	1	RC	x
70	26	Status Input 26	x	1	1	RC	x
70	27	Status Input 27	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Iota
70	28	Status Input 28	x	1	1	RC	x
70	29	Status Input 29	x	1	1	RC	x
70	30	Status Input 30	x	1	1	RC	x
70	31	Status Input 31	x	1	1	RC	x
70	32	Status Input 32	x	1	1	RC	x
70	33	Status Input 33	x	1	1	RC	x
70	34	Status Input 34	x	1	1	RC	x
70	35	Status Input 35	x	1	1	RC	x
70	36	Status Input 36	x	1	1	RC	x
70	37	Status Input 37	x	1	1	RC	x
70	38	Status Input 38	x	1	1	RC	x
70	39	Status Input 39	x	1	1	RC	x
70	40	Status Input 40	x	1	1	RC	x
70	41	Status Input 41	x	1	1	RC	x
70	42	Status Input 42	x	1	1	RC	x
70	43	Status Input 43	x	1	1	RC	x
70	44	Status Input 44	x	1	1	RC	x
70	45	Status Input 45	x	1	1	RC	x
70	46	Status Input 46	x	1	1	RC	x
70	47	Status Input 47	x	1	1	RC	x
70	48	Status Input 48	x	1	1	RC	x
70	49	Status Input 49	x	1	1	RC	x
70	50	Status Input 50	x	1	1	RC	x
70	51	Status Input 51	x	1	1	RC	x
70	52	Status Input 52	x	1	1	RC	x
70	53	Status Input 53	x	1	1	RC	x
70	54	Status Input 54	x	1	1	RC	x
70	55	Status Input 55	x	1	1	RC	x
70	56	Status Input 56	x	1	1	RC	x
70	57	Status Input 57	x	1	1	RC	x
70	58	Status Input 58	x	1	1	RC	x
70	59	Status Input 59	x	1	1	RC	x
70	60	Status Input 60	x	1	1	RC	x
70	61	Status Input 61	x	1	1	RC	x
70	62	Status Input 62	x	1	1	RC	x
70	63	Status Input 63	x	1	1	RC	x
70	64	Status Input 64	x	1	1	RC	x
80	1	Plant Control Relay 1	x	1	1	RC	x
80	2	Plant Control Relay 2	x	1	1	RC	x
80	3	Plant Control Relay 3	x	1	1	RC	x
80	4	Plant Control Relay 4	x	1	1	RC	x
80	5	Plant Control Relay 5	x	1	1	RC	x
80	6	Plant Control Relay 6	x	1	1	RC	x
80	7	Plant Control Relay 7	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Iota
80	8	Plant Control Relay 8	x	1	1	RC	x
80	9	Plant Control Relay 9	x	1	1	RC	x
80	10	Plant Control Relay 10	x	1	1	RC	x
80	11	Plant Control Relay 11	x	1	1	RC	x
80	12	Plant Control Relay 12	x	1	1	RC	x
80	13	Plant Control Relay 13	x	1	1	RC	x
80	14	Plant Control Relay 14	x	1	1	RC	x
80	15	Plant Control Relay 15	x	1	1	RC	x
80	16	Plant Control Relay 16	x	1	1	RC	x
80	17	Plant Control Relay 17	x	1	1	RC	x
80	18	Plant Control Relay 18	x	1	1	RC	x
80	19	Plant Control Relay 19	x	1	1	RC	x
80	20	Plant Control Relay 20	x	1	1	RC	x
80	21	Plant Control Relay 21	x	1	1	RC	x
80	22	Plant Control Relay 22	x	1	1	RC	x
80	23	Plant Control Relay 23	x	1	1	RC	x
80	24	Plant Control Relay 24	x	1	1	RC	x
80	25	Plant Control Relay 25	x	1	1	RC	x
80	26	Plant Control Relay 26	x	1	1	RC	x
80	27	Plant Control Relay 27	x	1	1	RC	x
80	28	Plant Control Relay 28	x	1	1	RC	x
80	29	Plant Control Relay 29	x	1	1	RC	x
80	30	Plant Control Relay 30	x	1	1	RC	x
80	31	Plant Control Relay 31	x	1	1	RC	x
80	32	Plant Control Relay 32	x	1	1	RC	x
80	33	Plant Control Relay 33	x	1	1	RC	x
80	34	Plant Control Relay 34	x	1	1	RC	x
80	35	Plant Control Relay 35	x	1	1	RC	x
80	36	Plant Control Relay 36	x	1	1	RC	x
80	37	Plant Control Relay 37	x	1	1	RC	x
80	38	Plant Control Relay 38	x	1	1	RC	x
80	39	Plant Control Relay 39	x	1	1	RC	x
80	40	Plant Control Relay 40	x	1	1	RC	x
80	41	Plant Control Relay 41	x	1	1	RC	x
80	42	Plant Control Relay 42	x	1	1	RC	x
80	43	Plant Control Relay 43	x	1	1	RC	x
80	44	Plant Control Relay 44	x	1	1	RC	x
80	45	Plant Control Relay 45	x	1	1	RC	x
80	46	Plant Control Relay 46	x	1	1	RC	x
80	47	Plant Control Relay 47	x	1	1	RC	x
80	48	Plant Control Relay 48	x	1	1	RC	x
80	49	Plant Control Relay 49	x	1	1	RC	x
80	50	Plant Control Relay 50	x	1	1	RC	x
80	51	Plant Control Relay 51	x	1	1	RC	x
80	52	Plant Control Relay 52	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Iota
80	53	Plant Control Relay 53	x	1	1	RC	x
80	54	Plant Control Relay 54	x	1	1	RC	x
80	55	Plant Control Relay 55	x	1	1	RC	x
80	56	Plant Control Relay 56	x	1	1	RC	x
80	57	Plant Control Relay 57	x	1	1	RC	x
80	58	Plant Control Relay 58	x	1	1	RC	x
80	59	Plant Control Relay 59	x	1	1	RC	x
80	60	Plant Control Relay 60	x	1	1	RC	x
80	61	Plant Control Relay 61	x	1	1	RC	x
80	62	Plant Control Relay 62	x	1	1	RC	x
80	63	Plant Control Relay 63	x	1	1	RC	x
80	64	Plant Control Relay 64	x	1	1	RC	x
200	1	CB 1	x	1	1	DP	x
200	2	CB 2	x	1	1	DP	x
200	3	CB 3	x	1	1	DP	x
200	4	CB 4	x	1	1	DP	x
200	5	CB 5	x	1	1	DP	x
200	21	Iso 1	x	1	1	DP	x
200	22	Iso 2	x	1	1	DP	x
200	23	Iso 3	x	1	1	DP	x
200	24	Iso 4	x	1	1	DP	x
200	25	Iso 5	x	1	1	DP	x
200	41	Earth Switch 1	x	1	1	DP	x
200	42	Earth Switch 2	x	1	1	DP	x
200	43	Earth Switch 3	x	1	1	DP	x
200	44	Earth Switch 4	x	1	1	DP	x
200	45	Earth Switch 5	x	1	1	DP	x
200	101	Control Item 1	x	1	1	DP	x
200	102	Control Item 2	x	1	1	DP	x
200	103	Control Item 3	x	1	1	DP	x
200	104	Control Item 4	x	1	1	DP	x
200	105	Control Item 5	x	1	1	DP	x
200	121	CB 1 Service Position	x	1	1	DP	x
200	122	CB 2 Service Position	x	1	1	DP	x
200	123	CB 3 Service Position	x	1	1	DP	x
200	124	CB 4 Service Position	x	1	1	DP	x
200	125	CB 5 Service Position	x	1	1	DP	x
200	255	Blocked By Interlocking	x	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	lota
211	2	Reset FCB	-	5	3	RO	x
211	3	Reset CU	-	5	4	RO	x
211	4	Start/Restart	-	5	5	RO	x
211	5	Power On	-	5	6	RO	x
211	19	LEDs reset	-	1	1, 20, 21	RO	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		lota
211	19	Reset Flag & Outputs	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

7.7 MicroTAPP

FUN	INF	Description	GI	TYP	COT	DIR	MicroTAPP
60	0	Data lost	-	1	1	RO	x
60	128	Cold Start	-	1	0	RO	x
60	129	Warm Start	-	1	0	RO	x
60	130	Re-Start	-	1	0	RO	x
60	135	Trigger Storage	-	1	0	RO	x
70	5	Status Input 5	x	1	1	RC	x
70	6	Status Input 6	x	1	1	RC	x
70	7	Status Input 7	x	1	1	RC	x
70	8	Status Input 8	x	1	1	RC	x
70	9	Status Input 9	x	1	1	RC	x
70	10	Status Input 10	x	1	1	RC	x
70	11	Status Input 11	x	1	1	RC	x
70	12	Status Input 12	x	1	1	RC	x
70	13	Status Input 13	x	1	1	RC	x
70	14	Status Input 14	x	1	1	RC	x
70	15	Status Input 15	x	1	1	RC	x
70	16	Status Input 16	x	1	1	RC	x
70	17	Status Input 17	x	1	1	RC	x
70	18	Status Input 18	x	1	1	RC	x
70	19	Status Input 19	x	1	1	RC	x
70	20	Status Input 20	x	1	1	RC	x
70	21	Status Input 21	x	1	1	RC	x
70	22	Status Input 22	x	1	1	RC	x
70	23	Status Input 23	x	1	1	RC	x
70	24	Status Input 24	x	1	1	RC	x
70	25	Status Input 25	x	1	1	RC	x
70	26	Status Input 26	x	1	1	RC	x
70	27	Status Input 27	x	1	1	RC	x
70	28	Status Input 28	x	1	1	RC	x
70	29	Status Input 29	x	1	1	RC	x
70	30	Status Input 30	x	1	1	RC	x
70	31	Status Input 31	x	1	1	RC	x
70	32	Status Input 32	x	1	1	RC	x
80	1	Plant Control Relay 1	x	1	1	RC	x
80	2	Plant Control Relay 2	x	1	1	RC	x
80	3	Plant Control Relay 3	x	1	1	RC	x
80	4	Plant Control Relay 4	x	1	1	RC	x
80	5	Plant Control Relay 5	x	1	1	RC	x
80	6	Plant Control Relay 6	x	1	1	RC	x
80	7	Plant Control Relay 7	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	MicroTAPP
80	8	Plant Control Relay 8	x	1	1	RC	x
80	9	Plant Control Relay 9	x	1	1	RC	x
80	10	Plant Control Relay 10	x	1	1	RC	x
80	11	Plant Control Relay 11	x	1	1	RC	x
80	12	Plant Control Relay 12	x	1	1	RC	x
80	13	Plant Control Relay 13	x	1	1	RC	x
80	14	Plant Control Relay 14	x	1	1	RC	x
80	15	Plant Control Relay 15	x	1	1	RC	x
80	16	Plant Control Relay 16	x	1	1	RC	x
80	17	Plant Control Relay 17	x	1	1	RC	x
80	18	Plant Control Relay 18	x	1	1	RC	x
80	19	Plant Control Relay 19	x	1	1	RC	x
80	20	Plant Control Relay 20	x	1	1	RC	x
80	21	Plant Control Relay 21	x	1	1	RC	x
80	22	Plant Control Relay 22	x	1	1	RC	x
80	23	Plant Control Relay 23	x	1	1	RC	x
80	24	Plant Control Relay 24	x	1	1	RC	x
80	25	Plant Control Relay 25	x	1	1	RC	x
80	26	Plant Control Relay 26	x	1	1	RC	x
80	27	Plant Control Relay 27	x	1	1	RC	x
80	28	Plant Control Relay 28	x	1	1	RC	x
80	29	Plant Control Relay 29	x	1	1	RC	x
80	30	Plant Control Relay 30	x	1	1	RC	x
80	31	Plant Control Relay 31	x	1	1	RC	x
80	32	Plant Control Relay 32	x	1	1	RC	x
179	2	Reset FCB	-	2	3	RO	x
179	3	Reset CU	-	2	4	RO	x
179	4	Start/restart	-	2	5	RO	x
179	5	Power on	-	5	6	RO	x
179	19	LED Reset	-	1	1	RO	x
179	21	Test Mode	-	1	1	RO	x
179	22	Settings changed	-	1	1	RO	x
179	23	Target 1 selected	x	1	1, 20, 21	RC	x
179	24	Target 2 selected	x	1	1, 20, 21	RC	x
179	25	Target 3 selected	x	1	1, 20, 21	RC	x
179	26	Target 4 selected	x	1	1, 20, 21	RC	x
179	31	Setting G1 selected	-	1	1, 20, 21	RO	x
179	32	Setting G2 selected	-	1	1, 20, 21	RO	x
179	33	Setting G3 selected	-	1	1, 20, 21	RO	x
179	34	Setting G4 selected	-	1	1, 20, 21	RO	x
179	35	Setting G5 selected	-	1	1, 20, 21	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	MicroTAPP
179	36	Setting G6 selected	-	1	1, 20, 21	RO	x
179	37	Setting G7 selected	-	1	1, 20, 21	RO	x
179	38	Setting G8 selected	-	1	1, 20, 21	RO	x
179	65	Auto raise	-	1	1	RO	x
179	66	Auto lower	-	1	1	RO	x
179	72	Man raise	-	1	1, 20, 21	RO	x
179	75	Man lower	-	1	1, 20, 21	RO	x
179	81	Voltage control automatic	x	1	1, 20, 21	RC	x
179	82	Remote Control	x	1	1	RC	x
179	83	MicroTAPP enabled	x	1	1	RC	x
179	91	Switchout Selected	-	1	1, 20, 21	RO	x
179	92	Switchout Ready	x	1	1	RC	x
179	93	Switchout Cancel	-	1	1	RO	x
179	94	Tap-stagger Selected	x	1	1, 20, 21	RC	x
179	101	Tap control signal in progress	x	1	1	RC	x
179	102	Tap change in progress	x	1	1	RC	x
179	103	Target not achievable	-	1	1	RO	x
179	104	Tap-change incomplete	-	1	1	RO	x
179	105	Tap-changer runaway	-	1	1	RO	x
179	106	Relay has locked out	x	1	1	RC	x
179	107	Tap-changer reset	-	1	1	RO	x
179	108	Delta tap-change count alarm	-	1	1	RO	x
179	108	Delta tap-change count alarm	-	4	1	-	x
179	109	Today's tap count	-	4	1	-	x
179	110	Total tap count	-	4	1	-	x
179	111	Delta sum of I ² alarm	-	1	1	RO	x
179	111	Delta sum of I ² alarm	-	4	1	-	x
179	112	Tap Position	-	4	1	-	x
179	121	Voltage out of limits alarm	-	1	1	RO	x
179	122	VT fuse failure alarm	-	1	1	RO	x
179	201	Measurand V _{Line} , F, Transformer Load, Group Load, Group Load Angle, Tap Position ^v	-	9	2,7	-	x
255	0	Time Synchronisation	-	6	8	-	x

^v These are per unit values and sent as fractions of the system rating. Please note that frequency rating is always 60 Hz, therefore the value will be approximately 0.83 on a 50 Hz system. The transformer and group load use the System group capacity, and the angle is sent as a fraction of 360 degrees. The tap position is sent as a fraction of the total tap range.

FUN	INF	Description	GI	TYP	COT	DIR	MicroTAPP
255	0	End of General Interrogation	-	8	10	-	x
255	27	Status Input 1	x	1	1	RC	x
255	28	Status Input 2	x	1	1	RC	x
255	29	Status Input 3	x	1	1	RC	x
255	30	Status Input 4	x	1	1	RC	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		MicroTAPP
179	23	Select target 1	ON	20	20		x
179	24	Select target 2	ON	20	20		x
179	25	Select target 3	ON	20	20		x
179	26	Select target 4	ON	20	20		x
179	31	Select group 1	ON	20	20		x
179	32	Select group 2	ON	20	20		x
179	33	Select group 3	ON	20	20		x
179	34	Select group 4	ON	20	20		x
179	35	Select group 5	ON	20	20		x
179	36	Select group 6	ON	20	20		x
179	37	Select group 7	ON	20	20		x
179	38	Select group 8	ON	20	20		x
179	72	Manual tap raise	ON	20	20		x
179	75	Manual tap Lower	ON	20	20		x
179	81	Automatic voltage control	ON/OFF	20	20		x
179	91	Prepare for switchover	ON/OFF	20	20		x
179	94	Tap stagger	ON/OFF	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

7.8 MSCDN

FUN	INF	Description	GI	TYP	COT	DIR	MSCDN
60	0	Data lost	-	1	1	RO	x
60	1	IEC870 Active Com1	x	1	1	RC	x
60	2	IEC870 Active Com2	x	1	1	RC	x
60	3	Front Port OverRide	x	1	1	RC	x
60	4	Remote Mode	x	1	1	RC	x
60	5	Service Mode	x	1	1	RC	x
60	6	Local Mode	x	1	1	RC	x
60	7	Local & Remote	x	1	1	RC	x
60	128	Cold Start	-	1	1	RO	x
60	129	Warm Start	-	1	1	RO	x
60	130	Re-Start	-	1	1	RO	x
60	135	Trigger Storage	-	1	1	RO	x
70	1	Status Input 1	x	1	1	RC	x
70	2	Status Input 2	x	1	1	RC	x
70	3	Status Input 3	x	1	1	RC	x
70	4	Status Input 4	x	1	1	RC	x
70	5	Status Input 5	x	1	1	RC	x
70	6	Status Input 6	x	1	1	RC	x
70	7	Status Input 7	x	1	1	RC	x
70	8	Status Input 8	x	1	1	RC	x
70	9	Status Input 9	x	1	1	RC	x
70	10	Status Input 10	x	1	1	RC	x
70	11	Status Input 11	x	1	1	RC	x
70	12	Status Input 12	x	1	1	RC	x
70	13	Status Input 13	x	1	1	RC	x
70	14	Status Input 14	x	1	1	RC	x
70	15	Status Input 15	x	1	1	RC	x
70	16	Status Input 16	x	1	1	RC	x
70	17	Status Input 17	x	1	1	RC	x
70	18	Status Input 18	x	1	1	RC	x
70	19	Status Input 19	x	1	1	RC	x
70	20	Status Input 20	x	1	1	RC	x
70	21	Status Input 21	x	1	1	RC	x
70	22	Status Input 22	x	1	1	RC	x
70	23	Status Input 23	x	1	1	RC	x
70	24	Status Input 24	x	1	1	RC	x
70	25	Status Input 25	x	1	1	RC	x
70	26	Status Input 26	x	1	1	RC	x
70	27	Status Input 27	x	1	1	RC	x
70	28	Status Input 28	x	1	1	RC	x
70	29	Status Input 29	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	MSCDN
70	30	Status Input 30	x	1	1	RC	x
70	31	Status Input 31	x	1	1	RC	x
70	32	Status Input 32	x	1	1	RC	x
80	1	Plant Control Relay 1	x	1	1	RC	x
80	2	Plant Control Relay 2	x	1	1	RC	x
80	3	Plant Control Relay 3	x	1	1	RC	x
80	4	Plant Control Relay 4	x	1	1	RC	x
80	5	Plant Control Relay 5	x	1	1	RC	x
80	6	Plant Control Relay 6	x	1	1	RC	x
80	7	Plant Control Relay 7	x	1	1	RC	x
80	8	Plant Control Relay 8	x	1	1	RC	x
80	9	Plant Control Relay 9	x	1	1	RC	x
80	10	Plant Control Relay 10	x	1	1	RC	x
80	11	Plant Control Relay 11	x	1	1	RC	x
80	12	Plant Control Relay 12	x	1	1	RC	x
80	13	Plant Control Relay 13	x	1	1	RC	x
80	14	Plant Control Relay 14	x	1	1	RC	x
80	15	Plant Control Relay 15	x	1	1	RC	x
80	16	Plant Control Relay 16	x	1	1	RC	x
80	17	Plant Control Relay 17	x	1	1	RC	x
80	18	Plant Control Relay 18	x	1	1	RC	x
80	19	Plant Control Relay 19	x	1	1	RC	x
80	20	Plant Control Relay 20	x	1	1	RC	x
80	21	Plant Control Relay 21	x	1	1	RC	x
80	22	Plant Control Relay 22	x	1	1	RC	x
80	23	Plant Control Relay 23	x	1	1	RC	x
80	24	Plant Control Relay 24	x	1	1	RC	x
80	25	Plant Control Relay 25	x	1	1	RC	x
80	26	Plant Control Relay 26	x	1	1	RC	x
80	27	Plant Control Relay 27	x	1	1	RC	x
80	28	Plant Control Relay 28	x	1	1	RC	x
80	29	Plant Control Relay 29	x	1	1	RC	x
80	30	Plant Control Relay 30	x	1	1	RC	x
80	31	Plant Control Relay 31	x	1	1	RC	x
80	32	Plant Control Relay 32	x	1	1	RC	x
180	2	Reset FCB	-	2	3	RO	x
180	3	Reset CU	-	2	4	RO	x
180	4	Start/Restart	-	2	5	RO	x
180	5	Power On	-	2	6	RO	x
180	19	LED Reset	-	1	20, 21	RO	x
180	22	Settings changed	-	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	MSCDN
180	23	Setting G1 selected	x	1	1	RC	x
180	24	Setting G2 selected	x	1	1	RC	x
180	25	Setting G3 selected	x	1	1	RC	x
180	26	Setting G4 selected	x	1	1	RC	x
180	32	Measurand Supervision I	x	1	1	RC	x
180	33	Measurand Supervision V	x	1	1	RC	x
180	36	Trip Circuit Fail	x	1	1	RC	x
180	64	Start/Pick-up L1	x	2	1	RC	x
180	65	Start/Pick-up L2	x	2	1	RC	x
180	66	Start/Pick-up L3	x	2	1	RC	x
180	67	Start/Pick-up N	x	2	1	RC	x
180	68	General Trip	-	2	1	RO	x
180	69	Trip L1	-	2	1	RO	x
180	70	Trip L2	-	2	1	RO	x
180	71	Trip L3	-	2	1	RO	x
180	84	General Start/Pick-up	x	2	1	RC	x
180	90	Trip I >	-	2	1	RO	x
180	91	Trip I >>	-	2	1	RO	x
180	92	Trip In >	-	2	1	RO	x
180	93	Trip In >>	-	2	1	RO	x
180	94	Thermal Alarm	-	2	1	RO	x
180	95	Thermal Trip	-	2	1	RO	x
180	96	Resistor Open Circuit	-	2	1	RO	x
180	97	Overall Differential	-	2	1	RO	x
180	98	Capacitor Unbalance	-	2	1	RO	x
180	99	Phase Unbalance	-	2	1	RO	x
180	100	Under Voltage	-	2	1	RO	x
180	101	Over Voltage	-	2	1	RO	x
180	102	Resistor R1 Open Circuit	-	2	1	RO	x
180	103	Resistor R2 Open Circuit	-	2	1	RO	x
180	104	Resistor R1 Thermal Alarm	-	2	1	RO	x
180	105	Resistor R1 Thermal Trip	-	2	1	RO	x
180	106	Resistor R2 Thermal Alarm	-	2	1	RO	x
180	107	Resistor R2 Thermal Trip	-	2	1	RO	x
180	108	Over Voltage 1	-	2	1	RO	x
180	109	Over Voltage 2	-	2	1	RO	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	Initiate General Interrogation	-	7	9	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		MSCDN
180	19	LED reset	ON	20	20		x

FUN	INF	Description	COM	TYP	COT		MSCDN
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

7.9 OHMEGA

FUN	INF	Description	GI	TYP	COT	DIR	Ohmega 3xx	Ohmega 4xx
60	3	Front Port Override	x	1	1	RC	x	x
128	2	Reset FCB	-	5	3	RO	x	x
128	3	Reset CU	-	5	4	RO	x	x
128	19	LED's reset	-	1	20, 21	RO	x	x
128	22	Setting Change	x	1	1	RO	x	x
128	27	Status Input 1	x	1	1	RC	x	x
128	28	Status Input 2	x	1	1	RC	x	x
128	29	Status Input 3	x	1	1	RC	x	x
128	30	Status Input 4	x	1	1	RC	x	x
128	36	TCS Alarm	x	1	1	RC	x	x
128	38	VTS Alarm	x	1	1	RC	x	x
128	39	Signal Channel Error	x	1	1	RC	x	x
128	48	Earth Fault L1	-	2	1	RO	x	x
128	49	Earth Fault L2	-	2	1	RO	x	x
128	50	Earth Fault L3	-	2	1	RO	x	x
128	64	Start/Pick-up L1	x	2	1	RC		x
128	65	Start/Pick-up L2	x	2	1	RC		x
128	66	Start/Pick-up L3	x	2	1	RC		x
128	67	Start/Pick-up N	x	2	1	RC		x
128	68	General Trip	-	2	1	RO	x	x
128	69	Trip L1	-	2	1	RO	x	x
128	70	Trip L2	-	2	1	RO	x	x
128	71	Trip L3	-	2	1	RO	x	x
128	72	High Set Trip	-	2	1	RO	x	x
128	73	Fault Location (X)	-	4	1	RO		x
128	76	Signal Sent 1	-	2	1	RO	x	x
128	77	Signal Received 1	-	2	1	RO	x	x
128	78	Zone 1	-	2	1	RO	x	x
128	79	Zone 2	-	2	1	RO	x	x
128	80	Zone 3	-	2	1	RO	x	x
128	81	Zone 4	-	2	1	RO		x

FUN	INF	Description	GI	TYP	COT	DIR	Ohmega 3xx	Ohmega 4xx
128	84	General Start/Pick-up	x	2	1	RC	x	x
128	128	CB Close by ARC	-	2	1	RO		x
128	130	ARC Blocked	x	1	1	RC		x
130	0	Data lost	-	1	1	RO	x	x
130	1	Switch on to Fault	-	2	1	RO	x	x
130	2	Aided Trip	-	2	1	RO	x	x
130	3	Storage Triggered	-	2	1	RO	x	x
130	38	3Ph V Chk Alarm	-	1	1	RC		x
130	41	TCS Alarm 1	-	1	1	RC		x
130	42	TCS Alarm 2	-	1	1	RC		x
130	43	TCS Alarm 3	-	1	1	RC		x
130	48	Phase Fault L12	-	2	1	RO		x
130	49	Phase Fault L23	-	2	1	RO		x
130	50	Phase Fault L31	-	2	1	RO		x
130	71	SOTF Trip	-	2	1	RO		x
130	72	Aided Distance Trip	-	2	1	RO	x	x
130	73	Fault Impedance (%Z1)	-	4	1	RO		x
130	74	Distance To Fault	-	4	1	RO		x
130	84	Power Swing Blocking	-	1	1	RC		x
130	85	Zone 1 Start	-	2	1	RC		x
130	86	Zone 2 Start	-	2	1	RC		x
130	87	Zone 3 Start	-	2	1	RC		x
130	88	Zone 4 Start	-	2	1	RC		x
130	90	Thermal Overload Trip	-	1	1	RO		x
130	91	Thermal Capacity Alarm	-	1	1	RC		x
130	92	Load Increase Alarm	-	1	1	RC		x
130	93	Thermal Overload Alarm	-	1	1	RC		x
130	100	Z1 AE	-	2	1	RO	x	x
130	101	Z1 BE	-	2	1	RO	x	x
130	102	Z1 CE	-	2	1	RO	x	x
130	103	Z1 AB	-	2	1	RO	x	x
130	104	Z1 BC	-	2	1	RO	x	x
130	105	Z1 CA	-	2	1	RO	x	x
130	106	Z2 AE	-	2	1	RO	x	x

FUN	INF	Description	GI	TYP	COT	DIR	Ohmega 3xx	Ohmega 4xx
130	107	Z2 BE	-	2	1	RO	x	x
130	108	Z2 CE	-	2	1	RO	x	x
130	109	Z2 AB	-	2	1	RO	x	x
130	110	Z2 BC	-	2	1	RO	x	x
130	111	Z2 CA	-	2	1	RO	x	x
130	112	Z3 AE	-	2	1	RO	x	x
130	113	Z3 BE	-	2	1	RO	x	x
130	114	Z3 CE	-	2	1	RO	x	x
130	115	Z3 AB	-	2	1	RO	x	x
130	116	Z3 BC	-	2	1	RO	x	x
130	117	Z3 CA	-	2	1	RO	x	x
130	151	Cold Start	-	1	0	RO	x	x
130	152	Warm Start	-	1	0	RO	x	x
130	153	Re-Start	-	1	0	RO	x	x
130	175	Status Input 5	x	1	1	RC	x	x
130	176	Status Input 6	x	1	1	RC	x	x
130	177	Status Input 7	x	1	1	RC	x	x
130	178	Status Input 8	x	1	1	RC	x	x
130	179	Status Input 9	x	1	1	RC	x	x
130	180	Status Input 10	x	1	1	RC	x	x
130	181	Status Input 11	x	1	1	RC	x	x
130	182	Status Input 12	x	1	1	RC	x	x
130	183	Status Input 13	x	1	1	RC	x	x
130	184	Status Input 14	x	1	1	RC	x	x
130	185	Status Input 15	x	1	1	RC	x	x
130	186	Status Input 16	x	1	1	RC	x	x
130	187	Status Input 17	x	1	1	RC	x	x
130	188	Status Input 18	x	1	1	RC	x	x
130	189	Status Input 19	x	1	1	RC	x	x
130	190	Status Input 20	x	1	1	RC	x	x
130	191	Status Input 21	x	1	1	RC	x	x
130	192	Status Input 22	x	1	1	RC	x	x
130	193	Status Input 23	x	1	1	RC	x	x
130	194	Status Input 24	x	1	1	RC	x	x
130	195	Status Input 25	x	1	1	RC	x	x
130	196	Status Input 26	x	1	1	RC	x	x
130	197	Status Input 27	x	1	1	RC	x	x
130	201	Plant Control Relay 1	x	1	1	RC	x	x
130	202	Plant Control Relay 2	x	1	1	RC	x	x
130	203	Plant Control Relay 3	x	1	1	RC	x	x
130	204	Plant Control Relay 4	x	1	1	RC	x	x

FUN	INF	Description	GI	TYP	COT	DIR	Ohmega 3xx	Ohmega 4xx
130	205	Plant Control Relay 5	x	1	1	RC	x	x
130	206	Plant Control Relay 6	x	1	1	RC	x	x
130	207	Plant Control Relay 7	x	1	1	RC	x	x
130	208	Plant Control Relay 8	x	1	1	RC	x	x
130	209	Plant Control Relay 9	x	1	1	RC	x	x
130	210	Plant Control Relay 10	x	1	1	RC	x	x
130	211	Plant Control Relay 11	x	1	1	RC	x	x
130	212	Plant Control Relay 12	x	1	1	RC	x	x
130	213	Plant Control Relay 13	x	1	1	RC	x	x
130	214	Plant Control Relay 14	x	1	1	RC	x	x
130	215	Plant Control Relay 15	x	1	1	RC	x	x
130	216	Plant Control Relay 16	x	1	1	RC	x	x
130	217	Plant Control Relay 17	x	1	1	RC	x	x
130	218	Plant Control Relay 18	x	1	1	RC	x	x
130	219	Plant Control Relay 19	x	1	1	RC	x	x
130	220	Plant Control Relay 20	x	1	1	RC	x	x
130	221	Plant Control Relay 21	x	1	1	RC	x	x
130	222	Plant Control Relay 22	x	1	1	RC	x	x
130	223	Plant Control Relay 23	x	1	1	RC	x	x
130	224	Plant Control Relay 24	x	1	1	RC	x	x
130	225	Plant Control Relay 25	x	1	1	RC	x	x
130	226	Plant Control Relay 26	x	1	1	RC	x	x
130	227	Plant Control Relay 27	x	1	1	RC	x	x
130	228	Plant Control Relay 28	x	1	1	RC	x	x
130	229	Plant Control Relay 29	x	1	1	RC	x	x
255	0	Time Synchronisation	-	6	8	-	x	x
255	0	End of General Interrogation	-	8	10	-	x	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		Ohmega 3xx	Ohmega 4xx
128	19	Reset Flag & Outputs	ON	20	20		x	x
255	0	Time Synchronisation	-	6	8		x	x
255	0	Initiate General Interrogation	-	7	9		x	x

Table Showing Command Information (INF) Numbers

FUN	ACC	Description	Ohmega 4xx
130	1	la	x
130	2	lb	x
130	3	lc	x
130	4	lres	x
130	5	laux	x
130	6	Va	x
130	7	Vb	x
130	8	Vc	x
130	9	Vres	x
130	10	Vaux	x

Table Showing Actual Channel (ACC) Numbers

7.10 Rho 3

FUN	INF	Description	GI	TYP	COT	DIR	Rho 3
165	0	Data lost	-	1	1	RO	x
165	2	Reset FCB	-	5	3	RO	x
165	3	Reset CU	-	5	4	RO	x
165	4	Start/Restart	-	5	5	RO	x
165	5	Power On	-	5	6	RO	x
165	6	A U/C Alarm Starter	-	1	1	RC	x
165	7	B U/C Alarm Starter	-	1	1	RC	x
165	8	C U/C Alarm Starter	-	1	1	RC	x
165	9	A U/C Alarm	x	1	1	RO	x
165	10	B U/C Alarm	x	1	1	RO	x
165	11	C U/C Alarm	x	1	1	RO	x
165	12	A U/C Starter	-	2	1	RC	x
165	13	B U/C Starter	-	2	1	RC	x
165	14	C U/C Starter	-	2	1	RC	x
165	15	A U/C Trip	-	2	1	RO	x
165	16	B U/C Trip	-	2	1	RO	x
165	17	C U/C Trip	-	2	1	RO	x
165	18	External Trip	-	1	1	RO	x
165	19	LEDs reset	-	1	1, 7, 11, 12, 20, 21	RO	x
165	20	Trip circuit fail	x	1	1	RC	x
165	21	Trip Test	-	1	1	RC	x
165	22	Settings changed	-	1	1, 11, 12	RC	x
165	23	Setting G1 selected	x	1	1, 11, 12, 20, 21	RC	x
165	24	Setting G2 selected	x	1	1, 11, 12, 20, 21	RC	x
165	25	Setting G3 selected	x	1	1, 11, 12, 20, 21	RC	x
165	26	Setting G4 selected	x	1	1, 11, 12, 20, 21	RC	x
165	27	Input 1	x	1	1	RC	x
165	28	Input 2	x	1	1	RC	x
165	29	Input 3	x	1	1	RC	x
165	30	Input 4	x	1	1	RC	x
165	31	Phase Unbalance Starter	-	2	1	RC	x
165	32	Phase Unbalance Trip	-	2	1	RO	x
165	33	Trip count alarm	x	1	1, 12, 20, 21	RC	x
165	33	Trip count alarm	x	4	1, 9	-	x
165	34	CB maintenance alarm	x	1	1, 12, 20, 21	RC	x
165	34	CB maintenance alarm	x	4	1, 9	-	x
165	35	Setting G5 selected	x	1	1, 11, 12, 20, 21	RC	x
165	36	Setting G6 selected	x	1	1, 11, 12, 20, 21	RC	x
165	37	Setting G7 selected	x	1	1, 11, 12, 20, 21	RC	x
165	38	Setting G8 selected	x	1	1, 11, 12, 20, 21	RC	x
165	39	Circuit breaker fail 2	-	2	1	RO	x
165	40	Thermal Overload Alarm	x	1	1	RC	x
165	41	Thermal Capacity Alarm	x	1	1, 12, 20, 21	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Rho 3
165	42	Thermal Overload Trip	-	1	1	RO	x
165	43	Load Increase Alarm	x	1	1	RC	x
165	44	Thermal Restart Inhibit	x	1	1	RC	x
165	45	Input 5	x	1	1	RC	x
165	46	Input 6	x	1	1	RC	x
165	47	Input 7	x	1	1	RC	x
165	48	Input 8	x	1	1	RC	x
165	49	Input 9	x	1	1	RC	x
165	50	E/F Inhibit	x	1	1	RC	x
165	51	Output 1	x	1	1, 12, 20, 21	RC	x
165	52	Output 2	x	1	1, 12, 20, 21	RC	x
165	53	Output 3	x	1	1, 12, 20, 21	RC	x
165	54	Output 4	x	1	1, 12, 20, 21	RC	x
165	55	Output 5	x	1	1, 12, 20, 21	RC	x
165	56	Output 6	x	1	1, 12, 20, 21	RC	x
165	57	Output 7	x	1	1, 12, 20, 21	RC	x
165	58	A O/C Alarm Starter	-	1	1	RC	x
165	59	B O/C Alarm Starter	-	1	1	RC	x
165	60	C O/C Alarm Starter	-	1	1	RC	x
165	61	A O/C Alarm	x	1	1	RO	x
165	62	B O/C Alarm	x	1	1	RO	x
165	63	C O/C Alarm	x	1	1	RO	x
165	64	A O/C Starter	-	2	1	RC	x
165	65	B O/C Starter	-	2	1	RC	x
165	66	C O/C Starter	-	2	1	RC	x
165	67	E/F Starter	-	2	1	RC	x
165	68	General trip	-	2	1	RO	x
165	69	A O/C Trip	-	2	1	RO	x
165	70	B O/C Trip	-	2	1	RO	x
165	71	C O/C Trip	-	2	1	RO	x
165	72	E/F Trip	-	2	1	RO	x
165	73	E/F Alarm Starter	-	1	1	RC	x
165	74	E/F Alarm	x	1	1	RO	x
165	75	Stall Delay 1 Starter	-	1	1	RC	x
165	76	Stall Delay 1 Trip	-	1	1	RO	x
165	77	Stall Delay 2 Starter	-	1	1	RC	x
165	78	Stall Delay 2 Trip	-	1	1	RO	x
165	79	Maximum Starts Exceeded	x	1	1, 12, 20, 21	RC	x
165	80	Waveform stored	-	1	1, 12, 20, 21	RO	x
165	81	Remote control interrupted	-	1	1	RO	x
165	82	Start Counter Alarm	x	1	1, 12, 20, 21	RC	x
165	82	Start Counter Alarm	x	4	1, 9	-	x
165	83	Run Time Hours Alarm	x	1	1, 12, 20, 21	RC	x
165	84	General starter	x	2	1	RC	x
165	85	Circuit breaker fail 1	-	2	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Rho 3
165	86	Motor Stopped	x	1	1	RC	x
165	87	Motor Running	x	1	1	RC	x
165	88	Motor Starting	x	1	1	RC	x
165	89	Motor Start Inhibit	x	1	1	RC	x
165	90	Temperature Input 1 Alarm	x	1	1	RC	x
165	91	Temperature Input 2 Alarm	x	1	1	RC	x
165	92	Temperature Input 3 Alarm	x	1	1	RC	x
165	93	Temperature Input 4 Alarm	x	1	1	RC	x
165	94	Temperature Input 5 Alarm	x	1	1	RC	x
165	95	Temperature Input 6 Alarm	x	1	1	RC	x
165	96	Temperature Input 7 Alarm	x	1	1	RC	x
165	97	Temperature Input 8 Alarm	x	1	1	RC	x
165	98	Temperature Input 1 Trip	-	1	1	RO	x
165	99	Temperature Input 2 Trip	-	1	1	RO	x
165	100	Temperature Input 3 Trip	-	1	1	RO	x
165	101	Temperature Input 4 Trip	-	1	1	RO	x
165	102	Temperature Input 5 Trip	-	1	1	RO	x
165	103	Temperature Input 6 Trip	-	1	1	RO	x
165	104	Temperature Input 7 Trip	-	1	1	RO	x
165	105	Temperature Input 8 Trip	-	1	1	RO	x
165	106	Temperature Input 1 Fail	x	1	1	RC	x
165	107	Temperature Input 2 Fail	x	1	1	RC	x
165	108	Temperature Input 3 Fail	x	1	1	RC	x
165	109	Temperature Input 4 Fail	x	1	1	RC	x
165	110	Temperature Input 5 Fail	x	1	1	RC	x
165	111	Temperature Input 6 Fail	x	1	1	RC	x
165	112	Temperature Input 7 Fail	x	1	1	RC	x
165	113	Temperature Input 8 Fail	x	1	1	RC	x
165	121	General Alarm 1	x	1	1	RC	x
165	122	General Alarm 2	x	1	1	RC	x
165	123	General Alarm 3	x	1	1	RC	x
165	124	General Alarm 4	x	1	1	RC	x
165	125	General Alarm 5	x	1	1	RC	x
165	126	General Alarm 6	x	1	1	RC	x
165	127	General Alarm 7	x	1	1	RC	x
165	128	General Alarm 8	x	1	1	RC	x
165	129	General Alarm 9	x	1	1	RC	x
165	130	Maximum Demand Reset	-	1	20, 21	RO	x
165	131	Last Start Info Reset	-	1	20, 21	RO	x
165	132	Motor Run-Time Reset	-	1	20, 21	RO	x
165	148	Measurand $I_{L1,2,3}$, $V_{L1,2,3}$, P, Q, F^{vi}	-	9	2,7	-	x
165	149	Measurand	-	9	2,7	-	x

^{vi} Only IL1, IL2, IL3 and F are valid, all other fields returned as zero.

FUN	INF	Description	GI	TYP	COT	DIR	Rho 3
165	184	Power On Counter Alarm	x	1	1	RC	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		Rho 3
165	19	Reset Flag & Outputs	ON	20	20		x
165	23	Settings Group 1 Select	ON	20	20		x
165	24	Settings Group 2 Select	ON	20	20		x
165	25	Settings Group 3 Select	ON	20	20		x
165	26	Settings Group 4 Select	ON	20	20		x
165	33	Trip counter reset	ON	20	20		x
165	34	Sum I ² Reset	ON	20	20		x
165	35	Settings Group 5 Select	ON	20	20		x
165	36	Settings Group 6 Select	ON	20	20		x
165	37	Settings Group 7 Select	ON	20	20		x
165	38	Settings Group 8 Select	ON	20	20		x
165	41	Thermal Capacity Reset	ON	20	20		x
165	51	Energise Output 1	ON	20	20		x
165	52	Energise Output 2	ON	20	20		x
165	53	Energise Output 3	ON	20	20		x
165	54	Energise Output 4	ON	20	20		x
165	55	Energise Output 5	ON	20	20		x
165	56	Energise Output 6	ON	20	20		x
165	57	Energise Output 7	ON	20	20		x
165	79	Reset Maximum Starts	ON	20	20		x
165	80	Trigger Waveform Storage	ON	20	20		x
165	82	Reset Start Counter	ON	20	20		x
165	83	Reset Run Time Hours	ON	20	20		x
165	130	Maximum Demand Reset	ON	20	20		x
165	131	Last Start Info Reset	ON	20	20		x
165	132	Motor Run-Time Reset	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

FUN	ACC	Description	Rho 3
165	1	I _A	x
165	2	I _B	x
165	3	I _C	x
165	4	I _E	x

Table Showing Disturbance Recorder Actual Channel (ACC) Numbers

7.11 SOLKOR-N

FUN	INF	Description	GI	TYP	COT	DIR	Solkor N
160	64	A-O/C starter	x	2	1	RC	x
160	65	B-O/C starter	x	2	1	RC	x
160	66	C-O/C starter	x	2	1	RC	x
160	67	E-O/C starter	x	2	1	RC	x
160	85	Circuit breaker fail 1	-	2	1	RO	x
160	91	P/F-general HS trip	-	2	1	RO	x
160	93	E/F-general HS trip	-	2	1	RO	x
164	1	A-lowset starter	-	2	1	RC	x
164	2	B-lowset starter	-	2	1	RC	x
164	3	C-lowset starter	-	2	1	RC	x
164	4	E-lowset starter	-	2	1	RC	x
164	5	A-lowset trip	-	2	1	RO	x
164	6	B-lowset trip	-	2	1	RO	x
164	7	C-lowset trip	-	2	1	RO	x
164	8	E-lowset trip	-	2	1	RO	x
164	9	A-delayed trip	-	2	1	RO	x
164	10	B-delayed trip	-	2	1	RO	x
164	11	C-delayed trip	-	2	1	RO	x
164	12	E-delayed trip	-	2	1	RO	x
164	13	A-HS1 trip	-	2	1	RO	x
164	14	B-HS1 trip	-	2	1	RO	x
164	15	C-HS1 trip	-	2	1	RO	x
164	16	E-HS1 trip	-	2	1	RO	x
164	17	A-HS2 trip	-	2	1	RO	x
164	18	B-HS2 trip	-	2	1	RO	x
164	19	C-HS2 trip	-	2	1	RO	x
164	20	E-HS2 trip	-	2	1	RO	x
164	26	A-HS1 starter	-	2	1	RC	x
164	27	B-HS1 starter	-	2	1	RC	x
164	28	C-HS1 starter	-	2	1	RC	x
164	29	E-HS1 starter	-	2	1	RC	x
164	30	A-HS2 starter	-	2	1	RC	x
164	31	B-HS2 starter	-	2	1	RC	x
164	32	C-HS2 starter	-	2	1	RC	x
164	33	E-HS2 starter	-	2	1	RC	x
164	39	Circuit breaker fail 2	-	2	1	RO	x
192	0	Data lost	-	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Solkor N
192	2	Reset FCB	-	5	3	RO	x
192	3	Reset CU	-	5	4	RO	x
192	4	Start/Restart	-	5	5	RO	x
192	5	Power On	-	5	6	RO	x
192	19	LEDs reset	-	1	1, 7, 11, 12, 20, 21	RO	x
192	21	Test Mode	x	1	7	RC	x
192	22	Settings changed	x	1	1, 11, 12	RC	x
192	23	Setting G1 selected	x	1	1, 11, 12, 20, 21	RC	x
192	24	Setting G2 selected	x	1	1, 11, 12, 20, 21	RC	x
192	25	Setting G3 selected	x	1	1, 11, 12, 20, 21	RC	x
192	26	Setting G4 selected	x	1	1, 11, 12, 20, 21	RC	x
192	27	Input 1	x	1	1	RC	x
192	28	Input 2	x	1	1	RC	x
192	29	Input 3	x	1	1	RC	x
192	30	Input 4	x	1	1	RC	x
192	36	Trip circuit fail	x	1	1	RC	x
192	39	Signalling Disturbed	x	1	1	RC	x
192	47	Alarm	x	1	1	RO	x
192	64	A-Diff Starter	x	2	1	RC	x
192	65	B-Diff Starter	x	2	1	RC	x
192	66	C-Diff Starter	x	2	1	RC	x
192	67	E-Diff Starter	x	2	1	RC	x
192	68	General trip	-	2	1	RO	x
192	69	A-general trip	-	2	1	RO	x
192	70	B-general trip	-	2	1	RO	x
192	71	C-general trip	-	2	1	RO	x
192	84	General Starter	x	2	1	RC	x
192	128	CB Status	x	1	1	DP	x
196	0	Data lost	-	1	1	RO	x
196	1	E-Diff Trip	-	2	1	RO	x
196	2	Internal Intertrip Sent	-	2	1, 20, 21	RC	x
196	3	Internal Intertrip Received	-	2	1	RC	x
196	4	External Intertrip 1 Sent	-	2	1, 20, 21	RC	x
196	5	External Intertrip 1 Received	-	2	1, 20, 21	RC	x
196	6	External Intertrip 2	ON	20	20	-	x

FUN	INF	Description	GI	TYP	COT	DIR	Solkor N
196	7	External Intertrip 2 Received	-	2	1	RC	x
196	8	External Trip	-	2	1	RO	x
196	9	A-Diff Trip	-	2	1	RO	x
196	10	B-Diff Trip	-	2	1	RO	x
196	11	C-Diff Trip	-	2	1	RO	x
196	21	Remote Test Mode	x	1	7	RC	x
196	35	Setting G5 selected	x	1	1, 11, 12, 20, 21	RC	x
196	36	Setting G6 selected	x	1	1, 11, 12, 20, 21	RC	x
196	37	Setting G7 selected	x	1	1, 11, 12, 20, 21	RC	x
196	38	Setting G8 selected	x	1	1, 11, 12, 20, 21	RC	x
196	45	Input 5	x	1	1	RC	x
196	46	Input 6	x	1	1	RC	x
196	47	Input 7	x	1	1	RC	x
196	48	Input 8	x	1	1	RC	x
196	49	Input 9	x	1	1	RC	x
196	51	Output 1	x	1	1, 12, 20, 21	RC	x
196	52	Output 2	x	1	1, 12, 20, 21	RC	x
196	53	Output 3	x	1	1, 12, 20, 21	RC	x
196	54	Output 4	x	1	1, 12, 20, 21	RC	x
196	55	Output 5	x	1	1, 12, 20, 21	RC	x
196	56	Output 6	x	1	1, 12, 20, 21	RC	x
196	57	Output 7	x	1	1, 12, 20, 21	RC	x
196	70	Trip count alarm	x	1	1	RC	x
196	70	Trip count alarm	-	4	1, 9	-	x
196	71	CB maintenance alarm	x	1	1	RC	x
196	71	CB maintenance alarm	x	4	1, 9	-	x
196	80	Waveform stored	-	1	1, 12, 20, 21	RO	x
196	81	Remote control interrupted	-	1	11	RO	x
196	92	E/F-general trip	-	2	1	RO	x
196	92	Power On Counter Alarm	x	1	1	RC	x
196	121	General alarm 1	x	1	1	RC	x
196	122	General alarm 2	x	1	1	RC	x
196	123	General alarm 3	x	1	1	RC	x
196	124	General alarm 4	x	1	1	RC	x
196	125	General alarm 5	x	1	1	RC	x
196	126	General alarm 6	x	1	1	RC	x
196	127	General alarm 7	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Solkor N
196	128	General alarm 8	x	1	1	RC	x
196	129	General alarm 9	x	1	1	RC	x
196	130	Ends In Synch	x	1	1	RC	x
196	131	P/F Guard	x	1	1, 20, 21	RC	x
196	132	A Guard	x	1	1, 20, 21	RC	x
196	133	B Guard	x	1	1, 20, 21	RC	x
196	134	C Guard	x	1	1, 20, 21	RC	x
196	135	E/F Guard	x	1	1, 20, 21	RC	x
196	250	Measurand Local $I_{L1,2,3,EF}$, Remote $I_{L1,2,3,EF}$ ^{vii}	-	9	2,7	-	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	GI / COM	TYP	COT	DIR	Solkor N
192	19	Reset Flag & Outputs	ON	20	20	-	x
192	23	Settings Group 1 Select	ON	20	20	-	x
192	24	Settings Group 2 Select	ON	20	20	-	x
192	25	Settings Group 3 Select	ON	20	20	-	x
192	26	Settings Group 4 Select	ON	20	20	-	x
196	2	Internal Intertrip	ON	20	20	-	x
196	4	External Intertrip 1	ON	20	20	-	x
196	6	External Intertrip 2 Sent	-	2	1	RC	x
196	35	Settings Group 5 Select	ON	20	20	-	x
196	36	Settings Group 6 Select	ON	20	20	-	x
196	37	Settings Group 7 Select	ON	20	20	-	x
196	38	Settings Group 8 Select	ON	20	20	-	x
196	51	Energise Output 1	ON	20	20	-	x
196	52	Energise Output 2	ON	20	20	-	x
196	53	Energise Output 3	ON	20	20	-	x
196	54	Energise Output 4	ON	20	20	-	x
196	55	Energise Output 5	ON	20	20	-	x
196	56	Energise Output 6	ON	20	20	-	x
196	57	Energise Output 7	ON	20	20	-	x
196	80	Trigger Waveform Storage	ON	20	20	-	x

^{vii} At present Remote EF returns zero.

FUN	INF	Description	GI / COM	TYP	COT	DIR	Solkor N
196	131	Energise P/F Guard Relay	ON	20	20	-	x
196	132	Energise A Guard Relay	ON	20	20	-	x
196	133	Energise B Guard Relay	ON	20	20	-	x
196	134	Energise C Guard Relay	ON	20	20	-	x
196	135	Energise E/F Guard Relay	ON	20	20	-	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	Initiate General Interrogation	-	7	9	-	x

Table Showing Command Information (INF) Numbers

FUN	ACC	Description	Solkor - N
196	1	A	Ü
196	2	B	Ü
196	3	C	Ü
196	4	E	Ü
196	5	A Local Mag	Ü
196	6	A Remote Mag	Ü
196	7	A Threshold Mag	Ü
196	8	A Differential Mag	Ü
196	9	A Counts To Trip Mag	Ü
196	10	A Local Angle	Ü
196	11	A Remote Angle	Ü
196	12	A Threshold Angle	Ü
196	13	A Differential Angle	Ü
196	14	A Counts To Trip Angle	Ü
196	15	B Local Mag	Ü
196	16	B Remote Mag	Ü
196	17	B Threshold Mag	Ü
196	18	B Differential Mag	Ü
196	19	B Counts To Trip Mag	Ü
196	20	B Local Angle	Ü
196	21	B Remote Angle	Ü
196	22	B Threshold Angle	Ü
196	23	B Differential Angle	Ü
196	24	B Counts To Trip Angle	Ü
196	25	C Local Mag	Ü
196	26	C Remote Mag	Ü
196	27	C Threshold Mag	Ü
196	28	C Differential Mag	Ü
196	29	C Counts To Trip Mag	Ü
196	30	C Local Angle	Ü
196	31	C Remote Angle	Ü
196	32	C Threshold Angle	Ü
196	33	C Differential Angle	Ü

FUN	ACC	Description	Solkor - N
196	34	C Counts To Trip Angle	Ü
196	35	Internal Intertrip Counts To Trip	Ü
196	36	External Intertrip 1 Counts To Trip	Ü
196	37	External Intertrip 2 Counts To Trip	Ü

Table Showing Disturbance Recorder Actual Channel (ACC) Numbers

7.12 TAU

FUN	INF	Description	GI	TYP	COT	DIR	TAU
70	5	Status Input 5	x	1	1	RC	x
70	6	Status Input 6	x	1	1	RC	x
70	7	Status Input 7	x	1	1	RC	x
70	8	Status Input 8	x	1	1	RC	x
70	9	Status Input 9	x	1	1	RC	x
70	10	Status Input 10	x	1	1	RC	x
70	11	Status Input 11	x	1	1	RC	x
70	12	Status Input 12	x	1	1	RC	x
70	13	Status Input 13	x	1	1	RC	x
70	14	Status Input 14	x	1	1	RC	x
70	15	Status Input 15	x	1	1	RC	x
70	16	Status Input 16	x	1	1	RC	x
70	17	Status Input 17	x	1	1	RC	x
70	18	Status Input 18	x	1	1	RC	x
70	19	Status Input 19	x	1	1	RC	x
70	20	Status Input 20	x	1	1	RC	x
70	21	Status Input 21	x	1	1	RC	x
70	22	Status Input 22	x	1	1	RC	x
70	23	Status Input 23	x	1	1	RC	x
70	24	Status Input 24	x	1	1	RC	x
70	25	Status Input 25	x	1	1	RC	x
70	26	Status Input 26	x	1	1	RC	x
70	27	Status Input 27	x	1	1	RC	x
70	28	Status Input 28	x	1	1	RC	x
70	29	Status Input 29	x	1	1	RC	x
70	30	Status Input 30	x	1	1	RC	x
70	31	Status Input 31	x	1	1	RC	x
70	32	Status Input 32	x	1	1	RC	x
70	33	Status Input 33	x	1	1	RC	x
70	34	Status Input 34	x	1	1	RC	x
70	35	Status Input 35	x	1	1	RC	x
70	36	Status Input 36	x	1	1	RC	x
70	37	Status Input 37	x	1	1	RC	x
70	38	Status Input 38	x	1	1	RC	x
70	39	Status Input 39	x	1	1	RC	x
70	40	Status Input 40	x	1	1	RC	x
70	41	Status Input 41	x	1	1	RC	x
70	42	Status Input 42	x	1	1	RC	x
70	43	Status Input 43	x	1	1	RC	x
80	1	Plant Control Relay 1	x	1	1	RC	x
80	2	Plant Control Relay 2	x	1	1	RC	x
80	3	Plant Control Relay 3	x	1	1	RC	x
80	4	Plant Control Relay 4	x	1	1	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	TAU
80	5	Plant Control Relay 5	x	1	1	RC	x
80	6	Plant Control Relay 6	x	1	1	RC	x
80	7	Plant Control Relay 7	x	1	1	RC	x
80	8	Plant Control Relay 8	x	1	1	RC	x
80	9	Plant Control Relay 9	x	1	1	RC	x
80	10	Plant Control Relay 10	x	1	1	RC	x
80	11	Plant Control Relay 11	x	1	1	RC	x
80	12	Plant Control Relay 12	x	1	1	RC	x
80	13	Plant Control Relay 13	x	1	1	RC	x
80	14	Plant Control Relay 14	x	1	1	RC	x
80	15	Plant Control Relay 15	x	1	1	RC	x
80	16	Plant Control Relay 16	x	1	1	RC	x
80	17	Plant Control Relay 17	x	1	1	RC	x
80	18	Plant Control Relay 18	x	1	1	RC	x
80	19	Plant Control Relay 19	x	1	1	RC	x
80	20	Plant Control Relay 20	x	1	1	RC	x
80	21	Plant Control Relay 21	x	1	1	RC	x
80	22	Plant Control Relay 22	x	1	1	RC	x
80	23	Plant Control Relay 23	x	1	1	RC	x
80	24	Plant Control Relay 24	x	1	1	RC	x
80	25	Plant Control Relay 25	x	1	1	RC	x
80	26	Plant Control Relay 26	x	1	1	RC	x
80	27	Plant Control Relay 27	x	1	1	RC	x
80	28	Plant Control Relay 28	x	1	1	RC	x
80	29	Plant Control Relay 29	x	1	1	RC	x
80	30	Plant Control Relay 30	x	1	1	RC	x
80	31	Plant Control Relay 31	x	1	1	RC	x
80	32	Plant Control Relay 32	x	1	1	RC	x
80	33	Plant Control Relay 33	x	1	1	RC	x
80	34	Plant Control Relay 34	x	1	1	RC	x
80	35	Plant Control Relay 35	x	1	1	RC	x
80	36	Plant Control Relay 36	x	1	1	RC	x
80	37	Plant Control Relay 37	x	1	1	RC	x
80	38	Plant Control Relay 38	x	1	1	RC	x
80	39	Plant Control Relay 39	x	1	1	RC	x
80	40	Plant Control Relay 40	x	1	1	RC	x
80	41	Plant Control Relay 41	x	1	1	RC	x
80	42	Plant Control Relay 42	x	1	1	RC	x
80	43	Plant Control Relay 43	x	1	1	RC	x
80	44	Plant Control Relay 44	x	1	1	RC	x
80	45	Plant Control Relay 45	x	1	1	RC	x
210	0	Data lost	-	1	1	RO	x
210	2	Reset FCB	-	2	3	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	TAU
210	3	Reset CU	-	2	4	RO	x
210	4	Start/Restart	-	2	5	RO	x
210	5	Power On	-	5	6	RO	
210	6	Fx One In Service	-	1	1	RO	x
210	7	Fx Two In Service	-	1	1	RO	x
210	8	Tx One In Service	-	1	1	RO	x
210	9	Tx Two In Service	-	1	1	RO	x
210	10	Fx One OutOfService	-	1	1	RO	x
210	11	Fx Two OutOfService	-	1	1	RO	x
210	12	Tx One OutOfService	-	1	1	RO	x
210	13	Tx Two OutOfService	-	1	1	RO	x
210	16	Auto-Recloser Active	x	1	1, 20, 21	RC	x
210	17	teleprotection active	-	1	1	RO	x
210	23	Setting G1 selected	x	1	1, 20, 21	RC	x
210	24	Setting G2 selected	x	1	1, 20, 21	RC	x
210	25	Setting G3 selected	x	1	1, 20, 21	RC	x
210	26	Setting G4 selected	x	1	1, 20, 21	RC	x
210	27	Status Input 1	x	1	1	RC	x
210	28	Status Input 2	x	1	1	RC	x
210	29	Status Input 3	x	1	1	RC	x
210	30	Status Input 4	x	1	1	RC	x
210	68	General Trip	-	2	1	RO	x
210	69	Trip L1	-	2	1	RO	x
210	70	Trip L2	-	2	1	RO	x
210	71	Trip L3	-	2	1	RO	x
210	84	General Start/Pick-up	x	2	1	RC	x
210	128	CB 'on' by AR	-	1	1	RO	x
210	130	AR blocked	x	1	1	RC	x
210	131	Lockout	x	1	1	RC	x
210	132	CB Failed To Close	-	1	1	RO	x
210	133	CB Failed To Open	-	1	1	RO	x
210	134	Close Onto Fault	-	1	1	RO	x
210	135	VT Failure Alarm	-	1	1	RO	x
210	136	Total CB Close Count Alarm	-	1	1	RO	x
210	137	Synch In Progress	x	1	1	RC	x
210	138	Sync Override	-	1	1	RO	x
210	139	Dead Line Close	-	1	1	RO	x
210	140	Dead Bus Close	-	1	1	RO	x
210	141	System Split Output	-	1	1	RO	x
210	142	Check Sync Start	-	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	TAU
210	161	Cold Start	-	1	1	RO	x
210	162	Warm Start	-	1	1	RO	x
210	163	Re-Start	-	1	1	RO	x
210	164	Trigger Storage	-	1	1	RO	x
210	165	Open Feeder Isolator One	-	1	1	RO	x
210	166	Open Feeder Isolator Two	-	1	1	RO	x
210	167	Feeder Isolator One Open	x	1	1	RO	x
210	168	Feeder Isolator Two Open	x	1	1	RO	x
210	169	Tx Isolator One Open	x	1	1	RO	x
210	170	Tx Isolator Two Open	x	1	1	RO	x
210	171	Tx Isolator One Closed	x	1	1	RO	x
210	172	Tx Isolator Two Closed	x	1	1	RO	x
210	173	Open Tx Isolator One	-	1	1	RO	x
210	174	Open Tx Isolator Two	-	1	1	RO	x
210	175	Close Tx Isolator One	-	1	1	RO	x
210	176	Close Tx Isolator Two	-	1	1	RO	x
210	177	Transformer One Trip	-	1	1	RO	x
210	178	Transformer Two Trip	-	1	1	RO	x
210	179	Ferroresonance Alarm Tx One	-	1	1	RO	x
210	180	Ferroresonance Alarm Tx Two	-	1	1	RO	x
210	182	F3 Tx One In Progress	x	1	1	RC	x
210	183	F3 Tx Two In Progress	x	1	1	RC	x
210	184	Tx Isolation Fail	-	1	1	RO	x
210	185	Feeder One Intertrip Receive	-	1	1	RO	x
210	186	Feeder Two Intertrip Receive	-	1	1	RO	x
210	187	Feeder One Trip	-	1	1	RO	x
210	188	Feeder Two Trip	-	1	1	RO	x
210	189	Mesh Corner One Trip	-	1	1	RO	x
210	190	Mesh Corner Two Trip	-	1	1	RO	x
210	191	A Trip	-	1	1	RO	x
210	192	B Trip	-	1	1	RO	x
210	193	C Trip	-	1	1	RO	x
210	194	3 Trip	-	1	1	RO	x
210	195	ES One Open	-	1	1	RO	x
210	196	ES One Closed	-	1	1	RO	x
210	197	F4 One Out Of Service	-	1	1	RO	x
210	198	F4 One In Service	-	1	1	RO	x
210	199	Close ES One	-	1	1	RO	x
210	200	Open ES One	-	1	1	RO	x
210	201	ES One Fail To Close	-	1	1	RO	x
210	202	ES One Fail To Open	-	1	1	RO	x
210	203	ES One DBI	-	1	1	RO	x
210	204	F4 One Ferrores Fail	-	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	TAU
210	205	F4 One In Progress	x	1	1	RC	x
210	206	F4 One Inhibit Plant Isolation	x	1	1	RC	x
210	207	ES Two Open	-	1	1	RO	x
210	208	ES Two Closed	-	1	1	RO	x
210	209	F4 Two Out Of Service	-	1	1	RO	x
210	210	F4 Two In Service	-	1	1	RO	x
210	211	Close ES Two	-	1	1	RO	x
210	212	Open ES Two	-	1	1	RO	x
210	213	ES Two Fail To Close	-	1	1	RO	x
210	214	ES Two Fail To Open	-	1	1	RO	x
210	215	ES Two DBI	-	1	1	RO	x
210	216	F4 Two Ferrores Fail	-	1	1	RO	x
210	217	F4 Two In Progress	x	1	1	RC	x
210	218	F4 Two Inhibit Plant Isolation	x	1	1	RC	x
210	219	F3 One Out Of Service	-	1	1	RO	x
210	220	F3 One In Service	-	1	1	RO	x
210	221	F3 Two Out Of Service	-	1	1	RO	x
210	222	F3 Two In Service	-	1	1	RO	x
210	223	F4 One Interlock	x	1	1	RC	x
210	225	Successful Close	-	1	1	RO	x
210	226	External A/R Start	-	1	1	RO	x
210	227	Manual Close	-	1	1	RO	x
210	228	Reset Lockout	-	1	1	RO	x
210	229	A/R Out	-	1	1	RO	x
210	230	A/R In	-	1	1	RO	x
210	231	In Sync Output	x	1	1	RC	x
210	232	Live Bus	x	1	1	RC	x
210	233	Live Line	x	1	1	RC	x
210	234	Trip	-	1	1	RO	x
210	235	Starter	-	1	1	RO	x
210	236	Reclose Lockout	-	1	1	RO	x
210	237	Trip And Reclose Input	-	1	1	RO	x
210	238	CB Pole Discrepancy	-	1	1	RO	x
210	239	Reclaim	-	1	1	RO	x
210	240	Ext Group Change	-	1	1	RO	x
210	241	Ext Group Back	-	1	1	RO	x
210	242	Manual Sync Override	-	1	1	RO	x
210	243	Intertrip Receive	-	1	1	RO	x
210	244	Autolossion Complete I/P	-	1	1	RO	x
210	245	Inhibit Seq Isolation	-	1	1	RO	x
210	246	Persistent Intertrip	-	1	1	RO	x
210	247	Autolossion Fail	-	1	1	RO	x
210	250	CB 'on' by MC	-	1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	TAU
210	251	A/R In Progress	x	1	1	RC	x
210	252	Total CB Count Reset	-	1	1, 20, 21	RO	x
210	253	Delta CB Count Reset	-	1	1, 20, 21	RO	x
255	0	Time Synchronisation	-	6	8	-	x
255	0	End of General Interrogation	-	8	10	-	x

Table Showing Information (INF) Numbers

FUN	INF	Description	GI	TYP	COT		TAU
210	16	Auto-reclose on/off	ON/OFF	20	20		x
210	23	Settings Group 1 Select	ON	20	20		x
210	24	Settings Group 2 Select	ON	20	20		x
210	25	Settings Group 3 Select	ON	20	20		x
210	26	Settings Group 4 Select	ON	20	20		x
210	252	Reset Total CB Count	ON	20	20		x
210	253	Reset Delta CB Count	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

7.13 DAD-N

FUN	INF	Description	GI	TYP	COT	DIR	DAD-N
60	1	IEC870 Active Com 1	x	1	1,9	RC	x
60	2	IEC870 Active Com 2	x	1	1,9	RC	x
60	3	Front Port OverRide	x	1	1,9	RC	x
60	4	Remote Mode		1	1,9		x
60	5	Service Mode		1	1,9		x
60	6	Local Mode		1	1,9		x
60	7	Local & Remote		1	1,9		x
60	128	Cold Start	-	1	1		x
60	129	Warm Start	-	1	1		x
60	130	Re-Start	-	1	1		x
60	135	Trigger Storage	-	1	1		x
70	1	Status Input 1	x	1	1,9	RC	x
70	2	Status Input 2	x	1	1,9	RC	x
70	3	Status Input 3	x	1	1,9	RC	x
70	4	Status Input 4	x	1	1,9	RC	x
70	5	Status Input 5	x	1	1,9	RC	x
70	6	Status Input 6	x	1	1,9	RC	x
70	7	Status Input 7	x	1	1,9	RC	x
70	8	Status Input 8	x	1	1,9	RC	x
70	9	Status Input 9	x	1	1,9	RC	x
70	10	Status Input 10	x	1	1,9	RC	x
70	11	Status Input 11	x	1	1,9	RC	x
70	12	Status Input 12	x	1	1,9	RC	x
70	13	Status Input 13	x	1	1,9	RC	x
70	14	Status Input 14	x	1	1,9	RC	x
70	15	Status Input 15	x	1	1,9	RC	x
70	16	Status Input 16	x	1	1,9	RC	x
70	17	Status Input 17	x	1	1,9	RC	x
70	18	Status Input 18	x	1	1,9	RC	x
70	19	Status Input 19	x	1	1,9	RC	x
70	20	Status Input 20	x	1	1,9	RC	x
70	21	Status Input 21	x	1	1,9	RC	x
70	22	Status Input 22	x	1	1,9	RC	x
70	23	Status Input 23	x	1	1,9	RC	x
70	24	Status Input 24	x	1	1,9	RC	x
70	25	Status Input 25	x	1	1,9	RC	x
70	26	Status Input 26	x	1	1,9	RC	x
70	27	Status Input 27	x	1	1,9	RC	x
80	1	Plant Control Relay 1	x	1	1,9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	DAD-N
80	2	Plant Control Relay 2	x	1	1,9	RC	x
80	3	Plant Control Relay 3	x	1	1,9	RC	x
80	4	Plant Control Relay 4	x	1	1,9	RC	x
80	5	Plant Control Relay 5	x	1	1,9	RC	x
80	6	Plant Control Relay 6	x	1	1,9	RC	x
80	7	Plant Control Relay 7	x	1	1,9	RC	x
80	8	Plant Control Relay 8	x	1	1,9	RC	x
80	9	Plant Control Relay 9	x	1	1,9	RC	x
80	10	Plant Control Relay 10	x	1	1,9	RC	x
80	11	Plant Control Relay 11	x	1	1,9	RC	x
80	12	Plant Control Relay 12	x	1	1,9	RC	x
80	13	Plant Control Relay 13	x	1	1,9	RC	x
80	14	Plant Control Relay 14	x	1	1,9	RC	x
80	15	Plant Control Relay 15	x	1	1,9	RC	x
80	16	Plant Control Relay 16	x	1	1,9	RC	x
80	17	Plant Control Relay 17	x	1	1,9	RC	x
80	18	Plant Control Relay 18	x	1	1,9	RC	x
80	19	Plant Control Relay 19	x	1	1,9	RC	x
80	20	Plant Control Relay 20	x	1	1,9	RC	x
80	21	Plant Control Relay 21	x	1	1,9	RC	x
80	22	Plant Control Relay 22	x	1	1,9	RC	x
80	23	Plant Control Relay 23	x	1	1,9	RC	x
80	24	Plant Control Relay 24	x	1	1,9	RC	x
80	25	Plant Control Relay 25	x	1	1,9	RC	x
80	26	Plant Control Relay 26	x	1	1,9	RC	x
80	27	Plant Control Relay 27	x	1	1,9	RC	x
80	28	Plant Control Relay 28	x	1	1,9	RC	x
80	29	Plant Control Relay 29	x	1	1,9	RC	x
181	2	Reset FCB	-	5	3	RO	x
181	3	Reset CU	-	5	4	RO	x
181	4	Start/Restart	-	5	5	RO	x
181	22	Settings changed	-	1	1		x
181	23	Setting G1 selected	x	1	1,9		x
181	24	Setting G2 selected	x	1	1,9		x
181	25	Setting G3 selected	x	1	1,9		x
181	26	Setting G4 selected	x	1	1,9		x
181	32	Measurand Supervision I	x	1	1,9		x
181	36	Trip Circuit Fail	x	1	1,9		x
181	64	Start/Pick-up L1	x	2	1,9		x
181	65	Start/Pick-up L2	x	2	1,9		x

FUN	INF	Description	GI	TYP	COT	DIR	DAD-N
181	66	Start/Pick-up L3	x	2	1,9		x
181	67	Start/Pick-up N	x	2	1,9		x
181	68	General Trip	-	2	1,9		x
181	69	Trip L1	-	2	1,9		x
181	70	Trip L2	-	2	1,9		x
181	71	Trip L3	-	2	1,9		x
181	84	General Start/Pick-up	x	2	1,9		x
181	97	Overall Differential	-	2	1		x
255	0	GI End	-	8	10		x
255	0	Time Synchronisation	-	6	8		x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		DAD-N
181	19	LED reset	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

FUN	ACC	Description	DAD-N
181	0	Global	Ü
181	1	Ia	Ü
181	2	Ib	Ü
181	3	Ic	Ü

Table Showing Actual Channel (ACC) Numbers

7.14 IOTA 210

FUN	INF	Description	GI	TYP	COT	DIR	IOTA 210
212	0	Data lost	-	1	1	RO	x
212	2	Reset FCB	-	5	3	RO	x
212	3	Reset CU	-	5	4	RO	x
212	4	Start/Restart	-	5	5	RO	x
212	5	Power On	-	5	6	RO	x
212	6	Reset TRR One	x	1	1,9	RC	x
212	7	Start Local 1	x	1	1,9	RC	x
212	8	Inhibit Local 1	x	1	1,9	RC	x
212	9	Lockout Local 1	x	1	1,9	RC	x
212	10	Start Remote 1	x	1	1,9	RC	x
212	11	Inhibit Remote 1	x	1	1,9	RC	x
212	12	Lockout Remote 1	x	1	1,9	RC	x
212	13	Feeder One Trip	x	1	1,9	RC	x
212	14	First Intertrip Rec One	x	1	1,9	RC	x
212	15	Second Intertrip Rec One	x	1	1,9	RC	x
212	16	Tx 1 Protn Trip	x	1	1,9	RC	x
212	17	MC One Protn Trip	x	1	1,9	RC	x
212	18	Enable Fx1 Isolation	x	1	1,9	RC	x
212	19	IsolatorOneOpen	x	1	1,9	RC	x
212	20	IsolatorOneClosed	x	1	1,9	RC	x
212	21	TxOnisolatorOpen	x	1	1,9	RC	x
212	22	TxOnisolatorClosed	x	1	1,9	RC	x
212	23	Tx One b Isol Open	x	1	1,9	RC	x
212	24	ESOneOpen	x	1	1,9	RC	x
212	25	Ferrores One Input	x	1	1,9	RC	x
212	26	Reset TRR Two	x	1	1,9	RC	x
212	27	Start Local 2	x	1	1,9	RC	x
212	28	Inhibit Local 2	x	1	1,9	RC	x
212	29	Lockout Local 2	x	1	1,9	RC	x
212	30	Start Remote 2	x	1	1,9	RC	x
212	31	Inhibit Remote 2	x	1	1,9	RC	x
212	32	Lockout Remote 2	x	1	1,9	RC	x
212	33	Feeder Two Trip	x	1	1,9	RC	x
212	34	First Intertrip Rec Two	x	1	1,9	RC	x
212	35	Second Intertrip Rec Two	x	1	1,9	RC	x
212	36	Tx 2 Protn Trip	x	1	1,9	RC	x
212	37	Tx Two Trip	x	1	1,9	RC	x
212	38	MC Two Protn Trip	x	1	1,9	RC	x
212	39	Enable Fx2 Isolation	x	1	1,9	RC	x
212	40	IsolatorTwoOpen	x	1	1,9	RC	x
212	41	IsolatorTwoClosed	x	1	1,9	RC	x
212	42	TxTwosolatorOpen	x	1	1,9	RC	x
212	43	TxTwosolatorClosed	x	1	1,9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	IOTA 210
212	44	Tx Two b Isol Open	x	1	1,9	RC	x
212	45	ESTwoOpen	x	1	1,9	RC	x
212	46	Ferrores Two Input	x	1	1,9	RC	x
212	47	CloseOntoFault	x	1	1,9	RC	x
212	48	Input1	x	1	1,9	RC	x
212	49	Input2	x	1	1,9	RC	x
212	50	Input3	x	1	1,9	RC	x
212	51	Input4	x	1	1,9	RC	x
212	52	Input5	x	1	1,9	RC	x
212	53	Input6	x	1	1,9	RC	x
212	54	Input7	x	1	1,9	RC	x
212	55	Input8	x	1	1,9	RC	x
212	56	Input9	x	1	1,9	RC	x
212	57	Input10	x	1	1,9	RC	x
212	58	Input11	x	1	1,9	RC	x
212	59	Input12	x	1	1,9	RC	x
212	60	Start Local DAR 1	x	1	1,9	RC	x
212	61	Inhibit Local DAR 1	x	1	1,9	RC	x
212	62	Lockout Local DAR 1	x	1	1,9	RC	x
212	63	Start Remote DAR 1	x	1	1,9	RC	x
212	64	Inhibit Remote DAR 1	x	1	1,9	RC	x
212	65	Lockout Remote DAR1	x	1	1,9	RC	x
212	66	Fx One Trip	x	1	1,9	RC	x
212	67	First IT One	x	1	1,9	RC	x
212	68	Second IT One	x	1	1,9	RC	x
212	69	Tx One Trip	x	1	1,9	RC	x
212	70	MC One Trip	x	1	1,9	RC	x
212	71	Backup One Trip	x	1	1,9	RC	x
212	72	Any MC1 Trip	x	1	1,9	RC	x
212	73	TD10OnePickup	x	1	1,9	RC	x
212	74	TD120OnePickup	x	1	1,9	RC	x
212	75	TRROneBus	x	1	1,9	RC	x
212	76	Start Local DAR 2	x	1	1,9	RC	x
212	77	Inhibit Local DAR 2	x	1	1,9	RC	x
212	78	Lockout Local DAR 2	x	1	1,9	RC	x
212	79	Start Remote DAR 2	x	1	1,9	RC	x
212	80	Inhibit Remote DAR 2	x	1	1,9	RC	x
212	81	Lockout Remote DAR2	x	1	1,9	RC	x
212	82	Fx Two Trip	x	1	1,9	RC	x
212	83	First IT Two	x	1	1,9	RC	x
212	84	Second IT Two	x	1	1,9	RC	x
212	85	Tx Two Trip	x	1	1,9	RC	x
212	86	MC Two Trip	x	1	1,9	RC	x
212	87	Backup Two Trip	x	1	1,9	RC	x
212	88	Any MC2 Trip	x	1	1,9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	IOTA 210
212	89	TD10TwoPickup	x	1	1,9	RC	x
212	90	TD120TwoPickup	x	1	1,9	RC	x
212	91	TRRTwoBus	x	1	1,9	RC	x
212	92	ESTwoOpen	x	1	1,9	RC	x
212	93	SecondFaultOne	x	1	1,9	RC	x
212	94	SecondFaultTwo	x	1	1,9	RC	x
212	95	Input1Operated	x	1	1,9	RC	x
212	96	Input2Operated	x	1	1,9	RC	x
212	97	Input3Operated	x	1	1,9	RC	x
22	98	Input4Operated	x	1	1,9	RC	x
212	99	Input5Operated	x	1	1,9	RC	x
212	100	Input6Operated	x	1	1,9	RC	x
212	101	Input7Operated	x	1	1,9	RC	x
212	102	Input8Operated	x	1	1,9	RC	x
212	103	Input9Operated	x	1	1,9	RC	x
212	104	Input10Operated	x	1	1,9	RC	x
212	105	Input11Operated	x	1	1,9	RC	x
212	106	Input12Operated	x	1	1,9	RC	x
212	107	Tx 1b Protn Trip	x	1	1,9	RC	x
212	108	Tx One b Isol Closed	x	1	1,9	RC	x
212	109	Tx One b Trip	x	1	1,9	RC	x
212	110	Tx 2b Protn Trip	x	1	1,9	RC	x
212	111	Tx Two b Isol Closed	x	1	1,9	RC	x
212	112	Tx Two b Trip	x	1	1,9	RC	x
255	0	GI End	-	8	10		x
255	0	Time Synchronisation	-	6	8		x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		IOTA 210
211	19	LED reset	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

7.15 Reyrolle TAU

FUN	INF	Description	GI	TYP	COT	DIR	Reyrolle TAU
60	1	IEC870 Active Com1	x	1	1,9	RC	x
60	2	IEC870 Active Com2	x	1	1,9	RC	x
60	3	Front Port OverRide	x	1	1,9	RC	x
60	4	Remote Mode	x	1	1,9	RC	x
60	5	Service Mode	x	1	1,9	RC	x
60	6	Local Mode	x	1	1,9	RC	x
60	7	Local & Remote	x	1	1,9	RC	x
60	12	Control Received		1	1	RO	x
60	13	Command Received		1	1	RO	x
60	128	Cold Start		1	1	RO	x
60	129	Warm Start		1	1	RO	x
60	130	Re-Start		1	1	RO	x
60	135	Trigger Storage		1	1	RO	x
70	5	Status Input 5	x	1	1,9	RC	x
70	6	Status Input 6	x	1	1,9	RC	x
70	7	Status Input 7	x	1	1,9	RC	x
70	8	Status Input 8	x	1	1,9	RC	x
70	9	Status Input 9	x	1	1,9	RC	x
70	10	Status Input 10	x	1	1,9	RC	x
70	11	Status Input 11	x	1	1,9	RC	x
70	12	Status Input 12	x	1	1,9	RC	x
70	13	Status Input 13	x	1	1,9	RC	x
70	14	Status Input 14	x	1	1,9	RC	x
70	15	Status Input 15	x	1	1,9	RC	x
70	16	Status Input 16	x	1	1,9	RC	x
70	17	Status Input 17	x	1	1,9	RC	x
70	18	Status Input 18	x	1	1,9	RC	x
70	19	Status Input 19	x	1	1,9	RC	x
70	20	Status Input 20	x	1	1,9	RC	x
70	21	Status Input 21	x	1	1,9	RC	x
70	22	Status Input 22	x	1	1,9	RC	x
70	23	Status Input 23	x	1	1,9	RC	x
70	24	Status Input 24	x	1	1,9	RC	x
70	25	Status Input 25	x	1	1,9	RC	x
70	26	Status Input 26	x	1	1,9	RC	x
70	27	Status Input 27	x	1	1,9	RC	x
70	28	Status Input 28	x	1	1,9	RC	x
70	29	Status Input 29	x	1	1,9	RC	x
70	30	Status Input 30	x	1	1,9	RC	x
70	31	Status Input 31	x	1	1,9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Reyrolle TAU
70	32	Status Input 32	x	1	1,9	RC	x
70	33	Status Input 33	x	1	1,9	RC	x
70	34	Status Input 34	x	1	1,9	RC	x
70	35	Status Input 35	x	1	1,9	RC	x
70	36	Status Input 36	x	1	1,9	RC	x
70	37	Status Input 37	x	1	1,9	RC	x
70	38	Status Input 38	x	1	1,9	RC	x
70	39	Status Input 39	x	1	1,9	RC	x
70	40	Status Input 40	x	1	1,9	RC	x
70	41	Status Input 41	x	1	1,9	RC	x
70	42	Status Input 42	x	1	1,9	RC	x
70	43	Status Input 43	x	1	1,9	RC	x
80	1	Plant Control Relay 1	x	1	1,9	RC	x
80	2	Plant Control Relay 2	x	1	1,9	RC	x
80	3	Plant Control Relay 3	x	1	1,9	RC	x
80	4	Plant Control Relay 4	x	1	1,9	RC	x
80	5	Plant Control Relay 5	x	1	1,9	RC	x
80	6	Plant Control Relay 6	x	1	1,9	RC	x
80	7	Plant Control Relay 7	x	1	1,9	RC	x
80	8	Plant Control Relay 8	x	1	1,9	RC	x
80	9	Plant Control Relay 9	x	1	1,9	RC	x
80	10	Plant Control Relay 10	x	1	1,9	RC	x
80	11	Plant Control Relay 11	x	1	1,9	RC	x
80	12	Plant Control Relay 12	x	1	1,9	RC	x
80	13	Plant Control Relay 13	x	1	1,9	RC	x
80	14	Plant Control Relay 14	x	1	1,9	RC	x
80	15	Plant Control Relay 15	x	1	1,9	RC	x
80	16	Plant Control Relay 16	x	1	1,9	RC	x
80	17	Plant Control Relay 17	x	1	1,9	RC	x
80	18	Plant Control Relay 18	x	1	1,9	RC	x
80	19	Plant Control Relay 19	x	1	1,9	RC	x
80	20	Plant Control Relay 20	x	1	1,9	RC	x
80	21	Plant Control Relay 21	x	1	1,9	RC	x
80	22	Plant Control Relay 22	x	1	1,9	RC	x
80	23	Plant Control Relay 23	x	1	1,9	RC	x
80	24	Plant Control Relay 24	x	1	1,9	RC	x
80	25	Plant Control Relay 25	x	1	1,9	RC	x
80	26	Plant Control Relay 26	x	1	1,9	RC	x
80	27	Plant Control Relay 27	x	1	1,9	RC	x
80	28	Plant Control Relay 28	x	1	1,9	RC	x
80	29	Plant Control Relay 29	x	1	1,9	RC	x
80	30	Plant Control Relay 30	x	1	1,9	RC	x
80	31	Plant Control Relay 31	x	1	1,9	RC	x
80	32	Plant Control Relay 32	x	1	1,9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	Reyrolle TAU
80	33	Plant Control Relay 33	x	1	1,9	RC	x
80	34	Plant Control Relay 34	x	1	1,9	RC	x
80	35	Plant Control Relay 35	x	1	1,9	RC	x
80	36	Plant Control Relay 36	x	1	1,9	RC	x
80	37	Plant Control Relay 37	x	1	1,9	RC	x
80	38	Plant Control Relay 38	x	1	1,9	RC	x
80	39	Plant Control Relay 39	x	1	1,9	RC	x
80	40	Plant Control Relay 40	x	1	1,9	RC	x
80	41	Plant Control Relay 41	x	1	1,9	RC	x
80	42	Plant Control Relay 42	x	1	1,9	RC	x
80	43	Plant Control Relay 43	x	1	1,9	RC	x
80	44	Plant Control Relay 44	x	1	1,9	RC	x
80	45	Plant Control Relay 45	x	1	1,9	RC	x
213	0	Data lost	-	1	1	RO	x
213	2	Reset FCB	-	5	3	RO	x
213	3	Reset CU	-	5	4	RO	x
213	4	Start/Restart	-	5	5	RO	x
213	5	Power On	-	5	6	RO	x
213	6	Line Check		1	1	RO	x
213	7	Manual Close Fail		1	1	RO	x
213	8	DAR Successful Close		1	1	RO	x
213	9	Manual Successful Close		1	1	RO	x
213	10	CB Not In Service		1	1	RO	x
213	11	CB Memory		1	1	RO	x
213	12	AR Not Allowed		1	1	RO	x
213	13	Sync Manual Close	x	1	1,9	RC	x
213	14	CB DBI	x	1	1,9	RC	x
213	16	Auto-Recloser Active	x	1	1,9	RC	x
213	17	teleprotection active		1	1	RO	x
213	27	Status Input 1	x	1	1,9	RC	x
213	28	Status Input 2	x	1	1,9	RC	x
213	29	Status Input 3	x	1	1,9	RC	x
213	30	Status Input 4	x	1	1,9	RC	x
213	68	General Trip		2	1	RO	x
213	69	Trip L1		2	1	RO	x
213	70	Trip L2		2	1	RO	x
213	71	Trip L3		2	1	RO	x
213	84	General Start/Pick-up	x	2	1,9	RC	x
213	128	CB 'on' by AR		1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Reyrolle TAU
213	130	AR blocked	x	1	1,9	RC	x
213	131	Lockout	x	1	1,9	RC	x
213	132	CB Failed To Close		1	1	RO	x
213	133	CB Failed To Open		1	1	RO	x
213	134	Close Onto Fault		1	1	RO	x
213	135	VT Failure Alarm	x	1	1,9	RC	x
213	136	Total CB Close Count Alarm		1	1	RO	x
213	137	Synch In Progress	x	1	1,9	RC	x
213	138	Sync Override		1	1	RO	x
213	139	Dead Line Close		1	1	RO	x
213	140	Dead Bus Close		1	1	RO	x
213	141	System Split Output	x	1	1,9	RC	x
213	142	Check Sync Start	x	1	1,9	RC	x
213	161	Cold Start		1	1	RO	x
213	162	Warm Start		1	1	RO	x
213	163	Re-Start		1	1	RO	x
213	164	Trigger Storage		1	1	RO	x
213	165	Sync Reset	x	1	1,9	RC	x
213	166	Start Up LO	x	1	1,9	RC	x
213	167	In Service LO	x	1	1,9	RC	x
213	168	CB Closed	x	1	1,9	RO	x
213	169	CB Open	x	1	1,9	RO	x
213	170	In Sync CS	x	1	1,9	RC	x
213	171	CS Phase Out Of Limits	x	1	1,9	RC	x
213	172	CS Slip Out Of Limits	x	1	1,9	RC	x
213	173	Voltage Check	x	1	1,9	RC	x
213	174	In Sync SS	x	1	1,9	RC	x
213	175	SS Phase Out Of Limits	x	1	1,9	RC	x
213	176	SS Slip Out Of Limits	x	1	1,9	RC	x
213	177	Coming In	x	1	1,9	RC	x
213	178	System Split Latch	x	1	1,9	RC	x
213	179	In Sync COZ	x	1	1,9	RC	x
213	180	COZ Out Of Limits	x	1	1,9	RC	x
213	181	CS In Progress	x	1	1,9	RC	x
213	182	SS In Progress	x	1	1,9	RC	x
213	183	COZ In Progress	x	1	1,9	RC	x
213	184	System Split LO		1	1	RO	x
213	185	DAR Revert To CS	x	1	1,9	RC	x
213	186	MC Revert To CS	x	1	1,9	RC	x
213	187	Feeder One Trip		1	1	RO	x
213	188	Feeder Two Trip		1	1	RO	x
213	189	Mesh Corner One Trip		1	1	RO	x
213	190	Mesh Corner Two Trip		1	1	RO	x
213	191	A Trip		1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Reyrolle TAU
213	192	B Trip		1	1	RO	x
213	193	C Trip		1	1	RO	x
213	194	3 Trip		1	1	RO	x
213	195	ES One Open		1	1	RO	x
213	196	ES One Closed		1	1	RO	x
213	197	F4 One Out Of Service		1	1	RO	x
213	198	F4 One In Service		1	1	RO	x
213	199	Close ES One		1	1	RO	x
213	200	Open ES One		1	1	RO	x
213	201	ES One Fail To Close		1	1	RO	x
213	202	ES One Fail To Open		1	1	RO	x
213	203	ES One DBI		1	1	RO	x
213	204	F4 One Ferrores Fail		1	1	RO	x
213	205	F4 One In Progress	x	1	1,9	RC	x
213	206	F4 One Inhibit Plant Isolation	x	1	1,9	RC	x
213	207	ES Two Open		1	1	RO	x
213	208	ES Two Closed		1	1	RO	x
213	209	F4 Two Out Of Service		1	1	RO	x
213	210	F4 Two In Service		1	1	RO	x
213	211	Close ES Two		1	1	RO	x
213	212	Open ES Two		1	1	RO	x
213	213	ES Two Fail To Close		1	1	RO	x
213	214	ES Two Fail To Open		1	1	RO	x
213	215	ES Two DBI		1	1	RO	x
213	216	F4 Two Ferrores Fail		1	1	RO	x
213	217	F4 Two In Progress	x	1	1,9	RC	x
213	218	F4 Two Inhibit Plant Isolation	x	1	1,9	RC	x
213	219	F3 One Out Of Service		1	1	RO	x
213	220	F3 One In Service		1	1	RO	x
213	221	F3 Two Out Of Service		1	1	RO	x
213	222	F3 Two In Service		1	1	RO	x
213	223	F4 One Interlock	x	1	1,9	RC	x
213	224	;ResetF4SequenceOne	x	1	1,9	RC	x
213	225	Successful Close		1	1	RO	x
213	226	External A/R Start		1	1	RO	x
213	227	Manual Close	x	1	1,9	RC	x
213	228	Reset Lockout		1	1	RO	x
213	229	A/R Out	x	1	1,9	RC	x
213	230	A/R In	x	1	1,9	RC	x
213	231	In Sync Output	x	1	1,9	RC	x
213	232	Live Bus	x	1	1,9	RC	x
213	233	Live Line	x	1	1,9	RC	x
213	234	Trip		1	1	RO	x
213	235	Starter		1	1	RO	x
213	236	Reclose Lockout		1	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	Reyrolle TAU
213	237	Trip And Reclose Input		1	1	RO	x
213	238	CB Pole Discrepancy		1	1	RO	x
213	239	Reclaim		1	1	RO	x
213	240	Ext Group Change		1	1	RO	x
213	241	Ext Group Back		1	1	RO	x
213	242	Manual Sync Override		1	1	RO	x
213	243	Intertrip Receive	x	1	1,9	RC	x
213	244	Autosolation Complete I/P		1	1	RO	x
213	245	Inhibit Seq Isolation		1	1	RO	x
213	246	Persistent Intertrip		1	1	RO	x
213	247	Autosolation Fail		1	1	RO	x
213	250	CB 'on' by MC		1	1	RO	x
213	251	A/R In Progress	x	1	1,9	RC	x
213	252	Total CB Count Reset		1	1	RO	x
213	253	Delta CB Count Reset		1	1	RO	x
255	0	GI End	-	8	10		x
255	0	Time Synchronisation	-	6	8		x

Table Showing Information (INF) Numbers

FUN	INF	Description	COM	TYP	COT		Reyrolle TAU
210	16	Auto-reclose on/off	ON/OFF	20	20		x
210	23	Select Group 1	ON	20	20		x
210	24	Select Group 2	ON	20	20		x
210	25	Select Group 3	ON	20	20		x
210	26	Select Group 4	ON	20	20		x
210	252	Reset Total CB Count	ON	20	20		x
210	253	Reset Delta CB Count	ON	20	20		x
255	0	Time Synchronisation	-	6	8		x
255	0	Initiate General Interrogation	-	7	9		x

Table Showing Command Information (INF) Numbers

8 APPENDIX C - DIALOGUE TYPE INFORMATION EXCHANGE

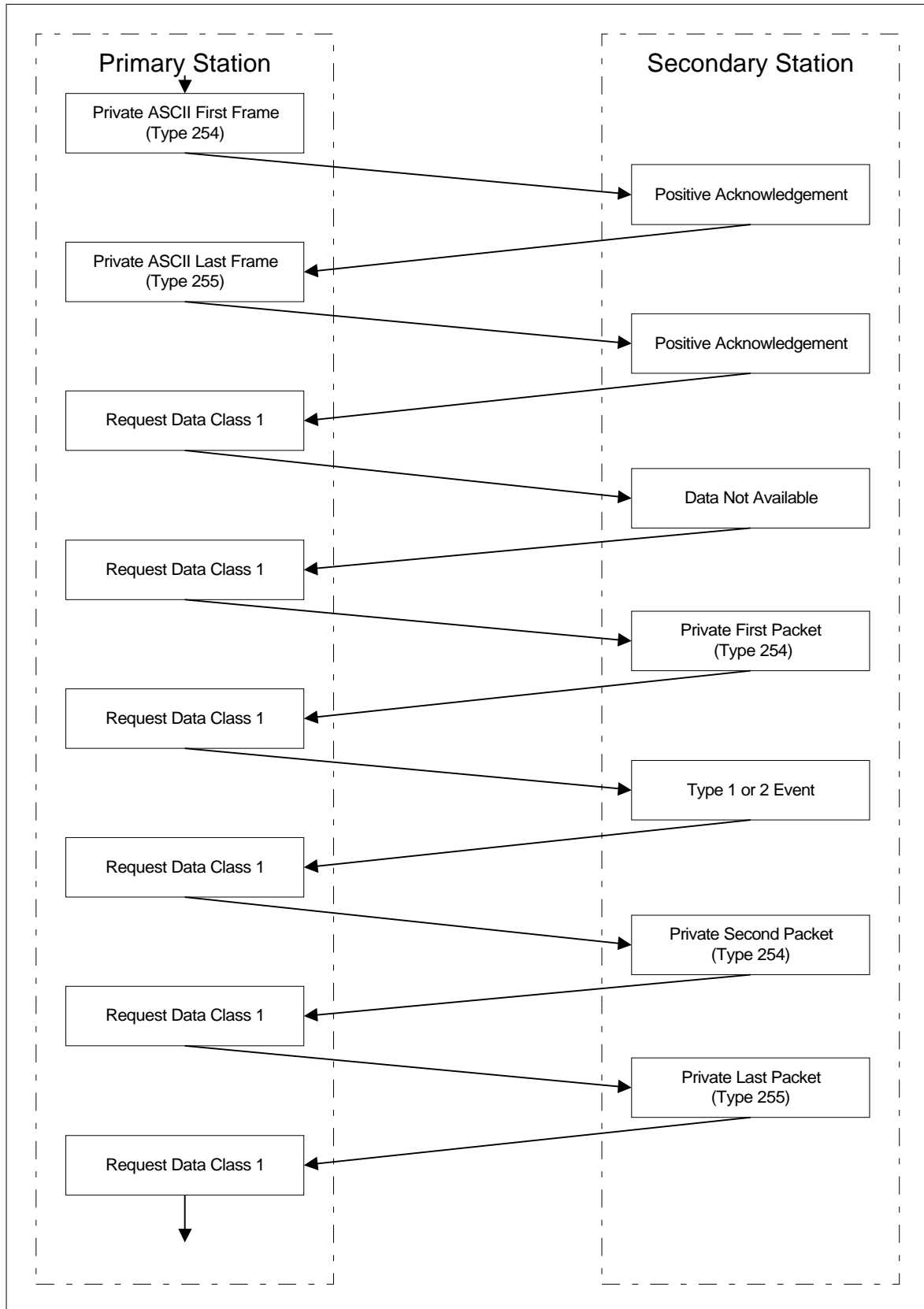


Figure 1 - Handshaking for Dialogue Type Information Exchange

9 APPENDIX D - EXAMPLES OF SETTING VALUE DESCRIPTIONS

[[]]
 [[1{?5+10*}]]
 [[-0{"INST"}60{?}]]
 [[48{?2+20/}]]
 [[0{"DTL"}1{"NI"}2{"VI"}3{"EI"}4{"LT1"}]]
 [[63{?1+40/}]]
 [[2000{?100/}]]
 [[-0{"OFF"}49{?1+20/}149{?44-2/}]]
 [[191{?1+200/}]]
 [@[MENU]]
 [[\$16{"ABCDEFGHIJKLMNPOQRSTUVWXYZ0123456789-+/"}]]
 [\$1{"_12345678"}]]
 [\$5{"_12345678"}]]
 [@[DATE]]
 [@[TIME]]
 [[1{?4*1+}]]
 [[[15]1999{?1+5*}][[1]1{?4*1+}]]
 [[0{"xIn"}1{"PRIMARY"}2{"SECONDARY"}]]
 [[0{"E/F"}1{"P/F"}]]
 [[0{"SEF"}1{"REF"}]]
 [[#7[7F]{R1}{R2}{R3}{R4}{R5}{R6}{R7}]]
 [[#11[7FF]{R1}{R2}{R3}{R4}{R5}{R6}{R7}{R8}{R9}{R10}{R11}]]
 [[#1[1]{S1}]]
 [[#5[1F]{S1}{S2}{S3}{S4}{S5}]]
 [[0{75}1{110}9{2?2-^150*}]]
 [[254{?}]]
 [[#4[F]{STA}{P/F}{E/F}{SEF}]]
 [[-0{"OFF"}10{?10*}]]
 [[0{"OFF"}999{?}]]
 [[-0{"OFF"}100{?100/}200{?100-10*}300{?200-10000*}]]
 [[0{"OFF"}1{"ON"}]]
 [[0{"LIGHT OFF"}1{"LIGHT ON"}]]
 [[PASSWORD]]
 [[7{1?+}]]
 [[[8]7{1?+}][[8]7{1?+}]]
 [[0{"NO"}1{"YES"}]]
 [[0{30}1{45}]]
 [[0{?}1{?15-}2{?45-}3{?65-}]]
 [[0{"NONE"}1{"EVEN"}]]
 [[-0{"OFF"}2001{?1-100/}]]
 [[0{"OFF"}1{"FWD"}2{"REV"}3{"TRI"}]]

10 APPENDIX E- REVERSE POLISH NOTATION EXPLAINED

In normal (infix) notation, the sum of 'a' and 'b' would be expressed as:

$$a + b$$

In reverse polish (post-fix) notation, the operators are bunched together before the operand, i.e.

$$a b +$$

Below is a more complex example:

$$a * b + c$$

In order to convert complicated expressions it is sometimes easier fully parenthesise the infix notion, i.e.

$$((a * b) + c)$$

Now to convert to reverse polish, start from the inner most level of parenthesis and work out:

$$(a b *) \quad \text{Inner-most level}$$

$$((a b *) c +) \quad \text{Next level}$$

$$a b * c + \quad \text{Finally, remove all braces:}$$

In contrast, compare the above example to the following:

$$a * (b + c)$$

$$(a * (b + c)) \quad \text{First fully parenthesise:}$$

$$(b c +) \quad \text{Convert inner-most level}$$

$$(a (b c +) *) \quad \text{Next level}$$

$$a b c + * \quad \text{Remove the braces}$$

In the relay, the variables are all replaced by either positive integers or a question mark '?'. The question mark represents the internal value of the setting. For example, if the internal value is 5 and the equation is :

$$? 2 +$$

this would equate to:

$$5 2 +$$

which in infix notation is:

$$5 + 2$$

i.e. seven.

Now use the formula for baud rate generation:

$$2^{n-2} \times 150$$

$$((2^{(n-2)}) * 150) \quad \text{written in fully parenthesised infix form}$$

$$(n 2 -) \quad \text{convert inner-most level}$$

$$(2 (n 2 -) ^) \quad \text{next level}$$

$$((2 (n 2 -) ^) 150 *) \quad \text{final level}$$

remove braces and replace the 'n' with a '?' and the reverse polish form is:

$$2 ? 2 - ^ 150 *$$

The following operators can currently be processed by the settings parser			
+	addition	d	integer division
-	subtraction	m	modulus
*	multiplication	^	raise to the power
/	floating-point division		

11 APPENDIX F - BNF FOR REVERSE POLISH SETTING VALUE DESCRIPTION

<DESCRIPTION>	::=	[<ITEMS>
<ITEMS>	::=	@ [<FIELD> [<FIELD>
<FIELD>	::=	Digit<NORMAL> -Digit<NORMAL> \$Digit<STRING> #Digit<BITWISE> [[Digit<NUM BITS> PASSWORD]]<DISPLAY_CONDITION> [MENU]]<DISPLAY_CONDITION> DATE]]<DISPLAY_CONDITION> [TIME]]<DISPLAY_CONDITION>]]<DISPLAY_CONDITION>
<NUM BITS>	::=	Digit<NUM BITS>]]Digit<NORMAL>
<NORMAL>	::=	Digit<NORMAL> {<FIRST RANGE>
<FIRST RANGE>	::=	?<RANGE> Digit<RANGE> "Printable<LABEL> }<NEXT VAL>
<RANGE>	::=	?<RANGE> Digit<RANGE> ArithmeticOperator<RANGE> Space<RANGE> }<NEXT VAL>
<NEXT VAL>	::=	Digit<NORMAL> -Digit<NORMAL>]<NEXT FIELD>
<LABEL>	::=	"} <NEXT VAL> Printable<LABEL>
<NEXT FIELD>	::=	[<NEXT NUM>]]<DISPLAY_CONDITION>
<NEXT NUM>	::=	[Digit<NUM BITS> Digit<NORMAL>
<BITWISE>	::=	Digit<BITWISE> [HexDigit<BITMASK>
<BITMASK>	::=	HexDigit<BITMASK> {"Printable<BIT LABEL>
<BIT LABEL>	::=	"}<NEXT BIT> Printable<BIT LABEL>
<NEXT BIT>	::=	{Printable<BIT LABEL>]]<DISPLAY_CONDITION>
<STRING>	::=	Digit<STRING> {"Printable<STRING BODY>
<STRING BODY>	::=	"]]<DISPLAY_CONDITION> Printable<STRING BODY>
Digit	::=	any digit 0-9
HexDigit	::=	any hex digit 0-9,a-f,A-F
Printable	::=	any printable character (ASCII 32 - 126)
Space	::=	the space character (ASCII 32)
ArithmeticOperator	::=	+, -, *, /, d, m, ^

12 APPENDIX G - BNF FOR REVERSE POLISH SETTING DISPLAY CONDITION

<DISPLAY_CONDITION> ::= [**<EXPRESSION>**
<EXPRESSION> ::= S**<FIRST_DIGIT>**|V**<FIRST_DIGIT>**
|LogicalOperator|
<FIRST_DIGIT> ::= Digit**<NEXT_DIGIT>**
<NEXT_DIGIT> ::= Digit**<NEXT_DIGIT>**|Space**<EXPRESSION>**
Digit ::= any digit 0-9
HexDigit ::= any hex digit 0-9,a-f,A-F
Space ::= the space character (ASCII 32)
LogicalOperator ::= &&,||,==,!|=,>=,>,<=,<

13 DIAGRAMS

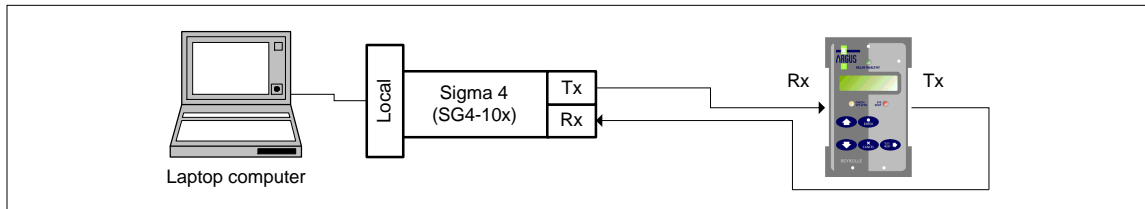


Figure 2 - Basic Communications Configuration

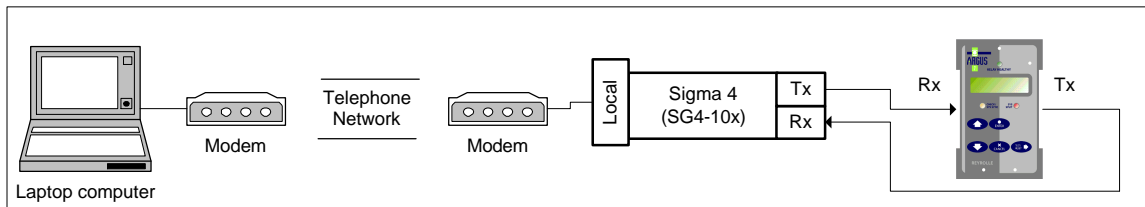


Figure 3 - Basic Communications Configuration (Remote)

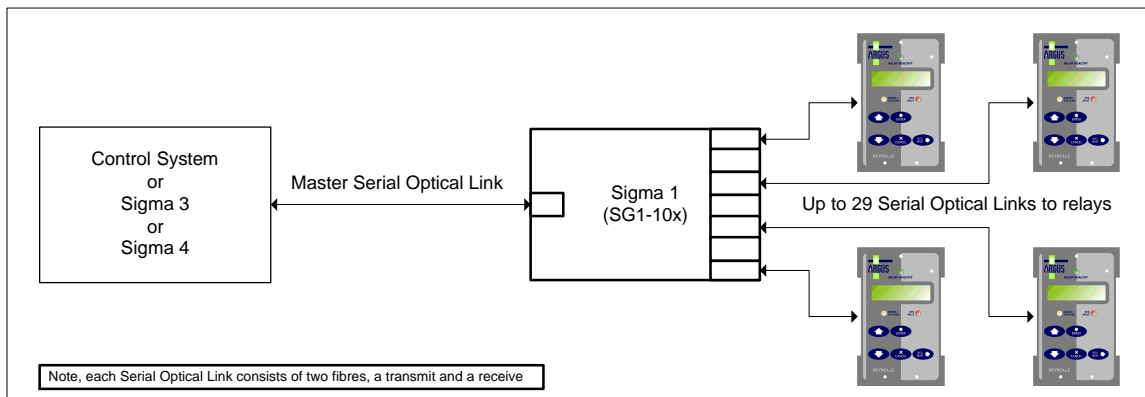


Figure 4 - Communications using Reyrolle Sigma 1 in Star Configuration

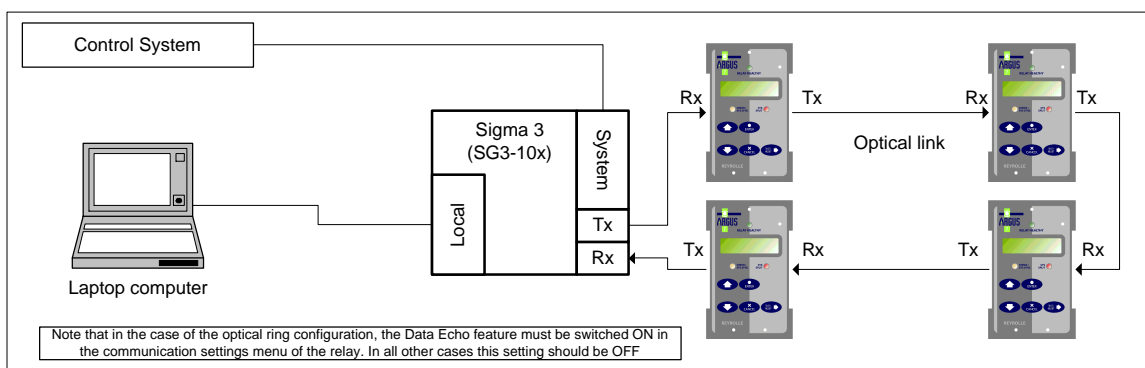


Figure 5 - Communication using Reyrolle Sigma 3 in Optical Ring Configuration

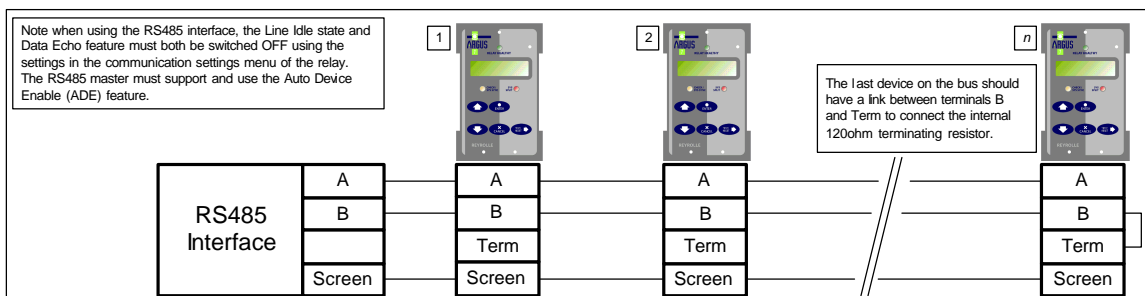


Figure 6 - Communication using the RS485 Interface

14 FIBRE-OPTIC DATA

Note. This data refers to the fibre optic data communications port only. It does not refer to the protection signalling of the Solkor-N relay. Refer to the Solkor-N manual for further information. All products are optimised for use with glass fibre cable, except where polymer (p) is stated.

14.1 LAUNCH POWER (dBm)

The amount of light that can be focussed into the fibre.

CABLE TYPE	SOURCE								
	Argus (p)	Argus	Modular I	Modular II	Sigma 1	Sigma 3 (p)	Sigma 3	Sigma 4 (p)	Sigma 4
1 mm polymer	-10.5	-7	-10	-7	-7	14.8	-14.6	10.6	-14.6
200 µm PCS	-14.4	-6.2	-11.7	-6.2	-6.2	21.8	-13.4	21.7	-13.4
62.5 / 125 µm glass	-29	-16	-20	-16	-16		-22.7		-22.7
50 / 125 µm glass	-32.6	-19.8	-22.8	-19.8	-19.8		-26.2		-26.2

14.2 RECEIVER SENSITIVITY (dBm)

The minimum amount of light required for operation.

	DESTINATION								
	Argus (p)	Argus	Modular I	Modular II	Sigma 1	Sigma 3 (p)	Sigma 3	Sigma 4 (p)	Sigma 4
Sensitivity (dBm)	-20	-24	-24	-24	-24	-20	-25.4	-25.4	-25.4

14.3 DISTANCE CALCULATION

Taking the launch power and receiver sensitivity from the above two tables, and allowing for a safety margin, losses due to joints in the cables and the loss per kilometre in the cables as specified by the cable manufacturer, the distance can be calculated as follows:

$$Distance(km) = \frac{LaunchPower - ReceiverSensitivity - SafetyMargin - JointLoss}{LossPerKiloMetre}$$

Example

Sigma 1 transmits to an Argus (g) using 62.5µm glass fibre cable (loss 2.8 dB / km) and a safety margin of 3dB.

$$d(km) = \frac{(-16) - (-24) - 3 - 0}{2.8}$$

$$d(km) = \frac{5}{2.8}$$

$$d(km) = 1.7857$$

14.4 DISTANCES

These figures are based on manufacturers' data and may be subject to change without notice. No account is taken of minimum distances. With certain fibres, it is possible to overload the receivers thus causing errors. All distances are in metres, and are maximum figures, allowing for LED degradation. All products are optimised for use with glass fibre cable, except where polymer (p) is stated.

1mm polymer

SOURCE	DESTINATION								
	Argus (p)	Argus	Modular I	Modular II	Sigma 1	Sigma 3 (p)	Sigma 3 (ST)	Sigma 4 (p)	Sigma 4
Argus (p)	40	70	0	70	70	40	80	80	80
Argus	4.5	6.5	0	6.5	6.5	4.5	6.0	7.0	6.0
Modular I	0	0	5.5	0	0	3.5	6.0	6.0	6.0
Modular II	4.5	6.5	0	6.5	6.5	4.5	6.0	7.0	6.0
Sigma 1	4.5	6.5	0	6.5	6.5	4.5	7.0	7.0	7.0
Sigma 3 (p)	10.0	35	35	35	35	10.0	45	45	45
Sigma 3 (ST)	2.5	4.5	4.5	4.5	4.5	2.5	5.0	5.0	5.0
Sigma 4 (p)	38	65	65	65	65	35	75	75	75
Sigma 4 (ST)	2.5	4.5	4.5	4.5	4.5	2.5	5.0	5.0	5.0

200µm PCS

SOURCE	DESTINATION								
	Argus (p)	Argus	Modular I	Modular II	Sigma 1	Sigma 3 (p)	Sigma 3 (ST)	Sigma 4 (p)	Sigma 4
Argus (p)	100	260	0	260	260	100	320	320	320
Argus	1540	2110	0	2110	2110	1540	2310	2310	2310
Modular I	0	0	1320	0	0	750	1520	1520	1520
Modular II	1540	2110	0	2110	2110	1540	2310	2310	2310
Sigma 1	1540	2110	0	2110	2110	1540	2310	2310	2310
Sigma 3 (p)	0	0	0	0	0	0	0	0	0
Sigma 3 (ST)	370	940	940	940	940	370	1140	1140	1140
Sigma 4 (p)	0	0	0	0	0	0	0	0	0
Sigma 4 (ST)	370	940	940	940	940	370	1140	1140	1140

62.5/125 µm glass

SOURCE	DESTINATION								
	Argus (p)	Argus	Modular I	Modular II	Sigma 1	Sigma 3 (p)	Sigma 3 (ST)	Sigma 4 (p)	Sigma 4
Argus (p)	0	0	0	0	0	0	0	0	0
Argus	350	1780	0	1780	1780	350	2280	2280	2280
Modular I	0	0	350	0	0	0	850	850	850
Modular II	350	1780	0	1780	1780	350	2280	2280	2280
Sigma 1	350	1780	0	1780	1780	350	2280	2280	2280
Sigma 3 (p)	0	0	0	0	0	0	0	0	0
Sigma 3 (ST)	20	20	20	20	20	20	20	20	20
Sigma 4 (p)	0	0	0	0	0	0	0	0	0
Sigma 4 (ST)	20	20	20	20	20	20	20	20	20

50/125 µm glass

SOURCE	DESTINATION								
	Argus (p)	Argus	Modular I	Modular II	Sigma 1	Sigma 3 (p)	Sigma 3 (ST)	Sigma 4 (p)	Sigma 4
Argus (p)	0	0	0	0	0	0	0	0	0
Argus	0	420	0	420	420	0	920	920	920
Modular I	0	0	0	0	0	0	0	0	0
Modular II	0	420	0	420	420	0	920	920	920
Sigma 1	0	420	0	420	420	0	920	920	920
Sigma 3 (p)	0	0	0	0	0	0	0	0	0
Sigma 3 (ST)	20	20	20	20	20	20	20	20	20
Sigma 4 (p)	0	0	0	0	0	0	0	0	0
Sigma 4 (ST)	20	20	20	20	20	20	20	20	20

Example:

A ring of relays with a Sigma 4p is required to communicate with a PC. The ring consists of an Argus relay and a MicroTAPP. From the Transmitter of the Sigma 4p to the Receiver of the Argus, using 1mm polymer fibre, the maximum distance is 38m. From the Transmitter of the Argus to the Receiver of the MicroTAPP (Modular II) using 1mm polymer fibre, the maximum distance is 70m. From the Transmitter of the MicroTAPP to the Receiver of the Sigma 4p, the maximum distance is only 7m with 1mm polymer fibre. However, using 200PCS, the maximum distance is extended to 2.3km! (There is a minimum distance associated with this configuration, however, of around 1.5km).