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eVD4
Breaker Integrated Protection RBX615
Modbus Communication Protocol Manual

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Document ID: 1MRS757103
Issued: 2011-12-13
Revision: B
Product version: 2.0

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Conformity

The IED is designed in accordance with the international standards of the IEC 60255 series, EMC Directive 2004/108/EC and MV circuit breaker standard IEC 62271-100.

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Section 1 Introduction

1.1 This manual

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

1.2 Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation from an IED perspective.

The system engineer or system integrator must have a basic knowledge of communication in protection and control systems and thorough knowledge of the specific communication protocol.

1.3 Product documentation

1.3.1 Product documentation set

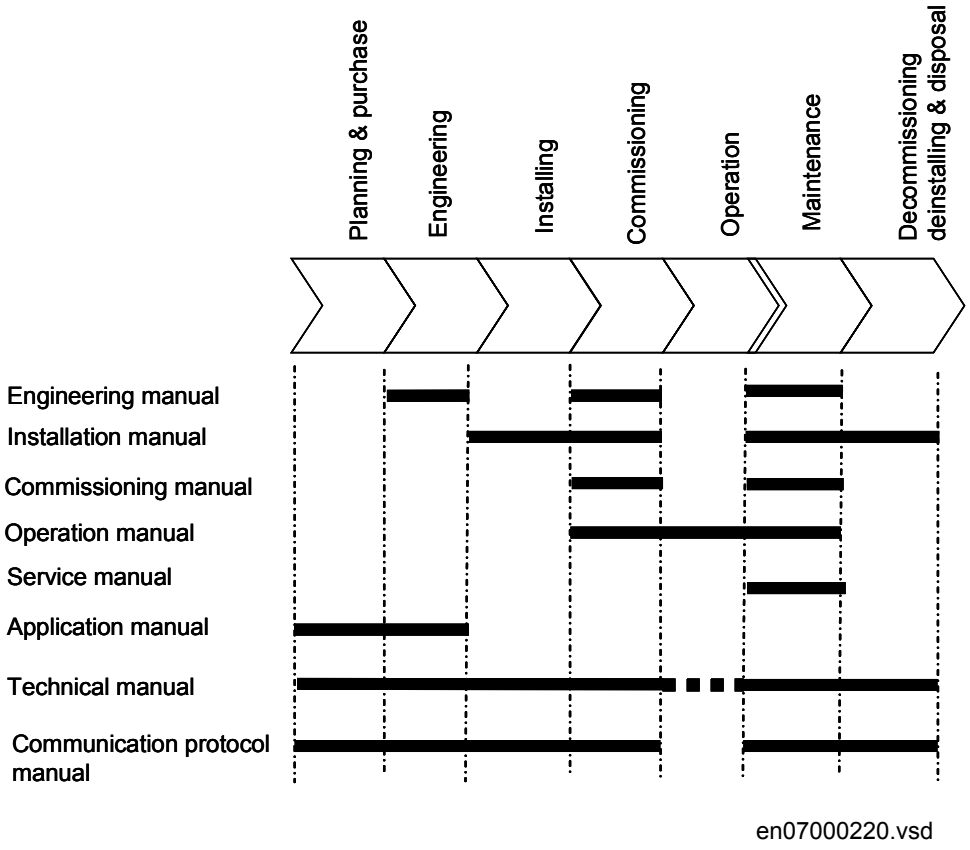

Figure 1: The intended use of manuals in different lifecycles

The engineering manual contains instructions on how to engineer the IEDs using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 61850 and other supported protocols.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for checking of external circuitry and energizing the IED, parameter setting and configuration as

well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in chronological order in which the IED should be commissioned.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

The troubleshooting manual contains quick answers to frequently asked questions about the IED use. The manual provides instant solutions to the problems that the end used might face while using the IED, both at commissioning and during the eVD4 life.

The service manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also be used when calculating settings.

The technical manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.

Some of the manuals are not available yet.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/2010-10-14	1.0	First release
B/2011-12-13	2.0	Content updated to correspond to the product series version

Download the latest documents from the ABB Web site http://www.abb.com/mediumvoltage.

1.3.3 Related documentation

Product-specific point list manuals and other product series- and product-specific manuals can be downloaded from the ABB web site http://www.abb.com/mediumvoltage.

1.4 Symbols and conventions

1.4.1 Symbols

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader of important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push-button navigation in the LHMI menu structure is presented by using the push-button icons.
  To navigate between the options, use and .
- HMI menu paths are presented in bold.
  Select **Main menu/Settings**.
- WHMI menu names are presented in bold.

Click **Information** in the WHMI menu structure.

- LHMI messages are shown in Courier font.
  To save the changes in non-volatile memory, select `Yes` and press  .
- Parameter names are shown in italics.
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.
  The corresponding parameter values are "On" and "Off".
- IED input/output messages and monitored data names are shown in Courier font.
  When the function starts, the `START` output is set to TRUE.

Section 2 Modbus overview

2.1 Modbus standard

Modbus is a communication protocol developed by the Modicon company in the 1970's. Originally it was used for communication in PLCs and RTU devices. Later on the Modbus protocol has been used in a variety of different device applications. Today the Modbus protocol is mainly used over serial communication networks and Ethernet.

The Modbus serial communication and the Ethernet based Modbus TCP/IP communication in this IED follow the specifications maintained by Modbus Organization.

Modbus communication reference guides are downloadable from Technical Resources at www.modbus.org.

2.1.1 Ethernet communication

Modbus communication over Ethernet TCP/IP is of client-server type. This IED operates as a Modbus server.

Modbus TCP/IP connection is established when the Modbus client opens a TCP socket connection to the Modbus server. The socket port 502 on the TCP/IP stack is reserved for Modbus. If the connection request is accepted by the server, the client can start communicating with the server unit.

IEDs can usually accept several simultaneous Modbus TCP/IP client connections even though the number of connections is limited. It is possible to configure the IED to only accept socket connection requests from known client IP addresses.

2.1.2 Application data implementation

This IED is designed to operate with a wide range of different Modbus masters and clients. The Modbus memory map offers the possibility to view IED's internal process data in a simple I/O map style which is mainly aimed at PLC masters and other process automation devices. Time-tagged, chronological event lists and fault records can be read over the Modbus interface. These data are more suitable for SCADA type of Modbus masters.

The Modbus standard defines four main memory areas for mapping IED's process data. Due to its open nature, the Modbus standard does not define exactly what

type of data should be mapped to each memory area. The Modbus mapping approach of the IED ensures that the same process data are readable from as many Modbus memory areas as possible. The users may then choose the memory areas that are most suitable for their Modbus master systems.

All Modbus data in the IEDs can be accessed using command functions belonging to Modbus conformance classes 0 and 1. This means that most master systems are able to communicate with the IED.

2.1.3 Terms and definitions

Modbus data appears in different memory areas in the Modbus device. The four most common areas are coils, digital input, input register and holding register. These are also referred to as 0X, 1X, 3X and 4X areas respectively.

Data within these four areas are addressed from 1 onwards. Modbus defines addressing in two ways: PLC addressing starts from address 1 and regular Modbus data addressing starts from 0. For example, a holding register at PLC address 234 can be referred to either as 4X register 234 or as 40234. The regular Modbus addressing, that is the PLC address decremented by one, is shown when analyzing the Modbus traffic on the physical network.

Listings and references to the Modbus data in this documentation follow the PLC addressing scheme. Refer also to the Modbus protocol standard documentation that can be found for free at www.modbus.org.

Section 3 Vendor-specific implementation

3.1 Modbus link alternatives

Modbus communication is only possible over the Ethernet interface.

3.1.1 TCP/IP link

The IED operates as a Modbus TCP/IP server. A Modbus TCP/IP client can establish a connection to the IED through the standardized TCP socket port 502.

The Modbus TCP/IP interface of the IED can be configured to accept several simultaneous Modbus client connections. It is possible to grant connections only to the predefined TCP/IP clients. The write authority of the Modbus TCP/IP client is configurable.

Modbus TCP usually shares the Ethernet connection with the other Ethernet based protocols of the IED. The number of Ethernet based clients that can be simultaneously connected to the IED is restricted.

3.1.1.1 TCP/IP interface configuration

The Modbus TCP/IP protocol uses the Ethernet interface. The general setup parameters of Ethernet, for example the IED's own IP address, are found via the LHMI path **Configuration/Communication/Ethernet**.

Client connections

The Modbus TCP/IP server accepts as many simultaneous client connections as defined with the *Max TCP/IP clients* parameter:

- The setting range for the parameter is 0...5.
- If the parameter value is zero, the Modbus TCP/IP server connection is not in use.
- The parameter works in conjunction with the parameters of a registered Modbus TCP/IP client.

When client X reconnects, the old connection of that client is disconnected and the new connection is accepted to avoid zombie clients. When the maximum number of clients are connected, a new connection request is handled as follows:

- If there are unregistered clients connected, the one with the longest silent period is disconnected and a new connection is accepted.
- If there are only registered clients connected, the new connection request is rejected.

It is possible to predefine the client or clients which are always granted Modbus TCP/IP connections by registering the clients' IP addresses. For example, if four concurrent connections are allowed and three of them are registered, they are seen as Client connection 1...Client connection 3. These three registered connections are then dedicated to certain clients only and the fourth connection is available to other clients.

Client IP addresses

There are five Modbus setting parameters for Modbus client IP addresses. The parameter value "0.0.0.0" indicates that the client IP address is not defined.

If there are, for example, four available TCP/IP connections defined and one of the connections is to be dedicated for a certain client X, enter the client X's IP address to the *Client IP1* parameter. The IP addresses of the Modbus clients 2..4 can be set to "0.0.0.0". The setting of the Modbus client5 IP address has no meaning in this example as the connection is not in use. In this example, the TCP/IP session 1 is dedicated to the client X which means that this registered client X is always able to connect to the IED. Unregistered clients can connect to sessions 2...4. However, an unregistered client connection request can be rejected if sessions 2...4 are already occupied. The write authority can also be assigned differently for registered TCP/IP clients.

Client's write authority

The registering of a Modbus client affects the client's write authority and the reading of latched Modbus data.

The *TCP write authority* parameter can be set to three different states:

- 0 = No write authority for any Modbus TCP/IP client
- 1 = Write authority only for registered Modbus TCP/IP clients
- 2 = Write authority for all Modbus TCP/IP clients

The possible blocking of write operation does not include the selection write operation that has to be done to read out Modbus event and fault record structures.

3.1.1.2 Modbus TCP/IP diagnostic counters

Modbus TCP/IP counters can be viewed via the LHMI path **Monitoring/Communication/Modbus/Ethernet**.

Counters related to the possible Modbus TCP/IP instances 1...5 have the suffixes 1…5 (N). The counters show the complete Modbus protocol link frames and Modbus

errors. The Ethernet communication driver maintains its own counters for lower level communication diagnostics.

Table 1: TCP/IP diagnostic counters

Counter	Description
Received frames N	Total amount of received Modbus frames.
Transmitted frames N	Total amount of transmitted Modbus responses.
Transmitted Exc A N	Total amount of exception responses 1 and 2. These exception responses usually reveal configuration errors on the Modbus client's side.
Transmitted Exc B N	Total amount of exception responses 3. These exceptions reveal the IED application level rejections.
Status N	Shows the value "True" if the TCP/IP or serial instance is in use. This means that a Modbus client has connected to the TCP socket and Modbus TCP messages are received regularly at least with a 30 second interval or faster. In all other cases this value shows "False". Resetting of all diagnostic counters in the instance N is done by writing value "True" into this same Status N object.

The counters and status of an instance N are reset when the client makes a TCP socket disconnection or if the TCP socket connection keep alive times out.

The common (instance independent) Modbus TCP/IP diagnostic counters can be reset separately by writing the value 0 into them.

Table 2: Common (instance independent) Modbus TCP/IP diagnostic counters

Counter	Description
CnReject No sockets	The amount of connection requests that are rejected due to unavailable TCP sockets.
CnReject Not reg	The amount of connection requests that are rejected since the client is not registered.

3.2 Supported function codes

3.2.1 Application functions

Table 3: Supported application functions

Function code	Name	Description
01	Read coil status	Reads the status of discrete outputs.
02	Read digital input status	Reads the status of discrete inputs.
03	Read holding registers	Reads the contents of output registers.
04	Read input registers	Reads the contents of input registers.
05	Force single coil	Sets the status of a discrete output.
06	Preset single register	Sets the value of a holding register.
Table continues on next page		

Function code	Name	Description
08	Diagnostics	Checks the communication system between the master and the slave.
15	Force multiple coils	Sets the status of multiple discrete outputs.
16	Preset multiple registers	Sets the value of multiple holding registers.
23	Read/write holding registers	Exchanges holding registers in one query.

3.2.2 Exception codes

Table 4: Supported exception codes

Function code	Name	Description
01	Illegal function	The slave does not support the requested function.
02	Illegal data address	The slave does not support the data address or the number of items in the query is incorrect.
03	Illegal data value	A value contained in the query data field is out of range.

3.3 Application data

3.3.1 Modbus data objects

The Modbus protocol in RBX615 IED is built on top of the internal IEC 61850 data model. Thus, the Modbus application data objects, proprietary events and MCD bits are derived from IEC 61850 data objects and data set reporting. The RBX615 IED have a predefined IEC 61850 data set configuration. In other words, it is predefined which internal data object changes the RBX615 IED detect.

The available Modbus indications in the RBX615 IED are generally selected from the IEC 61850 indications residing in data sets. Objects that do not reside in any data set are updated to the Modbus database slower. This concerns, for example, some measurand register values. Fast changes in these object values may not be detected or propagated to the Modbus database. However, the latest value of these objects is always found in the Modbus database. The DS column in the Modbus point list manual shows if the object resides in some data set as a default.

For a list of the available data objects, see the point list manual.

3.3.2 Modbus data implementation

The IED is internally modelled according to the IEC 61850 standard. The Modbus protocol is implemented on top of this model. However, all features of the IEC61850 data model are not available through the Modbus interface.

The Modbus protocol standard defines one bit digital data and 16 bit register data as the application data alternatives but it does not define exactly how the digital data and the register data should be used by the application. Instead, the choice of the usage is left to the IEDs implementation.

Change events and time synchronization

The Modbus standard does not define event reporting or time synchronization procedures. Proprietary solutions have been introduced in this IED to support these functionalities.

Control operations

The Modbus standard defines data types 0X for coils and 4X for holding registers to be used for control operations. This IED supports both data types.

Depending on the controlled object, the control operations may be of direct-operate or select-before-operate type. Control operations include automatic checking for authorization, local and remote blockings and preventing simultaneous controlling by multiple clients.

Application data compatibility

This IED is designed to operate with a wide range of Modbus masters spanning from industrial PLCs to substation SCADA devices. The application solutions have been chosen to achieve the highest possible level of compatibility with these systems:

- Application data are readable in many different Modbus memory areas. Digital data are readable as bits or packed bits in registers.
- Primarily 16 bit register sizes are used for measurands. 32 bits are used only in some rare cases.
- The measurands can be freely rescaled by the user.
- The proprietary Modbus event buffer can be read in many different ways. A master can continuously read and log change events in real time or, for example, read out the n latest events on demand.
- Change detect data can be used as an alternative to the event record reading to catch fast indication data transitions between the master scans.
- The Modbus fault record gives a summary of the captured max-min values and protection stages starting and possibly tripping during a fault.
- The addressing of the application data in the documentation and tools follows the so-called Modbus-PLC addressing principle where the base address 1 is

used. The application data addressing in this IED spans only between the locations 1 and 9999.
- The Modbus memory mapped data in the monitoring direction can additionally be re-assembled into user definable registers or bits in a specific UDR memory area. The data can then be scanned also from this area.

3.3.3 Data mapping principles

Modbus data is organized sequentially. This is the most efficient organization method since the master normally scans the Modbus data in blocks.

3.3.3.1 Data in monitoring direction

All data in the monitoring direction is available through the 3X and 4X memory areas.This includes the digital indication data which is also readable in the 1X and 0X areas.

All register structures are located in the 4X area.

The Modbus data may contain empty bits or registers within the sequential data areas. These bits and registers are intended for possible future expansion. Reading this data does not result in any Mobdus exception response. The value in these bits or registers is always zero.

3.3.3.2 One bit data mapping

All one bit data in the IED is readable either from the 0X or 1X memory area. The Modbus bit point addresses are similar regardless of the memory area. In addition, the same one bit data can also be read either from the 3X or the 4X area. In this case the bit values are packed into 16 bit 3X and 4X registers. The bit locations follow a pattern similar to the 0X and 1X locations.

If a one bit value is located in the 0X or 1X bit address 2893, the same bit value can also be found in the 3X or 4X register 180 (2893 DIV 16) at bit 13 (2893 MOD 16). The addressing pattern is evident when the address numbers are expressed in a hexadecimal format: 2893 = 0xB4D, 180 = 0xB4, 13 = 0xD.

3.3.3.3 Data in control direction

IED controls, set points and acknowledgements are mapped to Modbus 0X data (coils). Coils can only be operated one by one.

Some control bits are packed bits in the 4X control register structures. The 4X control structure contains a password which has to be given before starting control operations.

3.3.4 Digital input data

Indication signals related to protection applications often change rapidly. Thus, the Modbus master might not be able to detect all changes.

Momentary- and momentary change detect bits

In this IED, indications are presented as two adjacent Modbus bits in the Modbus memory map. The two bits represent the momentary position and the momentary change detect state of the indication.

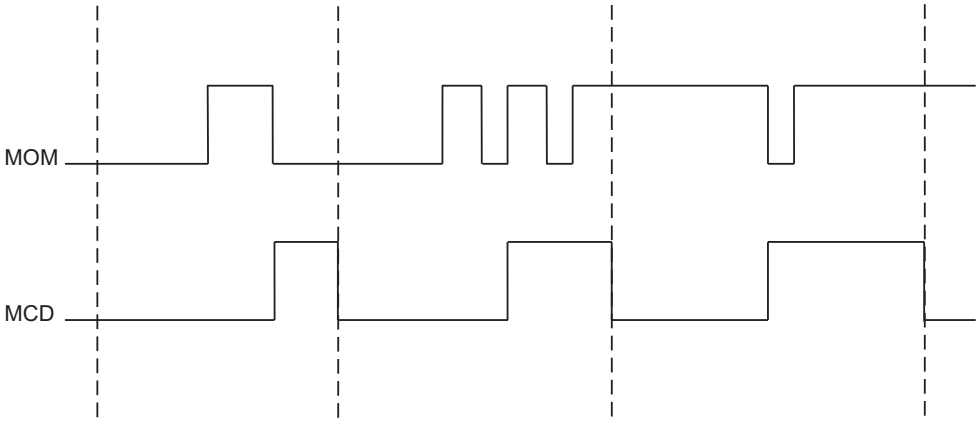

Figure 2: Change detection bit

If the momentary value of an indication bit has changed two times or more since the master last read it, the MCD bit is set to one. When the MCD bit has been read, it is reset to zero. Since indications usually are 1-active, it is easy to detect an indication activation by combining the MOM and MCD bits using a logical OR operation (MOM+MCD). The momentary position bit and the MCD bit of a certain indication point always occur as pairs in the Modbus memory map.

Observe that the MCD bit states are client dependent. The MCD bit is only reset for the specific Modbus client that reads it. Thus, other Modbus clients may still receive value one from the same MCD bit when it is read.

MOM indication changes are captured in the IED's sequential Modbus event buffer. Additionally, the Modbus event buffer provides a time stamp and chronology of indication changes.

3.3.4.1 Multiple digital inputs mapping

Digital inputs related to two-bit DPC or DPS objects, for instance circuit breaker and disconnectors, have a multiple mapping in the Modbus address space. The objects' open and close bits are coded as MOM+MCD bit pair entities. The MCD bits reveals if the object has changed its position several times since the Modbus master last scanned it. In addition, the open and close bits are also coded using MOM values only, among with a fault bit. The fault bit is set to "1" when the object is in intermediate (00) or faulty (11) position.

Table 5: Bit treatment

Bits	Treatment
Close MOM	One 2 bit entity
Close MCD	
Open MOM	One 2 bit entity
Open MCD	
:	
Close MOM	One 1 bit entity
Open MOM	One 1 bit entity
Faulty position MOM	One 1 bit entity
:	

The MOM values are identical in each entity. The MCD bit is only reset if the MOM bit in the same entity is read.

3.3.5 Measurand registers

The Modbus measurands are located in the Modbus register area. The measurands are readable from both 3X and 4X areas from the same register addresses.

The Modbus measurands derive from the IED's internal, original IEC 61850 measurand values. Modbus register values in this IED are always in integer format. Since the internal IEC 61850 values are often represented as decimal numbers, the Modbus stack needs to scale these values to integer format. Thus, there always exists a scaleFactor and an offset parameter for each Modbus register value. The user can freely configure these parameters with CMT.

The formula for calculating the Modbus register value is:

$$Modbus\ value = \left(IEC61850Value \times scaleFactor\right) + Offset$$

(Equation 1)

The range of the original IEC 61850 value can be seen in the Modbus memory map point list.

All frequently updated data are readable from a sequential data area. Additionally, there is a separate sequential data area for measurands and counters with a slow update rate.

3.3.5.1 Primary and per-unit values

Measurands originating from CT or VT measurements can be obtained from the IED in two ways. They can be viewed either as primary values or as per-unit values.

The primary values are represented internally as decimal numbers. The primary units are [A] for current and [kV] for voltage. The internal representation of the per-

unit values is always 1.0 at nominal current or voltage. A typical range for a per-unit value is 0.00...40.00, that is 0 to 40 times nominal. With CMT the user can select how these values are presented in the Modbus register. It may be necessary to upscale or downscale the primary values to fit the register's 16 bit integer value. The register's scaleFactor and offset parameters can be used for this purpose. As a default, this IED shows per-unit values multiplied with the scaleFactor 1000.

3.3.5.2 Register sizes

In most cases the measurands or counters are located in single 16 bit registers. The measurands are either unsigned or signed two's complement values while the counters are always unsigned values.

In some rare cases the measurands or counter values can be located in two consecutive registers, thus forming a single 32 bit integer value. The 32 bit value is always coded so that the high word part, that means the higher 16 bits, is located first in the lower register address. The low word part, that means the lower 16 bits, is then always in the next register address.

Register sizes and types are clearly stated in the Modbus memory map list.

3.3.5.3 Register saturation

After a re-scaling operation the Modbus value may exceed the limit of the Modbus register representation. The Modbus value then saturates to the closest max or min value of the register size in question.

3.3.5.4 Time of update

Some Modbus values may have a time structure attached to their values in the Modbus memory map. This is often the case with demand measurement values. The time structure shows the time when the value was last updated.

Table 6: Time structure data

Address	Register	Values	Comment
N	TimeStamp (Year,Month)		High byte:year, low byte:month
N+1	TimeStamp (Day,Hour)		High byte:day, low byte:hour
N+2	TimeStamp (Min,Sec)		High byte:min, low byte:seconds
N+3	TimeStamp (Milliseconds)		Word: milliseconds
N+4	Time quality	See the table about time quality register	

Table 7: Time quality register

Bit	Meaning	Values
15	Time format	0 = Local time
		1 = UTC time
14	Time source	0 = Internal (RTC)
		1 = Modbus stack
13	RTC not synchronized	0 = RTC synchronized
		1 = Not synchronized
12	RTC Failure	0 = RTC OK
		1 = RTC failure
11...0	Not used	0

3.3.6 Control operations

The IED's outputs can be controlled either through the 0X coil objects or 4X holding register control structures. Refer to the Modbus control objects' memory map for the available control objects.

The control objects in this IED are either single point or double point control objects.

Single point control object output types

Single point control objects can be either pulse outputs or persistent outputs.

The Modbus client can only write "1" to the pulse outputs. This write operation activates the control operation and there is no need for the Modbus client to ever write "0" to the object.

The Modbus client can write both "1" and "0" to the persistent outputs. Therefore, the persistent outputs have two defined levels: "0" and "1".

Most of the outputs in this IED are pulse outputs.

Control operation modes

This IED supports two control models: direct-operate and select-before-operate. The single point control objects in this IED are of direct-operate type. The double point control objects can be configured either into the direct-operate or select-before-operate mode.

An output cannot support both direct-operate and select-before-operate modes at the same time.

The double point select-before-operate mode is usually used for the circuit breaker operations. It consists of four controllable objects:

- Select open
- Select close
- Cancel selection
- Operate (=execute) selection

Direct operate of a double point object consists of two controllable objects:

- Direct open (writing a "1" value opens the circuit breaker, writing a "0" value closes the circuit breaker)
- Direct close (writing a "1" value closes the circuit breaker, writing a "0" value opens the circuit breaker)

Direct operate of a double point object is always possible. Select-before-operate control is possible if the controllable object's control model is set to "sbo-with-enhanced-sequrity".

3.3.6.1 Control functions

Generally, output objects are controlled one at a time. The IED accepts only functions 05 (force single coil) and 15 (force multiple coils), when the 0X coils control structure is used for control operation.

Only one control bit can be operated at a time when the 4X control structures are used.

Exception codes

Only a few exception code alternatives exist for the write coil and write register requests in Modbus:

- 01 = illegal function
- 02 = illegal address
- 03 = illegal value

The exception code 03 is also returned if a command operation is rejected due to the IED's other internal reasons. The client can find the code for the internal rejecting reason in the SSR6 register.

Internal control rejection reasons with coils may be, for example:

- The client has no write authority.
- The IED is in local state.
- The control operation is already reserved by another client and thus blocked.

If a positive acknowledgement is returned, the control command has been initiated by the IED.

3.3.6.2 Control operations through 4X register structures

The control outputs can be operated through the control structures in the 4X register area. This means that the control output is also located as a bit within the value and bit mask registers of the 4X control structure. Although usually less, there may be up to eight control structures defined in the IED.

The control structure operations can be controlled with passwords. As a default, no passwords exist for the structures. Any four character ASCII string can be used as a password. The password string “****” with four asterisks, that is ASCII code 42, indicates that a password is not used.

Table 8: Single control structure

Location	Meaning
4x Reg N	Execute register
4x Reg N+1	Password register 1 high, two ASCII characters
4x Reg N+2	Password register 2 low, two ASCII characters
4x Reg N+3	Value register
4x Reg N+4	Bitmask register

With the control operations the client must assemble the control structure register values and write them into the IED.

Execute register

Control step (select, execute or cancel) is executed when value "1" is written into this register.

Password register 1

If a password is defined, the two first ASCII characters of the four character password are written into this register: the first character into the higher byte and the second character into the lower byte of the register. If no password is defined for the control structure, this register is not checked by the IED.

Password register 2

If a password is defined, the two last ASCII characters of the four character password are written into this register: the third character into the higher byte and the fourth character into the lower byte of the register. If no password is defined for the control structure, this register is not checked by the IED.

Value register

Set the register bit corresponding to the output to the proper write value. For pulse type outputs the value is always "1".

Bitmask register

Set the register bit corresponding to the object to be operated to "1". All other bits must be set to zero.

Control structure register assembling order

The Modbus client can assemble all the control structure registers and write them in one multiple registers write function 16 request.

The Modbus client can also write the registers in several separate transactions or even one by one using registers write function 06. The execute register has to be written last and no more than 15 seconds may occur between the separate register writes. The control structure operation will time out after 15 seconds after the last register write. The timeout between select and operate steps is fixed to 15 seconds regardless of the controllable object's configured timeout value.

If several clients are allowed to perform control operations simultaneously, this method should not be used by more than one of the multiple clients in question.

Exception codes

Only a few exception code alternatives exist for control structures:

- 01 = illegal function
- 02 = illegal address
- 03 = illegal value

The exception code 03 is also returned if a command operation is rejected due to the IED's other internal reasons. The client can find the code for the internal rejecting reason in the SSR6 register.

The primary internal rejection reasons for control structure write operations may be for example:

- The Modbus control structure write has timed out (15 sec).
- The client has no write authority.
- The IED is in the local state.
- The control operation is blocked, that means already reserved, by another client.

If a positive acknowledgement is returned, the control command has been initiated inside the IED.

3.3.6.3 Additional control operations

Secured and unsecured control operations

If the control command initiates an object that is internally defined to perform a secured control operation, the SSR6 register CmdState bits will show "Command In Progress" during the actual control operation. Once the command sequence is

over, the SSR6 command state bits change to "Response Ready”. The contents of the SSR6 CmdResultCode can then be examined.

In unsecured operation mode, the positive confirmation response to a Modbus command request is based on the internal, IEC 61850 level, positive activation confirmation and not on the command termination confirmation. In secured operation mode, the Modbus command response is always based on the termination confirmation.

The update of the SSR6 bits (sequence number + command state) is based on the termination confirmation in both operation modes. If a new control operation is issued by the client before the previous command has been concluded, that is before the SSR6 has been updated, the operation is rejected because the command operation still in progress.

Disable coil writing

It is possible to disable the coil writing operations for the objects that are modelled both as coil 0X and 4X control structure bits.

Location of control structures

One or several control structures may be defined in the IED. If there are several control structures, they are located one after another in the Modbus 4X memory map. Refer to the IED's Modbus memory map for the actual locations of control structures.

3.3.7 System status registers

The ModbusSSRx 16 bit system status registers are located at the beginning of the regular Modbus map at addresses 40128...40133. The regular Modbus map starts from register location 128. See the Modbus memory map for the actual locations of SSRx registers. The SSRx registers can also be read from the 3X register area from corresponding register addresses.

Table 9: System status registers

Register	Description	Address
SSR1	Device health	40128
SSR2	Device mode	40129
SSR3	Data available 1	40130
SSR4	Data available 2	40131
SSR5	Device alive counter	40132
SSR6	Last command result	40133

3.3.7.1 SSR1

The device health SSR1 register is located at address 40128. The bits in SSR1 are common for all Modbus clients. The bits in SSR1 give an overview of the IED's

health. If a specific bit in this register is "1," it signifies a warning or an error in the hardware entity in question.

More specific warning and error codes can be read from elsewhere in the Modbus memory. Refer to the Modbus memory map for these register locations.

Table 10: 16-bit SSR1 register

Bit	Meaning
0	Device global warning
1	Device global error
2	Slot 0 (BSB) warning or error
3	Slot 2 (PSP) warning or error
4	Slot 3 (BIO) warning or error
5...15	0 = not used

3.3.7.2 SSR2

The device mode SSR2 register is located at address 40129. The bit values in SSR2 are common for all Modbus clients. The bits give an overview of the IED's mode. For example, bit 6 is activated if the IED's configured time synchronization source is lost.

Table 11: 16 bit SSR2 register

Bit	Meaning
0	Test mode (1= Device is set into test mode)
1	Local/Remote Off (0= On, 1= Off)
2	Local/Remote state (0= Remote, 1= Local, only relevant if Bit 1=0)
3...5	Active setting parameter setting group (bit 3 = LSB) 001 = Setting group 1 010 = Setting group 2 011 = Setting group 3 100 = Setting group 4 101 = Setting group 5 110 = Setting group 6
6	IED time synchronization failure (1 = Failure)
7	0 = not used
8	Last reset cause (1= Power reset)
9	Last reset cause (1= Watchdog reset)
10	Last reset cause (1= Warm reset)
11...15	0 = not used

3.3.7.3 SSR3

The data available 1 SSR3 register is located at address 40130. The bit values in the SSR3 register are Modbus client dependent.

Bits 0 and 1 are set to "1" as long as the client in question has not read out the available Modbus event or fault records.

Bit 4 is set to "1" if any momentary bit has been updated in the Modbus memory map. The bit is reset when the client reads the register.

Bit 5 is set to "1" if any MCD bit has been set in the Modbus memory map. The bit is reset when the client reads the register.

Bit 6 is set to "1" to indicate the device restart. The bit is reset when the client reads this register.

Bit 8 is set to "1" when an event record has been loaded into registers 49252...49262. The bit is reset when the client writes the reset code 4 to the event record selection register 49251.

Bit 9 is set to "1" when a fault record has been loaded into registers starting from 49402. The bit is reset when the client writes the reset code 4 to the fault record selection register 49401.

Table 12: 16 bit SSR3 register

Bit	Meaning
0	Unread event records available
1	Unread fault records available
2	0 = not used
3	0 = not used
4	Any MOM bit updated
5	Any indication MCD bit set
6	Device restart bit
7	0 = not used
8	Event record ready for reading
9	Fault record ready for reading
10...15	0 = not used

3.3.7.4 SSR4

The data available in SSR4 register is located at address 40131. The bit values in SSR4 are Modbus client dependent.

Bits 0...15 in the SSR4 registers correspond to different data categories in the regular Modbus memory map. Bit 0 corresponds to data category 1, bit 1 to data category 2 and so on.

If a bit is set to "1", some data belonging to the category in question has changed since the client last scanned the register. The SSR4 bit or bits are cleared when the register is read.

The data category number for each Modbus data is shown in the Modbus memory map. The meaning of the category number is available in a separate table. If the data have not been assigned to any category, the data category number for that data is set to "0". The data category number is freely configurable with PCM600/CMT. The table below is an example of how the categories can be divided.

Table 13: 16 bit SSR4 register

Bit	Meaning	Data category
0	Data in category 1 changed	1 = Physical inputs
1	Data in category 2 changed	1 = Protection function start/trip
2	Data in category 3 changed	1 = LED Alarm
3	Data in category 4 changed	1 = New disturbance record available
4	Data in category 5 changed	1 = New demand values
5	Data in category 6 changed	1 = New peak demand values
6	Data in category 7 changed	0
7	Data in category 8 changed	0
8	Data in category 9 changed	0
9	Data in category 10 changed	0
10	Data in category 11 changed	0
11	Data in category 12 changed	0
12	Data in category 13 changed	0
13	Data in category 14 changed	0
14	Data in category 15 changed	0
15	Data in category 16 changed	0

3.3.7.5 SSR5

The device alive counter SSR5 register is located at address 40132. SSR5 simply counts upwards from 0 to 65535 and then starts over. The meaning of this register is to assure that the device is actually operating.

3.3.7.6 SSR6

The last command result SSR6 register is located at address 40133. This client dependent SSR6 register shows the result of a specific client's last write attempt. This is especially useful if the exception code 03 appears or if the command initiates a secured control operation. The client will only see its own results, not the results of other clients. A client with no write authority will receive a 0x0000 value response when reading this register.

Table 14: 16 bit SSR6 register

ClientCmdSEQNo				Cmd State		Resp Type		CMDResultCode							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

ClientCmdSEQNo

Counts the client's failed control operations from 0000...1111, that is 0...15, and then starts over. Observe that successful control operations are not counted.

CmdState

00 = No write command has ever been issued by this client

01 = Command in progress

11 = Response Ready

RespType

01 = Unsecured control response

10 = Secured control response

11 = Modbus 03 exception response valid. CMDResultCode is in this case 0. The reason for the 03 exception is an invalid written value.

Table 15: CMDResultCode

Code	Meaning
0	OK
201	Device in local mode
202	Control operation reserved by another client
203	Select-timeout or Execute/Cancel without select
204	Control operation internally blocked
205	Control operation timed out
250	Other reason

3.3.8 User definable data

There can be several reasons for defining UD data. For example, the user may want to repack a limited amount of important data into sequential addresses and thereafter only scan this smaller set of data. Especially with serial links, this saves bandwidth and improves response times.

User definable register can be used if more advanced rescaling and re-manipulating of the regular Modbus register is needed.

3.3.8.1 User definable registers

The Modbus register areas 3X and 4X from 1 to 127 can be compiled freely by the user. Almost any regular register data in the Modbus memory map can be made to appear as a register copy in this UDR memory area. The regular Modbus source register is not moved away from its original location and thus it can be read also from the original location.

3.3.8.2 User definable bits

The Modbus bit address areas 0X and 1X from bit 16 to 2047 can be freely compiled by the user. Almost any regular bit data in the Modbus memory map can be made to appear as a bit data copy in this UDB memory area. The regular Modbus source bit data are not moved away from their original location and thus they can be read also from the original location.

The bit 16 is the first valid bit address in the address space because the register and bit addresses overlap and the register addresses start from the register location 1. The bit address 16 is the same as register 1, bit 0.

3.3.8.3 Data exceptions

Some exceptions exist for the Modbus source data concerning the UD mapping:

- None of the system status registers or fixed register structures can appear in the UD area.
- UD registers/bits themselves cannot act as source data for other UD data.
- Modbus source data can only be attached to one UD location.

3.3.8.4 Data properties

The UD data inherits all properties from the source data. This applies to:

- The memory areas on which the source data are located
- Data pre-scaling in case of registers

3.3.8.5 Unmapped data locations

It is possible to partially scan unmapped register or bit locations, also known as gaps. No exception responses are generated. The unmapped locations always return data value 0.

3.3.8.6 UDR data configuration

UDR definitions can be created using CMT.

3.3.8.7 UDR value manipulation

UDR values are initially copied from the source register. Thereafter the following manipulations can be applied to the UDR value:

- Additional rescaling of the source data value.
- Swapping high/low words within the 32 bit register types.
- Changing the saturation points of the UDR values, that is, the bit-length of the source value can be redefined. Also the justification of the redefined bits within the Modbus register can be defined.
- Swapping high/low bytes within the 16 bit register types.

Table 16: UDR scaling alternatives

Scaling alternative	Setting	Description
No scaling		No change is made to the sourceValue
Ratio scaling	UDRScaleArg1 = Min in	Uses all 4 scaling arguments UDRScaleArg1...UDRScaleArg4.
	UDRScaleArg2 = Max in	
	UDRScaleArg3 = Min out	
	UDRScaleArg4 = Max out	
Multiplicative scaling	UDRScaleArg1 = Multiplicand	Uses the argument UDRScaleArg1 (Min in)
Divisior scaling	UDRScaleArg1 = Divisor	Uses the argument UDRScaleArg1 (Min in)

Ratio scaling Operation

The sourceValue is to be checked for saturation. If it is less than Min in, the UDR result value is equal to Min out. If it is greater than Max in, the UDR result value is Max out. Otherwise the UDR result value is calculated as

- X = (MaxOut-MinOut)/(MaxIn-MinIn)
- UDR_ResultValue = X*sourceValue + (MinOut-X*MinIn)

Multiplicative scaling Operation

UDR_resultValue = sourceValue*multiplicand

Divisior scaling Operation

UDR_resultValue = sourceValue/Divisor

3.3.9 Event records

The IED creates a Modbus event record when a momentary digital input bit changes its value. The IED then stores the changed Modbus bit location and value into the Modbus event record buffer. The event time tag is also stored into the record. The time tag includes a full time stamp from a year down to milliseconds.

Modbus event generation on/off is selectable for each individual momentary bit in the Modbus memory map. It is possible to define whether events are to be generated from the rising edge- or both edges' transitions of the momentary bit.

Modbus events can also be generated from selected Modbus registers. This concerns registers containing status information. In this case events would be generated each time the register's integer value changes.

The size of the IED's internal Modbus event record buffer is 500 events. The 500 latest events are at any time readable from the IED. When the Modbus event record buffer becomes full, the IED overwrites the oldest event records in the buffer.

Multiple clients support

Several Modbus clients can independently of one another read out Modbus event records from the IED. The Modbus event buffer keeps track of where in the event buffer the different clients are reading at the moment. Clients are identified either by the serial port from where the requests are issued or by the client's IP address in the TCP/IP network. Up to 25 different IP addresses are memorized by the IED.

3.3.9.1 Single event record structure

The Modbus event record structure is located at addresses 49251...49262.

Table 17: Event record structure

Address	Register	Values	Comment
49251	Event selection	1...4 and -1...-499	Write register
49252	Sequence Number	0...65535	
49253	Unread records left	0...499	
49254	TimeStamp (Year,Month)		High byte:year, low byte:month
49255	TimeStamp (Day, Hour)		High byte:day, low byte:hour
49256	TimeStamp (Min, Sec)		High byte:min, low byte:second
49257	TimeStamp (Milliseconds)		Word: milliseconds (0...999)
49258	Event type		See separate description

Table continues on next page

Address	Register	Values	Comment
49259	Data Object ID 1	0 or UID high word	See separate description
49260	Data Object ID 2	Modbus address or UID low word	
49261	Data Value	Modbus data value	Value into which object has changed
49262	Data Value		Additional data

The event record can have two different data object identification alternatives. The data object can be identified by the Modbus address on which the object resides or it can be identified by a unique id which is platform dependent.

The identification alternative is selected with the Modbus parameter *Event ID*.

3.3.9.2 Single event record reading

As long as there are unread Modbus events available for the Modbus client in question, bit 0 of Modbus SSR3 register remains "1".

Events are read in two steps. First, the client writes a selection code to the Event selection register at location 49251. The selection code defines the type of read operation that the client wants to perform. The selected event record is loaded by the IED into the following 11 registers from 9252 to 9262. Second, the client reads out the 11 registers in one multiple register read operation.

Event records can be read by using two commands, function 5 for the write operation and function 3 for the read operation, or by using function 23 that includes write and read operations in the same transaction.

If event records are read by using two commands, the positive confirmation to the write select operation tells the client that an event record has been loaded for reading. Another way to detect the positive confirmation is by monitoring the state of SSR3 bit 8.

Selection code 1: Reading the oldest unread record

When writing the selection code 1, the IED first checks the client. If the client has read events before, the IED knows which internal event has been sent to this specific client during the last reading. The IED then loads the next event, that is the oldest unread, into the next 11 registers. If this is the first time the client reads events from the IED, the oldest event of the Modbus event buffer is loaded into the 11 event record registers.

Selection code 2: Reading the oldest stored record

Selection code 2 always forces the event reading to go back to the oldest event in the Modbus event buffer. The oldest event record is then loaded into the 11 event record registers. After the client has read out this record, the next record becomes the oldest unread. The client can continue with the selection code 1 by reading out the oldest unread event record again.

Selection code -1...-499

A negative selection code, that is a 16 bit two's complement value, defines how many records backwards from the newest event the event record reading is to be moved. For example, the ten latest events could be read out at any time by first selecting -10, reading out the event and then continuing with the selection code 1 to read out the nine additional event records. There can be 500 event records altogether.

Selection code 3: Resetting the event read pointer

The write selection 3 is not followed by a read operation. The selection 3 means that there are no unread records in the Modbus event buffer left for the client in question, that is, the buffer is cleared. The next new event that is logged into the Modbus event buffer becomes the first unread record for this specific client.

Selection code 4: Resetting SSR3 bit 8

The write selection 4 is not followed by a read operation. The selection code only resets the bit 8 in SSR3.

If event records are read by using two commands, the client can re-read the 11 event record registers as many times as it wants. As long as no new selection write operation is performed, the contents of the 11 event record registers are not changed.

3.3.9.3 Other event record registers

Sequence number

Every Modbus event record is given a sequence number. The sequence number runs from 1 to 65535 and then rolls over to 1 again. The client can check that the sequence numbers of the recorded data are sequential. During the event buffer overflow the client can notice a jump in the sequence numbers when some event records are lost. The gap between the new and the previous sequence number reveals exactly how many event records have been lost.

Unread records left

This register shows how many unread event records still remain unread for the client in question at a particular moment.

Time stamp registers

Time stamp is either in local time or UTC time. The time stamp alternative is selected with a Modbus parameter.

Time stamp registers usually hold two data values in the high and low byte of the registers. High byte value = RegisterValue DIV 256, Low byte value = RegisterValue MOD 256. The Milliseconds register is an exception as it contains the milliseconds 0...999 coded as such.

Event type

This register contains information to interpret the event data correctly.

Table 18: Information contained by the 16 bit register

Bit	Meaning	Values	
15	Event time stamp format	0 = Local time	1 = UTC time
14	Time stamp source	0 = Internal application	1 = Modbus stack
13	Clock not synchronized	0 = Synchronized	1 = Time not synchronized
12	Clock failure	0 = Clock OK	1 = Clock failure
11	Reserved	0	
10	Reserved	0	
9	Reserved	0	
8	Data object ID type	0 = Modbus address	1 = UID data
7...0	Data value identification	00000000 = One bit indication 00000010 = Two bit indication 00000100... 00001010 = Integer value 11111111 = reserved	00000001 = ACD indication 00000011 = SEC indication+add data 00001001 = reserved 00001011...

Event time stamp format bit 15

The time stamp format can be selected with a Modbus parameter via the LHMI or CMT.

Event time stamp source bit 14

The time stamp can be generated by the IED application (accurate time) or by Modbus. If generated by Modbus, the change values are detected by the Modbus background scan task. Since there is a latency time between the value change and the time when Modbus detects the change, the time stamp is not accurate in this case.

Clock not synchronized bit 13

The quality information bit is set in the IED's real-time clock if the IED has not been synchronized.

Clock failure bit 12

The quality information bit is set in the IED's real-time clock if the clock has a severe failure. Do not rely on this time stamp.

Data object ID bit 8

The coding alternatives of the data object ID registers 1 and 2 are the Modbus address or UID. The coding alternatives cannot occur simultaneously in the IED but are selected and configured at the system setup phase. The default setting is "Modbus address".

The UID code is 32 bits wide and occupies both registers 9259 and 9260. The word order is high/low. The UID code refers to the functional design of the IED platform in which the object resides. Shortly, it means that the UID code is equal in all the platform IEDs in which the same functional design and the same Modbus object is used.

Data value identification bits 5..0

Coding of the event data value is one bit, two bits or 32 bits. The coding depends on the IEC 61850 common data class which is the origin of the Modbus data in question.

Table 19: Modbus event value alternatives

Object derived from IEC 61850 Class	Meaning	One Bit Data Value	Two Bit Data Value	32 bit Data Value
SPS	Single Point Status	X		
SPC	Single Point Status of a controllable object	X		
DPS	Dual Point Status		X	
DPC	Dual Point Status of a controllable object		X	
ACT	Trip status	X		
ACD	Start/Pick-up status	X		
INS/INC	Integer status			X

Table 20: Interpretation of the one-bit data value

Register 9261 binary coded value	Meaning
xxxx.xxxx.xxxx.xxx0	Object in OFF position
xxxx.xxxx.xxxx.xxx1	Object in ON position

Table 21: Interpretation of the two-bit data value

Register 9261 binary coded value	Meaning
xxxx.xxxx.xxxx.xx00	Object in intermediate position (changing)
xxxx.xxxx.xxxx.xx01	Object in ON (close) position
xxxx.xxxx.xxxx.xx10	Object in OFF (open) position
xxxx.xxxx.xxxx.xx11	Object in faulty position

In case of a DPS/DPC two-bit event value (Data value identification = 2), the data object ID registers 9259 and 9260 always refer to the Modbus address or UID of the CLOSE momentary value bit.

Table 22: Interpretation of the integer status data value

Register address	Meaning
9261	Higher 16 bit part of the 32 bit integer value
9262	Lower 16 bit part of the 32 bit integer value

Table 23: Interpretation of the ACD data

Register address	Meaning
9261	xxxx.xxxx.xxxx.xxx0 Object in OFF position
	xxxx.xxxx.xxxx.xxx1 Object in ON position
9262	xxxx.xxxx.xxxx.xx00 Start in unknown direction
	xxxx.xxxx.xxxx.xx01 Start in forward direction
	xxxx.xxxx.xxxx.xx10 Start in backwards direction
	xxxx.xxxx.xxxx.xx11 Start in both directions

Table 24: Interpretation of the SEC data

Register address	Meaning
9261	xxxx.xxxx.xxxx.x000 Unknown security violation
	xxxx.xxxx.xxxx.x001 Critical security violation
	xxxx.xxxx.xxxx.x010 Major security violation
	xxxx.xxxx.xxxx.x011 Minor security violation
	xxxx.xxxx.xxxx.x100 Warning
9262	Security violations counter, 16 bits

The original SEC cnt attribute is actually defined as a 32 bit counter. The Modbus event shows the least significant 16 bits of that counter, that is 0...65535.

3.3.9.4 Multiple event records reading

It is possible to read out up to 10 sequential event records in one event select/read transaction. The number of sequential event records to be returned for reading shall be written to the Num of records register (49250) in front of the selection register. This number can be written once or it can be rewritten for each select/read transaction. If this number is never written, only one event record is returned.

If the Modbus client requests multiple event records, the returned records should also be read out by the client. One record consists of 11 registers, two records of 22 registers and so on. The read length must thus be adjusted depending on the number of records requested.

The selection/read operation is otherwise exactly similar to the single-record read case. The next records to be returned always continues from the last record in the previous read operation.

Reading out more event records than are available in the internal event buffer

The requested amount of event records is always returned for reading. For example, if 10 event records are requested, but the IED only contains five event records, the last valid event record is repeated (duplicated) in the last five event records returned. The easiest way to detect the duplication is to check the sequence number of the event records. The sequence numbers remain similar to the duplicated event records.

Extended event record structure

The extended register addresses are 49250 and 49263-49361.

Table 25: Extended event record structure with the maximum of 10 event records

Address	Register	Values	Description
49250	Num of records	1...10	Write: Number of Event structures
49251	Selection		Write: Selection code
49252	Sequence Number 1		Event record 1
49253	Unread records left 1		
49254	TimeStamp 1		
49255	TimeStamp 1		
49256	TimeStamp 1		
49257	TimeStamp 1		
49258	Event Type 1		
49259	Data Object Id 1_1		
49260	Data Object Id 2_1		
49261	Data Value 1		
49262	Data Value 1		

Table continues on next page

Address	Register	Values	Description
49263	Sequence Number 2		Event record 2
49264	Unread records left 2		
49265	TimeStamp 2		
49266	TimeStamp 2		
49267	TimeStamp 2		
49268	TimeStamp 2		
49269	Event Type 2		
49270	Data Object Id 1_2		
49271	Data Object Id 2_2		
49272	Data Value 2		
49273	Data Value 2		
49274	Sequence Number 3		Event record 3
:	:	:	:
49285	Sequence Number 4		Event record 4
:	:	:	:
49296	Sequence Number 5		Event record 5
:	:	:	:
49307	Sequence Number 6		Event record 6
:	:	:	:
49318	Sequence Number 7		Event record 7
:	:	:	:
49329	Sequence Number 8		Event record 8
:	:	:	:
49340	Sequence Number 9		Event record 9
:	:	:	:
49351	Sequence Number 10		Event record 10
49352	Unread records left 10		
49353	TimeStamp 10		
49354	TimeStamp 10		
49355	TimeStamp 10		
49356	TimeStamp 10		
49357	Event Type 10		
49358	Data Object Id 1_10		
49359	Data Object Id 2_10		
49360	Data Value 10		
49361	Data Value 10		

3.3.10 Fault records

A fault record is created by the IED as a set of registrations during a detected fault period. The registration includes the selected peak values of the protection stages, the time of recording and a sequence number for the fault record.

The size of the IED's internal Modbus fault record buffer is 100 records. The 100 latest fault records are at any time readable from the IED. The Modbus fault record is Modbus dependent and the data organization and buffer size differ from the IED's initial system level registrations. When the Modbus fault record buffer becomes full, the IED overwrites the oldest records in the buffer.

Multiple clients support

Several Modbus clients can independently of one another read out the Modbus fault records from the IED. The Modbus fault record buffer keeps track of where in the buffer the different clients are reading at the moment. Clients are identified either by the serial port from where the requests are issued or by the client's IP address in the TCP/IP network.

3.3.10.1 Fault record structure

The IED's fault record structure starts from the location 49401 and consists of a fixed header part and an application data part. The application data part is always IED type specific. The whole fault record including the IED-specific application data part is found in the Modbus memory map section.

Table 26: Header part of the record structure

Address	Register	Values	Comment
49401	Fault record selection	1...4 and -1...-99	Write register
49402	Sequence Number	0...65535	
49403	Unread records left	0...99	
49404	TimeStamp (Year,Month)		High byte:year, low byte:month
49405	TimeStamp (Day, Hour)		High byte:day, low byte:hour
49406	TimeStamp (Min, Sec)		High byte:min, low byte:second
49407	TimeStamp (Milliseconds)		Word: milliseconds (0...999)
49408	Time quality		
49409	From this location onwards starts the Fault record application data...		

Fault record application data part

The data in the application section are IED type dependent. The description of the data is found in the Modbus fault record section of the Modbus memory map.

3.3.10.2 Fault record reading

As long as there are unread fault records available for the Modbus client in question, bit 1 of the Modbus SSR3 register remains "1".

The fault record reading is done in two steps. First, the client writes a selection code to the Fault record selection register at the location 49401. The selection code defines the type of read operation that the client wants to do. The selected fault record is loaded by the IED into the following N registers (49402-NNNN). Second, the client reads out these registers in one multiple register read operation.

The fault records can be read by using two commands, the function 5 for the write operation and the function 3 for the read operation, or by using the function 23 that includes write and read operations in the same transaction.

If the fault records are read by using two commands, the positive confirmation to the write select operation tells the client that a fault record has been loaded for reading. Another way to detect the positive confirmation is by monitoring the state of SSR3 bit 9.

Fault record structure length

Since the application data part is IED type dependent, the length of the fault record structures vary in different types of IEDs. A client can read out more Modbus registers than are actually coded in one structure when reading out the data structures. The maximum read amount is 80 Modbus registers. The additional trailing registers contain the value 0. The Modbus protocol will give an exception response if the client tries to read out too few registers from the fault record structure.

Selection code 1: Reading the oldest unread record

When writing the selection code 1, the IED first checks the client. If the client has been reading fault records before, the IED knows which internal fault record has been sent to this specific client during the last reading. The IED then loads the next fault record, that is the oldest unread, into the registers following the selection register. If this is the first time the client reads fault records from the IED, the oldest fault record of the Modbus fault record buffer is given to the client.

Selection code 2: Reading the oldest stored record

The selection code 2 always forces the fault record reading to go back to the oldest fault record stored in the buffer. The oldest fault record is then loaded into the registers following the selection register. After the client has read out this record, the next record becomes the oldest unread. The client can continue by reading out the oldest unread fault records again with the selection code 1.

Selection code -1...-99

A negative selection code, that is a 16 bit two's complement value, defines how many records backwards from the newest fault record the reading is to be moved. For example, the ten latest fault records can be read out at any time by first selecting -10, reading out the record and then continuing with the selection code 1 to read out the nine additional records

Selection code 3: Resetting the fault record read pointer

The write selection code 3 is not followed by a read operation. The selection 3 means that there are no unread records in the Modbus fault record buffer left for the client in question, that is, the buffer is cleared.. The next new fault record that is logged into the Modbus fault record buffer becomes the first unread record for this specific client.

Selection code 4: Resetting SSR3 bit 9

The write selection 4 is not followed by any read operation. The selection code only resets bit 9 in SSR3.

If the fault records are read by using two commands, the client can re-read the given fault record registers as many times as it wants. As long as no new selection write operation is performed, the contents of the fault record registers are not changed.

3.3.10.3 Other fault record registers

Sequence number

Every fault record is given a sequence number. The sequence number runs from 1 to 65535 and then rolls over to one again. The client can check that the sequence numbers of the recorded data are sequential. During the fault record buffer overflow the client can notice a jump in the sequence numbers when some fault records are lost. The gap between the new and the previous sequence number reveals exactly how many records have been lost.

Unread records Left

This register shows how many unread fault records still remain unread for the client in question at a particular moment.

Time stamp registers

The time stamp registers usually hold two data values in the high and low byte of the registers. High byte value = RegisterValue DIV 256, Low byte value = RegisterValue MOD 256. An exception is the milliseconds register which contains the milliseconds 0...999 coded as such. Time stamp also contains a time quality register.

Time quality

Table 27: Information contained by the 16 bit (bits 15..0) register

Bit	Meaning	Values	
15	Event time stamp format	0 = Local time	1 = UTC time
14	Time stamp source	0 = Internal application	1 = Modbus stack
13	Clock not synchronized	0 = Synchronized	1 = Time not synchronized
12	Clock failure	0 = Clock OK	1 = Clock failure
11...0	Reserved	0	

Event time stamp format bit 15

The time stamp format can be selected with a Modbus parameter via the LHMI or the parameter setting tool.

Event time stamp source bit 14

The time stamp can be generated by the IED application, that is accurate time, or by Modbus. If generated by Modbus, the change values are detected by the Modbus background scan task. Since there is a latency time between the value change and the time when Modbus detects the change, in this case the time stamp is not accurate.

Clock not synchronized bit 13

The quality information bit is set in the IED's real-time clock if the IED has not been synchronized.

Clock failure bit 12

The quality information bit is set in the IED's real-time clock if the clock has a severe failure. Do not rely on this time stamp.

3.3.11 Parameter setting group selection

The active parameter setting group can be changed by writing the new setting group number to 4X register 9231. See the IED documentation for the number of available setting groups. Exception response 3 is given if the written value is out of range or the setting group changing is blocked.

3.3.12 Time synchronization

The real-time clock inside the IED runs in UTC time. However, the local time is also known by the IED through the time parameter settings. With Modbus the IED time can be viewed and set either in local time or UTC time.

Two identical time structures are available in the Modbus memory map: the IED's local time at location 49201...49208 and the internal UTC time at the location 49211...49218.

Time synchronization can be given either to the local time structure or to the UTC time structure.

The IED accepts Modbus time synchronization only if the *Synch source* setting is set to "Modbus". The parameter can be set via the LHMI path **Configuration/Time/Synchronization/Synch source**.

3.3.12.1 Real-time clock structure

Table 28: Modbus real-time clock structure

Modbus address		Register contents	Values
Local Time	UTC Time		
49201	49211	Control register	0...2
49202	49212	Year	2000...9999
49203	49213	Month	1...12
49204	49214	Day	1...31
49205	49215	Hour	0...23
49206	49216	Minutes	0...59
49207	49217	Seconds	0...59
49208	49218	Milliseconds	0...999

3.3.12.2 Writing to real-time structures

The Modbus time synchronization can be done in several ways. Over the serial interface, the host's synchronization write can be given with the Modbus broadcast address "0". Thus, all IEDs in the same serial network can be synchronized at the same time.

Method 1: Synchronization in one step

The registers 49201...49208 (49211...49218) should be written in one multiple registers preset request (function 16) by a Modbus TCP/IP client or by a serial interface master. The IED's Modbus address or the Modbus broadcast address can be used with the serial interface. If the clock is written in one step, the write value of the register 49201 (49211) is not checked by the IED.

Method 2: Synchronization in three steps

1. The client reserves the time synchronization by writing value "1" to the register 49201 (49211). If necessary, check that the reservation value is zero at

the beginning. If the time synchronization writing is already reserved by another client, the IED returns the exception response 03.
2. The client writes the time structure to the IED. This can be done in one transaction or alternatively each register can be written separately.
3. The client sets the clock by writing "2" into the register 49201 (49211). When the value "2" is written, the timesync registers are latched onto the IED's internal clock and the reservation in 49201 (49211) is released.

The Modbus broadcast address cannot be used with the synchronization method 2.

There is an internal timeout for the clock setting. The time synchronization reservation is released if the clock is not set within two minutes. The client can abort the time synchronization at any time by writing "0" into the register 49201 (49211). In that case the real-time clock is not set at all.

Other Modbus clients can read the currently running real-time clock even if the time writing is reserved by another client.

3.3.13 Device information

The IED's device information can be read from the Modbus registers 49001...49083.

If the information data are in practice shorter, the trailing registers in the response are filled with the value "0".

The Modbus device information is based on the IED's internal IEC 61850 device information model. All internal descriptions are coded as ASCII strings. The Modbus device information ASCII string includes the information from the IED:

- IED model (max. 12 characters)
- IED type (max. 6 characters)
- IED serial number (max. 12 characters)
- IED location information (max. 34 characters)
- CPU card SWand HW revision numbers
- HMI card SW and HW revision numbers
- Slot 0 (BSB) card SW and HW revision numbers
- Slot 1 Unused
- Slot 2 (PSP) card SW and HW revision numbers
- Slot 3 (BIO) card SW and HW revision numbers
- Slot 4 Unused

The IED does not need to contain cards in all slots nor does a specific card need to include a CPU. The SW revision information is simply omitted from the information string.

3.3.13.1 ASCII character coding

Table 29: The 8 bit ASCII character coding in the Modbus registers

Modbus register	ASCII character
Register 1 High byte	= ASCII character 1
Register 1 Low byte	= ASCII character 2
Register 2 High byte	= ASCII character 3
:	:

3.3.13.2 ASCII string syntax

Syntax:
`C(model;type;serialNo;location;swRev;hwRev)H(swRev;hwRev)0(swRev;hwRev)1(swRev;hwRev)2(swRev;hwRev)3(swRev;hwRev)4(swRev;HwRev)`

- Parenthesis and semicolon ASCII characters are used as delimiters inside the string.
- Section `C(...)` contains IED information and CPU version information.
- Section `H(...)` contains version information of the local HMI card.
- Sections `0(... )` to `4(...)` contain version information of the additional HW cards (slots 0...4).
- If an additional card does not include any version information, it is signalled with a ”–” (minus) character in the swRev field. If both swRev and hwRev are signalled with ”–” signs, the card in question does not exist in the IED.

Example of an identification string could be:
`C(REF615;FE01;1VHR123456R2;feeder 15.12;1.6;2.0)H(1.2;3.1)0(-;-)1(-;1.1)2(-;1.0)3(-;1.1)4(-;2.0)`

The data within the C section is restricted to certain maximum lengths. For example, the user definable IED location is here restricted to a maximum of 34 characters. If the IED location information on system level contains more characters, only the 34 first characters are displayed.

3.3.14 Reset time structure

The time and cause of the IED's last reset are stored into this structure. The reset time is taken directly from the IED's RTC at the startup. The clock might not be accurate and the data can be corrupted.

Table 30: Reset time structure

Address	Register	Values	Comment
49221	TimeStamp (Year,Month)		High byte:year, low byte:month
49222	TimeStamp (Day,Hour)		High byte:day, low byte:hour
49223	TimeStamp (Min,Sec)		High byte:min, low byte:seconds
49224	TimeStamp (Milliseconds)		Word: milliseconds
49225	Time Quality	See Time quality table	
49226	Cause of reset	1 = Power reset	
		2 = Watchdog reset	
		3 = Warm reset	

Table 31: Time quality

Bit	Meaning	Values
15	Time format	0 = Local time
		1 = UTC time
14	Time source	0 = Internal (RTC)
13	RTC not synchronized	0 = RTC synchronized
		1 = Not synchronized
12	RTC Failure	0 = RTC OK
		1 = RTC failure
11...0	Not used	0

Section 4 Modbus parameters and diagnostics

4.1 Parameter list

The Modbus parameters can be accessed with PCM600 or via the LHMI path **Configuration/Communication/Modbus**.

Table 32: MODBUS settings

Parameter	Values (Range)	Unit	Step	Default	Description
MaxTCPClients	0...5			5	Maximum number of Modbus TCP/IP clients
TCPWriteAuthority	0=No clients 1=Reg. clients 2=All clients			2=All clients	Write authority setting for Modbus TCP/IP clients
EventID	0=Address 1=UID			0=Address	Event ID selection
TimeFormat	0=UTC 1=Local			1=Local	Time format for Modbus time stamps
ClientIP1				000.000.000.000	Modbus Registered Client 1
ClientIP2				000.000.000.000	Modbus Registered Client 2
ClientIP3				000.000.000.000	Modbus Registered Client 3
ClientIP4				000.000.000.000	Modbus Registered Client 4
ClientIP5				000.000.000.000	Modbus Registered Client 5
CtlStructPWd1				****	Password for Modbus control struct 1[1)]
CtlStructPWd2				****	Password for Modbus control struct 2
CtlStructPWd3				****	Password for Modbus control struct 3
CtlStructPWd4				****	Password for Modbus control struct 4
CtlStructPWd5				****	Password for Modbus control struct 5
CtlStructPWd6				****	Password for Modbus control struct 6
CtlStructPWd7				****	Password for Modbus control struct 7
CtlStructPWd8				****	Password for Modbus control struct 8
Internal Overflow	0=False 1=True			0=False	Modbus Internal Overflow: TRUE-System level overflow occured (indication only)

1) The amount of available control structures may vary depending on the IED type.

4.2 Monitored data

The Modbus Ethernet monitored data can be accessed with PST or via the LHMI path **Monitoring/Communication/Modbus/Ethernet**.

Table 33: Modbus TCP/IP

Parameter	Values (range)	Description
Received frames N[1)]	0...2147483648	Received Modbus frames by instance N
Transmitted frames N	0...2147483648	Transmitted Modbus frames by instance N
Transmitted Exec A N	0...2147483648	Transmitted exception responses 1 and 2 by instance N
Transmitted Exec B N	0...2147483648	Transmitted exception responses 3 by instance N.
Cn Rejects No socket	0...2147483648	Connection rejections due to no free sockets
Cn Rejects Not reg	0...2147483648	Connection rejections due to not registered client IP.
Status N	True, False	Status of communication, instance N
		Reset of diagnostic counters instance N

1) N = instance number 1, 2...

Section 5 Modbus data mappings

This document describes the Modbus data points and structures available in Ver. 1.0.

Point list table columns

0x addr	Coil (0X) PLC address, base address = 1
Addr.	Signal address
AFL-Common SA name	AFL name of the corresponding data signal
Bit addr	Bit (1X and 0X) PLC address, base address = 1
Ctrl bit	Control bit (0..15) within control structure
Ctrl struct	Control structure number
Description	Signal description
Ds	Object resides as default in some IEC 61850 data set (Y = yes, N = no)
Identification	IED's internal IEC 61850 signal name
IEC 61850 name	IEC 61850 signal description
Mode	Control object mode: unsecured or secured
Reg addr	Modbus register address (3X or 4X). PLC address, base address = 1
Reg.bit	Register PLC address (3X and 4X) and bit within register (0..15)
Scale	Scale factor, default setting
Type	Register type and value interpretation: signed or unsigned
Value range	Value range of the signal

5.1 Point list for RBX615 Ver. 2.0

Table 34: Registers

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
128						System status register 1	See Modbus CPM
129						System status register 2	See Modbus CPM
130						System status register 3	See Modbus CPM
131						System status register 4	See Modbus CPM
132						System status register 5	See Modbus CPM
133						System status register 6	See Modbus CPM
134	i16	1	LD0.DARREC1.AutoRecSt.stVal	DARREC1.STATUS	Y	Autoreclosing status[.stVal]	-2…4 (= AR states: See doc)
135	u16	1	LD0.DARREC1.ShotPntr.stVal	DARREC1.SHOT_PTR	Y	AR shot pointer value[.stVal]	0…6
136	u16	1	LD0.DARREC1.OpCntRs.stVal	DARREC1.COUNTER	Y	AR resettable operation counter (all shots)	0...2147483647
137	u16	1000	LD0.CMMXU1.A.phsA.instCVal.mag	CMMXU1.I_INST_A	Y	Phase current A magnitude	0.00 …. 40.00 [xIn]
138	u16	1000	LD0.CMMXU1.A.phsB.instCVal.mag	CMMXU1.I_INST_B	Y	Phase current B magnitude	0.00 …. 40.00 [xIn]
139	u16	1000	LD0.CMMXU1.A.phsC.instCVal.mag	CMMXU1.I_INST_C	Y	Phase current C magnitude	0.00 …. 40.00 [xIn]
140	u16	1000	LD0.RESCMMXU1.A.res.instCVal.mag	RESCMMXU1.I0_INST	Y	Residual current magnitude	0.00 …. 40.00 [xIn]
141	u16	1000	LD0.VMMXU1.phV.phsA.instCVal.mag	VMMXU1.U_INST_A	Y	Phase-to-ground voltage A amplitude	0.00 …. 4.00 [xUn]
142	u16	1000	LD0.VMMXU1.phV.phsB.instCVal.mag	VMMXU1.U_INST_B	Y	Phase-to-ground voltage B amplitude	0.00 …. 4.00 [xUn]
143	u16	1000	LD0.VMMXU1.phV.phsB.instCVal.mag	VMMXU1.U_INST_C	Y	Phase-to-ground voltage C amplitude	0.00 …. 4.00 [xUn]
144	u16	1000	LD0.VMMXU1.PPV.phsAB.instCVal.mag	VMMXU1.U_INST_AB	Y	Phase-to-phase voltage AB amplitude	0.00 …. 4.00 [xUn]
145	u16	1000	LD0.VMMXU1.PPV.phsBC.instCVal.mag	VMMXU1.U_INST_BC	Y	Phase-to-phase voltage BC amplitude	0.00 …. 4.00 [xUn]
146	u16	1000	LD0.VMMXU1.PPV.phsCA.instCVal.mag	VMMXU1.U_INST_CA	Y	Phase-to-phase voltage CA amplitude	0.00 …. 4.00 [xUn]
147	u16	1000	LD0.RESVMMXU1.PhV.res.instCVal.mag	RESCMMXU1.U0_INST	Y	Residual voltage magnitude	0.00 …. 4.00 [xUn]
148	u16	1000	LD0.CSMSQI1.SeqA.c1.instCVal.mag	CMSQI1.I1_INST	Y	Positive sequence of current magnitude	0.00 …. 40.00 [xIn]
149	u16	1000	LD0.CSMSQI1.SeqA.c2.instCVal.mag	CMSQI1.I2_INST	Y	Negative sequence of current magnitude	0.00 …. 40.00 [xIn]
150	u16	1000	LD0.CSMSQI1.SeqA.c3.instCVal.mag	CMSQI1.I3_INST	Y	Zero sequence of current magnitude	0.00 …. 40.00 [xIn]
151	u16	1000	LD0.VSMSQI1.SeqA.c1.instCVal.mag	VMSQI1.I1_INST	Y	Positive sequence of voltage magnitude	0.00 …. 4.00 [xUn]
152	u16	1000	LD0.VSMSQI1.SeqA.c2.instCVal.mag	VMSQI1.I2_INST	Y	Negative sequence of voltage magnitude	0.00 …. 4.00 [xUn]
153	u16	1000	LD0.VSMSQI1.SeqA.c3.instCVal.mag	VMSQI1.I3_INST	Y	Zero sequence of voltage magnitude	0.00 …. 4.00 [xUn]
154	i32	1	LD0.PEMMXU1.TotW.instMag High	PEMMXU1.P_INST	Y	Total active power P	-999999…999999
155			LD0.PEMMXU1.TotW.instMag Low				
156	i32	1	LD0.PEMMXU1.TotVAr.instMag High	PEMMXU1.Q_INST	Y	Total reactive power R	-999999…999999
157			LD0.PEMMXU1.TotVAr.instMag Low				
158	i32	1	LD0.PEMMXU1.TotVA.instMag High	PEMMXU1.S_INST	Y	Total apparent power S	-999999…999999
159			LD0.PEMMXU1.TotVA.instMag Low				
160	i16	1000	LD0.PEMMXU1.TotPF.instMag	PEMMXU1.PF_INST	Y	Average power factor	-1.00…1.00
161	i16	1	LD0.T1PTTR1.Tmp.mag	T1PTTR1.TEMP	Y	Temperature of protected object	-100.0…9999.9 [Celsius]
162	u16	1	LD0.T1PTTR1.TmpRl.mag	T1PTTR1.TEMP_RL	Y	Relative temperature	0.00…99.99 [Celcius]
163						(reserved)	0
164						(reserved)	0

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
165	u16	1	LD0.MPTTR1.TmpRl.mag	MPTTR1.Therm-Lev	Y	Thermal level	0.00...99.99 [Celsius]
166						(reserved)	0
167						(reserved)	0
168						(reserved)	0
169						(reserved)	0
170				packed indications			
...							
2000							
Phase current demand values (latest values)							
2001	u16	1000	LD0.CMSTA1.AvAmps1.mag	CMMXU1.I_DMD_A	N	Demand value of phase A current	0.00 …. 40.00 [xIn]
2002	u16	1000	LD0.CMSTA1.AvAmps2.mag	CMMXU1.I_DMD_B	N	Demand value of phase B current	0.00 …. 40.00 [xIn]
2003	u16	1000	LD0.CMSTA1.AvAmps3.mag	CMMXU1.I_DMD_C	N	Demand value of phase C current	0.00 …. 40.00 [xIn]
2004							Time structure (see doc)
2005							
2006			Timestruct (demand capture)				
2007							
2008							
Maximum phase current demand values							
2009	u16	1000	LD0.CMSTA1.MaxAmps1.mag	CMMXU1.Max demand IL1	N	Max. demand value for Phase A current	0.00 …. 40.00 [xIn]
2010							Time structure (see doc)
2011							
2012			Timestruct (peak value capture)				
2013							
2014							
2015	u16	1000	LD0.CMSTA1.MaxAmps2.mag	CMMXU1.Max demand IL2	N	Max. demand value for Phase B current	0.00 …. 40.00 [xIn]
2016							Time structure (see doc)
2017							
2018			Timestruct (peak value capture)				
2019							
2020							
2021	u16	1000	LD0.CMSTA1.MaxAmps3.mag	CMMXU1.Max demand IL3	N	Max. demand value for Phase C current	0.00 …. 40.00 [xIn]
2022							Time structure (see doc)
2023							
2024			Timestruct (peak value capture)				
2025							
2026							
Counters - Circuit breaker, autorecloser							
2027						(reserved)	0
2028	u16	1	LD0.DARREC1.OpCnt1.stVal	DARREC1.CNT_SHOT1	N	Autorecloser operation counter (1st shot)	0…65535

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2029	u16	1	LD0.DARREC1.OpCnt2.stVal	DARREC1.CNT_SHOT2	N	Autorecloser operation counter (2nd shot)	0…65535
2030	u16	1	LD0.DARREC1.OpCnt3.stVal	DARREC1.CNT_SHOT3	N	Autorecloser operation counter (3rd shot)	0…65535
2031	u16	1	LD0.DARREC1.OpCnt4.stVal	DARREC1.CNT_SHOT4	N	Autorecloser operation counter (4th shot)	0…65535
2032	u16	1	LD0.DARREC1.OpCnt5.stVal	DARREC1.CNT_SHOT5	N	Autorecloser operation counter (5th shot)	0…65535
2033	u16	1	LD0.DARREC1.FrqOpCnt.stVal	DARREC1.FRQ_OPR_CN T	N	Autorecloser frequent operation counter	0…65535
2034	u16	1	LD0.T1PTTR1.TmsOp.stVal	T1PTTR1.THERMLEV_ST	N	Estimated time to operate	0…600000 [s]
2035	u16	1	LD0.T1PTTR1.TmsRecEna.stVal	T1PTTR1.THERMLEV_END	N	Estimated time to deactivate BLK_CLOSE	0…600000 [s]
2036						(reserved)	0
2037						(reserved)	0
Energy counters							
2038	u16	10	LD0.MPTTR1.ThmLevSt	MPTTR1.THERMLEV_ST	N	Thermal level at beginning of motor startup	0.00…9.99
2039	u16	10	LD0.MPTTR1.ThmLevEnd	MPTTR1.THERMLEV_END	N	Thermal level at the end of motor startup situation	0.00…9.99
2040	u16	1	LD0.MPTTR1.StrInhTms.stVal	MPTTR1.T_ENARESTART	N	Estimated time to reset of block restart	0...99999 [s]
2041						(reserved)	0
2042	u32	1	LD0.PEMMTR1.SupWh.actVal High	LD0.PEMMTR1.SupWh.actVal	N	Reverse active energy Wh	0…999999999 (units = see doc.)
2043							
2044	u32	1	LD0.PEMMTR1.SupVArh.actVal High	LD0.PEMMTR1.SupVArh.actVal	N	Reverse reactive energy Var	0…999999999 (units = see doc.)
2045							
2046	u32	1	LD0.PEMMTR1.DemWh.actVal High	LD0.PEMMTR1.DemWh.actVal	N	Forward active energy Wh	0…999999999 (units = see doc.)
2047							
2048	u32	1	LD0.PEMMTR1.DemVArh.actVal High	LD0.PEMMTR1.DemVArh.actVal	N	Forward reactive energy VAr	0…999999999 (units = see doc.)
2049							
2050						(reserved)	0
2051						(reserved)	0
2052						(reserved)	0
Diagnostics							
2053	u16	1	LD0.LPHD1.PhyHealth1.stVal	Warning	Y	Physical device - Warning	Codes: see documentation
2054	u16	1	LD0.LPHD1.PhyHealth2.stVal	Internal Fault	Y	Physical device - Internal Fault	Codes: see documentation
2055	u16	1	DR.RDRE1.FltNum.stVal		N	Disturbance recorder - Number of recordings	0…N
2056	u16	1	DR.RDRE1.MemUsed.stVa		N	Disturbance recorder - Rec. Memory used	0…100 [%]
2057	u16	1	LD0.LPHD1.NumPwrUp.stVal		N	Physical device - Number of Power ups	0…65535
2058	u16	1	LD0.LPHD1.WrmStr.stVal		N	Physical device - Number of Warm starts	0…65535
2059	u16	1	LD0.LPHD1.WacTrg.stVal		N	Physical device - Number of watchdog resets	0…65535
2060	u16	1	LD0.LPHD1.NumCmpChg.stVal		N	Number of composition changes	0…65535
2061			(reserved)			(reserved)	0
Circuit breaker condition monitoring							
2062	u32	1	LD0.ESSCBR1.OpCnt.stVal	ESSCBR1.NO_OPR	Y	Num of CB operations - low word	0…99999
2063						Num of CB operations - high word	

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2064	u32	1	LD0.ESSCBR1.PrOpCnt.stVal	ESSCBR1.NO_PROT_OPR	N	Num of operations under load - low word	0…99999
2065						Num of operations under load - high word	
2066	u16	1	LD0.ESSCBR1.InaTmdCnt.stVal	ESSCBR1.INA_DAYS	N	Num of inactive days for CB	0…9999
2067	u16	1	LD0.ESSCBR1.TmmsOpn.mag.i	ESSCBR1.TRV_OP_T	N	Travelling time for Open operation	0…60000 [ms]
2068	u16	1	LD0.ESSCBR1.TmmsCls.mag.i	ESSCBR1.TRV_CL_T	N	Travelling time for Close operation	0…60000 [ms]
2069	u16	100	LD0.ESSCBR1.TmmsSprCha.mag.i	ESSCBR1.SPR_CHR_T	N	Spring charging time	0.00 … 99.99 [s]
2070	i16	1	LD0.ESSCBR1.RmnLifPhA.stVal	ESSCBR1.CB_LIFE_A	N	Remaining CB life, phase A	-9999…9999
2071	i16	1	LD0.ESSCBR1.RmnLifPhB.stVal	ESSCBR1.CB_LIFE_B	N	Remaining CB life, phase B	-9999…9999
2072	i16	1	LD0.ESSCBR1.RmnLifPhC.stVal	ESSCBR1.CB_LIFE_C	N	Remaining CB life, phase C	-9999…9999
2073	u16	1	LD0.ESSCBR1.ContQA.stVal	ESSCBR1.CONTACT_A_Q	N	Contact quality, phase A	0…100 [%]
2074	u16	1	LD0.ESSCBR1.ContQB.stVal	ESSCBR1.CONTACT_B_Q	N	Contact quality, phase B	0…100 [%]
2075	u16	1	LD0.ESSCBR1.ContQC.stVal	ESSCBR1.CONTACT_C_Q	N	Contact quality, phase C	0…100 [%]
2076	u16	1	LD0.ESSCBR1.TrvOpQ.stVal	ESSCBR1.TRV_OP_Q	N	Travel time Open quality	0…100 [%]
2077	u16	1	LD0.ESSCBR1.TrvClQ.stVal	ESSCBR1.TRV_CL_Q	N	Travel time Close quality	0…100 [%]
2078	u16	1	LD0.ESSCBR1.SprChaQ.stVal	ESSCBR1.SPR_CHR_Q	N	Spring charge quality	0…100 [%]
2079	u16	1	LD0.ESSCBR1.SprFacQ.stVal	ESSCBR1.FAC_Q	N	Spring, fatal attempt to charge, quality	0…100 [%]
2080			(reserved)			(reserved)	0
2081			(reserved)			(reserved)	0
2082			(reserved)			(reserved)	0
2083			(reserved)			(reserved)	0
Operation counters							
2084	u16	1	CTRL.FCBCSWI1.OpCntRs.stVal	FCBCSWI.Operation counter	N	Operation counter	0…65535
2085	u16	1	CTRL.WCBCSWI1.OpCntRs.stVal	WCBCSWI.Operation counter	N	Operation counter	0…65535
2086	u16	1	CTRL.MESCSWI1.OpCntRs.stVal	MESCSWI.Operation counter	N	Operation counter	0…65535
2087	u16	1	CTRL.TRCSWI1.OpCntRs.stVal	TRCSWI.Operation counter	N	Operation counter	0…65535
…							
LED states							
2091	u16	1	LD0.MLEDGGIO1.INCSO1.stVal		Y	Led object 1 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2092	u16	1	LD0.MLEDGGIO1.INCSO2.stVal		Y	Led object 2 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2093	u16	1	LD0.MLEDGGIO1.INCSO3.stVal		Y	Led object 3 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2094	u16	1	LD0.MLEDGGIO1.INCSO4.stVal		Y	Led object 4 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2095	u16	1	LD0.MLEDGGIO1.INCSO5.stVal		Y	Led object 5 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2096	u16	1	LD0.MLEDGGIO1.INCSO6.stVal		Y	Led object 6 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2097	u16	1	LD0.MLEDGGIO1.INCSO7.stVal		Y	Led object 7 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2098	u16	1	LD0.MLEDGGIO1.INCSO8.stVal		Y	Led object 8 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2099	u16	1	LD0.MLEDGGIO1.INCSO9.stVal		Y	Led object 9 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2100	u16	1	LD0.MLEDGGIO1.INCSO10.stVal		Y	Led object 10 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2101	u16	1	LD0.MLEDGGIO1.INCSO11.stVal		Y	Led object 11 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2102	u16	1	LD0.MLEDGGIO1.INCSO12.stVal		Y	Led object 12 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2103	u16	1	LD0.MLEDGGIO1.INCSO13.stVal		Y	Led object 13 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2104	u16	1	LD0.MLEDGGIO1.INCSO14.stVal		Y	Led object 14 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2105	u16	1	LD0.MLEDGGIO1.INCSO15.stVal		Y	Led object 15 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2106	u16	1	LD0.MLEDGGIO1.INCSO16.stVal		Y	Led object 16 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2107	u16	1	LD0.MLEDGGIO1.INCSO17.stVal		Y	Led object 17 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2108	u16	1	LD0.MLEDGGIO1.INCSO18.stVal		Y	Led object 18 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2109	u16	1	LD0.MLEDGGIO1.INCSO19.stVal		Y	Led object 19 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2110	u16	1	LD0.MLEDGGIO1.INCSO20.stVal		Y	Led object 20 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2111	u16	1	LD0.MLEDGGIO1.INCSO21.stVal		Y	Led object 21 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2112	u16	1	LD0.MLEDGGIO1.INCSO22.stVal		Y	Led object 22 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2113	u16	1	LD0.MLEDGGIO1.INCSO23.stVal		Y	Led object 23 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
2114	u16	1	LD0.MLEDGGIO1.INCSO24.stVal		Y	Led object 24 status [.stVal]	0=Off, 1=Green, 2=Red, 3=Yellow
….							
8000							
Control structure 1							
8001	u16		For information on control structure 1 bit definitions, see Modbus controls table.			Control Struct 1 - Execute register	Control structure (see Modbus CPM)
8002	u16					Control Struct 1 - Password 1	
8003	u16					Control Struct 1 - Password 2	
8004	u16					Control Struct 1 - Control register	
8005	u16					Control Struct 1 - Confirm register	
Control structure 2							

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
8006	u16		For information on control structure 2 bit definitions, see Modbus controls table.			Control Struct 2 - Execute register	Control structure (see Modbus CPM)
8007	u16					Control Struct 2 - Password 1	
8008	u16					Control Struct 2 - Password 2	
8009	u16					Control Struct 2 - Control register	
8010	u16					Control Struct 2 - Confirm register	
Control structure 3							
8011	u16		For information on control structure 3 bit definitions, see Modbus controls table.			Control Struct 3 - Execute register	Control structure (see Modbus CPM)
8012	u16					Control Struct 3 - Password 1	
8013	u16					Control Struct 3 - Password 2	
8014	u16					Control Struct 3 - Control register	
8015	u16					Control Struct 3 - Confirm register	
Control structure 4							
8016	u16		For information on control structure 4 bit definitions, see Modbus controls table.			Control Struct 4 - Execute register	Control structure (see Modbus CPM)
8017	u16					Control Struct 4 - Password 1	
8018	u16					Control Struct 4 - Password 2	
8019	u16					Control Struct 4 - Control register	
8020	u16					Control Struct 4 - Confirm register	
Control structure 5							
8021	u16		For information on control structure 5 bit definitions, see Modbus controls table.			Control Struct 5 - Execute register	Control structure (see Modbus CPM)
8022	u16					Control Struct 5 - Password 1	
8023	u16					Control Struct 5 - Password 2	
8024	u16					Control Struct 5 - Control register	
8025	u16					Control Struct 5 - Confirm register	
8026						(reserved)	0
...							
9000							
Device ID string							
9001						Max length of device ID string may be 128 registers	Device ID string (see Modbus CPM)
9002						(reserved)	0
...							
9128							
Device real-time clock in local time							
9201	u16					Real-time struct - Control register (0..2)	
9202	u16					Real-time struct - Year (2000..2999)	
9203	u16					Real-time struct - Month (1..12)	

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
9204	u16					Real-time struct - Day (1..31)	
9205	u16					Real-time struct - Hour (0..23)	
9206	u16					Real-time struct - Minute (0..59)	
9207	u16					Real-time struct - Seconds (0..59)	
9208	u16					Real-time struct - Milliseconds (0..999)	
9209						(reserved)	0
9210						(reserved)	0
Device real-time clock in UTC time							
9211	u16					Real-time struct UTC - Control register (0..2)	
9212	u16					Real-time struct UTC - Year (2000..2999)	
9213	u16					Real-time struct UTC - Month (1..12)	
9214	u16					Real-time struct UTC - Day (1..31)	
9215	u16					Real-time struct UTC - Hour (0..23)	
9216	u16					Real-time struct UTC - Minute (0..59)	
9217	u16					Real-time struct UTC - Seconds (0..59)	
9218	u16					Real-time struct UTC - Milliseconds (0..999)	
9219						(reserved)	0
9220						(reserved)	0
Timestamp of last device reset							
9221	u16					Reset time struct - Year (2000..2999)	
9222	u16					Reset time struct - Month (1..12)	
9223	u16					Reset time struct - Day (1..31)	
9224	u16					Reset time struct - Hour (0..23)	
9225	u16					Reset time struct - Minute (0..59)	
9226	u16					Reset time struct - Seconds (0..59)	
9227	u16					Reset time struct - Milliseconds (0..999)	
9228	u16					Reset time struct - Reason	1 = Cold reset 2 = Watchdog reset 4 = Warm reset
9229						(reserved)	0
9230						(reserved)	
Active parameter setting group							
9231	u16		-	-		Setting group in use	1...6
...						(reserved)	0
9249							
Event record structure							
9250	u16	0	Event read selection	-		Number of events records in multiple event reading	1…10
9251	i16	0				Event read operation selection	-499…3

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
9252	u16	0	Event record 1 (11 registers)	-		Event record struct - Sequence number	Event record structure (see Modbus CPM)
9253	u16	0				Event record struct - Unread records left	
9254	u16	0				Event record struct - TimeStamp (Year,Month)	
9255	u16	0				Event record struct - TimeStamp (Day, Hour)	
9256	u16	0				Event record struct - TimeStamp (Min, Sec)	
9257	u16	0				Event record struct - TimeStamp (Milliseconds)	
9258	u16	0				Event record struct - Event identification	
9259	u16	0				Event record struct - Data object ID 1	
9260	u16	0				Event record struct - Data object ID 2	
9261	u16	0				Event record struct - Data value	
9262	u16	0				Event record struct - Data value	
9263 … 9273			Event record 2 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9274 … 9284			Event record 3 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9285 … 9295			Event record 4 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9296 … 9306			Event record 5 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9307 … 9317			Event record 6 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9318 … 9328			Event record 7 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9329 … 9339			Event record 8 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9340 … 9350			Event record 9 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9351 … 9361			Event record 10 (11 registers)	-		Event record structure	Event record structure (see Modbus CPM)
9362						(reserved)	0
…							
9400							
Fault record structure							
9401	i16	0	Fault record read selection	-		Fault record read operation selection	-99…3

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
9402	u16	0				Fault record struct - Sequence number	Header
9403	u16	0				Fault record struct - Unread records left	
9404	u16	0				Fault record struct - TimeStamp (Year,Month)	
9405	u16	0				Fault record struct - TimeStamp (Day, Hour)	
9406	u16	0				Fault record struct - TimeStamp (Min, Sec)	
9407	u16	0				Fault record struct - TimeStamp (Milliseconds)	
9408	u16	0				Fault record struct - TimeStamp (Time quality)	
Fault records							
9409						(reserved)	0
9410						(reserved)	0
9411						(reserved)	0
9412	u16	1000	LD0.FLTMSTA1.MxDifAClcA.mag			Max differential current in phase A during fault	0.00 …. 40.00 [xIn]
9413	u16	1000	LD0.FLTMSTA1.MxDifAClcB.mag			Max differential current in phase B during fault	0.00 …. 40.00 [xIn]
9414	u16	1000	LD0.FLTMSTA1.MxDifAClcC.mag			Max differential current in phase C during fault	0.00 …. 40.00 [xIn]
9415	u16	1000	LD0.FLTMSTA1.MxRstAClcA.mag			Max bias current in phase A during fault	0.00 …. 40.00 [xIn]
9416	u16	1000	LD0.FLTMSTA1.MxRstAClcB.mag			Max bias current in phase B during fault	0.00 …. 40.00 [xIn]
9417	u16	1000	LD0.FLTMSTA1.MxRstAClcC.mag			Max bias current in phase C during fault	0.00 …. 40.00 [xIn]
9418	u16	1000	LD0.FLTMSTA1.DifAmpsA.mag			Differential current in phase A at moment of trip	0.00 …. 40.00 [xIn]
9419	u16	1000	LD0.FLTMSTA1.DifAmpsB.mag			Differential current in phase B at moment of trip	0.00 …. 40.00 [xIn]
9420	u16	1000	LD0.FLTMSTA1.DifAmpsC.mag			Differential current in phase C at moment of trip	0.00 …. 40.00 [xIn]
9421	u16	1000	LD0.FLTMSTA1.RstAmpsA.mag			Bias current in phase A at moment of trip	0.00 …. 40.00 [xIn]
9422	u16	1000	LD0.FLTMSTA1.RstAmpsB.mag			Bias current in phase B at moment of trip	0.00 …. 40.00 [xIn]
9423	u16	1000	LD0.FLTMSTA1.RstAmpsC.mag			Bias current in phase C at moment of trip	0.00 …. 40.00 [xIn]
9424	u16	1000	LD0.FLTMSTA1.DifAmpsN.mag			Differential residual current at moment of trip	0.00 …. 40.00 [xIn]
9425	u16	1000	LD0.FLTMSTA1.RstAmpsN.mag			Bias residual current at moment of trip	0.00 …. 40.00 [xIn]
9426	u16	1000	LD0.FLTMSTA1.MaxAmpsA.mag			Max phase A current during fault	0.00 …. 40.00 [xIn]
9427	u16	1000	LD0.FLTMSTA1.MaxAmpsB.mag			Max phase B current during fault	0.00 …. 40.00 [xIn]
9428	u16	1000	LD0.FLTMSTA1.MaxAmpsC.mag			Max phase C current during fault	0.00 …. 40.00 [xIn]
9429	u16	1000	LD0.FLTMSTA1.MaxAmpsN.mag			Max residual current during fault	0.00 …. 40.00 [xIn]
9430	u16	1000	LD0.FLTMSTA1.AmpsA.mag			Phase A current at moment of trip	0.00 …. 40.00 [xIn]
9431	u16	1000	LD0.FLTMSTA1.AmpsB.mag			Phase B current at moment of trip	0.00 …. 40.00 [xIn]
9432	u16	1000	LD0.FLTMSTA1.AmpsC.mag			Phase C current at moment of trip	0.00 …. 40.00 [xIn]
9433	u16	1000	LD0.FLTMSTA1.AmpsN.mag			Residual current at moment of trip	0.00 …. 40.00 [xIn]
9434	u16	1000	LD0.FLTMSTA1.AmpsNClc.mag			Residual Clc current at moment of trip	0.00 …. 40.00 [xIn]
9435	u16	1000	LD0.FLTMSTA1.AmpsNgSeq.mag			Negative sequence current at moment of trip	0.00 …. 40.00 [xIn]
9436	u16	1000	LD0.FLTMSTA1.MaxAmpsAb.mag			Max phase Ab current during fault	0.00 …. 40.00 [xIn]
9437	u16	1000	LD0.FLTMSTA1.MaxAmpsBb.mag			Max phase Bb current during fault	0.00 …. 40.00 [xIn]
9438	u16	1000	LD0.FLTMSTA1.MaxAmpsCb.mag			Max phase Cb current during fault	0.00 …. 40.00 [xIn]
9439	u16	1000	LD0.FLTMSTA1.AmpsAb.mag			Phase Ab current at moment of trip	0.00 …. 40.00 [xIn]

Table continues on next page

Reg addr	Type	Scale	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
9440	u16	1000	LD0.FLTMSTA1.AmpsBb.mag			Phase Bb current at moment of trip	0.00 …. 40.00 [xIn]
9441	u16	1000	LD0.FLTMSTA1.AmpsCb.mag			Phase Cb current at moment of trip	0.00 …. 40.00 [xIn]
9442	u16	1000	LD0.FLTMSTA1.AmpsNClcb.mag			Residual Clc b current at moment of trip	0.00 …. 40.00 [xIn]
9443	u16	1000	LD0.FLTMSTA1.AmpsNgSeqb.mag			Negative sequence b current at moment of trip	0.00 …. 40.00 [xIn]
9444	u16	1000	LD0.FLTMSTA1.VoltsA.mag			Phase A voltage at moment of trip	0.00 …. 4.00 [xUn]
9445	u16	1000	LD0.FLTMSTA1.VoltsB.mag			Phase B voltage at moment of trip	0.00 …. 4.00 [xUn]
9446	u16	1000	LD0.FLTMSTA1.VoltsC.mag			Phase C voltage at moment of trip	0.00 …. 4.00 [xUn]
9447	u16	1000	LD0.FLTMSTA1.VoltsAB.mag			Phase-to-phase voltage AB at moment of trip	0.00 …. 4.00 [xUn]
9448	u16	1000	LD0.FLTMSTA1.VoltsBC.mag			Phase-to-phase voltage BC at moment of trip	0.00 …. 4.00 [xUn]
9449	u16	1000	LD0.FLTMSTA1.VoltsCA.mag			Phase-to-phase voltage CA at moment of trip	0.00 …. 4.00 [xUn]
9450	u16	1000	LD0.FLTMSTA1.VoltsN.mag			Residual voltage at moment of trip	0.00 …. 4.00 [xUn]
9451	u16	1000	LD0.FLTMSTA1.VZroSeq.mag			Positive sequence voltage at moment of trip	0.00 …. 4.00 [xUn]
9452	u16	1000	LD0.FLTMSTA1.VPsSeq.mag			Negative sequence voltage at moment of trip	0.00 …. 4.00 [xUn]
9453	u16	1000	LD0.FLTMSTA1.VNgSeq.mag			Zero sequence voltage at moment of trip	0.00 …. 4.00 [xUn]
9454	u16	1000	LD0.FLTMSTA1.MaxTmpRl.mag			Max relative temperature	0.00…99.99 [degrees Celsius]
9455	i16	10	LD0.FLTMSTA1.DifNAngN.mag			Residual voltage-residual current angle	-180.00...180.00 [degrees]
9456	i16	10	LD0.FLTMSTA1.DifAAngBC.mag			Angle phase B to phase C voltage - phase A current	-180.00...180.00 [degrees]
9457	i16	10	LD0.FLTMSTA1.DifAAngCA.mag			Angle phase C to phase A voltage - phase B current	-180.00...180.00 [degrees]
9458	i16	10	LD0.FLTMSTA1.DifAAngAB.mag			Angle phase A to phase B voltage - phase C current	-180.00...180.00 [degrees]

Table 35: Indications

Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2720	170.00	CTRL.LLN0.Loc.stVal		Y	Local/Remote state - mom	0 = Local, 1=Remote
2721	170.01	CTRL.LLN0.LocRem.stVal.ON_OFF		Y	Local/Remote ON/OFF - mom	0 = OFF, 1 = ON
2722	170.02	DR.RDRE1.RcdMade.stVal		Y	Disturbance recorder file ready	1 = DR file captured
2723	170.03	DR.RDRE1.RcdMade.stVal - MCD			Disturbance recorder file ready-MCD	
2724	170.04	LD0.DARREC1.AROn.stVal	DARREC1.AR_ON	Y	Autorecloser state - mom	1 = AR in use, 0 = not in use
2725	170.05				(reserved)	0
2726	170.06	LD0.GSEGGIO1.Alm.stVal		Y	Goose alarm state - mom	1=Goose alarm
2727	170.07	LD0.GSEGGIO1.Alm.stVal - MCD			Goose alarm state - MCD	
2728	170.08				(reserved)	0
2729	170.09				(reserved)	0
2730	170.10				(reserved)	0
2731	170.11				(reserved)	0
2732	170.12				(reserved)	0
2733	170.13				(reserved)	0
2734	170.14				(reserved)	0
2735	170.15				(reserved)	0
Global conditioning						
2736	171.00	LD0.LEDPTRC1.Str.general		Y	Start [.general] - mom	1=Start (LEDPTRC)
2737	171.01	LD0.LEDPTRC1.Str.general - MCD			Start [.general] - MCD	
2738	171.02	LD0.LEDPTRC1.Op.general		Y	Operate [.general] - mom	1=Operate (LEDPTRC)
2739	171.03	LD0.LEDPTRC1.Op.general - MCD			Operate [.general] - MCD	
Protection trip conditioning (1)						
2740	171.04	LD0.TRPPTRC1.Op.general		Y	Input signal [.general] - mom	1=Input signal ON
2741	171.05	LD0.TRPPTRC1.Op.general - MCD			Input signal [.general] - MCD	
2742	171.06	LD0.TRPPTRC1.Tr.general		Y	Trip output signal [.general] - mom	1=Trip output signal ON

Table continues on next page

Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2743	171.07	LD0.TRPPTRC1.Tr.general - MCD			Trip output signal [.general] - MCD	
Protection trip conditioning (2)						
2744	171.08	LD0.TRPPTRC2.Op.general		Y	Input signal [.general] - mom	1=Input signal ON
2745	171.09	LD0.TRPPTRC2.Op.general - MCD			Input signal [.general] - MCD	
2746	171.10	LD0.TRPPTRC2.Tr.general		Y	Trip output signal [.general] - mom	1=Trip output signal ON
2747	171.11	LD0.TRPPTRC2.Tr.general - MCD			Trip output signal [.general] - MCD	
Open coil switch supervision						
2748	171.12	LD0.OCSSCBR1.CirAlm.stVal	OCSSCBR1.ALARM	Y	Circuit alarm [.stVal] - mom	1=Alarm
2749	171.13	LD0.OCSSCBR1.CirAlm.stVal -MCD			Circuit alarm [.stVal] - MCD	
Close coil switch supervision						
2750	171.14	LD0.CCSSCBR1.CirAlm.stVal	CCSSCBR1.ALARM	Y	Circuit alarm [.stVal] - mom	1=Alarm
2751	171.15	LD0.CCSSCBR1.CirAlm.stVal - MCD			Circuit alarm [.stVal] - MCD	
Phase current value limit supervision						
2752	172.00	LD0.CMMXU1.HiAlm.stVal	CMMXU1.HIGH_ALARM	Y	High alarm[.stVal] - mom	1=High alarm
2753	172.01	LD0.CMMXU1.HiAlm.stVal - MCD			High alarm[.stVal] - MCD	
2754	172.02	LD0.CMMXU1.HiWrn.stVal	CMMXU1.HIGH_WARN	Y	High warning[.stVal] - mom	1=High warning
2755	172.03	LD0.CMMXU1.HiWrn.stVal - MCD			High warning[.stVal] - MCD	
2756	172.04	LD0.CMMXU1.LoWrn.stVal	CMMXU1.LOW_WARN	Y	Low warning[.stVal] - mom	1=Low warning
2757	172.05	LD0.CMMXU1.LoWrn.stVal - MCD			Low warning[.stVal] - MCD	
2758	172.06	LD0.CMMXU1.LoAlm.stVal	CMMXU1.LOW_ALARM	Y	Low alarm[.stVal] - mom	1=Low alarm
2759	172.07	LD0.CMMXU1.LoAlm.stVal - MCD			Low alarm[.stVal] - MCD	
Residual current value limit supervision						
2760	172.08	LD0.RESCMMXU1.HiAlm.stVa l	RESCMMXU1.HIGH_ALARM	Y	High alarm[.stVal] - mom	1=High alarm

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2761	172.09	LD0.RESCMMXU1.HiAlm.stVal -MCD			High alarm[.stVal] - MCD	
2762	172.10	LD0.RESCMMXU1.HiWrn.stVal	RESCMMXU1.HIGH_WARN	Y	High warning[.stVal] - mom	1=High warning
2763	172.11	LD0.RESCMMXU1.HiWrn.stVal -MCD			High warning[.stVal] - MCD	
Residual voltage value limit supervision						
2764	172.12	LD0.RESVMMXU1.HiAlm.stVal	RESVMMXU1.HIGH_ALARM	Y	High alarm[.stVal] - mom	1=High alarm
2765	172.13	LD0.RESVMMXU1.HiAlm.stVal -MCD			High alarm[.stVal] - MCD	
2766	172.14	LD0.RESVMMXU1.HiWrn.stVal	RESVMMXU1.HIGH_WARN	Y	High warning[.stVal] - mom	1=High warning
2767	172.15	LD0.RESVMMXU1.HiWrn.stVal -MCD			High warning[.stVal] - MCD	
Phase voltage value limit supervision						
2768	173.00	LD0.VMMXU1.HiAlm.stVal	VMMXU1.HIGH_ALARM	Y	High alarm[.stVal] - mom	1=High alarm
2769	173.01	LD0.VMMXU1.HiAlm.stVal - MCD			High alarm[.stVal] - MCD	
2770	173.02	LD0.VMMXU1.HiWrn.stVal	VMMXU1.HIGH_WARN	Y	High warning[.stVal] - mom	1=High warning
2771	173.03	LD0.VMMXU1.HiWrn.stVal - MCD			High warning[.stVal] - MCD	
2772	173.04	LD0.VMMXU1.LoWrn.stVal	VMMXU1.LOW_WARN	Y	Low warning[.stVal] - mom	1=Low warning
2773	173.05	LD0.VMMXU1.LoWrn.stVal - MCD			Low warning[.stVal] - MCD	
2774	173.06	LD0.VMMXU1.LoAlm.stVal	VMMXU1.LOW_ALARM	Y	Low alarm[.stVal] - mom	1=Low alarm
2775	173.07	LD0.VMMXU1.LoAlm.stVal - MCD			Low alarm[.stVal] - MCD	
2776	173.08				(reserved)	0
...					(reserved)	0
2823	176.07				(reserved)	0
FCB - Circuit breaker 1 position						
2824	176.08	CTRL.FCBCSWI1.Pos.stVal - Close	FCBCSWI1.POSITION	Y	Close mom	1 = Close

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2825	176.09	CTRL.FCBCSWI1.Pos.stVal - Open		Y	Open mom	1 = Open
2826	176.10	CTRL.FCBCSWI1.Pos.stVal - Error		Y	Error mom	1 = Faulty or Intermediate
WCB - Circuit breaker 2 position						
2827	176.11	CTRL.WCBCSWI1.Pos.stVal - Close	WCBCSWI1.POSITION	Y	Close mom	1 = Close
2828	176.12	CTRL.WCBCSWI1.Pos.stVal - Open		Y	Open mom	1 = Open
2829	176.13	CTRL.WCBCSWI1.Pos.stVal - Error		Y	Error mom	1 = Faulty or Intermediate
ES - Earthswitch 1 position						
2830	176.14	CTRL.MESCSWI1.Pos.stVal - Close	MESCSWI1.POSITION	Y	Close mom	1 = Close
2831	176.15	CTRL.MESCSWI1.Pos.stVal - Open		Y	Open mom	1 = Open
2832	177.00	CTRL.MESCSWI1.Pos.stVal - Error		Y	Error mom	1 = Faulty or Intermediate
TR -Truck 1 position						
2833	177.01	CTRL.WCBCSWI1.TrkPos.stVal -Close	TRCSWI1.POSITION	Y	Close mom	1 = Close
2834	177.02	CTRL.WCBCSWI1.TrkPos.stVal -Open		Y	Open mom	1 = Open
2835	177.03	CTRL.WCBCSWI1.TrkPos.stVal -Error		Y	Error mom	1 = Faulty or Intermediate
2836	177.04				(reserved)	0
2837	177.05				(reserved)	0
2838	177.06				(reserved)	0
2839	177.07				(reserved)	0
FCB - Circuit breaker 1 status						
2840	177.08	CTRL.FCBCSWI1.Pos.stSeld	FCBCSWI1.SELECTED	Y	Selected [.stSeld] - mom	1=Selected
2841	177.09	CTRL.FCBCSWI1.Pos.stSeld - MCD			Selected [.stSeld] - MCD	

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2842	177.10	CTRL.FCBCSWI1.OpnEna.stVal	FCBCSWI1.ENA_OPEN	Y	Open enabled [.stVal] - mom	1=Open enable
2843	177.11	CTRL.FCBCSWI1.ClsEna.stVal	FCBCSWI1.ENA_CLOSE	Y	Close enabled [.stVal] - mom	1=Close enable
WCB - Circuit breaker 2 status						
2844	177.12	CTRL.WCBCSWI1.Pos.stSeld	WCBCSWI1.SELECTED	Y	Selected [.stSeld] - mom	1=Selected
2845	177.13	CTRL.WCBCSWI1.Pos.stSeld -MCD			Selected [.stSeld] - MCD	
2846	177.14	CTRL.WCBCSWI1.OpnEna.stVal	WCBCSWI1.ENA_OPEN	Y	Open enabled [.stVal] - mom	1=Open enable
2847	177.15	CTRL.WCBCSWI1.ClsEna.stVal	WCBCSWI1.ENA_CLOSE	Y	Close enabled [.stVal] - mom	1=Close enable
ES - Earthswitch 1 status						
2848	178.00	CTRL.MESCSWI1.Pos.stSeld	MESCSWI1.SELECTED	Y	Selected [.stSeld] - mom	1=Selected
2849	178.01	CTRL.MESCSWI1.Pos.stSeld - MCD			Selected [.stSeld] - MCD	
2850	178.02	CTRL.MESCSWI1.OpnEna.stVal	MESCSWI1.ENA_OPEN	Y	Open enabled [.stVal] - mom	1=Open enable
2851	178.03	CTRL.MESCSWI1.ClsEna.stVal	MESCSWI1.ENA_CLOSE	Y	Close enabled [.stVal] - mom	1=Close enable
TR -Truck 1 status						
2852	178.04	CTRL.TRCSWI1.Pos.stSeld	TRCSWI1.SELECTED	Y	Selected [.stSeld] - mom	1=Selected
2853	178.05	CTRL.TRCSWI1.Pos.stSeld - MCD			Selected [.stSeld] - MCD	
2854	178.06	CTRL.TRCSWI1.OpnEna.stVal	TRCSWI1.ENA_OPEN	Y	Open enabled [.stVal] - mom	1=Open enable
2855	178.07	CTRL.TRCSWI1.ClsEna.stVal	TRCSWI1.ENA_CLOSE	Y	Close enabled [.stVal] - mom	1=Close enable
2856	178.08				(reserved)	0
2857	178.09				(reserved)	0
2858	178.10				(reserved)	0
2859	178.11				(reserved)	0
2860	178.12				(reserved)	0
2861	178.13				(reserved)	0
2862	178.14				(reserved)	0

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2863	178.15				(reserved)	0
Curcuit breaker failure protection						
2864	179.00	LD0.CCBRBRF1.Str.general	CCBRBRF1.CB_FAULT_AL	Y	Start, timer running[.general] - mom	1=Start,timer running
2865	179.01	LD0.CCBRBRF1.Str.general - MCD			Start, timer running[.general] - MCD	
2866	179.02	LD0.CCBRBRF1.OpEx.genera l	CCBRBRF1.TRBU	Y	Failure, external trip [.general] - mom	1=Failure,external trip
2867	179.03	LD0.CCBRBRF1.OpEx.genera l -MCD			Failure, external trip [.general] - MCD	
2868	179.04	LD0.CCBRBRF1.OpIn.general	CCBRBRF1.TRRET	Y	Operate, internal retrip [.general] - mom	1=Operate, internal retrip
2869	179.05	LD0.CCBRBRF1.OpIn.general -MCD			Operate, internal retrip [.general] - MCD	
2870	179.06				(reserved)	0
Circuit breaker condition monitoring						
2871	179.07	LD0.ESSCBR1.OpnWrn.stVal	ESSCBR1.TRV_T_OP_WRN	Y	Open travel time quality warning	1=warning
2872	179.08	LD0.ESSCBR1.OpnAlm.stVal	ESSCBR1.TRV_T_OP_ALM	Y	Open travel time quality alarm	1=alarm
2873	179.09	LD0.ESSCBR1.ClsWrn.stVal	ESSCBR1.TRV_T_CL_WRN	Y	Close travel time quality warning	1=warning
2874	179.10	LD0.ESSCBR1.ClsAlm.stVal	ESSCBR1.TRV_T_CL_ALM	Y	Close travel time quality alarm	1=alarm
2875	179.11	LD0.ESSCBR1.SprChaWrn.st Val	ESSCBR1.SPR_CHR_WRN	Y	Spring charge quality warning	1=warning
2876	179.12	LD0.ESSCBR1.SprChaAlm.st Val	ESSCBR1.SPR_CHR_ALM	Y	Spring charge quality alarm	1=alarm
2877	179.13	LD0.ESSCBR1.OpNumAlm.st Val	ESSCBR1.OPR_ALM	Y	Num of CB oper. alarm limit	1=alarm
2878	179.14	LD0.ESSCBR1.OpNumLO.stV al	ESSCBR1.OPR_LO	Y	Num of CB oper. lockout limit	1=lockout
2879	179.15	LD0.ESSCBR1.PrOpNumAlm. stVal	ESSCBR1.PROT_OPR_ALM	Y	Num of CB oper. under load alarm limit	1=alarm
2880	180.00	LD0.ESSCBR1.PrOpNumLO.st Val	ESSCBR1.PROT_OPR_LO	Y	Num of CB oper. under load lockout limit	1=lockout
2881	180.01	LD0.ESSCBR1.ContQWrn.stV al	ESSCBR1.CONT_Q_WRN	Y	Contact quality value warning limit	1=warning
2882	180.02	LD0.ESSCBR1.ContQAlm.stV al	ESSCBR1.CONT_Q_ALM	Y	Contact quality value alarm limit	1=alarm

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2883	180.03	LD0.ESSCBR1.ContQLO.stVal	ESSCBR1.CONT_Q_LO	Y	Contact quality value lockout limit	1=lockout
2884	180.04	LD0.ESSCBR1.CBLifAlm.stVal	ESSCBR1.CB_LIFE_ALM	Y	Remaining life of CB exceeds alarm limit	1=alarm
2885	180.05	LD0.ESSCBR1.LonTmWrn.stVal	ESSCBR1.MON_WRN	Y	CB long time inactive warning	1=warning
2886	180.06	LD0.ESSCBR1.LonTmAlm.stVal	ESSCBR1.MON_ALM	Y	CB long time inactive alarm	1=alarm
2887	180.07	LD0.ESSCBR1.DampWrn.stVal	ESSCBR1.DAMPER_WRN	Y	Damper quality warning	1=warning
2888	180.08	LD0.ESSCBR1.DampAlm.stVal	ESSCBR1.DAMPER_ALM	Y	Damper quality alarm	1=alarm
2889	180.09	LD0.ESSCBR1.SprFacWrn.stVal	ESSCBR1.FAC_WRN	Y	Spring fatal attemp to charge quality warning	1=warning
2890	180.10	LD0.ESSCBR1.SprFacAlm.stVal	ESSCBR1.FAC_ALM	Y	Spring fatal attemp to charge quality alarm	1=alarm
2891	180.11	LD0.ESSCBR1.PosOpn.stVal	ESSCBR1.OPENPOS	N	CB is in open position	1=open
2892	180.12	LD0.ESSCBR1.PosIvd.stVal	ESSCBR1.INVALIDPOS	N	CB is in invalid position	1=invalid
2893	180.13	LD0.ESSCBR1.PosCls.stVal	ESSCBR1.CLOSEPOS	N	CB is in close position	1=closed
2894	180.14	LD0.ESSCBR1.TrvTAlm.stVal	ESSCBR1.TRV_OT_STATUS	N	Travel time alarm	1=alarm
2895	180.15	LD0.ESSCBR1.SprChaTAlm.stVal	ESSCBR1.SPR_OT_STATUS	N	Spring charging time crossed the set value	1=crossed value
Non directional phase overcurrent protection						
2896	181.00	LD0.PHLPTOC1.Str.general	PHLPTOC1.START	Y	Low stage Start[.general] - mom	1=Low stage start
2897	181.01	LD0.PHLPTOC1.Str.general - MCD			Low stage Start[.general] - MCD	
2898	181.02	LD0.PHLPTOC1.Str.phsA		Y	Low stage Start[.phsA] - mom	1=Low stage phsA start
2899	181.03	LD0.PHLPTOC1.Str.phsA - MCD			Low stage Start[.phsA] - MCD	
2900	181.04	LD0.PHLPTOC1.Str.phsB		Y	Low stage Start[.phsB] - mom	1=Low stage phsB start
2901	181.05	LD0.PHLPTOC1.Str.phsB - MCD			Low stage Start[.phsB] - MCD	
2902	181.06	LD0.PHLPTOC1.Str.phsC		Y	Low stage Start[.phsC] - mom	1=Low stage phsC start
2903	181.07	LD0.PHLPTOC1.Str.phsC - MCD			Low stage Start[.phsC] - MCD	
2904	181.08	LD0.PHLPTOC1.Op.general	PHLPTOC1.OPERATE	Y	Low stage Operate[.general] - mom	1=Low stage operate

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2905	181.09	LD0.PHLPTOC1.Op.general - MCD			Low stage Operate[.general] - MCD	
2906	181.10	LD0.PHHPTOC1.Str.general	PHHPTOC1.START	Y	High stage(1) Start[.general] - mom	1=High(1) stage start
2907	181.11	LD0.PHHPTOC1.Str.general - MCD			High stage(1) Start[.general] - MCD	
2908	181.12	LD0.PHHPTOC1.Str.phsA		Y	High stage(1) Start[.phsA] - mom	1=High(1) stage phsA start
2909	181.13	LD0.PHHPTOC1.Str.phsA - MCD			High stage(1) Start[.phsA] - MCD	
2910	181.14	LD0.PHHPTOC1.Str.phsB		Y	High stage(1) Start[.phsB] - mom	1=High(1) stage phsB start
2911	181.15	LD0.PHHPTOC1.Str.phsB - MCD			High stage(1) Start[.phsB] - MCD	
2912	182.00	LD0.PHHPTOC1.Str.phsC		Y	High stage(1) Start[.phsC] - mom	1=High(1) stage phsC start
2913	182.01	LD0.PHHPTOC1.Str.phsC - MCD			High stage(1) Start[.phsC] - MCD	
2914	182.02	LD0.PHHPTOC1.Op.general	PHHPTOC1.OPERATE	Y	High stage(1) Operate[.general] - mom	1=High(1) stage operate
2915	182.03	LD0.PHHPTOC1.Op.general - MCD			High stage(1) Operate[.general] - MCD	
2916	182.04	LD0.PHHPTOC2.Str.general	PHHPTOC2.START	Y	High stage(2) Start[.general] - mom	1=High(2) stage start
2917	182.05	LD0.PHHPTOC2.Str.general - MCD			High stage(2) Start[.general] - MCD	
2918	182.06	LD0.PHHPTOC2.Str.phsA		Y	High stage(2) Start[.phsA] - mom	1=High(2) stage phsA start
2919	182.07	LD0.PHHPTOC2.Str.phsA - MCD			High stage(2) Start[.phsA] - MCD	
2920	182.08	LD0.PHHPTOC2.Str.phsB		Y	High stage(2) Start[.phsB] - mom	1=High(2) stage phsB start
2921	182.09	LD0.PHHPTOC2.Str.phsB - MCD			High stage(2) Start[.phsB] - MCD	
2922	182.10	LD0.PHHPTOC2.Str.phsC		Y	High stage(2) Start[.phsC] - mom	1=High(2) stage phsC start
2923	182.11	LD0.PHHPTOC2.Str.phsC - MCD			High stage(2) Start[.phsC] - MCD	
2924	182.12	LD0.PHHPTOC2.Op.general	PHHPTOC2.OPERATE	Y	High stage(2) Operate[.general] - mom	1=High(2) stage operate
2925	182.13	LD0.PHHPTOC2.Op.general - MCD			High stage(2) Operate[.general] - MCD	
2926	182.14	LD0.PHIPTOC1.Str.general	PHIPTOC1.START	Y	Instanteous stage Start[.general] - mom	1=Instanteous stage start

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2927	182.15	LD0.PHIPTOC1.Str.general - MCD			Instanteous stage Start[.general] - MCD	
2928	183.00	LD0.PHIPTOC1.Str.phsA		Y	Instanteous stage Start[.phsA] - mom	1=Instanteous stage phsA start
2929	183.01	LD0.PHIPTOC1.Str.phsA - MCD			Instanteous stage Start[.phsA] - MCD	
2930	183.02	LD0.PHIPTOC1.Str.phsB		Y	Instanteous stage Start[.phsB] - mom	1=Instanteous stage phsB start
2931	183.03	LD0.PHIPTOC1.Str.phsB - MCD			Instanteous stage Start[.phsB] - MCD	
2932	183.04	LD0.PHIPTOC1.Str.phsC		Y	Instanteous stage Start[.phsC] - mom	1=Instanteous stage phsC start
2933	183.05	LD0.PHIPTOC1.Str.phsC - MCD			Instanteous stage Start[.phsC] - MCD	
2934	183.06	LD0.PHIPTOC1.Op.general	PHIPTOC1.OPERATE	Y	Instanteous stage Operate[.general] - mom	1=Instanteous stage operate
2935	183.07	LD0.PHIPTOC1.Op.general - MCD			Instanteous stage Operate[.general] - MCD	
Directional earthfault protection						
2936	183.08	LD0.DEFLPTOC1.Str.general	DEFLPTOC1.START	Y	Low(1) stage Start[.general] - mom	1=Low(1) stage start
2937	183.09	LD0.DEFLPTOC1.Str.general - MCD			Low(1) stage Start[.general] - MCD	
2938	183.10	LD0.DEFLPTOC1.Op.general	DEFLPTOC1.OPERATE	Y	Low(1) stage Operate[.general] - mom	1=Low(1) stage operate
2939	183.11	LD0.DEFLPTOC1.Op.general - MCD			Low(1) stage Operate[.general] - MCD	
2940	183.12	LD0.DEFLPTOC2.Str.general	DEFLPTOC2.START	Y	Low(2) stage Start[.general] - mom	1=Low(2) stage start
2941	183.13	LD0.DEFLPTOC2.Str.general - MCD			Low(2) stage Start[.general] - MCD	
2942	183.14	LD0.DEFLPTOC2.Op.general	DEFLPTOC2.OPERATE	Y	Low(2) stage Operate[.general] - mom	1=Low(2) stage operate
2943	183.15	LD0.DEFLPTOC2.Op.general - MCD			Low(2) stage Operate[.general] - MCD	
2944	184.00	LD0.DEFHPTOC1.Str.general	DEFHPTOC1.START	Y	High stage Start[.general] - mom	1=High stage start
2945	184.01	LD0.DEFHPTOC1.Str.general - MCD			High stage Start[.general] - MCD	
2946	184.02	LD0.DEFHPTOC1.Op.general	DEFHPTOC1.OPERATE	Y	High stage Operate[.general] - mom	1=High stage operate

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2947	184.03	LD0.DEFHPTOC1.Op.general -MCD			High stage Operate[.general] - MCD	
Non directional earthfault protection						
2948	184.04	LD0.EFLPTOC1.Str.general	EFLPTOC1.START	Y	Low(1) stage Start[.general] - mom	1=Low(1) stage start
2949	184.05	LD0.EFLPTOC1.Str.general - MCD			Low(1) stage Start[.general] - MCD	
2950	184.06	LD0.EFLPTOC1.Op.general	EFLPTOC1.OPERATE	Y	Low(1) stage Operate[.general] - mom	1=Low(1) stage operate
2951	184.07	LD0.EFLPTOC1.Op.general - MCD			Low(1) stage Operate[.general] - MCD	
2952	184.08	LD0.EFLPTOC2.Str.general	EFLPTOC2.START	Y	Low(2) stage Start[.general] - mom	1=Low(2) stage start
2953	184.09	LD0.EFLPTOC2.Str.general - MCD			Low(2) stage Start[.general] - MCD	
2954	184.10	LD0.EFLPTOC2.Op.general	EFLPTOC2.OPERATE	Y	Low(2) stage Operate[.general] - mom	1=Low(2) stage operate
2955	184.11	LD0.EFLPTOC2.Op.general - MCD			Low(2) stage Operate[.general] - MCD	
2956	184.12	LD0.EFHPTOC1.Str.general	EFHPTOC1.START	Y	High stage Start[.general] - mom	1=High stage start
2957	184.13	LD0.EFHPTOC1.Str.general - MCD			High stage Start[.general] - MCD	
2958	184.14	LD0.EFHPTOC1.Op.general	EFHPTOC1.OPERATE	Y	High stage Operate[.general] - mom	1=High stage operate
2959	184.15	LD0.EFHPTOC1.Op.general - MCD			High stage Operate[.general] - MCD	
2960	185.00	LD0.EFIPTOC1.Str.general	EFIPTOC1.START	Y	Instanteous stage Start[.general] - mom	1=Instanteous stage start
2961	185.01	LD0.EFIPTOC1.Str.general - MCD			Instanteous stage Start[.general] - MCD	
2962	185.02	LD0.EFIPTOC1.Op.general	EFIPTOC1.OPERATE	Y	Instanteous stage Operate[.general] - mom	1=Instanteous stage operate
2963	185.03	LD0.EFIPTOC1.Op.general - MCD			Instanteous stage Operate[.general] - MCD	
Phase overvoltage protection						
2964	185.04	LD0.PHPTOV1.Str.general	PHPTOV1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
2965	185.05	LD0.PHPTOV1.Str.general - MCD			Stage 1 Start[.general] - MCD	
2966	185.06	LD0.PHPTOV1.Str.phsA		Y	Stage 1 Start[.phsA] - mom	1=Stage 1 phsA start
2967	185.07	LD0.PHPTOV1.Str.phsA -MCD			Stage 1 Start[.phsA] - MCD	

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2968	185.08	LD0.PHPTOV1.Str.phsB		Y	Stage 1 Start[.phsB] - mom	1=Stage 1 phsB start
2969	185.09	LD0.PHPTOV1.Str.phsB -MCD			Stage 1 Start[.phsB] - MCD	
2970	185.10	LD0.PHPTOV1.Str.phsC		Y	Stage 1 Start[.phsC] - mom	1=Stage 1 phsC start
2971	185.11	LD0.PHPTOV1.Str.phsC -MCD			Stage 1 Start[.phsC] - MCD	
2972	185.12	LD0.PHPTOV1.Op.general	PHPTOV1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
2973	185.13	LD0.PHPTOV1.Op.general - MCD			Stage 1 Operate[.general] - MCD	
2974	185.14	LD0.PHPTOV2.Str.general	PHPTOV2.START	Y	Stage 2 Start[.general] - mom	1=Stage 2 start
2975	185.15	LD0.PHPTOV2.Str.general			Stage 2 Start[.general] - MCD	
2976	186.00	LD0.PHPTOV2.Str.phsA		Y	Stage 2 Start[.phsA] - mom	1=Stage 2 phsA start
2977	186.01	LD0.PHPTOV2.Str.phsA			Stage 2 Start[.phsA] - MCD	
2978	186.02	LD0.PHPTOV2.Str.phsB		Y	Stage 2 Start[.phsB] - mom	1=Stage 2 phsB start
2979	186.03	LD0.PHPTOV2.Str.phsB			Stage 2 Start[.phsB] - MCD	
2980	186.04	LD0.PHPTOV2.Str.phsC		Y	Stage 2 Start[.phsC] - mom	1=Stage 2 phsC start
2981	186.05	LD0.PHPTOV2.Str.phsC			Stage 2 Start[.phsC] - MCD	
2982	186.06	LD0.PHPTOV2.Op.general	PHPTOV2.OPERATE	Y	Stage 2 Operate[.general] - mom	1=Stage 2 operate
2983	186.07	LD0.PHPTOV2.Op.general			Stage 2 Operate[.general] - MCD	
2984	186.08	LD0.PHPTOV3.Str.general	PHPTOV3.START	Y	Stage 3 Start[.general] - mom	1=Stage 3 start
2985	186.09	LD0.PHPTOV3.Str.general			Stage 3 Start[.general] - MCD	
2986	186.10	LD0.PHPTOV3.Str.phsA		Y	Stage 3 Start[.phsA] - mom	1=Stage 3 phsA start
2987	186.11	LD0.PHPTOV3.Str.phsA			Stage 3 Start[.phsA] - MCD	
2988	186.12	LD0.PHPTOV3.Str.phsB		Y	Stage 3 Start[.phsB] - mom	1=Stage 3 phsB start
2989	186.13	LD0.PHPTOV3.Str.phsB			Stage 3 Start[.phsB] - MCD	
2990	186.14	LD0.PHPTOV3.Str.phsC		Y	Stage 3 Start[.phsC] - mom	1=Stage 3 phsC start
2991	186.15	LD0.PHPTOV3.Str.phsC			Stage 3 Start[.phsC] - MCD	
2992	187.00	LD0.PHPTOV3.Op.general	PHPTOV3.OPERATE	Y	Stage 3 Operate[.general] - mom	1=Stage 3 operate
2993	187.01	LD0.PHPTOV3.Op.general			Stage 3 Operate[.general] - MCD	
Positive sequence undervoltage protection						
2994	187.02	LD0.PSPTUV1.Str.general	PSPTUV1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
2995	187.03	LD0.PSPTUV1.Str.general - MCD			Stage 1 Start[.general] - MCD	
2996	187.04	LD0.PSPTUV1.Str.phsA		Y	Stage 1 Start[.phsA] - mom	1=Stage 1 phsA start
2997	187.05	LD0.PSPTUV1.Str.phsA -MCD			Stage 1 Start[.phsA] - MCD	
2998	187.06	LD0.PSPTUV1.Str.phsB		Y	Stage 1 Start[.phsB] - mom	1=Stage 1 phsB start
2999	187.07	LD0.PSPTUV1.Str.phsB -MCD			Stage 1 Start[.phsB] - MCD	
3000	187.08	LD0.PSPTUV1.Str.phsC		Y	Stage 1 Start[.phsC] - mom	1=Stage 1 phsC start
3001	187.09	LD0.PSPTUV1.Str.phsC -MCD			Stage 1 Start[.phsC] - MCD	
3002	187.10	LD0.PSPTUV1.Op.general	PSPTUV1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3003	187.11	LD0.PSPTUV1.Op.general - MCD			Stage 1 Operate[.general] - MCD	
Current circuit supervision						
3004	187.12	CTRL.CCRDIF1.Op.general	CCRDIF1.FAIL	Y	Current circuit failure alarm - mom	1=Alarm
3005	187.13	CTRL.CCRDIF1.Op.general			Current circuit failure alarm - MCD	
3006	187.14	CTRL.CCRDIF1.Alm.general	CCRDIF1.ALARM	Y	Current circuit failure operate - mom	1=Operate
3007	187.15	CTRL.CCRDIF1.Alm.general			Current circuit failure operate - MCD	
3008	188.00				(reserved)	0
3009	188.01				(reserved)	0
3010	188.02				(reserved)	0
3011	188.03				(reserved)	0
Phase discontinuity protection						
3012	188.04	LD0.PDNSPTOC1.Str.general	PDNSPTOC1.START	Y	Stage Start[.general] - mom	1=Stage start
3013	188.05	LD0.PDNSPTOC1.Str.general -MCD			Stage Start[.general] - MCD	
3014	188.06	LD0.PDNSPTOC1.Op.general	PDNSPTOC1.OPERATE	Y	Stage Operate[.general] - mom	1=Stage operate
3015	188.07	LD0.PDNSPTOC1.Op.general -MCD			Stage Operate[.general] - MCD	
Negative-sequence overcurrent protection						
3016	188.08	LD0.NSPTOC1.Str.general	NSPTOC1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3017	188.09	LD0.NSPTOC1.Str.general - MCD			Stage 1 Start[.general] - MCD	

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3018	188.10	LD0.NSPTOC1.Op.general	NSPTOC1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3019	188.11	LD0.NSPTOC1.Op.general - MCD			Stage 1 Operate[.general] - MCD	
3020	188.12	LD0.NSPTOC2.Str.general	NSPTOC2.START	Y	Stage 2 Start[.general] - mom	1=Stage 2 start
3021	188.13	LD0.NSPTOC2.Str.general - MCD			Stage 2 Start[.general] - MCD	
3022	188.14	LD0.NSPTOC2.Op.general	NSPTOC2.OPERATE	Y	Stage 2 Operate[.general] - mom	1=Stage 2 operate
3023	188.15	LD0.NSPTOC2.Op.general - MCD			Stage 2 Operate[.general] - MCD	
Three-phase inrush detector						
3024	189.00	LD0.INRPHAR1.Str.general	INRPHAR1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3025	189.01	LD0.INRPHAR1.Str.general - MCD			Stage 1 Start[.general] - MCD	
3026	189.02	LD0.INRPHAR1.Str.phsA		Y	Stage 1 Start[.phsA] - mom	1=Stage 1 phsA start
3027	189.03	LD0.INRPHAR1.Str.phsA - MCD			Stage 1 Start[.phsA] - MCD	
3028	189.04	LD0.INRPHAR1.Str.phsB		Y	Stage 1 Start[.phsB] - mom	1=Stage 1 phsB start
3029	189.05	LD0.INRPHAR1.Str.phsB - MCD			Stage 1 Start[.phsB] - MCD	
3030	189.06	LD0.INRPHAR1.Str.phsC		Y	Stage 1 Start[.phsC] - mom	1=Stage 1 phsC start
3031	189.07	LD0.INRPHAR1.Str.phsC - MCD			Stage 1 Start[.phsC] - MCD	
Runtime counter for machines and devices						
3032	189.08	LD0.MDSOPT1.OpTmWrn.stVal	MDSOPT1.WARNING	Y	Accumulated operation time warning [.stVal] - mom	1=Warning
3033	189.09	LD0.MDSOPT1.OpTmWrn.stVal			Accumulated operation time warning [.stVal] - MCD	
3034	189.10	LD0.MDSOPT1.OpTmAlm.stVal	MDSOPT1.ALARM	Y	Accumulated operation time alarm [.stVal] - mom	1=Alarm
3035	189.11	LD0.MDSOPT1.OpTmAlm.stVal			Accumulated operation time alarm [.stVal] - MCD	
3036	189.12				(reserved)	0
3037	189.13				(reserved)	0
Three-phase thermal protection for feeders, cables and distribution transformers						

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3038	189.14	LD0.T1PTTR1.Str.general	T1PTTR1.START	Y	Start[.general] - mom	1=Start
3039	189.15	LD0.T1PTTR1.Str.general - MCD			Start[.general] - MCD	
3040	190.00	LD0.T1PTTR1.AlmThm.genera l	T1PTTR1.ALARM	Y	Thermal Alarm[.general] - mom	1=Thermal Alarm
3041	190.01	LD0.T1PTTR1.AlmThm.genera l -MCD			Thermal Alarm[.general] - MCD	
3042	190.02	LD0.T1PTTR1.Op.general	T1PTTR1.OPERATE	Y	Operate[.general] - mom	1=Operate
3043	190.03	LD0.T1PTTR1.Op.general - MCD			Operate[.general] - MCD	
Thermal overload protection for motors						
3044	190.04	LD0.MPTTR1.StrInh.general	MPTTR1.BLK_RESTART	Y	Restart inhibit [.stVal] - mom	1=Inhibit
3045	190.05	LD0.MPTTR1.StrInh.general - MCD			Restart inhibit [.stVal] - MCD	
3046	190.06	LD0.MPTTR1.AlmThm.general	MPTTR1.ALARM	Y	Thermal Alarm[.general] - mom	1=Thermal Alarm
3047	190.07	LD0.MPTTR1.AlmThm.general -MCD			Thermal Alarm[.general] - MCD	
3048	190.08	LD0.MPTTR1.Op.general	MPTTR1.OPERATE	Y	Operate[.general] - mom	1=Operate
3049	190.09	LD0.MPTTR1.Op.general - MCD			Operate[.general] - MCD	
Fuse failure supervision						
3050	190.10	LD0.SEQRFUF1.Str.general	SEQRFUF1.FUSEF_U	Y	General start [.general] - mom	1=General start
3051	190.11	LD0.SEQRFUF1.Str.general - MCD			General start [.general] - MCD	
3052	190.12	LD0.SEQRFUF1.Str3Ph.gener al	SEQRFUF1.FUSEF_3PH	Y	Three-phase start [.general] - mom	1=3-Phase start
3053	190.13	LD0.SEQRFUF1.Str3Ph.gener al -MCD			Three-phase start [.general] - MCD	
3054	190.14				(reserved)	0
3055	190.15				(reserved)	0
Three-phase directional overcurrent protection						
3056	191.00	LD0.DPHLPTOC1.Str.general	DPHLPDEF1.START	Y	Low stage(1) Start[.general] - mom	1=Low stage(1) start
3057	191.01	LD0.DPHLPTOC1.Str.general - MCD			Low stage(1) Start[.general] - MCD	

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3058	191.02	LD0.DPHLPTOC1.Str.phsA		Y	Low stage(1) Start[.phsA] - mom	1=Low stage(1) phsA start
3059	191.03	LD0.DPHLPTOC1.Str.phsA - MCD			Low stage(1) Start[.phsA] - MCD	
3060	191.04	LD0.DPHLPTOC1.Str.phsB		Y	Low stage(1) Start[.phsB] - mom	1=Low stage(1) phsB start
3061	191.05	LD0.DPHLPTOC1.Str.phsB - MCD			Low stage(1) Start[.phsB] - MCD	
3062	191.06	LD0.DPHLPTOC1.Str.phsC		Y	Low stage(1) Start[.phsC] - mom	1=Low stage(1) phsC start
3063	191.07	LD0.DPHLPTOC1.Str.phsC - MCD			Low stage(1) Start[.phsC] - MCD	
3064	191.08	LD0.DPHLPTOC1.Op.general	DPHLPDEF1.OPERATE	Y	Low stage(1) Operate[.general] - mom	1=Low stage(1) operate
3065	191.09	LD0.DPHLPTOC1.Op.general - MCD			Low stage(1) Operate[.general] - MCD	
3066	191.10	LD0.DPHLPTOC2.Str.general	DPHLPDEF2.START	Y	Low stage(2) Start[.general] - mom	1=Low stage(2) start
3067	191.11	LD0.DPHLPTOC2.Str.general - MCD			Low stage(2) Start[.general] - MCD	
3068	191.12	LD0.DPHLPTOC2.Str.phsA		Y	Low stage(2) Start[.phsA] - mom	1=Low stage(2) phsA start
3069	191.13	LD0.DPHLPTOC2.Str.phsA - MCD			Low stage(2) Start[.phsA] - MCD	
3070	191.14	LD0.DPHLPTOC2.Str.phsB		Y	Low stage(2) Start[.phsB] - mom	1=Low stage(2) phsB start
3071	191.15	LD0.DPHLPTOC2.Str.phsB - MCD			Low stage(2) Start[.phsB] - MCD	
3072	192.00	LD0.DPHLPTOC2.Str.phsC		Y	Low stage(2) Start[.phsC] - mom	1=Low stage(2) phsC start
3073	192.01	LD0.DPHLPTOC2.Str.phsC - MCD			Low stage(2) Start[.phsC] - MCD	
3074	192.02	LD0.DPHLPTOC2.Op.general	DPHLPDEF2.OPERATE	Y	Low stage(2) Operate[.general] - mom	1=Low stage(2) operate
3075	192.03	LD0.DPHLPTOC2.Op.general - MCD			Low stage(2) Operate[.general] - MCD	
3076	192.04	LD0.DPHHPTOC1.Str.general	DPHHPDEF1.START	Y	High stage(1) Start[.general] - mom	1=High(1) stage start
3077	192.05	LD0.DPHHPTOC1.Str.general -MCD			High stage(1) Start[.general] - MCD	
3078	192.06	LD0.DPHHPTOC1.Str.phsA		Y	High stage(1) Start[.phsA] - mom	1=High(1) stage phsA start
3079	192.07	LD0.DPHHPTOC1.Str.phsA - MCD			High stage(1) Start[.phsA] - MCD	
3080	192.08	LD0.DPHHPTOC1.Str.phsB		Y	High stage(1) Start[.phsB] - mom	1=High(1) stage phsB start

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3081	192.09	LD0.DPHHPTOC1.Str.phsB - MCD			High stage(1) Start[.phsB] - MCD	
3082	192.10	LD0.DPHHPTOC1.Str.phsC		Y	High stage(1) Start[.phsC] - mom	1=High(1) stage phsC start
3083	192.11	LD0.DPHHPTOC1.Str.phsC - MCD			High stage(1) Start[.phsC] - MCD	
3084	192.12	LD0.DPHHPTOC1.Op.general	DPHHPDEF1.OPERATE	Y	High stage(1) Operate[.general] - mom	1=High(1) stage operate
3085	192.13	LD0.DPHHPTOC1.Op.general -MCD			High stage(1) Operate[.general] - MCD	
Emergency start enable						
3086	192.14	LD0.ESMGAPC1.Str.general	ESMGAPC1.ST_EMERG_ENA	Y	Start[.general] - mom	1=Emergency start enabled
3087	192.15	LD0.ESMGAPC1.Str.general - MCD			Start[.general] - MCD	
Phase undervoltage protection						
3088	193.00	LD0.PHPTUV1.Str.general	PHPTUV1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3089	193.01	LD0.PHPTUV1.Str.general - MCD			Stage 1 Start[.general] - MCD	
3090	193.02	LD0.PHPTUV1.Str.phsA		Y	Stage 1 Start[.phsA] - mom	1=Stage 1 phsA start
3091	193.03	LD0.PHPTUV1.Str.phsA -MCD			Stage 1 Start[.phsA] - MCD	
3092	193.04	LD0.PHPTUV1.Str.phsB		Y	Stage 1 Start[.phsB] - mom	1=Stage 1 phsB start
3093	193.05	LD0.PHPTUV1.Str.phsB -MCD			Stage 1 Start[.phsB] - MCD	
3094	193.06	LD0.PHPTUV1.Str.phsC		Y	Stage 1 Start[.phsC] - mom	1=Stage 1 phsC start
3095	193.07	LD0.PHPTUV1.Str.phsC -MCD			Stage 1 Start[.phsC] - MCD	
3096	193.08	LD0.PHPTUV1.Op.general	PHPTUV1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3097	193.09	LD0.PHPTUV1.Op.general - MCD			Stage 1 Operate[.general] - MCD	
3098	193.10	LD0.PHPTUV2.Str.general	PHPTUV2.START	Y	Stage 2 Start[.general] - mom	1=Stage 2 start
3099	193.11	LD0.PHPTUV2.Str.general			Stage 2 Start[.general] - MCD	
3100	193.12	LD0.PHPTUV2.Str.phsA		Y	Stage 2 Start[.phsA] - mom	1=Stage 2 phsA start
3101	193.13	LD0.PHPTUV2.Str.phsA			Stage 2 Start[.phsA] - MCD	
3102	193.14	LD0.PHPTUV2.Str.phsB		Y	Stage 2 Start[.phsB] - mom	1=Stage 2 phsB start
3103	193.15	LD0.PHPTUV2.Str.phsB			Stage 2 Start[.phsB] - MCD	
3104	194.00	LD0.PHPTUV2.Str.phsC		Y	Stage 2 Start[.phsC] - mom	1=Stage 2 phsC start

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3105	194.01	LD0.PHPTUV2.Str.phsC			Stage 2 Start[.phsC] - MCD	
3106	194.02	LD0.PHPTUV2.Op.general	PHPTUV2.OPERATE	Y	Stage 2 Operate[.general] - mom	1=Stage 2 operate
3107	194.03	LD0.PHPTUV2.Op.general			Stage 2 Operate[.general] - MCD	
3108	194.04	LD0.PHPTUV3.Str.general	PHPTUV3.START	Y	Stage 3 Start[.general] - mom	1=Stage 3 start
3109	194.05	LD0.PHPTUV3.Str.general			Stage 3 Start[.general] - MCD	
3110	194.06	LD0.PHPTUV3.Str.phsA		Y	Stage 3 Start[.phsA] - mom	1=Stage 3 phsA start
3111	194.07	LD0.PHPTUV3.Str.phsA			Stage 3 Start[.phsA] - MCD	
3112	194.08	LD0.PHPTUV3.Str.phsB		Y	Stage 3 Start[.phsB] - mom	1=Stage 3 phsB start
3113	194.09	LD0.PHPTUV3.Str.phsB			Stage 3 Start[.phsB] - MCD	
3114	194.10	LD0.PHPTUV3.Str.phsC		Y	Stage 3 Start[.phsC] - mom	1=Stage 3 phsC start
3115	194.11	LD0.PHPTUV3.Str.phsC			Stage 3 Start[.phsC] - MCD	
3116	194.12	LD0.PHPTUV3.Op.general	PHPTUV3.OPERATE	Y	Stage 3 Operate[.general] - mom	1=Stage 3 operate
3117	194.13	LD0.PHPTUV3.Op.general			Stage 3 Operate[.general] - MCD	
Negative-sequence overvoltage protection						
3118	194.14	LD0.NSPTOV1.Str.general	NSPTOV1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3119	194.15	LD0.NSPTOV1.Str.general - MCD			Stage 1 Start[.general] - MCD	
3120	195.00	LD0.NSPTOV1.Str.phsA		Y	Stage 1 Start[.phsA] - mom	1=Stage 1 phsA start
3121	195.01	LD0.NSPTOV1.Str.phsA -MCD			Stage 1 Start[.phsA] - MCD	
3122	195.02	LD0.NSPTOV1.Str.phsB		Y	Stage 1 Start[.phsB] - mom	1=Stage 1 phsB start
3123	195.03	LD0.NSPTOV1.Str.phsB -MCD			Stage 1 Start[.phsB] - MCD	
3124	195.04	LD0.NSPTOV1.Str.phsC		Y	Stage 1 Start[.phsC] - mom	1=Stage 1 phsC start
3125	195.05	LD0.NSPTOV1.Str.phsC -MCD			Stage 1 Start[.phsC] - MCD	
3126	195.06	LD0.NSPTOV1.Op.general	NSPTOV1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3127	195.07	LD0.NSPTOV1.Op.general - MCD			Stage 1 Operate[.general] - MCD	
Residual overvoltage protection						
3128	195.08	LD0.ROVPTOV1.Str.general	ROVPTOV1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3129	195.09	LD0.ROVPTOV1.Str.general - MCD			Stage 1 Start[.general] - MCD	

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3130	195.10	LD0.ROVPTOV1.Op.general	ROVPTOV1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3131	195.11	LD0.ROVPTOV1.Op.general - MCD			Stage 1 Operate[.general] - MCD	
3132	195.12	LD0.ROVPTOV2.Str.general	ROVPTOV2.START	Y	Stage 2 Start[.general] - mom	1=Stage 2 start
3133	195.13	LD0.ROVPTOV2.Str.general - MCD			Stage 2 Start[.general] - MCD	
3134	195.14	LD0.ROVPTOV2.Op.general	ROVPTOV2.OPERATE	Y	Stage 2 Operate[.general] - mom	1=Stage 2 operate
3135	195.15	LD0.ROVPTOV2.Op.general - MCD			Stage 2 Operate[.general] - MCD	
3136	196.00	LD0.ROVPTOV3.Str.general	ROVPTOV3.START	Y	Stage 3 Start[.general] - mom	1=Stage 3 start
3137	196.01	LD0.ROVPTOV3.Str.general - MCD			Stage 3 Start[.general] - MCD	
3138	196.02	LD0.ROVPTOV3.Op.general	ROVPTOV3.OPERATE	Y	Stage 3 Operate[.general] - mom	1=Stage 3 operate
3139	196.03	LD0.ROVPTOV3.Op.general - MCD			Stage 3 Operate[.general] - MCD	
Negative-sequence overcurrent protection for motors						
3140	196.04	LD0.MNSPTOC1.Str.general	MNSPTOC1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3141	196.05	LD0.MNSPTOC1.Str.general			Stage 1 Start[.general] - MCD	
3142	196.06	LD0.MNSPTOC1.Op.general	MNSPTOC1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3143	196.07	LD0.MNSPTOC1.Op.general			Stage 1 Operate[.general] - MCD	
3144	196.08	LD0.MNSPTOC2.Str.general	MNSPTOC2.START	Y	Stage 2 Start[.general] - mom	1=Stage 2 start
3145	196.09	LD0.MNSPTOC2.Str.general			Stage 2 Start[.general] - MCD	
3146	196.10	LD0.MNSPTOC2.Op.general	MNSPTOC2.OPERATE	Y	Stage 2 Operate[.general] - mom	1=Stage 2 operate
3147	196.11	LD0.MNSPTOC2.Op.general			Stage 2 Operate[.general] - MCD	
Phase reversal protection						
3148	196.12	LD0.PREVPTOC1.Str.general	PREVPTOC1.START	Y	Stage 1 Start[.general] - mom	1=Stage 1 start
3149	196.13	LD0.PREVPTOC1.Str.general - MCD			Stage 1 Start[.general] - MCD	
3150	196.14	LD0.PREVPTOC1.Op.general	PREVPTOC1.OPERATE	Y	Stage 1 Operate[.general] - mom	1=Stage 1 operate
3151	196.15	LD0.PREVPTOC1.Op.general -MCD			Stage 1 Operate[.general] - MCD	
Motor startup supervision						

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Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3152	197.00	LD0.STTPMSS1.Str.general	STTPMSU1.MOT_START	Y	Motor startup in progress [.general] - mom	1=Startup in progress
3153	197.01	LD0.STTPMSS1.Str.general - MCD			Motor startup in progress [.general] - MCD	
3154	197.02	LD0.STTPMSS1.Op.general	STTPMSU1.OPR_IIT	Y	Thermal stress operate [.general] - mom	1=Thermal stress operate
3155	197.03	LD0.STTPMSS1.Op.general - MCD			Thermal stress operate [.general] - MCD	
3156	197.04	LD0.STTPMRI1.StrInh.general	STTPMSU1.LOCK_START	Y	Restart inhibit [.general] - mom	1=Restart inhibit
3157	197.05	LD0.STTPMRI1.StrInh.general -MCD			Restart inhibit [.general] - MCD	
3158	197.06	LD0.STTPMRI1.Op.general	STTPMSU1.OPR_STALL	Y	Stalling operate [.general] - mom	1=Stalling operate
3159	197.07	LD0.STTPMRI1.Op.general - MCD			Stalling operate [.general] - MCD	
Stalled motor protection						
3160	197.08	LD0.JAMPTOC1.Op.general	JAMPTOC1.OPERATE	Y	Operate[.general] - mom	1=Operate
3161	197.09	LD0.JAMPTOC1.Op.general - MCD			Operate[.general] - MCD	
Loss of load protection						
3162	197.10	LD0.LOFLPTUC1.Str.general	LOFLPTUC1.START	Y	Start[.general] - mom	1=Start
3163	197.11	LD0.LOFLPTUC1.Str.general - MCD			Start[.general] - MCD	
3164	197.12	LD0.LOFLPTUC1.Op.general	LOFLPTUC1.OPERATE	Y	Operate[.general] - mom	1=Operate
3165	197.13	LD0.LOFLPTUC1.Op.general - MCD			Operate[.general] - MCD	
3168	198.00				(reserved)	0
3169	198.01				(reserved)	0
3170	198.02				(reserved)	0
3171	198.03				(reserved)	0
Sensor temperature						
3172	198.04	LD0.VDSTMP1.Alm.stVal		Y	Temperature alarm(1) level [.stVal] - mom	1= Alarm level (1)
3173	198.05	LD0.VDSTMP1.Alm.stVal - MCD			Temperature alarm(1) level [.stVal] - MCD	
3174	198.06	LD0.VDSTMP1.Trip.stVal		Y	Temperature trip(1) level [.stVal] - mom	1= Trip level (1)

Table continues on next page

Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3175	198.07	LD0.VDSTMP1.Trip.stVal - MCD			Temperature trip(1) level [.stVal] - MCD	
3176	198.08	LD0.VDSTMP2.Alm.stVal		Y	Temperature alarm(2) level [.stVal] - mom	1= Alarm level (2)
3177	198.09	LD0.VDSTMP2.Alm.stVal - MCD			Temperature alarm(2) level [.stVal] - MCD	
3178	198.10	LD0.VDSTMP2.Trip.stVal		Y	Temperature trip(2) level [.stVal] - mom	1= Trip level (2)
3179	198.11	LD0.VDSTMP2.Trip.stVal - MCD			Temperature trip(2) level [.stVal] - MCD	
3180	198.12	LD0.VDSTMP3.Alm.stVal		Y	Temperature alarm(3) level [.stVal] - mom	1= Alarm level (3)
3181	198.13	LD0.VDSTMP3.Alm.stVal - MCD			Temperature alarm(3) level [.stVal] - MCD	
3182	198.14	LD0.VDSTMP3.Trip.stVal		Y	Temperature trip(3) level [.stVal] - mom	1= Trip level (3)
3183	198.15	LD0.VDSTMP3.Trip.stVal - MCD			Temperature trip(3) level [.stVal] - MCD	
Autorecloser						
3184	199.00	LD0.DARREC1.PrgRec.stVal	DARREC1.INPRO	Y	AR in progress [.stVal] - mom	1=In progress
3185	199.01	LD0.DARREC1.PrgRec.stVal - MCD			AR in progress [.stVal] - MCD	
3186	199.02	LD0.DARREC1.PrgRec1.stVal	DARREC1.INPRO_1	Y	AR in progress 1st reclose[.stVal] - mom	1=In progress
3187	199.03	LD0.DARREC1.PrgRec1.stVal -MCD			AR in progress 1st reclose[.stVal] - MCD	
3188	199.04	LD0.DARREC1.PrgRec2.stVal	DARREC1.INPRO_2	Y	AR in progress 2nd reclose[.stVal] - mom	1=In progress
3189	199.05	LD0.DARREC1.PrgRec2.stVal -MCD			AR in progress 2nd reclose[.stVal] - MCD	
3190	199.06	LD0.DARREC1.PrgRec3.stVal	DARREC1.INPRO_3	Y	AR in progress 3rd reclose[.stVal] - mom	1=In progress
3191	199.07	LD0.DARREC1.PrgRec3.stVal -MCD			AR in progress 3rd reclose[.stVal] - MCD	
3192	199.08	LD0.DARREC1.PrgRec4.stVal	DARREC1.INPRO_4	Y	AR in progress 4th reclose[.stVal] - mom	1=In progress
3193	199.09	LD0.DARREC1.PrgRec4.stVal -MCD			AR in progress 4th reclose[.stVal] - MCD	
3194	199.10	LD0.DARREC1.PrgRec5.stVal	DARREC1.INPRO_5	Y	AR in progress 5th reclose[.stVal] - mom	1=In progress
3195	199.11	LD0.DARREC1.PrgRec5.stVal -MCD			AR in progress 5th reclose[.stVal] - MCD	
3196	199.12	LD0.DARREC1.SucRec.stVal	DARREC1.SUC_RECL	Y	Successful reclose status[.stVal] - mom	1=Successful reclose

Table continues on next page

Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3197	199.13	LD0.DARREC1.SucRec.stVal - MCD			Successful reclose status[.stVal] - MCD	
3198	199.14	LD0.DARREC1.UnsRec.stVal	DARREC1.UNSUC_RECL	Y	Unsuccessful reclose status[.stVal] - mom	1=Unuccessful reclose
3199	199.15	LD0.DARREC1.UnsRec.stVal - MCD			Unsuccessful reclose status[.stVal] - MCD	
3200	200.00	LD0.DARREC1.LO.stVal	DARREC1.LOCKED	Y	Lockout status[.stVal] - mom	1=Lockout
3201	200.01	LD0.DARREC1.LO.stVal -MCD			Lockout status[.stVal] - MCD	
3202	200.02	LD0.DARREC1.RdyRec.stVal	DARREC1.READY	Y	Ready reclose status[.stVal] - mom	1=Reclose ready
3203	200.03	LD0.DARREC1.RdyRec.stVal - MCD			Ready reclose status[.stVal] - MCD	
3204	200.04	LD0.DARREC1.ActRec.stVal	DAAREC1.ACTIVE	Y	Active reclose status[.stVal] - mom	1=Reclose active
3205	200.05	LD0.DARREC1.ActRec.stVal - MCD			Active reclose status[.stVal] - MCD	
3206	200.06	LD0.DARREC1.PrgDsr.stVal	DARREC1.DISCR_INPRO	Y	Discrimination time in progress[.stVal] - mom	1=Discr. time in progress
3207	200.07	LD0.DARREC1.PrgDsr.stVal - MCD			Discrimination time in progress[.stVal] - MCD	
3208	200.08	LD0.DARREC1.PrgCutOut.stVal	DARREC1.CUTOUT_INPRO	Y	Cutout time in progress[.stVal] - mom	1=Cutout time in progress
3209	200.09	LD0.DARREC1.PrgCutOut.stVal -MCD			Cutout time in progress[.stVal] - MCD	
3210	200.10	LD0.DARREC1.FrqOpAlm.stVal	DARREC1.FRQ_OP_ALM	Y	Frequent operation counter alarm[.stVal] - mom	1=Frequent op. Alarm
3211	200.11	LD0.DARREC1.FrqOpAlm.stVal -MCD			Frequent operation counter alarm[.stVal] - MCD	
					gap	
Raw I/O signals						
3520	220.00	LD0.XB0GGIO1.Ind1.stVal		Y		
3521	220.01	LD0.XB0GGIO1.Ind1.stVal - MCD				
3522	220.02	LD0.XB0GGIO1.Ind2.stVal		Y		
3523	220.03	LD0.XB0GGIO1.Ind2.stVal - MCD				
3524	220.04	LD0.XB0GGIO1.Ind3.stVal		Y		

Table continues on next page

Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3525	220.05	LD0.XB0GGIO1.Ind3.stVal - MCD				
3526	220.06	LD0.XB0GGIO1.Ind4.stVal		Y		
3527	220.07	LD0.XB0GGIO1.Ind4.stVal - MCD				
3528	220.08	LD0.XB0GGIO1.Ind5.stVal		Y		
3529	220.09	LD0.XB0GGIO1.Ind5.stVal - MCD				
3530	220.10	LD0.XB0GGIO1.Ind6.stVal		Y		
3531	220.11	LD0.XB0GGIO1.Ind6.stVal - MCD				
3532	220.12	LD0.XB0GGIO1.Ind7.stVal		Y		
3533	220.13	LD0.XB0GGIO1.Ind7.stVal - MCD				
3534	220.14	LD0.XB0GGIO1.Ind8.stVal		Y		
3535	220.15	LD0.XB0GGIO1.Ind8.stVal - MCD				
3536	221.00	LD0.XB0GGIO1.Ind9.stVal		Y		
3537	221.01	LD0.XB0GGIO1.Ind9.stVal - MCD				
3538	221.02	LD0.XB0GGIO1.Ind10.stVal		Y		
3539	221.03	LD0.XB0GGIO1.Ind10.stVal - MCD				
3540	221.04	LD0.XB0GGIO1.Ind11.stVal		Y		
3541	221.05	LD0.XB0GGIO1.Ind11.stVal - MCD				
3542	221.06	LD0.XB0GGIO1.Ind12.stVal		Y		
3543	221.07	LD0.XB0GGIO1.Ind12.stVal - MCD				
3544	221.08	LD0.XB0GGIO1.Ind13.stVal		Y		
3545	221.09	LD0.XB0GGIO1.Ind13.stVal - MCD				
3546	221.10	LD0.XB0GGIO1.Ind14.stVal		Y		

Table continues on next page

Bit addr	Reg.bit	IEC 61850 name	AFL-Common SA name	Ds	Description	Value range
3547	221.11	LD0.XB0GGIO1.Ind14.stVal - MCD				
3548	221.12	LD0.XB0GGIO1.Ind15.stVal		Y		
3549	221.13	LD0.XB0GGIO1.Ind15.stVal - MCD				
3550	221.14	LD0.XB0GGIO1.Ind16.stVal		Y		
3551	221.15	LD0.XB0GGIO1.Ind16.stVal - MCD				
3552	222.00	LD0.XB0GGIO1.Ind17.stVal		Y		
3553	222.01	LD0.XB0GGIO1.Ind17.stVal - MCD				
3554	222.02	LD0.XB0GGIO1.SPSC01.stVal		Y		
3555	222.03	LD0.XB0GGIO1.SPSC01.stVal -MCD				
3556	222.04	LD0.XB0GGIO1.SPSC02.stVal		Y		
3557	222.05	LD0.XB0GGIO1.SPSC02.stVal -MCD				
3558	222.06	LD0.XB0GGIO1.SPSC03.stVal		Y		
3559	222.07	LD0.XB0GGIO1.SPSC03.stVal -MCD				
3560	222.08	LD0.XB0GGIO1.SPSC04.stVal		Y		
3561	222.09	LD0.XB0GGIO1.SPSC04.stVal -MCD				
3562	222.10	LD0.XB0GGIO1.SPSC05.stVal		Y		
3563	222.11	LD0.XB0GGIO1.SPSC05.stVal -MCD				

Table 36: *Controls*

0x addr	Ctrl struct	Ctrl bit	Mode	Identification	Description
2048	1	0	Uns	CTRL.FCBCSWI1.Pos.ctlVal	FCBCSWI - SBO Select Open
2049		1	Uns		FCBCSWI - SBO Select Close
2050		2	Uns		FCBCSWI - SBO Cancel
2051		3	Uns		FCBCSWI - SBO Operate
2052		4	Uns		FCBCSWI - Direct Open
2053		5	Uns		FCBCSWI - Direct Close
2054		6	Uns	CTRL.WCBCSWI1.Pos.ctlVal	WCBCSWI - SBO Select Open
2055		7	Uns		WCBCSWI - SBO Select Close
2056		8	Uns		WCBCSWI - SBO Cancel
2057		9	Uns		WCBCSWI - SBO Operate
2058		10	Uns		WCBCSWI - Direct Open
2059		11	Uns		WCBCSWI - Direct Close
2060	2	0	Uns	CTRL.ESCSWI1.Pos.ctlVal	ESCSWI - SBO Select Open
2061		1	Uns		ESCSWI - SBO Select Close
2062		2	Uns		ESCSWI - SBO Cancel
2063		3	Uns		ESCSWI - SBO Operate
2064		4	Uns		ESCSWI - Direct Open
2065		5	Uns		ESCSWI - Direct Close
2066		6	Uns	CTRL.TRCSWI1.Pos.ctlVal	TRCSWI - SBO Select Open
2067		7	Uns		TRCSWI - SBO Select Close
2068		8	Uns		TRCSWI - SBO Cancel
2069		9	Uns		TRCSWI - SBO Operate
2070		10	Uns		TRCSWI - Direct Open
2071		11	Uns		TRCSWI - Direct Close
2072	4	0	Uns	LD0.LLN0.LEDRs1.ctlVal	Reset Indications and LEDs
2073		1	Uns	LD0.LLN0.LEDRs2.ctlVal	Reset Alarm LEDs olny
2074		2	Uns	LD0.LLN0.RecRs.ctlVal	Reset all data
2075		3	Uns		(reserved)
2076		4	Uns	LD0.ESSCBR1.RsCBWear.ctlVal	Reset CB remaining life and operation counter
2077		5	Uns	DR.RDRE1.RcdTrg.ctlVal	Disturbance recorder - External recording trig
2078		6	Uns	DR.RDRE1.MemClr.ctlVal	Disturbance recorder - Delete all records
2079		7	Uns	LD0.CMSTA1.RecRs.ctlVal	Reset CMMXU1 max.demand values
2080		8	Uns	LD0.PEMMXU1.SupDmdRs.ctlVal	Reset accumulated energy metering
2081		9	Uns	LD0.ESSCBR1.RsTrvQ.stVal	Reset CB closing and opening travel times quality estimator
2082		10	Uns	LD0.ESSCBR1.RsSprChaQ.stVal	Reset input for the recharge quality of the CB spring
2083		11	Uns	LD0.ESSCBR1.RsContQ.stVal	Reset CB contact quality estimation
2084		12	Uns	LD0.ESSCBR1.RsDampCnt.stVal	Reset input for quality estimation of CB dampers
2085		13	Uns	LD0.ESSCBR1.RsSprFacQ.stVal	Reset quality estimation of fatal attempt to recharge of CB spring

Table continues on next page

0x addr	Ctrl struct	Ctrl bit	Mode	Identification	Description
2086		14			(reserved)
2087		15			(reserved)
2090	6	0	Uns	LD0.LPHD1.RsDev.ctlVal	Reset physical device

Section 6 Glossary

ACD	Start/pickup status
ACT	Application Configuration tool in PCM600; Trip status
AFL	Application function block library
AR	Autoreclosing
ASCII	American Standard Code for Information Interchange
CB	Circuit breaker
CmdState	Command state
CMT	Communication Management tool in PCM600
CPM	Communication protocol manual
CPU	Central processing unit
CT	Current transformer
DPC	Double-point control
DPS	Double-point status
DR	Disturbance recorder
DS	Data set
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
HMI	Human-machine interface
HW	Hardware
IEC 61850	International standard for substation communication and modeling
IED	Intelligent electronic device
INS/INC	Integer status
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
LED	Light-emitting diode
LHMI	Local human-machine interface
LSB	Least significant bit

MCD	Momentary change detect
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
Modbus memory map	Allocation of accessible protocol data
Modbus TCP/IP	Modbus RTU protocol which uses TCP/IP and Ethernet to carry data between devices
MOM	Momentary position
MV	Medium voltage
PCM600	Protection and Control IED Manager
PLC	Programmable logic controller
PST	Parameter Setting tool in PCM600
RTC	Real-time clock
RTU	Remote terminal unit
SBO	Select-before-operate
SCADA	Supervision, control and data acquisition
SEC	Security violation
SPC	Single-point status of a controllable object
SPS	Single-point status
SSR1	System status register for device health
SSR2	System status register for device mode
SSR3	System status register for data available 1
SSR4	System status register for data available 2
SSR5	System status register for device alive counter
SSR6	System status register for last command result
SSRx	System status register
SW	Software
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
UD	User-definable
UDB	User-definable bit
UDR	User-definable register
UID	Unique ID
UTC	Coordinated universal time

VT	Voltage transformer
WHMI	Web human-machine interface

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