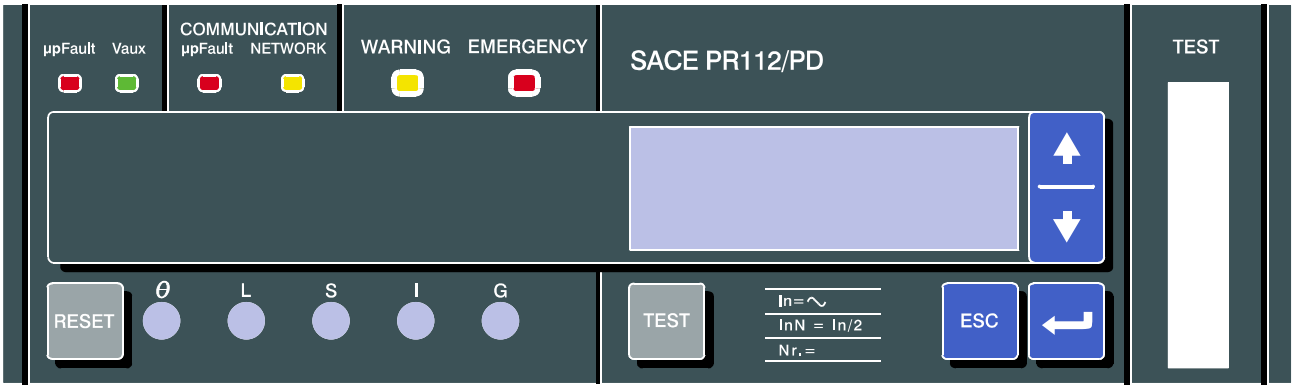
PR112/PD-M Modbus™ System Interface



Author Autore	LB-PA		L0440		Doc. Type Tipo Doc.	Lang. Lingua
Approv. Approv.					Title Titolo	**PR112/PD-M Modbus™ System Interface** ENG
ABB	19-09-2001				Doc. No N. Doc.	**RH0295.001** Tot. Pag.
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1. General

This document describes the Modbus™ interface regarding:

- Network Management of the device (installation, configuration, …)
- Application Objects and Slave Variables

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ModConnect	BM85	RR85	SQ85
Modcom	BP85	SA85	

1.1 Applicability

This document applies to the Communication Unit of the PR112/PD-Modbus ™ (also called PR112/PD-M) device only.
It could be used as a starting point for other Modbus™ device too.

1.2 Applicable Documents

[1] Schneider Automation Inc., '*Modicon MODBUS Protocol Reference Guide*', June 1996, rev. J, PI-MBUS-300

1.3 Acronyms and Definitions

1.3.1 Acronyms

AI	**Analog Input**
AO	**Analog Output**
AppObj	**Application Object**
CB	**Circuit Breaker (ACB EMAX family)**
CP	**Configuration Parameter**
CT	**Current Transformer**
CU	**Communication Unit (PR112/D-M)**
DI	**Digital Input**
DCP	**Dialogue (CU) Configuration Parameter**
DO	**Digital Output**
ETT	**Electronic Trip Test**
In	**Nominal current**
LSb	**Least Significant bit**
LSB	**Least Significant Byte**
MSb	**Most Significant bit**
MSB	**Most Significant Byte**
PCP	**Protection Configuration Parameter**
PU	**Protection Unit (PR112/P)**
OR	**(Main) Opening Release**
SOR	**Shunt Opening Release**
UVR	**Under Voltage Release**

1.3.2 Definitions

ALARM there are two types of alarm:

Alarm Type	Definition
Alarm	It's similar to a status. It will be frozen after a protection trip into the "Trip Report" structures. A Trip Reset is NOT necessary to reset it. Ex. L Pre-Alarm, S Alarm, ...
Trip	Only a command can reset it, i.e. a new alarm won't be signalled until the reset. Ex. L Tripped, S Tripped, ...

Trips are reset after a Trip Reset command.

BUFFER Meaningful part of a Modbus™ Map section.

It's defined by the device Modbus™ Map.

CB RESET command equal to a Trip Reset.

COIL the least digital information container (i.e. one bit)

COMMUNICATION UNIT PR112/D-M electronic board that implements the Modbus™ interface

DEVICE Protection and Communication Unit (i.e. the PR112/PD-M)

EVENT information that signals a normal (foreseen) device behaviour.

Typically, the producer of an event is the device, while the consumer (who resets it) is the system.

Reset of an event is automatically done after a read operation from the system.

ITEM a Digital (coil) or an Analog (register) Modbus™ data type

OPERATION every CB status transition toward OPEN state. It doesn't matter which is the starting state (TRIPPED or CLOSED).

OTHER TRIPS sum of CB status transitions toward the TRIPPED state, either from the OPEN or CLOSED starting state, but not caused by the protection.

So they are all the transitions caused by an electronic trip test, under voltage release and secondary shunt opening release.

PARAMETER information that allows configuration of a device functionality (e.g. a protection algorithm).

PERSISTENCE 'volatile/non-volatile' attribute concerning information, i.e. the information is/is not still available after a power fail/HW reset/...

PERSISTENCE	Description
Temporary (default)	Information is NOT still available after a power fail/HW reset/...
Permanent	Information is still available after a power fail/HW reset/...

For example, parameters and trip data have this attribute set to PERMANENT, while states/events/alarms settings are TEMPORARY.

PROTECTION TRIPS sum of real protection trips (Σ LSIG trips).
'Real' means 'not caused by the Test Unit PR010/T.
Trips that come up when:

- Test Unit connected
- CB closed and/or currents NOT equal to zero

are considered 'real'.
In fact, in his case the Test Unit can only read values and can NOT simulate a trip.

PROTECTION UNIT PR112/P electronic board that implements protection algorithms

PROTECTION X TRIPS sum of trip of protection X (e.g. L, S, I, G).

REGISTER the least analogue information container (one word = 2 bytes)

STATUS information that represents the dynamics of a functionality (e.g. the CB or a protection algorithm). It can be managed (i.e. set/reset) only by the device itself.

TRIP COMMAND FAIL after a protection trip, with relevant opening command to the release, CB stays in CLOSED state. In this case, the CU tries to open the CB using the YO.

TRIP RESET event (Any Alarm) /alarm reset of any information related to the (last) trip.
It doesn't change the 'real' CB status (i.e. the CB is OPEN) but it changes the 'virtual' CB status from TRIPPED to OPEN.

(PROCESS) VARIABLE information strictly connected to device functionality. Examples are:

- commands
- states/events
- alarms
- measurements
- historical/statistical data
- ...

2. Introduction

It has been decided to describe the device according to the Modbus™ protocol [1] and a high level description for different functionality called *Application Object (AppObj)*.
These AOs manage the reporting of the Protection Unit information to the remote system. This information is polled by the Communication Unit to the Protection Unit according to the Internal Bus Protocol.
Moreover the Communication Unit manages the Internal Bus sharing with the Test Unit (e.g. PR010/T) according to the Master Token Protocol.

2.1 Modbus™ Protocol and Map Organisation

2.1.1 Communication parameters

1. Transmission mode: RTU (2 four bits hexadecimal chars for each byte).

2. Serial parameters:

Start Bit	Data Bits	Parity Bit	Stop Bit
1	8 (LSb first)	1 (even | odd)	1

Table 1. Serial parameters

Please note that mode and serial parameters MUST be the same for all devices on a Modbus™ network.
Only the parity parameter is modifiable.

3. Baud Rate: [9600 | 19200].

DEFAULT VALUES: Even Parity, Baud Rate = 19200

2.1.2 Device RTU Framing

START	SLAVE ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1 – T2 – T3 – T4	8 bits	8 bits	n * 8	16 bits	T1 – T2 – T3 – T4

Figure 1. Modbus™ message

Up to 256 bytes can be sent.

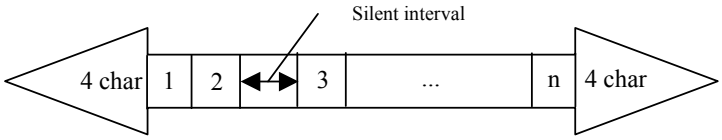
The allowed inter-character silent interval is been relaxed from ‘at least 2 characters’ to ‘at least 4 characters’ (the same silent interval to recognise the end of a message). This means:

2.1.2.1 Silent interval < 4 char between two characters inside the message

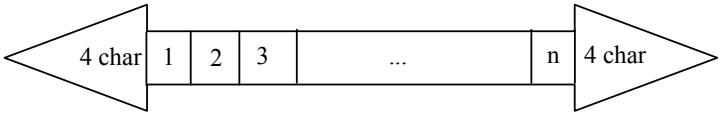
In this case the receiver filters the silent interval and the following characters will be appended to those already received.
The difference from the protocol specification is:

1. Silent interval < 2 char between two characters inside the message

Transmitter



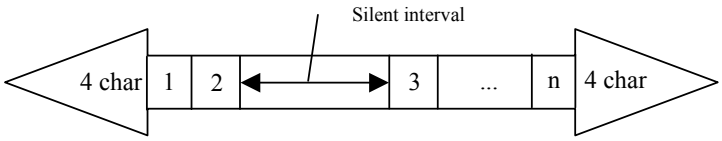
Receiver



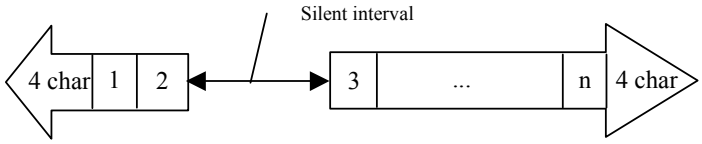
The behaviour is exactly as specified by the protocol.

2. Silent interval ≥ 2 char and < 4 char between two characters inside the message
The received characters are NOT flushed and the following ones will be appended.

Transmitter



Receiver



Note that after flushing, the standard protocol specification allows:

- reception of the remaining characters of a partially received message;
- reception of a completely new message.

The device behaviour **doesn't cover the second case** because it always appends new incoming characters to the previous ones, leading to a CRC error.
So the behaviour is exactly the same if and only if the incoming characters are NOT a new message. In this case the received packet will lead to a CRC error and the CRC error counter will be incremented.

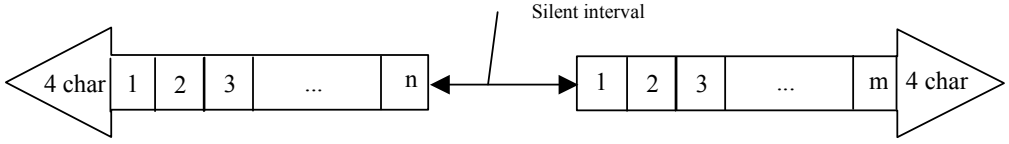
2.1.2.2 Silent interval ≥ 4 char between two characters inside the message

If the message transmission is NOT ended, all the previously received characters are managed as a message because this is exactly the protocol specification regarding the end of a message.

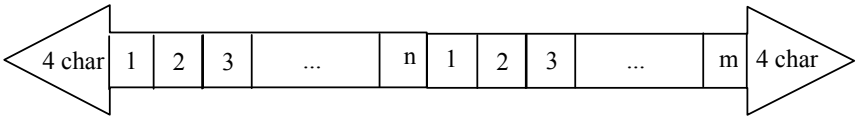
2.1.2.3 New frame before 4 character silent interval at the end of a frame

In this case the receiver filters the silent interval and the following characters (of the new frame) will be appended to those already received (see case 2 of par. 2.1.2.1).
This will lead to a CRC error.

Transmitter



Receiver



So the CRC error counter will count both the 'real' CRC errors and the inter-character errors.

2.1.3 Response Timeout

The reported timeouts have been measured over more than 100 samples (normal responses) in the following conditions:

- device in 'normal' status, i.e. only measurements are periodically updated and NO alarm conditions are satisfied

	Minimum (ms)	Medium (ms)	Maximum (ms)
Single COIL Read	17.095	17.410	19.442
Multiple COILS (42) Read	20.678	21.081	23.290
Single REGISTER Read	17.572	17.978	19.894
Multiple REGISTERS (56) Read	81.805	82.824	84.397

Table 2. Response Timeout

Please note that the multiple items read has been performed on maximum number of items allowed by the device map, in particular:

- 42, status / events, alarms, trips
- 56, present parameters in use

The minimum suggested response timeout for **periodically polled information** is 25 ms.

2.1.4 Reception checks

After reception, the device performs the following checks:

- CRC,
- Max Message Length allowed (256 bytes),
- Slave Address.

If any of this information is not correct, the received message is discarded and no response message is sent back to the Master.

2.1.5 Function Codes

The following standard functions have to be supported:

Code	HEX Code	Name	Applies to
01	0x01	Read Coil Status	DO
02	0x02	Read Input Status	DI
03	0x03	Read Holding Register	AO
04	0x04	Read Input Register	AI
05	0x05	Force Single Coil	DO
06	0x06	Preset Single Register	AO
08	0x08	Diagnostic Sub-function: 0 (0x00)	
15	0x0F	Force Multiple Coils	DO
16	0x10	Preset Multiple Registers	AO
17	0x11	Report Slave ID	

Table 3. PR112/PD-M function codes

All other NOT supported function codes lead to an Exception response 'ILLEGAL_FUNCTION'.

These functions can be grouped into two different categories:

1. Data Management functions.
   Functions applied to device data into the Modbus™ Map (codes 01, 02, 03, 04, 05, 06, 15 and 16).

2. Network / Device Management functions.
   Functions applied to device that can:
   - request / setting general information
   - change the device behaviour / status
   - …

   Function codes 08 and 17 belong to this category.

2.1.5.1 08 (0x08) Diagnostic

The function uses a two-byte sub-function code field in the query to define the type of test to be performed.
Most of the diagnostic queries use a two-byte data field to send diagnostic data or control information to the slave.

Sub-function Hi	Sub-function Lo	Data Hi	Data Lo

Figure 2. 'Diagnostic' query data field structure

where the only supported sub-function code is:

Sub-function code	HEX code	Name	Description
00	0x00	Return Query Data	The data passed in the information field will be returned to the Master via the addressed Modbus™ Slave. The entire message returned should be identical to the message transmitted by the Master, field-per-field.

NOTE: the protocol specification on data field ('Any', pages 74 – 75, 77) is NOT clear. The device allows both a generic field length (i.e. more than two bytes) and a generic value range.

2.1.5.2 17 (0x11) Report Slave ID

A normal response has some fields defined and others device dependent:

Byte Count	Slave ID	Run Indicator Status	Additional Data ...

Figure 3. 'Report Slave ID' response data field structure

where:

- 'Byte Count' depends on 'Additional Data'. Its minimum value is 2.
- 'Slave ID' is the identifier of the device of a specific manufacturer (i.e. devices from different manufacturers could have the same 'Slave ID'):

Slave ID	Device
2 = 0x02	PR112/PD-M

Table 4. Slave ID

- 'Run Indicator Status' reports the current Slave Run status, fixed to ON (0xFF).

2.1.6 Data Addressing (Map organisation)

Two different data addressing types are implemented:

1. Standard Modbus™ addressing
2. ABB SACE addressing (old ABB SACE Modbus™ Communication Units)

Standard			ABB	
Starting Address	**Item Address**	**Data Type**	**Starting Address**	**Item Address**
0 … 9999	1 … 10000	DO	1 … 10000	1 … 10000
0 … 9999	10001 … 20000	DI	10001 … 20000	10001 … 20000
0 … 9999	30001 … 40000	AI	30001 … 40000	30001 … 40000
0 … 9999	40001 … 50000	AO	40001 … 50000	40001 … 50000

It is possible to configure it using the 'Network Info' menu of the HMI.

The organisation of every section of the map (i.e. DO, DI, AI, AO) can be partitioned into different areas, called '*buffers*', containing a contiguous number of item. For example

Item Address	Item Value
1	
…	
27	
28	
29	
30	
31	
…	
…	
10000	

defines a DO buffer starting at 27 and with length 5 (grey cells are map items not defined for the device).

Please note that:

Item Address	Item Value
1	
…	
27	
28	
29	
30	
31	
32	
…	
10000	

defines two different DO buffers. The first one starts at 27 with length 2, while the second one starts at 30 with length 3.

It's possible to query a buffer as a whole or a portion of it, but **it's NOT possible to query two buffers within the same message: an exception response will rise up.**

2.1.6.1 Standard Modbus™ Addressing

In Modbus™ messages Start Address is always referred to zero.

Every single item in these sections is identified by a LOGICAL ABSOLUTE ADDRESS in the following ranges:

Data	Logical Absolute Address Range	Offset / Reference (decimal)	Offset / Reference (hex)
DO	00001 – 10000 (MAX_DO_ADDR)	00000 (DO_OFFSET)	0x0000
DI	10001 – 20000 (MAX_DI_ADDR)	10000 (DI_OFFSET)	0x2710
AI	(MIN_AI_ADDR) 30001 – 40000 (MAX_AI_ADDR)	30000 (AI_OFFSET)	0x7530
AO	40001 – 50000 (MAX_AO_ADDR)	40000 (AO_OFFSET)	0x9C40

Table 5. Modbus™ logical memory map

Please note that when the Master specifies the 'Starting Address' into the Modbus™ message, it uses a LOGICAL RELATIVE ADDRESS, calculated from the LOGICAL ABSOLUTE ADDRESS:

$$\begin{aligned} \text{Starting Address} &= \text{LOGICAL RELATIVE ADDRESS} \\ &= \text{LOGICAL ABSOLUTE ADDRESS} - \text{XX\_OFFSET} - 1 \\ &= \text{Item Address} - \text{XX\_OFFSET} - 1 \end{aligned} \qquad \textbf{Equation 1.}$$

So the Logical Relative Address Range is 00000 – 09999 (= 0x270F, MAX_RELATIVE_ADDR) for all data types.

Moreover, items like 10005, 40001, ... are addressed like 0005, 0001, ... because the function code uniquely identifies the portion of Modbus™ map they belong to.

Example
Coil with LOGICAL ABSOLUTE ADDRESS = 13 will be addressed by the Master with the LOGICAL RELATIVE ADDRESS = 12.

Register with LOGICAL ABSOLUTE ADDRESS = 32475 will be addressed by the Master with the LOGICAL RELATIVE ADDRESS = 32475 – 30000 – 1 = 2474.

So the device performs the following check on the Starting Address field:

- Starting Address range between 0 and 9999
- Starting Address belongs to a valid part of the section pointed by the Function Code

2.1.6.2 ABB SACE Addressing

The item address is:

Starting Address = LOGICAL ABSOLUTE ADDRESS = Item Address

The device performs the following check on the Starting Address field:

- Starting Address congruency with the section pointed by the Function Code (see Table 5).
- Starting Address belongs to a valid part of the pointed section

2.1.7 Data Field

The data field is formed by an 'header' part and a data value part: following points consider only the header part of this field.

In some function, there could be a 0 length data field (i.e. the message contains only the function code like in the 'Report Slave ID' function).

There is no restriction to max data length except the maximum message length (256 bytes).

2.1.7.1 Query

Number of items [2 bytes] (except writing functions 5 and 6)	Byte Count (only for writing functions 15 and 16) [1 byte]
How many items to read/write	How many data bytes follow

Figure 4. Query data field structure

Function Code	Data Type	Max number of items	Max byte count	Min message length	Max message length
1	DO	2008 (251 * 8)	N/A	8	8
2	DI	2008 (251 * 8)	N/A	8	8
3	AI	125	N/A	8	8
4	AO	125	N/A	8	8
5	DO	N/A (1 fixed)	N/A	8	8
6	AO	N/A (1 fixed)	N/A	8	8
15	DO	1976 (247 * 8)	247	10	256
16	AO	123	246	11	256

The device performs the following checks on the above-mentioned fields:

- Max number of items, conforming to the Function Code
- Byte Count congruency with the Number of Items
- Data value field length congruency with the Byte Count

Moreover, also the following checks are performed:

- (Starting Address + Number Of Items) belongs to the section pointed by the Function Code
- (Starting Address + Number Of Items) belongs to a valid part of the pointed section

2.1.7.2 Response

1. Read function codes

Byte Count (only for writing functions 15 and 16) [1 byte]
How many data bytes follow

Figure 5. Read function response data field structure

Function Code	Data Type	Max number of items	Max byte count	Min message length
1	DO	2008 (251 * 8)	251	6
2	DI	2008 (251 * 8)	251	6
3	AI	125	250	7
4	AO	125	250	7

2. Single item Write function codes (5, 6)
   It' simply an echo of the query message.

3. Multiple items Write function codes (15, 16)

Starting Address [2 bytes]	Number of items [2 bytes]
Starting item	How many items to read/write

Figure 6. Multiple items Write function response data field structure

So the message length is fixed and equal to 8.

2.1.8 Exception Responses

In this case, the MSb of the function code in the response message is set to one and an error code is added.

Error Code	Error Name	Meaning
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the slave. If a 'Poll Program Complete' command is issued, this code indicates that no program function preceded it.
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the slave.
03	ILLEGAL DATA VALUE	A value contained in the query data field in not an allowable value for the slave.
06	SLAVE DEVICE BUSY	The slave is processing a long-duration program command. The master should retransmit the message later when the slave is free.

Table 6. Exception response error codes

No response is sent by the slave device if there is a communication error (i.e. a parity o a CRC error).

Error Code	Error Name	When
01	ILLEGAL FUNCTION	1. The message is too short (i.e. there is NO Function Code field!), with right CRC. 2. Device does NOT support the received Function Code. Please note that this means that the Function Code 2 (Read Input Status, DI) will NOT lead to this Exception.
02	ILLEGAL DATA ADDRESS	1. The message is too short (i.e. there is NO Starting Address field!), with right CRC. 2. Starting Address is > 10000 (Standard Addressing Type). 3. Starting Address is outside a map section (ABB SACE Addressing Type). 4. Starting Address doesn't belong to any buffer.
03	ILLEGAL DATA VALUE	1. The message is too short, with right CRC. 2. The message is too long, with right CRC. 3. Diagnostic function: sub-function is not supported (≠ 0) 4. The Number of Items is NOT in range (= 0 or > Max number of items, see 2.1.7). 5. Byte Count is different from the number of bytes calculated using the number of items and the relevant data type. 6. The whole query requested buffer (Starting Address + Number of Items) doesn't belong to a device map buffer. 7. Force Single Coil function: the value is different from 0x0000 or 0xFF00. 8. Command value: it is different from '1'. 9. DCP Installation Date value: not valid
06	SLAVE DEVICE BUSY	1. Start-up (before complete polling of PU information) 2. Commands inhibition (see par. 6.2.3)

2.2 Installation and Configuration

At the first start-up, the device is NOT configured for communication to the Remote System.
The communication parameters to be defined are:

Communication Parameters	Allowed Values	Start Up Values
Slave Address	{1 … 247} | 255 (UNCONFIGURED)	255 (UNCONFIGURED)
Baud Rate	9600 | 19200 bit/s	19200 bit/s
Parity	Even | Odd	Even
Addressing Type	Standard | ABB SACE	Standard

These parameters can be changed if and only if the Operating Mode is LOCAL, using the LCD Display of the device.

If the device is NOT configured (i.e. Slave Address = 255), no query is processed and the warning message 'MODBUS Not Configured' is displayed in the first line of the LCD Display.

3. Start-up behaviour

At start up, the Communication Unit needs about 5 seconds to update the information coming from the Protection Unit. During this time, the data are not available to the Remote System: the Communication Unit returns a "SLAVE DEVICE BUSY" exception response to any query coming from it.

If an "Internal Bus Fault" condition occurs during the Start-up, preventing from information update, the CU sets all the information to default values, letting the Remote System to read the data:

Data Type	Default Values	Description
States/Events/Alarms/Trips (but IB Status)	0	No alarm pending: the only one set is "IB Fault"
IB Status	1	This value are readable only when a "IB fault" condition occurs at start up
CB States	Value read from I/O	They don't depend on Internal Bus communication
Parameters	0xFF	Values out of allowed ranges
Measurements	0xFF	Values out of allowed ranges → Not reliable data
Communication Statistics	0	They are updated run-time
PU Process Statistics	0xFF	Data not available
CU Process Statistics	Value read from EEPROM	They don't depend on Internal Bus communication

4. Operating Mode

The device can operate in two different modes, Local and Remote. The mode can be selected by means of a dedicated menu of the device (PU). The default value at start up is “Local”.

4.1 Local Operating Mode

From the remote point of view, the device has the following behaviour:

Actions forbidden	Actions allowed
No remote parameterisation allowed	Consultation of measurements
No remote command allowed	Consultation of configuration parameters of the device
	Consultation of protection unit information

4.2 Remote Operating Mode

From the remote point of view, the device has the following behaviour:

Actions forbidden	Actions allowed
None	Remote parameterisation allowed
	Remote command allowed
	Consultation of measurements
	Consultation of configuration parameters of the device
	Circuit Breaker commands (open / close)
	Trip Reset / CB Reset

5. Configuration parameters programming model

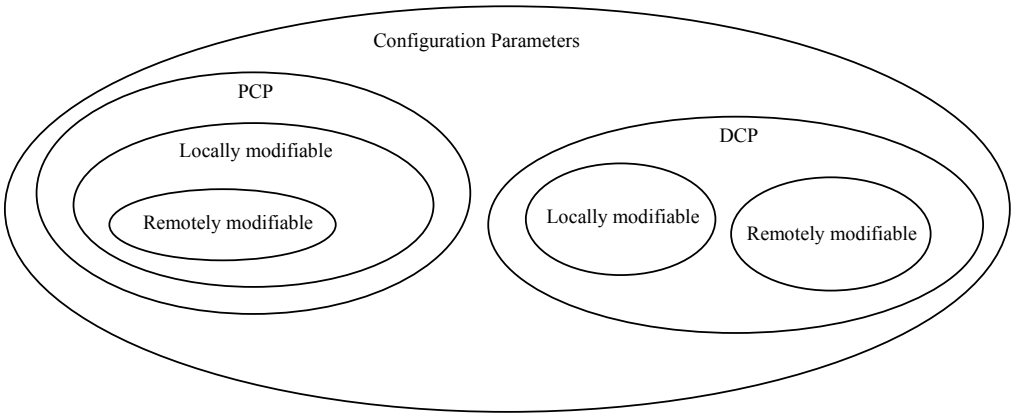


Figure 7. Configuration parameters categories

5.1 Local programming state

Every time the PU stores a new parameter configuration, the CU updates it and if something has changed, propagates towards the Remote System the event "Parameters changed".

PR112 is considered to be in "Local Programming" state when at least one of the following situations is verified:

1. PR112/PD Operating Mode = LOCAL

2. Test Unit Connected
   When the Test Unit disconnection occurs, the CU reads the configuration parameters to update them towards the Remote System.

5.2 Remote programming model

It is possible to configure two different kinds of configuration parameters:

a) Protection Configuration Parameters (PCP) relevant to the PU
b) Dialogue Configuration Parameters (DCP) relevant to the CU

All these configuration parameters are readable, while only some of them are remotely modifiable.

All configuration parameters are Items. They can be:

- READ ONLY (the system can't modify them)
  The configuration parameter is associated only to an Input Item (DI / AI)
- READ/WRITE (the system can modify them)
  The configuration parameter is associated both to an Input (DI / AI) **and** to an Output (DO / AO) Item

Obviously, "READ/WRITE" configuration parameters are a subset of those "READ ONLY".

5.2.1 Programming Model

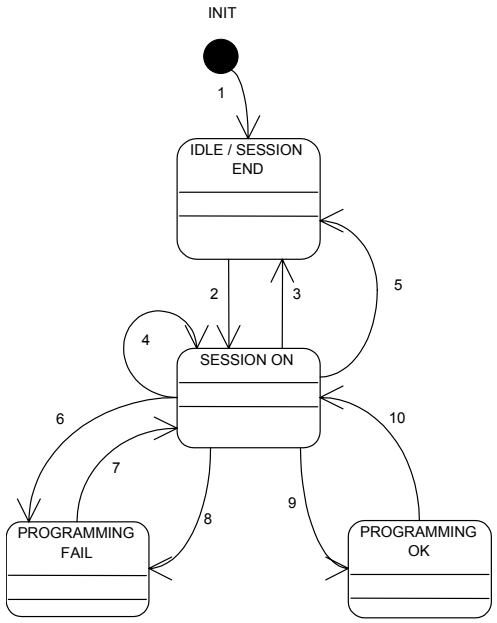


Figure 8. Remote Programming Model state chart

STATE NAME	STATE DESCRIPTION	PROGRAMMING OK Item	PROGRAMMING FAIL Item
INIT	Initial state	0	0
IDLE / SESSION END	Session is ended	0	0
SESSION ON	Session is active	1	1
PROGRAMMING OK	Session ended without errors	1	0
PROGRAMMING FAIL	Session ended with errors	0	1

TRANSITION	INITIAL STATE	FINAL STATE	TRANSITION CONDITION
1	INIT	IDLE / SESSION END	Start-up
2	IDLE / SESSION END	SESSION ON	'Start programming' command received from system.
3	SESSION ON	IDLE / SESSION END	'Abort programming' command received from system.
4	SESSION ON	SESSION ON	'Start programming' command received from system.
5	SESSION ON	IDLE / SESSION END	Session timeout (1 hour)
6	SESSION ON	PROGRAMMING FAIL	'Stop programming' command received from system **and** errors detected (see also 'Programming Fail Code').
7	PROGRAMMING FAIL	SESSION ON	'Start programming' command received from system.
8	SESSION ON	PROGRAMMING FAIL	A 'local' aborting event has occurred: 1. Internal Bus Fault 2. Operating Mode from REMOTE to LOCAL
9	SESSION ON	PROGRAMMING OK	'Stop programming' command received from system **and** NO errors detected.
10	PROGRAMMING OK	SESSION ON	'Start programming' command received from system.

The actions associated to each transition are:

TRANSITION	ACTION
1	N/A
2	1. Set the programming items. 2. Copy the 'Present parameters' buffer into 'New Parameters'.
3	Reset the programming items.
4	Copy the 'Present parameters' buffer into 'New Parameters'.
5	Reset the programming items.
6	1. If needed, PU programming. 2. If there is NO error and it's needed, CU programming. 3. If there is an error, reset the 'Programming OK' item **and** write the 'Programming Fail Code' item.
7	1. Set the 'Programming OK' item. 2. Copy the 'Present parameters' buffer into 'New Parameters'.
8	Reset the 'Programming OK' item.
9	1. If needed, PU programming. 2. If there is NO error and it's needed, CU programming. 3. If there is NO error, reset the 'Programming Fail' item **and** set the 'Parameter Changed' item
10	1. Set the 'Programming Fail' item. 2. Copy the 'Present parameters' buffer into 'New Parameters'.

NOTE: When the CU is in SESSION ON state, the Internal Bus is NOT shared with the Test Unit, i.e. the Master Token is not released from the CU to the Test Unit.

6. Commands

The CU manages two different command 'sources':

1. Remote Operator Station, i.e. a remote command from the system (remote command)
2. Local Operator, i.e. an action performed locally on the relay and / or the circuit breaker (local command)

From now on, the word 'command' means 'remote command'.

6.1 Command Categories

Remote commands handled by CU can be organised in three different categories:

a) Protection Unit Slow Commands: they are the commands requiring a significant amount of time for being executed due to an 'heavy' interaction with the PU
   - Start Programming
   - Stop Programming
   - LC1 Open Reset
   - LC2 Open Reset
   - LC2 Number of AR Reset

b) Protection Unit Fast Commands: they are the commands requiring a negligible amount of time for being executed, even if there is an interaction with the PU
   - Abort Programming
   - Wink
   - Trip Reset / CB Reset

c) Circuit Breaker Commands: they are commands concerning only the Circuit Breaker
   - CB Open
   - CB Close

Only the value '1' is allowed for a command.
If a different value is sent, an exception response 'ILLEGAL_DATA_VALUE' will be returned.

The commands concerning only the PU (e.g. Trip Reset) and not the Circuit Breaker are independent from CB states.

6.1.1 Wink Command

The "wink" command is used for recognising a device by making its display flash (also a warning message is displayed).
The command is sent from the Remote System and has a toggle behaviour, i.e., to stop the LCD display flashing another "wink" command has to be sent.
See the following finite state machine:

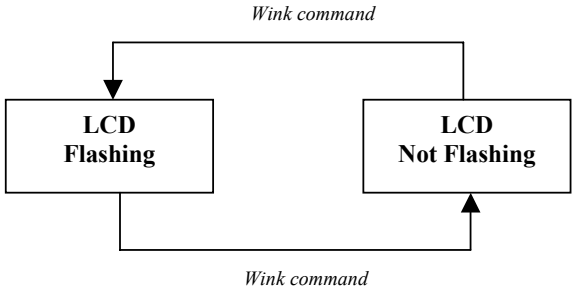


Figure 9. Wink Command behaviour

6.1.2 Trip Reset / CB Reset

These commands are equivalent. In fact, both reset:

1. the internal CU states
2. the relevant PU states and magnetic flag
3. the external signalling unit (e.g. PR010/K)

This is also the behaviour of the CU when a LOCAL Trip Reset command is issued by pressing the frontal 'RESET' push button.

6.1.3 Remote 'CB Close' command after Trip Command Fail

When a "Trip Command Fail" condition occurs (see its definition in par. 1.3.2), the CB reaches the "Open" position: in this situation the only allowed remote command is "Trip Reset". Only after it, the "Close" command is accepted.

6.2 Commands management

6.2.1 Commands completion

After receiving a command, the CU verifies the inhibition conditions and sends the response.
If there is an error, an exception response is sent and the requested command is NOT processed.

Even if there is an error or not, during this time, the relevant command item is NOT reset, signalling that the command is pending, and command completion will be signalled by the relevant item reset.

If there is NO error, the command result is signalled in the following way:

	Command result
Start Programming	Programming OK = Programming Fail = 1 (i.e. Remote programming session ON)
Abort Programming	Programming OK = Programming Fail = 0 (i.e. Remote programming session OFF)
Stop Programming	1. Programming result = OK • Programming OK = 1, Programming Fail = 0 • Parameter changed = 1 2. Programming result = FAIL • Programming OK = 0, Programming Fail = 1 3. Nothing changed • Programming OK = Programming Fail = 0
Wink	1. LCD Display flashing ON / OFF 2. Warning message on the first line of the LCD Display
CB Reset	1. CB Tripped reset, if previously set (mutually exclusive with Trip Command Fail Item) 2. Trip Command Fail reset, if previously set (mutually exclusive with CB Tripped Item) 3. Relevant Trip Item reset ➔ Any Trip reset 4. Magnetic flags reset 5. Signalling Unit reset, if present
Trip Reset	1. CB Tripped reset, if previously set (mutually exclusive with Trip Command Fail Item) 2. Trip Command Fail reset, if previously set (mutually exclusive with CB Tripped Item) 3. Relevant Trip Item reset ➔ Any Trip reset 4. Magnetic flags reset 5. Signalling Unit reset, if present
CB Open	CB Open / Closed = 0, if CB Undefined = 0
CB Close	CB Open / Closed = 1, if CB Undefined = 0
LC1 Open Reset	Relevant Alarm Item reset ➔ Any Alarm reset, if no more alarms are set
LC2 Open Reset	Relevant Alarm Item reset ➔ Any Alarm reset, if no more alarms are set
LC2 Nr. AR Reset	1. Relevant Alarm Item reset ➔ Any Alarm reset, if no more alarms are set 2. Number of auto-reclosure = 0

LEGENDA		Slow Command Type
		Circuit Breaker Command Type
		Fast Command Type

Table 7. Command results

6.2.2 CB commands execution

In case of CB command (i.e. 'CB Open' and 'CB Close'), the command implies an external actor (i.e. a power actuator) for its completion.
Because of this, a particular event is defined, 'CB Command Executed', that signals the end of the CU command processing.

This event is reset before the CU starts driving the external actor and it's set after the CU has completed driving the external actor:

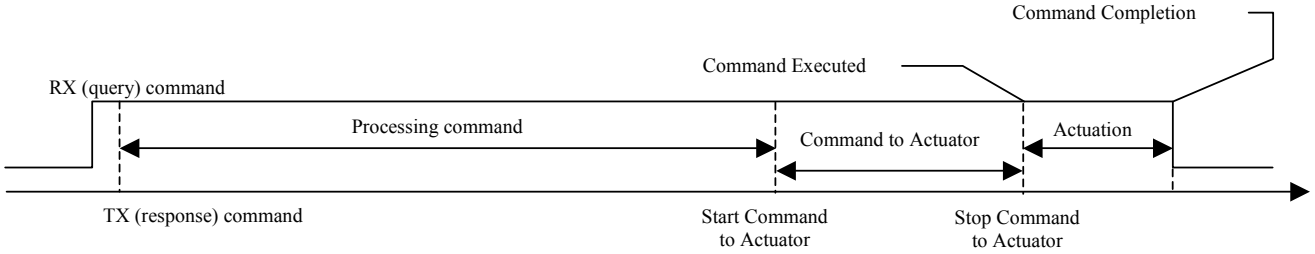


Figure 10. 'Command Executed' event (Executed before completion)

Please note that also the following situation is allowed:

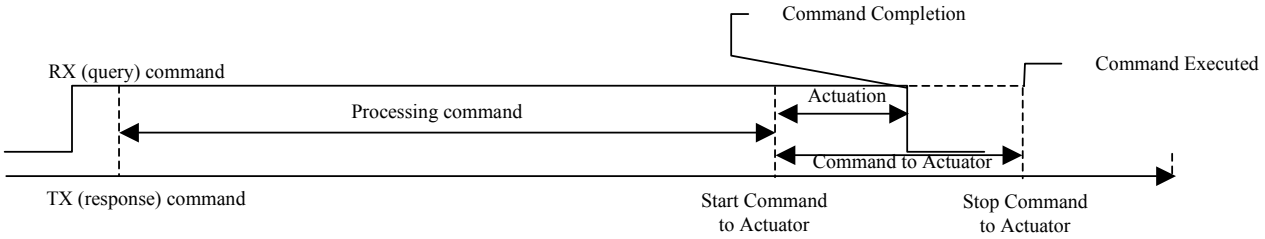


Figure 11. 'Command Executed' event (Completed before execution)

This situation represents an electromechanical dynamics faster than the electronic command or an electronic command longer than what the actuator needs.

In this case, both 'CB Command Executed' and CB status (related to the command) events are set for a little period of time.

In both situations, this event tells the system that:

1. the command is correctly received (normal response);
2. the SW has correctly processed it ('Command Executed' reset);
3. the SW has correctly driven the actuator ('Command Executed' set).

So this event could be helpful to analyse CB command failures.

6.2.3 Commands inhibition

There are three different levels of command inhibition conditions:

1. functional conditions (highest)
   Ex.: Abort / Stop Programming command outside a remote programming session.
2. feasibility conditions
   Ex.: programming commands with the Test Unit connected
3. security conditions (lowest)
   Ex.: remote command in Operating Mode = LOCAL

Moreover, inside a command category only one command at a time can be processed, i.e. if there is another pending command belonging to the same category of the issued command, the latter will be refused.

	Operating Mode LOCAL	IB Fault	Test Unit Connected	CB Undefined	CB Isolated	CB Tripped	Pending Command	Functional conditions
Start Programming	**X**	**X**	**X**				**X**	
Abort Programming	**X**	**X**	**X**				**X**	**Programming Session ON**
Stop Programming	**X**	**X**	**X**				**X**	**Programming Session ON**
Wink	**X**	**X**	**X**				**X**	
CB Reset	**X**	**X**	**X**				**X**	
Trip Reset	**X**	**X**	**X**				**X**	
CB Open	**X**				**X**		**X**	
CB Close	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
LC1 Open Reset	**X**	**X**	**X**				**X**	**LC1 enabled**
LC2 Open Reset	**X**	**X**	**X**				**X**	**LC2 enabled**
LC2 NR. AR Reset	**X**	**X**	**X**				**X**	**LC2 enabled**

LEGENDA		Slow Command Type
		Circuit Breaker Command Type
		Fast Command Type

Table 8. Conditions for commands' inhibition

The refused command is signalled via an exception response 'SLAVE_DEVICE_BUSY', that means 'the device is not ready to perform the requested command'.

NOTE: there is a little probability that a command is NOT be executed and no exception response sent when an inhibition condition rises up after the normal response has been sent.
This behaviour is due to different period of time (milliseconds) between query message processing (leading to the normal or exception response) and the requested command management.

6.3 Local Commands management

The CU manages six local commands:

1. CB Open
2. CB Close
3. Trip Reset
4. Test Open Release (YO)
5. Test Close Release (YC)
6. Local programming session (ENTER, ESCAPE)

6.3.1 CB Open

A local user performs this command when he switches manually the circuit breaker from CLOSED to OPEN.

The CU manages this command in the following way:

- CB status change
- Number of CB manual operation update

6.3.2 CB Close

A local user performs this command when he switches manually the circuit breaker from OPEN to CLOSED.

The CU manages this command in the following way:

- CB status change
- If the CB was in TRIPPED (virtual) state, reset the relevant event and perform a Trip Reset.

6.3.3 Trip Reset

A local user performs this command when he presses the frontal RESET push button.

The CU manages this command as the remote command, except that there is no completion.

6.3.4 Test Open Release (YO)

This command is performed by a local user when, after selecting the menu 'Other functions … CB Info … CB I/O' and setting 'Test YO/YC = YO', he presses the frontal TEST push button.

The CU manages this command in the following way:

- drive the relevant release
- CB status change
- Number of CB manual operation update
- 'Test YO/YC = Off'

6.3.5 Test Close Release (YC)

This command is performed by a local user when, after selecting the menu 'Other functions … CB Info … CB I/O' and setting 'Test YO/YC = YC', he presses the frontal TEST push button.

The CU manages this command in the following way:

- drive the relevant release
- CB status change
- 'Test YO/YC = Off'

6.3.6 Local programming session

When Operating Mode is LOCAL and after password entry, a local programming session is opened when a local user changes at least one of the communication parameters into the 'Other functions … Network Info' page.

This session is closed by pressing either the ENTER or the ESC push button when the storing page is displayed.

The CU manages the ENTER pressing in the following way:

- Permanently store relevant communication parameters
- Update relevant in use communication parameters

7. Human-Machine Interface / Local User Interface

The HMI is based on:

1. LCD Display (visualisation)
2. Keyboard (UP, DOWN, ENTER, ESC, TEST push buttons)
3. Network LED (controlled by software), also called TX LED
4. µp Fault LED (controlled by hardware), also called Watchdog LED

CU manages:

- push buttons
- timeouts
- passwords

conforming to PU relevant management.

7.1 LCD Display and Keyboard Management

Besides Operating Mode, the device could be in two different states:

– READ (Default), where data entry is disabled.
  Please note that after a 60 seconds timeout the page with current values will be displayed.
– EDIT, where data entry is enabled.
  Please note that after a 120 seconds timeout the page with current values will be displayed.

The device status is READ when entering a page without modifiable parameters.
In a page with modifiable parameters, press the **<ENTER>** (↵) key to change the device status.
A "User Password" (Default: 0001) is requested to enter the 'EDIT' state, except when this password is '0000'.

8. Modbus™ Map description

All the information is divided among the different application objects. The criteria for the subdivision are:

1. The handling of all protection configuration parameters is entrusted to the AppObj "Node Object", which reads and writes them. In this document, however, the configuration parameters are allotted to the pertaining Application Objects. For example, the configuration parameter "Protection L Threshold" can be found into the description of the AppObj "Protection L" even if its handling is completely delegated to the AppObj "Node Object".
2. AppObj "Node Object", Circuit Breaker and Load Controller handles the command input slave variables.
3. The output slave variables are organised in buffers: for every AppObj are showed the buffers and those variables inside them that the AppObj handles. The Remote System can choose how to read the variables, on the assumption that it is always possible to read either all the information or single information contained in a buffer, but can not query outside of it.

The Modbus™ map is contained in par. 9.

8.1 Buffers

These are the buffers defined for this device:

Buffer Name	Buffer Type	Items Number	Description
One buffer for each command	Analog Output	1 Register	
Reports	Digital Input	42 Coils	States, Events, Alarms and Trips reports
Trip Reports	Digital Input	42 Coils	States, Events, Alarms and Trips reports after trip
Statistics	Analog Input	17 Registers	Communication and Process Statistics
Programming Fail Code	Analog Input	1 Registers	Code of the wrong configuration parameters
Run-time RMS Measurements	Analog Input	10 Registers	Run time measurements
Trip currents	Analog Input	10 Registers	Measurements after trip
Present Parameters (in use)	Analog Input	56 Registers	Reading Parameters
New Parameters	Analog Output	30 Registers	Writing Parameters

8.1.1 Reports

STATES / EVENTS	ALARMS	TRIPS
Any Alarm	Harmonic distortion	L tripped
Any Trip	Unbalanced phases	S tripped
CB tripped	Contact Wear Pre-Alarm	I tripped
CB open/closed	Contact Wear Alarm	G tripped
CB undefined	L Pre-alarm	T tripped
CB connected/isolated	L Alarm (timing / tripping)	
Springs charged/discharged	S Alarm (timing / tripping)	
Trip Command Fail	G Alarm (timing / tripping)	
Electronic Trip Test	G Blocked Trip	
Simulated Trip from Test Unit	T Pre-Alarm	
I.B. Fault	T Alarm	
Local/Remote Operating Mode	T Blocked Trip	
Test Unit connected	LC1 Alarm (timing to open)	
Programming OK	LC1 Load open	
Programming Fail	LC2 Alarm (timing to open)	
Parameter changed	LC2 Load open	
CB Command executed	LC2 Max number of AR reached	
Trip data available		
LC2 is timing to close		
LC2 Load closed		

Table 9. Reports Buffer

(1) 'Any Trip' is set if any of trip item is set. It is reset after local or remote 'Trip Reset' / 'CB Reset'.
(2) 'Any Alarm' is set if any of alarm item is set. It is reset when all the alarm items are equal to 0.
(3) If the CB is opened by a trip (real or electronic test), also 'CB tripped' is set.
(4) CB contacts mapping:

CB open/closed	0 = Open, 1 = Closed
CB inputs error	0 = No Error, 1 = Error
CB connected/isolated	0 = Isolated, 1 = Connected
Springs charged/discharged	0 = Discharged, 1 = Charged

(5) If 'CB undefined' is set, this is the last CB state before transition to undefined.
(6) Operating Mode mapping:

Local/Remote Operating Mode 0 = Remote, 1 = Local

(7) Remote Programming Status:

Programming OK	Programming Fail	Description
0	0	Idle / Remote programming session OFF
0	1	Programming Fail
1	0	Programming OK
1	1	Remote programming session ON

(8) 'Trip Data available' is always ON, but when the PU is storing trip currents after a trip. The data are considered to be available after a period of about 350 ms.
(9) If all these conditions are satisfied:
- start-up or Load Management Type is changed from LM1 (Open – Open) to LM2 (Open – Close)
- LC2 is CLOSED
- current satisfies auto-reclosure conditions

both 'LC2 is timing to close' and 'LC2 Load closed' are set for a little period of time (see parameter 'LC2 Closing Time').

(10) If all these conditions are satisfied:
- start-up
- LCx is OPEN (before start-up)
- current satisfies opening conditions

both 'LCx is timing to open' and 'LCx Load open' are set for a little period of time (see parameter 'LCx Opening Time').

(11) If 'L Alarm (timing / tripping)' is set, 'L Pre-alarm' is reset.

(12) If 'X tripped' is set, the relevant 'X Alarm (timing / tripping)' is reset.

(13) 'G Alarm (timing / tripping)' and 'G Blocked Trip' are mutually exclusive, depending on the relevant configuration parameter.

(14) 'T Alarm (timing / tripping)' and 'T Blocked Trip' are mutually exclusive, depending on the relevant configuration parameter.

8.1.2 Trip Reports

Their structure is the same as "Reports", described in par. 8.1.1.

8.1.3 Statistics

Communication Statistics
Number of received messages (Bus Message Count)
Number of received messages with char/frame error (Bus Communication Error Count)
Number of responses (Slave Message Count)
Number of Slave Busy responses (Slave Busy Count)
Number of exception responses (Bus Exception Error Count)

Process Statistics
CB contact wear
CB number of operations
CB number of manual opens
CB number of protection trips
CB number of protection trips fail
CB number of other trips (trip test)
Protection L number of trips
Protection S number of trips
Protection I number of trips
Protection G number of trips
Protection T number of trips
Number of auto reclosure

Table 10. Statistics Buffer

8.1.4 Programming Fail Code

During a programming session, both the Communication Unit and the Protection Unit make some checks on the configuration parameters to find possible errors. The relevant codes are subdivided into three categories:

System Error Codes	Error Type
0	NO ERROR
1 – 1000	Parameter errors detected by PU
1001 – 2000	Parameter errors detected by CU
2001 – 3000	Other errors detected by CU

Inside every block, the error codes are not consecutive to let spaces for further upgrades. Homogeneous blocks are indicated with the colour of the cells.

The not used error code are intentionally NOT described because they are used into the other devices (e.g. PR113/PD-M), so that two different devices have the same code for the same error.

System Error Code	Description
0	NO ERROR
1	PU EEPROM Busy
2	PU EEPROM Writing
11	PU Programming while S Alarm
12	PU Programming while G Alarm
13	PU Programming while L Alarm
31	S Threshold ≤ L Threshold
32	I Threshold ≤ S Threshold
35	G & S Zone Selectivity both ON
40	LC1 Open Threshold < LC2 Open Threshold
41	LC2 Open Threshold < LC2 Close Threshold
43	G Threshold > 1200 A (UL version only)
1009	K Unit Presence Out Of Range
1017	Relay K51 Out Of Range
1031	L Threshold Out Of Range
1033	L Time Delay Out Of Range
1035	L Thermal Memory Out Of Range
1040	S Disable Out Of Range
1041	S Curve Type Out Of Range
1042	S Threshold Out Of Range
1043	S Time Delay Out Of Range
1044	S Thermal Memory Out Of Range
1045	S Zone Selectivity Out Of Range
1050	I Disable Out Of Range
1051	I Threshold Out Of Range
1060	G Disable Out Of Range
1061	G Curve Type Out Of Range
1062	G Threshold Out Of Range
1063	G Time Delay Out Of Range
1064	G Trip Enable Out Of Range
1065	G Zone Selectivity Out Of Range
1070	T Trip Enable Out Of Range
1075	Min Unbalanced Phase Out Of Range
1081	Load Management Type Out Of Range
1082	LC1 Opening Threshold Out Of Range
1083	LC2 Opening Threshold Out Of Range
1084	LC2 Opening Threshold Out Of Range
1085	LC2 Closing Threshold Out Of Range
1086	LC2 Closing Time Out Of Range
1087	Auto-Reclosure Max Number Out Of Range
2001	Abort Program – IB Error
2002	Abort Program – Local
2003	Abort Program – Query Error
2004	Abort Program – CU Flash Error

Table 11. Programming Fail Error Code

8.1.5 Run-time RMS Measurements

RMS current phase L1
RMS current phase L2
RMS current phase L3
RMS current neutral
RMS current ground

Table 12. Run-time RMS Measurements Buffer

At start-up, all values are set to the full range scale value (0xFFFFFFFF = VALUE NOT AVAILABLE).
If any current is < 10% of In (0.1*In), the value is considered to be not reliable and the value provided to the Remote System is 0.
If phase / neutral current is ≥ 16*In, 16*In is returned.
If the Ground current is ≥ 4*In, the full range scale value (0xFFFFFFFF = VALUE NOT AVAILABLE) is returned.

8.1.6 Trip currents

Trip current phase L1
Trip current phase L2
Trip current phase L3
Trip current neutral
Trip current ground

Table 13. Trip currents Buffer

See 8.1.5.

8.1.7 Present Parameters (in use)

Slave ID (PCP)
Product execution (PCP)
Product Standard Reference (PCP)
Relay Serial Number (PCP)
Protection Unit SW version (PCP)
Communication Unit SW version (DCP)
Slave Address (DCP)
Baud Rate (DCP)
Even / Odd parity (DCP)
Addressing Type (DCP)
HMI Language (PCP)
Line Frequency (PCP)
Neutral Selection (PCP)
Ground Toroid Internal / External Selection (PCP)
Int. toroid value / Protection Unit nominal current (In) (PCP)
External Ground Toroid Current (PCP)
CB Type (PCP)
CB Serial Number (DCP)
Date of installation (DCP)
Unit K present / not present (PCP)
PR112 Relay K51 (PCP)
Protection L threshold (PCP)
Protection L trip delay time (PCP)
Protection L thermal memory (PCP)
Protection S disable (PCP)
Protection S curve type (PCP)
Protection S threshold (PCP)
Protection S trip delay time (PCP)
Protection S thermal memory (PCP)
Protection S zone selectivity (PCP)
Protection I disable (PCP)
Protection I threshold (PCP)
Protection G disable (PCP)
Protection G curve type (PCP)
Protection G threshold (PCP)
Protection G trip delay time (PCP)
Protection G Block Trip (PCP)
Protection G zone selectivity (PCP)
Protection T Block Trip (PCP)
Load Management Type (PCP)
Load Controller 1 opening threshold (PCP)
Load Controller 2 opening threshold (PCP)
Load Controller 2 closing threshold (PCP)
Load Controller 2 closing delay (PCP)
Load Controller 2 max auto-reclosure number (PCP)

Table 14. Present Parameters Buffer

Please note that the following parameter value sets depend from another parameter:

Parameter value set selector	Parameter value set
Protection S curve type	Protection S threshold, Protection S trip delay time
Protection G curve type	Protection G threshold, Protection G trip delay time
Load Management Type	Load Controller 2 opening threshold

So if the parameter value set selector is changed, the relevant parameter values change according to the new selector value.

8.1.8 New Parameters

Date of installation (DCP)
Unit K present / not present (PCP)
PR112 Relay K51 (PCP)
Protection L threshold (PCP)
Protection L trip delay time (PCP)
Protection L thermal memory (PCP)
Protection S disable (PCP)
Protection S curve type (PCP)
Protection S threshold (PCP)
Protection S trip delay time (PCP)
Protection S thermal memory (PCP)
Protection S zone selectivity (PCP)
Protection I disable (PCP)
Protection I threshold (PCP)
Protection G disable (PCP)
Protection G curve type (PCP)
Protection G threshold (PCP)
Protection G trip delay time (PCP)
Protection G Block Trip (PCP)
Protection G zone selectivity (PCP)
Protection T Block Trip (PCP)
Load Management Type (PCP)
Load Controller 1 opening threshold (PCP)
Load Controller 2 opening threshold (PCP)
Load Controller 2 closing threshold (PCP)
Load Controller 2 closing delay (PCP)
Load Controller 2 max auto-reclosure number (PCP)

Table 15. New Parameters Buffer

9. Modbus™ Logical Map

In this section are contained all the Modbus™ variables, both in Input and in Output, handled by CU and accessible from the Remote System. They are divided according to their Modbus™ data type: Analog/Digital, Input/Output.

9.1 Digital Output

Not applicable.

9.2 Digital Input

9.2.1 Buffer "Reports"

This buffer contains all States / Events / Alarms / Trips reports during run-time:

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Reports	**10001**	**0001**	**0000**	**0000**	**42**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address – 1 (HEX)	Number of items	Description	Comments
States/Events	**10001**	**0001**	**0000**	**0000**	**20**		
	10001	0001	0000	0000	1	Any Alarm	
	10002	0002	0001	0001	1	Any Trip	
	10003	0003	0002	0002	1	CB tripped	
	10004	0004	0003	0003	1	CB open/closed	
	10005	0005	0004	0004	1	CB undefined	
	10006	0006	0005	0005	1	CB connected/isolated	
	10007	0007	0006	0006	1	Springs charged/discharged	
	10008	0008	0007	0007	1	Trip command fail	
	10009	0009	0008	0008	1	Electronic Trip Test	
	10010	0010	0009	0009	1	Simulated Trip from Test Unit	
	10011	0011	0010	000A	1	I.B. Fault	
	10012	0012	0011	000B	1	Local/Remote Operating Mode	
	10013	0013	0012	000C	1	Test Unit connected	
	10014	0014	0013	000D	1	Programming OK	
	10015	0015	0014	000E	1	Programming Fail	
	10016	0016	0015	000F	1	Parameter changed	Event
	10017	0017	0016	0010	1	CB command executed	Event
	10018	0018	0017	0011	1	Trip data available	
	10019	0019	0018	0012	1	LC2 is timing to close	
	10020	0020	0019	0013	1	LC2 Load closed	
Alarms	**10021**	**0021**	**0020**	**0014**	**17**		
	10021	0021	0020	0014	1	Harmonic distortion > 2.1	
	10022	0022	0021	0015	1	Unbalanced phases	
	10023	0023	0022	0016	1	Contact wear Pre-alarm	
	10024	0024	0023	0017	1	Contact wear Alarm	
	10025	0025	0024	0018	1	L Pre-alarm	
	10026	0026	0025	0019	1	L Alarm (timing / tripping)	
	10027	0027	0026	001A	1	S Alarm (timing / tripping)	
	10028	0028	0027	001B	1	G Alarm (timing / tripping)	
	10029	0029	0028	001C	1	G Blocked Trip	
	10030	0030	0029	001D	1	T Pre-alarm	
	10031	0031	0030	001E	1	T Alarm	
	10032	0032	0031	001F	1	T Blocked Trip	
	10033	0033	0032	0020	1	LC1 Alarm (timing to open)	
	10034	0034	0033	0021	1	LC1 Load open	
	10035	0035	0034	0022	1	LC2 Alarm (timing to open)	
	10036	0036	0035	0023	1	LC2 Load open	
	10037	0037	0036	0024	1	LC2 Max number of AR reached	
Trips	**10038**	**0038**	**0037**	**0025**	**5**		
	10038	0038	0037	0025	1	L tripped	
	10039	0039	0038	0026	1	S tripped	
	10040	0040	0039	0027	1	I tripped	
	10041	0041	0040	0028	1	G tripped	
	10042	0042	0041	0029	1	T tripped	

Table 16. DI – Buffer 'Reports'

9.2.2 Buffer "Trip Reports"

This buffer is the copy, at trip time, of the above reports.

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Trip Reports	**10201**	**0201**	**0200**	**00C8**	**42**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address – 1 (HEX)	Number of items	Description	Comments
Trip States/Events	**10201**	**0201**	**0200**	**00C8**	**20**		
	10201	0201	0200	00C8	1	Any Alarm	
	10202	0202	0201	00C9	1	Any Trip	
	10203	0203	0202	00CA	1	CB tripped	
	10204	0204	0203	00CB	1	CB open/closed	
	10205	0205	0204	00CC	1	CB undefined	
	10206	0206	0205	00CD	1	CB connected/isolated	
	10207	0207	0206	00CE	1	Springs charged/discharged	
	10208	0208	0207	00CF	1	Trip command fail	
	10209	0209	0208	00D0	1	Electronic Trip Test	
	10210	0210	0209	00D1	1	Simulated Trip from Test Unit	
	10211	0211	0210	00D2	1	I.B. Fault	
	10212	0212	0211	00D3	1	Local/Remote Operating Mode	
	10213	0213	0212	00D4	1	Test Unit connected	
	10214	0214	0213	00D5	1	Programming OK	
	10215	0215	0214	00D6	1	Programming Fail	
	10216	0216	0215	00D7	1	Parameter changed	
	10217	0217	0216	00D8	1	CB command executed	
	10218	0218	0217	00D9	1	Trip data available	
	10219	0219	0218	00DA	1	LC2 is timing to close	
	10220	0220	0219	00DB	1	LC2 Load closed	
Trip Alarm	**10221**	**0221**	**0220**	**00DC**	**17**		
	10221	0221	0220	00DC	1	Harmonic distortion > 2.1	
	10222	0222	0221	00DD	1	Unbalanced phases	
	10223	0223	0222	00DE	1	Contact wear Pre-alarm	
	10224	0224	0223	00DF	1	Contact wear Alarm	
	10225	0225	0224	00E0	1	L Pre-alarm	
	10226	0226	0225	00E1	1	L Alarm (timing / tripping)	
	10227	0227	0226	00E2	1	S Alarm (timing / tripping)	
	10228	0228	0227	00E3	1	G Alarm (timing / tripping)	
	10229	0229	0228	00E4	1	G Blocked Trip	
	10230	0230	0229	00E5	1	T Pre-alarm	
	10231	0231	0230	00E6	1	T Alarm	
	10232	0232	0231	00E7	1	T Blocked Trip	
	10233	0233	0232	00E8	1	LC1 Alarm (timing to open)	
	10234	0234	0233	00E9	1	LC1 Load open	
	10235	0235	0234	00EA	1	LC2 Alarm (timing to open)	
	10236	0236	0235	00EB	1	LC2 Load open	
	10237	0237	0236	00EC	1	LC2 Max number of AR reached	
Trip Trips	**10238**	**0238**	**0237**	**00ED**	**5**		
	10238	0238	0237	00ED	1	L tripped	
	10239	0239	0238	00EE	1	S tripped	
	10240	0240	0239	00EF	1	I tripped	
	10241	0241	0240	00F0	1	G tripped	
	10242	0242	0241	00F1	1	T tripped	

Table 17. DI – Buffer 'Trip Reports'

9.3 Analog Input

9.3.1 Buffer "Statistics"

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Statistics	**30001**	**0001**	**0000**	**0000**	**17**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address – 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Unit of Meas.	Persistence
Communication Statistics	**30001**	**0001**	**0000**	**0000**	**5**							
	30001	0001	0000	0000	1			Number of received messages	Bus Message Count	0 - 65535		
	30002	0002	0001	0001	1			Number of received messages with char/frame error	Bus Communication Error Count	0 - 65535		
	30003	0003	0002	0002	1			Number of responses	Slave Message Count	0 - 65535		
	30004	0004	0003	0003	1			Number of Slave Busy responses	Slave Busy Count	0 - 65535		
	30005	0005	0004	0004	1			Number of exception responses	Bus Exception Error Count	0 - 65535		
Process Statistics	**30006**	**0006**	**0005**	**0005**	**12**							
	30006	0006	0005	0005	1	N/A		CB contact wear		0 - 100	%	Permanent (PU)
	30007	0007	0006	0006	1			CB number of operations		0 - 65535		Permanent (PU)
	30008	0008	0007	0007	1			CB number of manual opens		0 - 65535		Permanent (CU)
	30009	0009	0008	0008	1			CB number of protection trips		0 - 65535		Permanent (CU)
	30010	0010	0009	0009	1			CB number of protection trips fail		0 - 65535		Permanent (CU)
	30011	0011	0010	000A	1			CB number of other trips (trip test)		0 - 65535		Permanent (CU)
	30012	0012	0011	000B	1			Protection L number of trips		0 - 65535		Permanent (CU)
	30013	0013	0012	000C	1			Protection S number of trips		0 - 65535		Permanent (CU)
	30014	0014	0013	000D	1			Protection I number of trips		0 - 65535		Permanent (CU)
	30015	0015	0014	000E	1			Protection G number of trips		0 - 65535		Permanent (CU)
	30016	0016	0015	000F	1			Protection T number of trips		0 - 65535		Permanent (CU)
	30017	0017	0016	0010	1	N/A		Number of auto-reclosure		0-9		Permanent (PU)

Table 18. AI – Buffer 'Statistics'

'Persistence = PERMANENT' means that value is saved into non-volatile memory (into PU or CU).

9.3.2 Buffer "Programming Fail Code"

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Programming Fail Code	**30051**	**0051**	**0050**	**0032**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address – 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Unit of Meas.	Persistence
Programming Fail Code	**30051**	**0051**	**0050**	**0032**	**1**			Programming Fail Error Code		see Table 20		

Table 19. AI – Buffer 'Programming Fail Code'

System Error Code	Description
0	NO ERROR
1	PU EEPROM Busy
2	PU EEPROM Writing
11	PU Programming while S Alarm
12	PU Programming while G Alarm
13	PU Programming while L Alarm
31	S Threshold ≤ L Threshold
32	I Threshold ≤ S Threshold
35	G & S Zone Selectivity both ON
40	LC1 Open Threshold < LC2 Open Threshold
41	LC2 Open Threshold < LC2 Close Threshold
43	G Threshold > 1200 A (UL version only)

System Error Code	Description
1009	K Unit Presence Out Of Range
1017	Relay K51 Out Of Range
1031	L Threshold Out Of Range
1033	L Time Delay Out Of Range
1035	L Thermal Memory Out Of Range
1040	S Disable Out Of Range
1041	S Curve Type Out Of Range
1042	S Threshold Out Of Range
1043	S Time Delay Out Of Range
1044	S Thermal Memory Out Of Range
1045	S Zone Selectivity Out Of Range
1050	I Disable Out Of Range
1051	I Threshold Out Of Range
1060	G Disable Out Of Range
1061	G Curve Type Out Of Range
1062	G Threshold Out Of Range
1063	G Time Delay Out Of Range
1064	G Trip Enable Out Of Range
1065	G Zone Selectivity Out Of Range
1070	T Trip Enable Out Of Range
1075	Min Unbalanced Phase Out Of Range
1081	Load Management Type Out Of Range
1082	LC1 Opening Threshold Out Of Range
1083	LC2 Opening Threshold Out Of Range
1084	LC2 Opening Threshold Out Of Range
1085	LC2 Closing Threshold Out Of Range
1086	LC2 Closing Time Out Of Range
1087	Auto-Reclosure Max Number Out Of Range

System Error Code	Description
2001	Abort Program – IB Error
2002	Abort Program – Local
2003	Abort Program – Query Error
2004	Abort Program – CU Flash Error

Table 20. 'Programming Fail Code' range

9.3.3 Buffer "Run-time RMS Measurements"

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Run-time RMS Measurements	**30101**	**0101**	**0100**	**0064**	**10**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Unit of Meas.	Persistence
Run-time RMS Measurements	**30101**	**0101**	**0100**	**0064**	**10**							
	30101	0101	0100	0064	2			RMS current phase L1			A	
	30103	0103	0102	0066	2			RMS current phase L2			A	
	30105	0105	0104	0068	2			RMS current phase L3			A	
	30107	0107	0106	006A	2			RMS current neutral			A	
	30109	0109	0108	006C	2			RMS current ground			A	

Table 21. AI – Buffer 'Run-time RMS Measurements'

9.3.4 Buffer "Trip currents"

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Trip currents	**30201**	**0201**	**0200**	**00C8**	**10**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Unit of Meas.	Persistence
Trip currents	**30201**	**0201**	**0200**	**00C8**	**10**							
	30201	0201	0200	00C8	2			Trip current phase L1			A	Permanent (PU)
	30203	0203	0202	00CA	2			Trip current phase L2			A	Permanent (PU)
	30205	0205	0204	00CC	2			Trip current phase L3			A	Permanent (PU)
	30207	0207	0206	00CE	2			Trip current neutral			A	Permanent (PU)
	30209	0209	0208	00D0	2			Trip current ground			A	Permanent (PU)

Table 22. AI – Buffer 'Trip currents'

9.3.5 Buffer "Present Parameters"

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Present parameters	**30301**	**0301**	**0300**	**012C**	**56**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Default	Mapped in
Present parameters	**30301**	**0301**	**0300**	**012C**	**56**							
	30301	0301	0300	012C	1	N/A		Slave ID (DCP)			2	
	30302	0302	0301	012D	1	N/A		Product execution		[LSI | LSIG]		[0 | 1]
	30303	0303	0302	012E	1	N/A		Product Standard Reference		[IEC | UL]	IEC	[0 | 1]
	30304	0304	0303	012F	5			Relay Serial Number	One byte for each character			
	30309	0309	0308	0134	1			PU SW version	'major'.'minor'			
	30310	0310	0309	0135	1			CU SW version (DCP)	'major'.'minor'			
	30311	0311	0310	0136	1	N/A		Slave Address (DCP)		[255 (UNCONFIGURED) | {1 … 247}]	255	
	30312	0312	0311	0137	1	N/A		Addressing Type (DCP)		[Standard | ABB SACE]	Standard	[0 | 1]
	30313	0313	0312	0138	1	N/A		Baud rate (DCP)		[9600 | 19200]	19200	
	30314	0314	0313	0139	1	N/A		Even / Odd parity (DCP)		[Even | Odd]	Even	[0 | 1]
	30315	0315	0314	013A	1	N/A		HMI Language		[English | Italiano | Francais | Deutsch | Espanol]	English	{0 …4}
	30316	0316	0315	013B	1	N/A		Line Frequency		[50 | 60] Hz	50	
	30317	0317	0316	013C	1	N/A		Neutral selection		[50 | 100] %	50%	
	30318	0318	0317	013D	1	N/A		Ground Toroid int. / ext. selection		[Internal | External]	Internal	[0 | 1]
	30319	0319	0318	013E	1	N/A		Ext. ground toroid		[100 | 250 | 400 | 800] A	100	
	30320	0320	0319	013F	1			Int. toroid value / PU nominal current In		**IEC**: [250 | 400 | 800 | 1250 | 1600 | 2000 | 2500 | 3200 | 4000 | 5000 | 6300] A **UL**: [250 | 400 | 800 | 1200 | 1600 | 2000 | 2500 | 3200 | 3600 | 4000 | 5000] A	250	
	30321	0321	0320	0140	1	N/A		CB type		see Table 24	0 [E1B-(A)800]	see Table 24
	30322	0322	0321	0141	5			CB Serial Number (DCP)	One byte for each character			

Table 23. AI – Buffer 'Present parameters', Part 1

Parameter Value	ANSI	IEC
0	E1B-A800	E1B800

1	E1B-A1200	E1B1250
2	E2B-A1600	E2B1600
3	E2N-A1200	E2B2000
4	E2N-A1600	E2N1250
5	E3N-A2000	E2N1600
6	E3N-A2500	E2N2000
7	E3S-A1200	E2L1250
8	E3S-A1600	E2L1600
9	E3S-A2000	E3N2500
10	E3S-A2500	E3N3200
11	E3H-A1200	E3S1250
12	E3H-A1600	E3S1600
13	E3H-A2000	E3S2000
14	E3H-A2500	E3S2500
15	E3V-A1200	E3S3200
16	E3V-A1600	E3H1200
17	E3V-A2000	E3H1600
18	E3V-A2500	E3H2000
19	E4S-A3200	E3H2500
20	E4S-A3600	E3H3200
21	E4H-A3200	E3L2000
22	E4H-A3600	E3L2500
23	E4V-A3200	E4S4000
24	E4V-A3600	E4H3200
25	E6H-A4000	E4H4000
26	E6H-A5000	E6H5000
27	E6V-A4000	E6H6300
28	E6V-A5000	E6V3200
29		E6V4000
30		E6V5000
31		E6V6300

Table 24. 'CB Type' range

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Default	Mapped in
	30327	0327	0326	0146	3			Date of installation (DCP)	DD, MM, YYYY	DD = 1 – 31 MM = 1 – 12 YYYY = 0 – 65535	00/00/0000	
	30330	0330	0329	0149	1	N/A		Unit K present / not present		[Not Present | Present]	Not Present	[0 | 1]
	30331	0331	0330	014A	1	N/A		Load Management Type		[LM1 (Open-Open) | LM2 (Open-Close)]	LM1 (Open-Open)	[0 | 1]
	30332	0332	0331	014B	1	N/A		K51 Contact configuration		[L preal. | L timing | S timing | G timing | G alarm | L trip | S trip | I trip | G trip | T trip | T >70°C | T >85°C]	L timing	{0 … 11}
	30333	0333	0332	014C	1	N/A		Minimum unbalanced phases		[OFF (0) | {10 … 90}%, step 10]	OFF	
	30334	0334	0333	014D	1	N/A		Protection L threshold		{0,40 …1,00}In, step 0,01	1,00	scaled *100
	30335	0335	0334	014E	1	N/A		Protection L trip delay		{3 … 144}s, step 3	144	
	30336	0336	0335	014F	1	N/A		Protection L thermal memory		[OFF | ON]	OFF	[0 | 1]
	30337	0337	0336	0150	1	N/A		Protection S disable		[Disabled | Enabled]	Disabled	[1 | 0]
	30338	0338	0337	0151	1	N/A		Protection S curve time constant		[Definite Time | Inverse Time]	Definite Time	[0 | 1]
	30339	0339	0338	0152	1	N/A		Protection S threshold		{0,6 …10}In, step 0,1	0,6	scaled *10
	30340	0340	0339	0153	1	N/A		Protection S trip delay time		**IEC**: {0,03, 0,05 … 0,75}s, step 0,01 (0,03 only with Definite Time curve) **UL**: {0,03, 0,05 … 0,40}s, step 0,01 (0,03 only with Definite Time curve)	0,03	scaled *100
	30341	0341	0340	0154	1	N/A		Protection S thermal memory		[OFF | ON]	OFF	[0 | 1]
	30342	0342	0341	0155	1	N/A		Protection S zone selectivity		[OFF | ON]	OFF	[0 | 1]
	30343	0343	0342	0156	1	N/A		Protection I disable		[Disabled | Enabled]	Disabled	[1 | 0]
	30344	0344	0343	0157	1	N/A		Protection I threshold		{1,5 …15}In, step 0,1	1,5	scaled *10

Table 25. AI – Buffer 'Present parameters', Part 2

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Default	Mapped in
	30345	0345	0344	0158	1	N/A		Protection G disable		[Disabled | Enabled]	Disabled	[1 | 0]
	30346	0346	0345	0159	1	N/A		Protection G curve time constant		[Definite Time | Inverse Time]	Definite Time	[0 | 1]
	30347	0347	0346	015A	1	N/A		Protection G threshold		{0,2 …1,00}In, step 0,02	0,2	scaled *100
	30348	0348	0347	015B	1	N/A		Protection G trip delay time		IEC: {0,10 … 1,00}s, step 0,05 UL: {0,10 … 0,40}s, step 0,05	0,10	scaled *100
	30349	0349	0348	015C	1	N/A		Protection G zone selectivity		[OFF | ON]	OFF	[0 | 1]
	30350	0350	0349	015D	1	N/A		Protection G block trip		[Trip not allowed | Trip allowed]	Trip allowed	[1 | 0]
	30351	0351	0350	015E	1	N/A		Protection T block trip		[Trip not allowed | Trip allowed]	Trip allowed	[1 | 0]
	30352	0352	0351	015F	1	N/A		Load Controller 1 opening threshold		[OFF (0) | {0,50 … 1,00}*Ith(L), step 0,01]	OFF (0)	[0 | scaled *100]
	30353	0353	0352	0160	1	N/A		Load Controller 2 opening threshold		[OFF (0) | {0,50 … 1,00}*Ith(L), step 0,01]	OFF (0)	[0 | scaled *100]
	30354	0354	0353	0161	1	N/A		Load Controller 2 closing threshold		[OFF (0) | {0,50 … 1,00}*Ith(L), step 0,01]	OFF (0)	[0 | scaled *100]
	30355	0355	0354	0162	1	N/A		Load Controller 2 closing delay		{10 … 120}s, step 5	10	
	30356	0356	0355	0163	1	N/A		Load Controller 2 max number of auto-reclosure allowed		{1 … 9}	3	

Table 26. AI – Buffer 'Present parameters', Part 3

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9.4 Analog Output

9.4.1 Buffer "CB Open" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
CB Open	**40001**	**0001**	**0000**	**0000**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
CB Open	**40001**	**0000**	**0000**	**0000**	**1**				
	40001	0001	0000	0000	1	N/A		CB Open	Mutually exclusive to other CB commands

Table 27. AO – Buffer 'CB Open' Command

9.4.2 Buffer "CB Close" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
CB Close	**40003**	**0003**	**0002**	**0002**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
CB Open	**40003**	**0003**	**0002**	**0002**	**1**				
	40003	0003	0002	0002	1	N/A		CB Close	Mutually exclusive to other CB commands

Table 28. AO – Buffer 'CB Close' Command

9.4.3 Buffer "CB Reset" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
CB Reset	**40005**	**0005**	**0004**	**0004**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
CB Reset	**40005**	**0005**	**0004**	**0004**	**1**				
	40005	0005	0004	0004	1	N/A		CB Reset	Mutually exclusive to other 'Fast' commands.

Table 29. AO – Buffer 'CB Reset' Command

9.4.4 Buffer "Start programming session" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Start Programming session	**40007**	**0007**	**0006**	**0006**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
Start Programming session	**40007**	**0007**	**0006**	**0006**	**1**				
	40007	0007	0006	0006	1	N/A		Start Programming session	Mutually exclusive to other 'Slow' commands. They require an EEPROM operation to the PU.

Table 30. AO – Buffer 'Start programming session' Command

9.4.5 Buffer "Abort programming session" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Abort Programming session	**40009**	**0009**	**0008**	**0008**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
Abort Programming session	**40007**	**0007**	**0006**	**0006**	**1**				
	40009	0009	0008	0008	1	N/A		Abort Programming session	Mutually exclusive to other 'Fast' commands.

Table 31. AO – Buffer 'Abort programming session' Command

9.4.6 Buffer "Stop programming session" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Stop Programming session	**40011**	**0011**	**0010**	**000A**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
Stop Programming session	**40011**	**0011**	**0010**	**000A**	**1**				
	40011	0011	0010	000A	1	N/A		Stop Programming session	Mutually exclusive to other 'Slow' commands. They require an EEPROM operation to the PU.

Table 32. AO – Buffer 'Stop programming session' Command

9.4.7 Buffer "Trip Reset" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Trip Reset	**40013**	**0013**	**0012**	**000C**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
Trip Reset	**40013**	**0013**	**0012**	**000C**	**1**				
	40013	0013	0012	000C	1	N/A		Trip Reset	Mutually exclusive to other 'Fast' commands.

Table 33. AO – Buffer 'Trip Reset' Command

9.4.8 Buffer "LC1 Open Reset" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
LC1 Open Reset	**40015**	**0015**	**0014**	**000E**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
LC1 Open Reset	**40015**	**0015**	**0014**	**000E**	**1**				
	40015	0014	0014	000E	1	N/A		LC1 Open Reset	Mutually exclusive to other 'Slow' commands. They require an EEPROM operation to the PU.

Table 34. AO – Buffer 'LC1 Open Reset' Command

9.4.9 Buffer "LC2 Open Reset" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
LC2 Open Reset	**40017**	**0017**	**0016**	**0010**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
LC2 Open Reset	**40017**	**0017**	**0016**	**0010**	**1**				
	40017	0017	0016	0010	1	N/A		LC2 Open Reset	Mutually exclusive to other 'Slow' commands. They require an EEPROM operation to the PU.

Table 35. AO – Buffer 'LC2 Open Reset' Command

9.4.10 Buffer "LC2 Number of Auto-reclosure Reset" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
LC2 Number of Auto-reclosure Reset	**40019**	**0019**	**0018**	**0012**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
LC2 Number of Auto-reclosure Reset	**40019**	**0019**	**0018**	**0012**	**1**				
	40019	0019	0018	0012	1	N/A		LC2 Number of Auto-reclosure Reset	Mutually exclusive to other 'Slow' commands. They require an EEPROM operation to the PU.

Table 36. AO – Buffer 'LC2 Number of Auto-reclosure Reset' Command

9.4.11 Buffer "Wink" command

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
Wink	**40021**	**0021**	**0020**	**0014**	**1**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments
Wink	**40021**	**0021**	**0020**	**0014**	**1**				
	40021	0021	0020	0014	1	N/A		Wink	Mutually exclusive to other 'Fast' commands.

Table 37. AO – Buffer 'Wink' Command

9.4.12 Buffer "New Parameters"

Section	Absolute Address	Relative Address	Relative Address – 1	Relative Address – 1 (HEX)	Number of items
New parameters	**40327**	**0327**	**0326**	**0146**	**30**

and these are the relevant items:

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Default	Mapped in
	40327	0327	0326	0146	3			Date of installation (DCP)	DD, MM, YYYY	DD = 1 – 31 MM = 1 – 12 YYYY = 0 – 65535	00/00/0000	
	40330	0330	0329	0149	1	N/A		Unit K present / not present		[Not Present | Present]	Not Present	[0 | 1]
	40331	0331	0330	014A	1	N/A		Load Management Type		[LM1 (Open-Open) | LM2 (Open-Close)]	LM1 (Open-Open)	[0 | 1]
	40332	0332	0331	014B	1	N/A		K51 Contact configuration		[L preal. | L timing | S timing | G timing | G alarm | L trip | S trip | I trip | G trip | T trip | T >70°C | T >85°C]	L timing	{0 … 11}
	40333	0333	0332	014C	1	N/A		Minimum unbalanced phases		[OFF (0) | {10 … 90}%, step 10]	OFF	
	40334	0334	0333	014D	1	N/A		Protection L threshold		{0,40 …1,00}In, step 0,01	1,00	scaled *100
	40335	0335	0334	014E	1	N/A		Protection L trip delay		{3 … 144}s, step 3	144	
	40336	0336	0335	014F	1	N/A		Protection L thermal memory		[OFF | ON]	OFF	[0 | 1]

Table 38. AO – Buffer 'New parameters', Part 1

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Default	Mapped in
	40337	0337	0336	0150	1	N/A		Protection S disable		[Disabled | Enabled]	Disabled	[1 | 0]
	40338	0338	0337	0151	1	N/A		Protection S curve time constant		[Definite Time | Inverse Time]	Definite Time	[0 | 1]
	40339	0339	0338	0152	1	N/A		Protection S threshold		{0,6 …10}In, step 0,1	0,6	scaled *10
	40340	0340	0339	0153	1	N/A		Protection S trip delay time		**IEC**: {0,03, 0,05 … 0,75}s, step 0,01 (0,03 only with Definite Time curve) **UL**: {0,03, 0,05 … 0,40}s, step 0,01 (0,03 only with Definite Time curve)	0,03	scaled *100
	40341	0341	0340	0154	1	N/A		Protection S thermal memory		[OFF | ON]	OFF	[0 | 1]
	40342	0342	0341	0155	1	N/A		Protection S zone selectivity		[OFF | ON]	OFF	[0 | 1]
	40343	0343	0342	0156	1	N/A		Protection I disable		[Disabled | Enabled]	Disabled	[1 | 0]
	40344	0344	0343	0157	1	N/A		Protection I threshold		{1,5 …15}In, step 0,1	1,5	scaled *10
	40345	0345	0344	0158	1	N/A		Protection G disable		[Disabled | Enabled]	Disabled	[1 | 0]
	40346	0346	0345	0159	1	N/A		Protection G curve time constant		[Definite Time | Inverse Time]	Definite Time	[0 | 1]
	40347	0347	0346	015A	1	N/A		Protection G threshold		{0,2 …1,00}In, step 0,02	0,2	scaled *100
	40348	0348	0347	015B	1	N/A		Protection G trip delay time		IEC: {0,10 … 1,00}s, step 0,05 UL: {0,10 … 0,40}s, step 0,05	0,10	scaled *100
	40349	0349	0348	015C	1	N/A		Protection G zone selectivity		[OFF | ON]	OFF	[0 | 1]
	40350	0350	0349	015D	1	N/A		Protection G block trip		[Trip not allowed | Trip allowed]	Trip allowed	[1 | 0]
	40351	0351	0350	015E	1	N/A		Protection T block trip		[Trip not allowed | Trip allowed]	Trip allowed	[1 | 0]

Table 39. AO – Buffer 'New parameters', Part 2

Section	Absolute Address	Relative Address	Relative Address - 1	Relative Address - 1 (HEX)	Number of items	HIGH byte	LOW byte	Description	Comments	Range	Default	Mapped in
	40352	0352	0351	015F	1	N/A		Load Controller 1 opening threshold		[OFF (0) | {0,50 … 1,00}*Ith(L), step 0,01]	OFF (0)	[0 | scaled *100]
	40353	0353	0352	0160	1	N/A		Load Controller 2 opening threshold		[OFF (0) | {0,50 … 1,00}*Ith(L), step 0,01]	OFF (0)	[0 | scaled *100]
	40354	0354	0353	0161	1	N/A		Load Controller 2 closing threshold		[OFF (0) | {0,50 … 1,00}*Ith(L), step 0,01]	OFF (0)	[0 | scaled *100]
	40355	0355	0354	0162	1	N/A		Load Controller 2 closing delay		{10 … 120}s, step 5	10	
	40356	0356	0355	0163	1	N/A		Load Controller 2 max number of auto-reclosure allowed		{1 … 9}	3	

Table 40. AO – Buffer 'New parameters', Part 3

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Ith(L) Protection L Threshold