605 series / Relion® Protection and Control

Feeder Protection and Control/ Feeder Protection REF601/REJ601 Modbus Communication Protocol Manual

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Document ID: 1MDU07222-YN
Issued: 2014-06-23
Revision: B
Product version: 2.2 FP1

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Section 1 Modbus Overview

1.1 Protocol Overview

The Modbus protocol was first introduced by Modicon Inc. and is widely accepted as a communication standard for industrial device controllers and programmable logic controllers (PLCs). The protocol determines how each controller connected to a Modbus network will recognize a message addressed to it. It also determines the task to be performed and extracts any data or other information contained in the message. If a reply is required, the controller will construct a reply message and send it using the Modbus protocol.

A master device can be connected to slave devices either directly, or via modems using a compatible serial interface. The interface defines the connector pinouts, cabling, signal levels, transmission baud rates, and parity checking.

The communication technique used in the Modbus protocol is a master-slave technique. This means that only one device can be the master and initiate transactions while other devices connected to the network are slaves and can therefore not initiate any transactions.

A message sent by the master to the slave is called a query.

The master can address a query to an individual slave or to all slaves, that is, to broadcast the query. After the slave has received a query, it attempts to perform the requested task. If a query has been sent to an individual slave, the slave will send a message, that is, a response to the master. However, if it has been broadcast, no response will be sent. The response can be either a normal response (in case of performing the requested task) or an exception response (other cases).

1.2 RTU transmission frame format

For Modbus serial line using the RTU (Remote Terminal Unit) mode, each byte (8 bits) in a message contains two hexadecimal (4 bits) characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate. In the RTU mode each message telegram is sent in binary format. Each telegram has:

- One start bit,
- Eight data bits,
- One even, odd or no parity bit, and
- One or two stop bits

The number of stop bits depends on whether a parity bit is used. If odd or even parity is used, the character will have one stop bit. If parity is not used, however, there will be two stop bits. In total there are eleven bits in one character.

A Modbus message is placed by the transmitting device into a frame that has a known beginning and ending point. This allows devices that receive a new frame to begin at the start of the message, and to know when the message is completed. Partial messages must be detected and errors for the same must be set as a result.

In RTU mode, message frames are separated by a silent interval of at least 3.5 characters (3.5 bytes time) times and this time interval is called t3, 5.

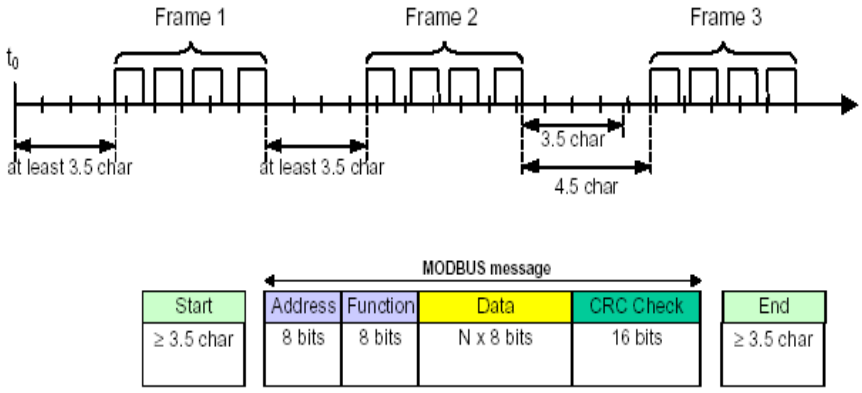


Figure 1 RTU Message Frame

The entire message frame must be transmitted as a continuous stream of characters. If a silent interval of more than 3.5 character times occurs between two characters, the message frame is declared incomplete and should be discarded by the receiver.

The RTU mode includes an error–checking field that is based on a Cyclic Redundancy Check (CRC) method performed on the message contents. The CRC field checks the contents of the entire message. It is applied regardless of any parity checking method used for the individual characters of the message. The CRC field contains a 16–bit value implemented as two 8–bit bytes. The CRC field is appended to the message as the last field in the message.

Section 2 IED specific implementation

2.1 Modbus Interface details

REF601/REJ601 is a dedicated feeder protection relay, intended for the protection of utility substations and industrial power systems, in primary and secondary distribution networks. REF601/REJ601 is a member of ABB's Relion ® product family and part of its 605 series.

The Relay equipped with the optional communication board provides RS485 communication port with Modbus RTU protocol support.

Table 1: Supported Modbus Interface Type

Description	Value
Protocol	Modbus, RTU
Communication port	RS485 , 2wire

2.2 Protocol parameters

The protocol and link parameters of the Modbus interface can be programmed by means of a local HMI by selecting :

Main Menu → Settings → COM Parameters

The following parameters are available:

Table 2: Modbus Settings

Sr. No.	Name	Default Value	Range
1	Baud Rate	19200	Baud rates: 2400/4800/9600/19200/38400 bps
2	Relay address	001	The Modbus unit address 1…247
3	Parity	Even	None parity Odd parity Even parity

2.3 Connectivity diagram

The below diagram (Figure 2) shows the connection details for a standard USB-RS485 converter and REJ/REF601 R2.2 FP1 variant relay.

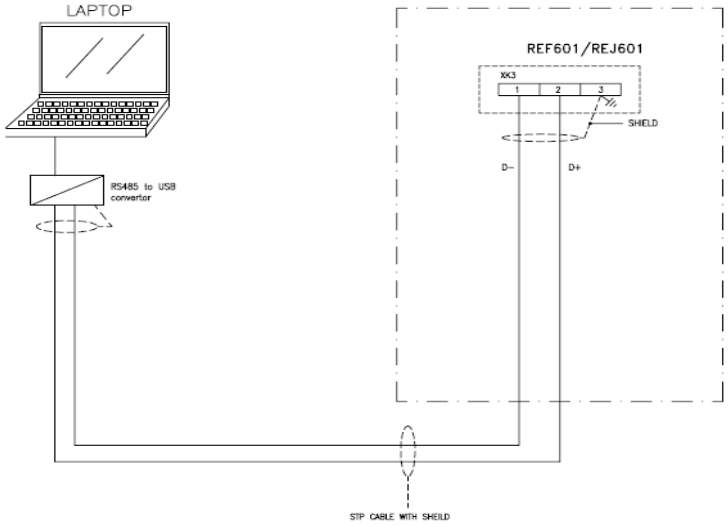
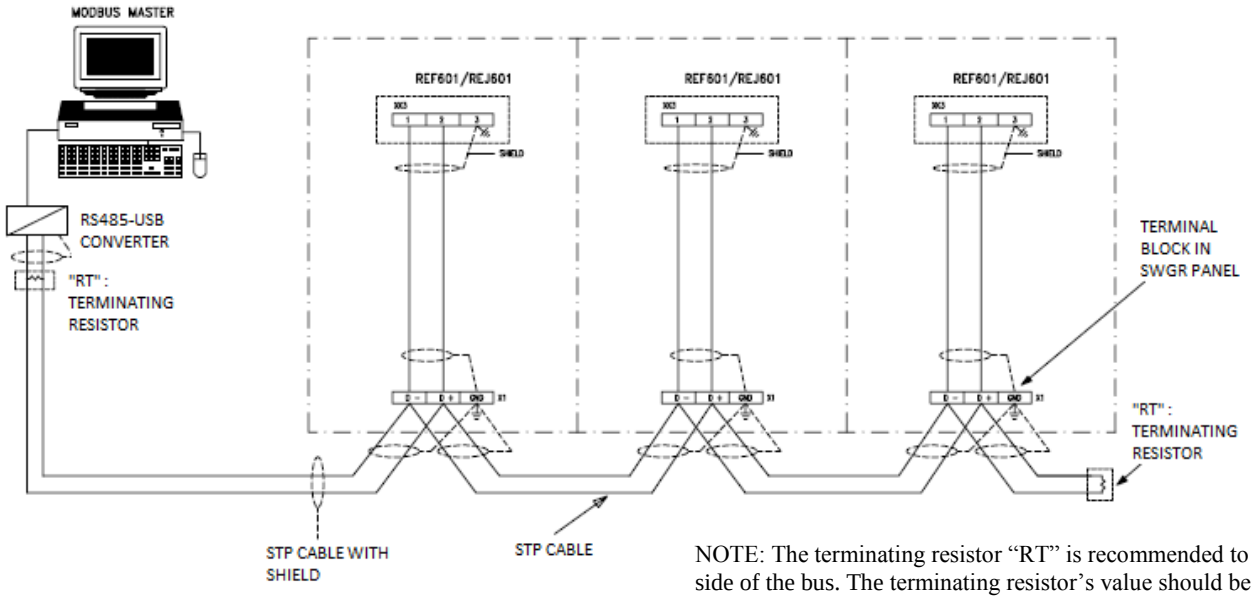


Figure: 2 Peer-to-peer Connection diagram



NOTE: The terminating resistor “RT” is recommended to have on both side of the bus. The terminating resistor’s value should be equal to the characteristic impedance “Z0” of STP cable.

Figure: 3 Multiple IED connection diagram

The following RS485 STP cables with the listed resistor values can be used for connecting the controller.

Belden #9271 (or equivalent with 120 ohm termination resistors (2,000 ft. /610 meters maximum)

Belden #9182 (or equivalent with 150 ohm termination resistors (4,000 ft./1220 meters maximum).Example used converter for USB-RS485 is MOXA /UPORT-1150.

2.4 Supported Functions

The implementation of the Modbus protocol in the REF601 / REJ601 supports the following functions:

2.4.1 Application Functions

Table 3: Modbus RTU function codes and definitions

Function Code	Name	Usage
1	Read Coils	Read the status of Coils (Discrete Outputs).
2	Read Discrete Inputs	Read the status of discrete inputs.
3	Read Holding Registers	Read data in 16-bit Register Format (High/Low).Used to read process data. Registers are consecutive and are imaged from the instrument to the host. These are used to read settings/configuration from the relay.
4	Read Input Registers	These are used to read event log/data log from the relay.
5	Change Digital Output	Change the state of the digital output. In case of REF/REJ 601 R2.2 FP1 this is used to set/clear binary outputs like Breaker open/Breaker close/Reset of Protection Trip/Remote Trip.
6	Pre-set Single Register	Write data in 16-bit Integer format (High/Low) only. These are used to write settings/configuration to the relay.
8	Loop Back Test	Used for diagnostic testing of the communications port.
16	Write Multiple registers	Only write to single register is supported.

2.4.1.1 Function Code: 01 (Read Relay Coils)

This function code is used to read the status of coils (discrete outputs) of the relay unit. The Request Packet specifies the starting address, i.e. the address of the first output specified, and the number of outputs. In the Packet, Coils are addressed starting at zero. Therefore, coils numbered 1-6 are addressed as 0-5.

The coils (discrete outputs) in the response message are packed as one output per bit of the data field. Status is indicated as 1 = ON; 0 = OFF. The LSB of the first data byte contains the output addressed in query. The other coils follow towards the higher order end of this byte, and from low order to high order in subsequent bytes.

If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the higher order end of byte). Byte count field specifies the quantity of complete bytes of data.

Example: Read relay output 1 to 3, from slave at output address 01.

Table 4: Request

Slave Address	Function Code	Starting Address high	Starting Address low	Quantity of outputs high	Quantity of outputs low	CRC	CRC
0x01	0x 01	0x 00	0x 01	0x 00	0x 03	CRC	CRC

Table 5: Response message format for function code 01

Slave Address	Function Code	Byte count	Output status	CRC	CRC
0x 01	0x 01	0x 01*	0x 07	CRC	CRC

* Byte count (N) = no. of outputs / 8; If the remainder is equal to 0; N = N. If the remainder is different of 0; N = N+1. The status of the discrete outputs 01 – 03 is shown as byte value 07 hex, or binary 0000 0111. Status of output 1 is shown as LSB, status of output 2 as 2nd bit from LSB and so on...

2.4.1.2 Function Code: 02 (Read Relay Discrete Inputs)

This function code is used to read the status of discrete inputs of the relay unit. The Request Packet specifies the starting address, i.e. the address of the first input specified, and the number of inputs. In the Packet, Discrete Inputs are addressed starting at zero. Therefore, inputs numbered 1-7 are addressed as 0-6.

The discrete inputs in the response message are packed as one input per bit of the data field. Status is indicated as 1 = ON; 0 = OFF. The LSB of the first data byte contains the input addressed in query. The other inputs follow towards the higher order end of this byte, and from low order to high order in subsequent bytes.

If the returned input quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the higher order end of byte). Byte count field specifies the quantity of complete bytes of data.

Example: Read relay input 1 to 3, from slave at input address 01.

Table 6: Request

Slave Address	Function Code	Starting Address high	Starting Address low	Quantity of outputs high	Quantity of outputs low	CRC	CRC
0x 01	0x 01	0x 00	0x 01	0x 00	0x 03	CRC	CRC

Table 7: Response message format for function code 02

Slave Address	Function Code	Byte count	Output status	CRC	CRC
0x 01	0x 01	0x 01*	0x 07	CRC	CRC

* Byte count (N) = no. of inputs / 8;

If the remainder is equal to 0; N = N

If the remainder is different of 0; N = N+1

The status of the discrete inputs 01 – 03 is shown as byte value 07 hex, or binary 0000 0111. Status of input1 is shown as LSB, status of input 2 as 2nd bit from LSB and so on.

2.4.1.3 Function Code: 03 (Read Relay Settings and Configurations)

This function code is used to read the parameter settings of the relay unit. The Request Packet specifies the starting register address and the number of registers. In the packet, registers are addressed starting at zero. Therefore, registers numbered 1-18 are addressed as 0-17.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Example: Read relay settings 1 to 5, from slave at address 01.

Table 8: Request

Slave Address	Function Code	Starting Address high	Starting Address low	Quantity of outputs high	Quantity of outputs low	CRC	CRC	
0x 01	0x 03	0x 00	0x 01	0x 00	0x 05	CRC	CRC	

Table 9: Response message format for function code 03

Slave Address	Function Code	Byte count	Data1 Hi	Data1 Lo	…..	Data5 Hi	Data5 Lo	CRC	CRC
0x 01	0x 03	0x 0A	0x 00	0x 05	…	0x 00	0x38	CRC	CRC

In the response the relay settings is shown as data bytes. The byte count provides the number of bytes that will follow. The same function code is also used to read the relay configuration parameters.

2.4.1.4 Function Code: 04 (Read Fault Record, Event log, Measurements)

This function code is used to read fault record of last five faults and event log of last hundred events occurred in the relay. The same function code is also used to read the phase and earth current (i.e. I1-I2-I3-I0). The mapping of current measurement is 1In = 1000. For example, a current value of 2In will be displayed in Hex format as 0x07D0 (2000 in decimal). The measurement will not be a real time measurement but it will be a query based communication between the base relay and the communication board and subsequently for the Modbus.

The Request Packet specifies the starting register address and the number of registers. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Example: Read Fault Record_1 log from slave at address 01.

Table 10: Request

Slave Address	Function Code	Starting Address high	Starting Address low	Quantity of outputs high	Quantity of outputs low	CRC	CRC
0x 01	0x 04	0x 00	0x 00	0x 00	0x1C	CRC	CRC

Table 11: Response message format for function code 04

Slave Address	Function Code	Byte count	Data1 Hi	Data1 Lo	…..	Data5 Hi	Data5 Lo	CRC	CRC
0x 01	0x 04	0x26	0x 05	0x 01	…	C0	0xF6	CRC	CRC

In the response the Fault Record of the last event is shown as data bytes. The byte count provides the number of bytes that will follow.

2.4.1.5 Function Code: 05 (Change Digital output)

This function code is used to enable digital output/s of the relay. A value of 0xFF00 or 0x0000 requests the output to be enabled or disabled. However, in the commands implemented for Relay, writing a value 0xFF00 will enable the output as per Binary Output configured and 0x0000 will have no effect also generate exception of illegal data value, since there are no such operations that need to be disabled. The normal response is an echo of the request, returned after the coil state has been written. A value other than 0xFF00 will generate an exception for illegal data value and any address other than those mentioned will generate an exception of illegal data address.

Example: Change the Breaker Close output.

Table 12: Request

Slave Address	Function Code	Starting Address high	Starting Address low	Quantity of outputs high	Quantity of outputs low	CRC	CRC
0x 01	0x 05	0x 00	0x 01	0x FF	0x 00	CRC	CRC

Table 13: Response message format for function code 0x05

Slave Address	Function Code	Output Address high	Output Address low	Output value high	Output value low	CRC	CRC
0x 01	0x 05	0x 00	0x 01	0x FF	0x 00	CRC	CRC

2.4.1.6 Function Code: 06 (Write single register-Change relay setting and configuration)

This function code is used to change single setting of relay device. The Request Packet specifies the address of the register to be written. The normal response is an echo of the request, returned after the register contents have been written. The same function code is also used for editing the configuration of the relay. The configuration parameters that can be edited through the Modbus include Phase/Earth Secondary CT Type selection (1A - 5A), Frequency Selection (50Hz - 60 Hz) and Earth Type Selection (Internal-External) of relay. Also Binary Inputs and Outputs Configuration supported by this function.

Example: Write 0Ah value to register value with address 0x0005 on slave at address 01.

Table 14: Request

Slave Address	Function Code	Starting Address high	Starting Address low	Quantity of outputs high	Quantity of outputs low	CRC	CRC
0x 01	0x 06	0x 00	0x 05	0x 00	0x 0A	CRC	CRC

Table 15: Response message format for function code 06

Slave Address	Function Code	Starting Address high	Starting Address low	Setting value High	Setting value Low	CRC	CRC
0x 01	0x 06	0x 00	0x 05	0x 00	0x 0A	CRC	CRC

2.4.1.7 Function Code: 08 (Diagnostics- Loop back message)

This function code is to check the health of the RS485 link, where the query sent is received back by the master. The message can be of any length from 4 to 16 bytes. The normal Response is an echo of the query.

Table 16: Request

Slave Address	Function Code	Any data, length limited from 4 to 16 bytes				CRC	CRC
0x 01	0x 08	0x 01	0x 02	0x 03	0x 04	CRC	CRC

Table 17: Response:

Slave Address	Function Code	Any data, length limited from 4 to 16 bytes				CRC	CRC
0x 01	0x 08	0x 01	0x 02	0x 03	0x 04	CRC	CRC

2.4.2 Exception Response

When a client device sends a request to a slave device it expects a normal response. But, if the slave device cannot handle the request (for example, if the request is to read a non–existent output or register), it will return an exception response informing the master of the nature of the error.

The exception response message has two fields that differentiate it from a normal response:

Function Code Field:

In a normal response, the server echoes the function code of the original request in the function code field of the response. All function codes have a most significant bit (MSB) of 0 (their values are all below 80 hexadecimal). In an exception response, the server sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal, higher than the value for a normal response. With the function code’s MSB set, the client's application program can recognize the exception response and can examine the data field for the exception code.

Data Field:

In a normal response, the server may return data or statistics in the data field (any information that was requested in the request). In an exception response, the server returns an exception code in the data field. This defines the server condition that caused the exception.

An example for the same is as below:

Table 18: Request frame

Slave Address	Function Code	Starting Address High	Starting Address Low	Quantity of registers High	Quantity of registers Low	CRC	CRC
0x 01	0x 01	0x 00	0x 01	0x 00	0x 05	CRC	CRC

This creates an exception and the response format is as below:

Table 19: Response message format

Slave Address	Function Code	Exception Code	CRC	CRC
0x 01	0x 81	0x 01	CRC	CRC

81h in the starting field indicates that the frame is for exception frame and exception code 0x01 indicates that the requested function code is not implemented in the slave device.

Table 20: Modbus Exception codes

Exception Code	Exception Code	Description
0x01	Illegal Function	The function code received in the query is not an allowable action for the slave. This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the slave is in the wrong state to process a request of this type, for example because it is un-configured and is being asked to return register values.
0x02	Illegal Data Address	The data address received in the query is not an allowable address for the slave. More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and length 4 would succeed a request with offset 96 and length 5 will generate exception 02.
0x03	Illegal Data Value	A value contained in the query data field is not an allowable value for slave. This also indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect.
0x06	Slave Device Busy	Specialized use in conjunction with programming commands. The server (or slave) is engaged in processing a long–duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.
0x08	Memory Parity Error	The slave attempted to read record file but detected a parity error in the memory.

2.5 Modbus address mapping details

Measurands and other 16-bit values can be read from the Input register (IR) and are marked as Read-only (R).However, there are also write-only coils in the Modbus data mapping of REF601 / REJ601.Those coils are marked as writable (W) in the point lists. Parameter that can be possible to read and write both, are Marked as (R/W).

2.5.1 Current measurement

Table 21: Current measurement

Sr. No.	Parameter description	Modbus Address	Function code	Read / Write	Range HEX (decimal)	Scale	Comments
1	Data for current measurement on I1	512	0x04	(R)	0000-FFFF (0 – 65535)	1)	Nominal Current
2	Data for current measurement on I2	513	0x04	(R)	0000-FFFF (0 – 65535)	-	Nominal Current
3	Data for current measurement on I3	514	0x04	(R)	0000-FFFF (0 – 65535)	-	Nominal Current
4	Data for current measurement on I0	515	0x04	(R)	0000-FFFF (0 – 65535)	-	Nominal Current
5	Operation counter	516	0x04	(R)	0000-FFFF (0 – 65535)	-	Nominal Current
6	Negative phase sequence current measurement	517	0x04	(R)	0000-FFFF (0 – 65535)	-	Nominal Current
7	Thermal level	518	0x04	(R)	0000-FFFF (0 – 65535)	-	Nominal Current

1) Scaling formula for measuring primary current

CT variant

Actual Current = (Value in Modbus Register * Ipn) /1000

Sensor variant

Actual Current = (Value in Modbus Register * Ir) /1000

Where:

Ipn: 20..9999 (Primary current of phase CT),

Ir: Relay reference current (only for sensor variant)

2.5.2 Binary Input / Output status

Table 22: Binary Input / Output status

Sr. No.	Parameter description	Modbus Address	Function code	Read / Write	Range HEX
1	Binary Input 1 Status	3	0x02	(R)	0=OFF, 1=ON
2	Binary Input 2 Status	4	0x02	(R)	0=OFF, 1=ON
3	Binary Input 3 Status	5	0x02	(R)	0=OFF, 1=ON
4	Binary Input 4 Status	6	0x02	(R)	0=OFF, 1=ON
5	Binary Output 1 Status	0	0x01	(R)	0=OFF, 1=ON
6	Binary Output 2 Status	1	0x01	(R)	0=OFF, 1=ON
7	Binary Output 3 Status	2	0x01	(R)	0=OFF, 1=ON
8	Binary Output 4 Status	3	0x01	(R)	0=OFF, 1=ON
9	Binary Output 5 Status	4	0x01	(R)	0=OFF, 1=ON
10	Binary Output 6 Status	5	0x01	(R)	0=OFF, 1=ON
11	Programmable LED 1 Status	6	0x01	(R)	0=OFF, 1=ON
12	Programmable LED 2 Status	7	0x01	(R)	0=OFF, 1=ON
13	Programmable LED 3 Status	8	0x01	(R)	0=OFF, 1=ON
14	Programmable LED 4 Status	9	0x01	(R)	0=OFF, 1=ON
15	Programmable LED 5 Status	10	0x01	(R)	0=OFF, 1=ON

2.5.3 Breaker status / control parameters

Table 23: Breaker status / control parameters

Sr. No.	Parameter description	Modbus Address	Function code	Read / Write	Range HEX
1	Breaker Open Status	0	0x02	(R)	0000=Not Open, 0001=Open
2	Breaker Close Status	1	0x02	(R)	0000=Not Closed, 0001=Closed
3	Breaker in Service Status	2	0x02	(R)	0000=Not in Service, 0001=In Service
4	Breaker Open command	0	0x05	(W)	0x00FF
5	Breaker Close command	1	0x05	(W)	0x00FF
6	Reset of protection command	2	0x05	(W)	0x00FF
7	Remote trip command	3	0x05	(W)	0x00FF
8	IED Status	288	0x04	(R)	0000=Internal Relay Fault, 0004=Unit Ready with no trip 0005=Unit Ready with Phase Trip 0006=Unit Ready with Earth Trip
9	L/R Status	289	0x04	(R)	0000=Local, 0001=Remote

Binary inputs BI2 to BI4 can be configured to indicate the status of circuit breaker i.e. breaker open or breaker close or breaker in maintenance (service).

2.5.4 RTC / Date and time

Table 24: RTC / Date and time

Sr. No.	Parameter description	Modbus Address	Modbus new Address	Function code	Read / Write	Range HEX (decimal)
1	RTC – DD – Date	45	4877	0x03	(R)	0001-001F (1 – 31)
				0x06 or 0x10	(W)	
2	RTC – MM – Month	46	4878	0x03	(R)	0001-000C (1 – 12)
				0x06 or 0x10	(W)	
3	RTC – YY – Year	47	4879	0x03	(R)	000B-0063 (11 – 99)
				0x06 or 0x10	(W)	
4	RTC – HH – Hour	48	4880	0x03	(R)	0000-0017 (0 – 23)
				0x06 or 0x10	(W)	
5	RTC – MM – Minute	49	4881	0x03	(R)	0000-003B (0 – 59)
				0x06 or 0x10	(W)	
6	RTC – SS – Second	50	4882	0x03	(R)	0000-003B (0 – 59)
				0x06 or 0x10	(W)	
7	RTC – MILLI – Second	51	4883	0x03	(R)	0000-03E7 (0 – 999)

2.5.5 Protection settings

Table 25: Protection settings

Sr no	Parameter description	Modbus Old Address	SG1/ SG2 Address	Function code	Read / Write	Range	Default value	Step Size	Scale
1	I> Curve	0	4096/ 7936	0x03	(R)	1- DT 2- IEC NI 3- IEC VI 4- IEC LI 5- IEC EI 6- IEC RI 7-ANSI NI 8- ANSI VI 9- ANSI MI 10-ANSI EI	DT	1(1)	1
				0x06 or 0x10	(W)				
2	I> k (Time multiplier)	1	4097/ 7937	0x03	(R)	20 – 1600 (0.02 – 1.6)	-	10 (0.01)	0.001
				0x06 or 0x10	(W)				
3	I>	2	4098/ 7938	0x03	(R)	100 – 2500 (0.1 In – 2.5 In)	01.500 In	1 (0.001)	0.001
				0x06 or 0x10	(W)				
4	t>	3	4099/ 7939	0x03	(R)	40 – 64000 (0.04s – 64s)	01.00 s	10 (0.01)	0.001
				0x06 or 0x10	(W)				
5	I>>	4	4100/ 7940	0x03	(R)	200 – 25000 (0.2 In – 25 In)	04.000 In	1 (0.001)	0.001
				0x06 or 0x10	(W)				
6	t>>	5	4101/ 7941	0x03	(R)	40 – 64000 (0.04s – 64s)	00.30 s	10 (0.01)	0.001
				0x06 or 0x10	(W)				
7	I>>>	6	4102/ 7942	0x03	(R)	500 – 25000 (0.5 In – 25 In)	10.000 In	1 (0.001)	0.001
				0x06 or 0x10	(W)				
8	t>>>	7	4103/ 7943	0x03	(R)	30 – 64000 (0.03s – 64s)	00.03 s	10 (0.01)	0.001
				0x06 or 0x10	(W)				
9	I0> Curve	8	4104/ 7944	0x03	(R)	1- DT 2- IEC NI 3- IEC VI 4- IEC LI 5- IEC EI 6- IEC RI 7-ANSI NI 8- ANSI VI 9- ANSI MI 10-ANSI EI	DT	1 (1)	1
				0x06 or 0x10	(W)				
10	I0> k0 (Time multiplier)	9	4105/ 7945	0x03	(R)	20 – 1600 (0.02 – 1.6)		10 (0.01)	0.001
				0x06 or 0x10	(W)				

Sr No	Parameter description	Modbus Old Address	SG1/ SG2 Address	Function code	Read / Write	Range	Default value	Step Size	Scale
11	I0>	10	4106/ 7946	0x03 0x06 or 0x10	(R) (W)	For External Earth type : 10 – 2000 (0.01 In – 2.0 In) For Internal Earth type: 100 – 2000 (0.1 In – 2.0 In)	00.500 In	1 (0.001)	0.001
12	t0>	11	4107/ 7947	0x03 0x06 or 0x10	(R) (W)	40 – 64000 (0.04s – 64s)	01.50 s	10 (0.01)	0.001
13	I0>>	12	4108/ 7948	0x03 0x06 or 0x10	(R) (W)	For External Earth type: 50 – 12500 (0.05 In – 12.5 In) For Internal Earth type: 500 – 12500 (0.5 In – 12.5 In)	02.500 In	1 (0.001)	0.001
14	t0>>	13	4109/ 7949	0x03 0x06 or 0x10	(R) (W)	40–64000 (0.04s – 64s)	00.50 s	10 (0.01)	0.001
15	I inr (Inrush Current Threshold)	14	4110/ 7950	0x03 0x06 or 0x10	(R) (W)	200–25000* (0.2 In – 25 In)	00.50 In	10 (0.01)	0.001
16	Inrush Ratio	15	4111/ 7951	0x03 0x06 or 0x10	(R) (W)	30 - 50 (30% - 50%)	30%	1 (1)	1
17	st_I2>Isat	-	4112/ 7952	0x03 0x06 or 0x10	(R) (W)	0.1 - 1.50	0.30	0.01	
18	st_I2>Time	-	4113/ 7953	0x03 0x06 or 0x10	(R) (W)	10-30000 (0.1s –300s)	1.0	10 (0.1)	
19	st_I2/I1>Isat	-	4114/ 7954	0x03 0x06 or 0x10	(R) (W)	10 - 100	15	1	
20	st_I2/I1>.Time	-	4115/ 7955	0x03 0x06 or 0x10	(R) (W)	100- 64000 (0.1s – 64s)	0.1	100 (0.1)	
21	Counter. BI Map	-	4116/ 7956	0x03 0x06 or 0x10	(R) (W)	0 - 4	1	1	

Sr. No.	Parameter description	Modbus Old Address	SG1/ SG2 Address	Function code	Read / Write	Range	Default value	Step Size	Scale
22	Counter. Value Set	-	4117/ 7957	0x03	(R)	0 -65535	1	1	
				0x06 or 0x10	(W)				
23	Setting Group Selection	-	4118/ 7958	0x03	(R)	1 = Setting Group 1 2 = Setting Group 2	1	1 (1)	
				0x06 or 0x10	(W)				
24	Setting Group Activation	-	4119/ 7959	0x03	(R)	1 = Setting Group 1 2 = Setting Group 2	1	1 (1)	
				0x06 or 0x10	(W)				
25	Setting Group Edit	-	4120/ 7960	0x03	(R)	1 = Setting Group 1 2 = Setting Group 2	1	1 (1)	
				0x06 or 0x10	(W)				
26	RSVD	-	4121/ 7961	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
27	RSVD	-	4122/ 7962	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
28	RSVD	-	4123/ 7963	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
29	ϑ_0	-	4124/ 7964	0x03	(R)	0 - 100	80	1	
				0x06 or 0x10	(W)				
30	Ib	-	4125/ 7965	0x03	(R)	0.1 - 1.5	1	0.1	
				0x06 or 0x10	(W)				
31	t↑	-	4126/ 7966	0x03	(R)	1 - 300	45	1	
				0x06 or 0x10	(W)				
32	t↓s	-	4127/ 7967	0x03	(R)	1 - 300	45	1	
				0x06 or 0x10	(W)				
33	RSVD	-	4128/ 7968	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
34	ϑ_{alm}	-	4129/ 7969	0x03	(R)	50 - 200	121	1	
				0x06 or 0x10	(W)				
35	ϑ_{trip}	-	4130/ 7970	0x03	(R)	50 - 200	144	1	
				0x06 or 0x10	(W)				

Sr. No.	Parameter description	Modbus Old Address	SG1/ SG2 Address	Function code	Read / Write	Range	Default value	Step Size	Scale
36	$\vartheta_{startinhibit}$	-	4131/ 7971	0x03	(R)	50 - 200	105	1	
				0x06 or 0x10	(W)				
37	RSVD	-	4132/ 7972	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
38	Mode $\vartheta_{powerOFF}$	-	4133/ 7973	0x03	(R)	1 – 4	4	1	
				0x06 or 0x10	(W)				
39	RSVD	-	4134/ 7974	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
40	AR start mode	-	4135/ 7975	0x03	(R)	1=Select trip 2=General Start & Trip	1	1	1
				0x06 or 0x10	(W)				
41	CB Ready	-	4136/ 7976	0x03	(R)	1 = OCO 2 = CO	1	1	1
				0x06 or 0x10	(W)				
42	Shot of Cycle(#)	-	4137/ 7977	0x03	(R)	0 – 4	1	1	
				0x06 or 0x10	(W)				
43	RSVD	-	4138/ 7978	0x03	(R)	-	-	-	
				0x06 or 0x10	(W)				
44	Cycle t1	-	4139/ 7979	0x03	(R)	20-30000	50	1	0.01
				0x06 or 0x10	(W)				
45	Cycle t2	-	4140/ 7980	0x03	(R)	20-30000	50	1	0.01
				0x06 or 0x10	(W)				
46	Cycle t3	-	4141/ 7981	0x03	(R)	20-30000	50	1	0.01
				0x06 or 0x10	(W)				
47	Cycle t4	-	4142/ 7982	0x03	(R)	20-30000	50	1	0.01
				0x06 or 0x10	(W)				

Sr. No.	Parameter description	Modbus Old Address	SG1/ SG2 Address	Function code	Read / Write	Range	Default value	Step Size	Scale
48	Reclaim tr	-	4143/ 7983	0x03	(R)	1-300	1	1	1
				0x06 or 0x10	(W)				
49	Block tb	-	4144/ 7984	0x03	(R)	1-300	5	1	1
				0x06 or 0x10	(W)				
50	Pulse tp	-	4145/ 7985	0x03	(R)	200-20000	200	100	0.001
				0x06 or 0x10	(W)				
51	Activate t	-	4146/ 7986	0x03	(R)	100-5000	800	100	0.001
				0x06 or 0x10	(W)				
52	I CBFP	-	4147/ 7987	0x03	(R)	200-2000	1100	100	0.001
				0x06 or 0x10	(W)				
53	I0 CBFP	-	4148/ 7988	0x03	(R)	100-2000	1100	100	0.001
				0x06 or 0x10	(W)				
54	t Retrip	-	4149/ 7989	0x03	(R)	60-500	100	10	0.001
				0x06 or 0x10	(W)				
55	t Backup	-	4150/ 7990	0x03	(R)	60-500	120	10	0.001
				0x06 or 0x10	(W)				
				0x06 or 0x10	(W)				

* Upper Current Limit for Sensor Variant - 20000 and for CT Variant- 25000.

2.5.6 Binary Input / Output configuration

Table 26: Binary Input / Output Configuration parameters

Sr.	Parameter	Modbus	Modbus	Function	Read	Range	Defa

No.	description	old Address	New Address	code	/ Write	Values in [HEX]	ult valu e
1	Binary Input1 configuration status	60	5632	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted, 0001 = Inverted	0
2	Binary Input2 configuration status	61	5633	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted 0001 = Inverted	0
3	Binary Input3 configuration status	62	5634	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted, 0001 = Inverted	0
4	Binary Input4 configuration status	63	5635	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted, 0001 = Inverted	0
5	Binary Output 1 configuration status	90	6400	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted Hold 0001 = Non-Inverted Latch 0002 = Non-Inverted Self Reset 0003 = Non-Inverted Pulse 0100 = Inverted Hold 0101 = Inverted Latch 0102 = Inverted Self Reset 0103 = Inverted Pulse	3
6	Binary Output 2 configuration status	91	6401	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted Hold 0001 = Non-Inverted Latch 0002 = Non-Inverted Self Reset 0003 = Non-Inverted Pulse 0100 = Inverted Hold 0101 = Inverted Latch 0102 = Inverted Self Reset 0103 = Inverted Pulse	3
7	Binary Output 3 configuration status	92	6402	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted Hold 0001 = Non-Inverted Latch 0002 = Non-Inverted Self Reset 0003 = Non-Inverted Pulse 0100 = Inverted Hold 0101 = Inverted Latch 0102 = Inverted Self Reset 0103 = Inverted Pulse	3
8	Binary Output 4 configuration status	93	6403	0x03	(R)	0000 = Non-Inverted Hold 0001 = Non-Inverted Latch 0002 = Non-Inverted Self Reset 0003 = Non-Inverted Pulse 0100 = Inverted Hold 0101 = Inverted Latch 0102 = Inverted Self Reset 0103 = Inverted Pulse	2

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value
9	Binary Output 5	94	6404	0x03	(R)	0000 = Non-Inverted Hold	3

	configuration status			0x06 or 0x10	(W)	0001 = Non-Inverted Latch 0002 = Non-Inverted Self Reset 0003 = Non-Inverted Pulse 0100 = Inverted Hold 0101 = Inverted Latch 0102 = Inverted Self Reset 0103 = Inverted Pulse	
10	Binary Output 6 configuration status	95	6405	0x03 0x06 or 0x10	(R) (W)	0000 = Non-Inverted Hold 0001 = Non-Inverted Latch 0002 = Non-Inverted Self Reset 0003 = Non-Inverted Pulse 0100 = Inverted Hold 0101 = Inverted Latch 0102 = Inverted Self Reset 0103 = Inverted Pulse	3
11	I> Block	70*	5652	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped & 0001=Mapped with BI1	0
12	I>> Block	71*	5653	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped & 0001=Mapped with BI1	0
13	I>>> Block	72*	5654	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped & 0001=Mapped with BI1	0
14	I0> Block	73*	5655	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped & 0001=Mapped with BI1	0
15	I0>> Block	74*	5656	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped & 0001=Mapped with BI1	0
16	CB Ctl Blk	75*	5657	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped & 0001=Mapped with BI1	0
17	Lockout Rs (Reset)	76*	5658	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	8
18	CB Cls Pos	77*	5659	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
19	CB Opn Pos	78*	5660	0x03 0x06 or 0x10	(R) (W)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value
20	CB Maint	79*	5661	0x03	(R)	0000=Not mapped,	0

				0x06 or 0x10	(W)	0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	
21	TCS	80*	5662	0x03	(R)	0000=Not mapped & 0001=Mapped with BI2	1
				0x06 or 0x10	(W)		
22	Ext Trip	81*	5663	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	4
				0x06 or 0x10	(W)		
23	Ext Close	82*	5664	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				20x06 or 0x10	(W)		
24	Power Off	83*	5665	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
25	SIGNAL 1	84*	5666	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
26	SIGNAL 2	85*	5667	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
27	SIGNAL 3	86*	5668	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
28	TCS Block	87*	5669	0x03	(R)	0000=Not mapped & 0001=Mapped with BI1	0
				0x06 or 0x10	(W)		
29	I2> Block	-	5670	0x03	(R)	0000=Not mapped & 0001=Mapped with BI1	0
				0x06 or 0x10	(W)		
30	I2/I1> Block	-	5671	0x03	(R)	0000=Not mapped 0001=Mapped with BI1	0
				0x06 or 0x10	(W)		
31	3Ith Block	-	5672	0x03	(R)	0000=Not mapped 0001=Mapped with BI1	0
				0x06 or 0x10	(W)		
32	SG Select	-	5673	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value
33	RSVD	-	5674	0x03	(R)	-	0

				0x06 or 0x10	(W)		
34	RSVD	-	5675	0x03	(R)	-	0
				0x06 or 0x10	(W)		
35	CB Ready	-	5676	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
36	BF Block	-	5677	0x03	(R)	0000=Not mapped 0001=Mapped with BI1	0
				0x06 or 0x10	(W)		
37	BF ProtExt	-	5678	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
38	BF RecTrip	-	5679	0x03	(R)	0000=Not mapped, 0002=Mapped with BI2, 0004=Mapped with BI3, 0008=Mapped with BI4	0
				0x06 or 0x10	(W)		
				0x06 or 0x10	(W)		
39	I>Start mapped with Binary Output _Data value	100*	6420	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
40	I>>Start Mapped with Binary Output _Data Value	101*	6421	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
41	I>>>Start Mapped with Binary Output _Data Value	102*	6422	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
42	Unit Rdy Mapped with Binary Output _Data Value	103*	6423	0x03	(R)	0000-003F	8
				0x06 or 0x10	(W)		
43	I0>Start Mapped with Binary Output _Data Value	104*	6424	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
44	I0>>Start Mapped with Binary Output _Data Value	105*	6425	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
45	I>Trip Mapped with Binary Output _Data Value	106*	6426	0x03	(R)	0000-003F	19
				0x06 or 0x10	(W)		
46	I>>Trip Mapped with Binary Output _Data Value	107*	6427	0x03	(R)	0000-003F	19
				0x06 or 0x10	(W)		
47	I>>>Trip Mapped with Binary Output _Data Value	108*	6428	0x03	(R)	0000-003F	19
				0x06 or 0x10	(W)		

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value
48	TCS Fault Mapped	109*	6429	0x03	(R)	0000-003F	0

	with Binary Output _Data Value			0x06 or 0x10	(W)		
49	I0>Trip Mapped with Binary Output _Data Value	110*	6430	0x03	(R)	0000-003F	19
				0x06 or 0x10	(W)		
50	I0>>Trip apped with Binary Output _Data Value	111*	6431	0x03	(R)	0000-003F	19
				0x06 or 0x10	(W)		
51	CB Cls Cmd Mapped with Binary Output _Data Value	112*	6432	0x03	(R)	0000-003F	4
				0x06 or 0x10	(W)		
52	CB Opn Cmd Mapped with Binary Output _Data Value	113*	6433	0x03	(R)	0000-003F	3
				0x06 or 0x10	(W)		
53	SIGNAL 1 with Binary Output _Data Value	114*	6434	0x03	(R)	0000-003F	
				0x06 or 0x10	(W)		
54	SIGNAL 2 with Binary Output _Data Value	115*	6435	0x03	(R)	0000-003F	
				0x06 or 0x10	(W)		
55	SIGNAL 3 with Binary Output _Data Value	116*	6436	0x03	(R)	0000-003F	
				0x06 or 0x10	(W)		
56	I2> Start with Binary Output _Data Value	-	6437	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
57	I2> Trip with Binary Output _Data Value	-	6438	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
58	I2/I1> Start with Binary Output _Data Value	-	6439	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
59	I2/I1> Trip with Binary Output _Data Value	-	6440	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
60	3Ith tr with Binary Output _Data Value	-	6441	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		
61	3Ith Alarm with Binary Output _Data Value	-	6442	0x03	(R)	0000-003F	0
				0x06 or 0x10	(W)		

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value
62		-	6443	0x03	(R)	0000-003F	0

	3Ith BLK CL with Binary Output _Data Value			0x06 or 0x10	(W)		
63	0->I Close with Binary Output _Data Value	-	6444	0x03 0x06 or 0x10	(R) (W)	0000-003F	0
64	0->I InPro with Binary Output _Data Value	-	6445	0x03 0x06 or 0x10	(R) (W)	0000-003F	0
65	0->I Final Tr with Binary Output _Data Value	-	6446	0x03 0x06 or 0x10	(R) (W)	0000-003F	0
66	0->I Blocked with Binary Output _Data Value	-	6447	0x03 0x06 or 0x10	(R) (W)	0000-003F	0
67	BF Stage 1 with Binary Output _Data Value	-	6448	0x03 0x06 or 0x10	(R) (W)	0000-003F	0
68	BF Stage 2 with Binary Output _Data Value	-	6449	0x03 0x06 or 0x10	(R) (W)	0000-003F	0
69	BF Rec Trip with Binary Output _Data Value	-	6450	0x03 0x06 or 0x10 0x06 or 0x10	(R) (W) (W)	0000-003F	0

Refer below table for Data Value Description

Data Value	BO6	BO5	BO4	BO3	BO2	BO1	Description
0x0000	0	0	0	0	0	0	No Channel Selected
0x0001	0	0	0	0	0	1	Binary Output Channel 1 Selected
0x0003	0	0	0	0	1	1	Binary Output Channel 1 & 2 Selected
0x003F	1	1	1	1	1	1	All Channel Selected

UNIT READY status is permanent configured at BO4 and cannot be changed. No other signals can be configured at BO4.

2.5.7 LED Configuration parameters

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value

1	LED 1 Config	-	7168	0x03	R/W	0000=Non-Inverted Hold 0002=Non-Inverted Self Reset	
2	LED 2 Config	-	7169	0x03	R/W	0000=Non-Inverted Hold 0002=Non-Inverted Self Reset	
3	LED 3 Config	-	7170	0x03	R/W	0000=Non-Inverted Hold 0002=Non-Inverted Self Reset	
4	LED 4 Config	-	7171	0x03	R/W	0000=Non-Inverted Hold 0002=Non-Inverted Self Reset	
5	LED 5 Config	-	7172	0x03	R/W	0000=Non-Inverted Hold 0002=Non-Inverted Self Reset	
6	I> Start	-	7188	0x03	R/W	0000 – 001F	
7	I>> Start	-	7189	0x03	R/W	0000 – 001F	
8	I>>> Start	-	7190	0x03	R/W	0000 – 001F	
9	I0> Start	-	7191	0x03	R/W	0000 – 001F	
10	I0>> Start	-	7192	0x03	R/W	0000 – 001F	
11	I> Trip	-	7193	0x03	R/W	0000 – 001F	
12	I>> Trip	-	7194	0x03	R/W	0000 – 001F	
13	I>>> Trip	-	7195	0x03	R/W	0000 – 001F	
14	I0> Trip	-	7196	0x03	R/W	0000 – 001F	
15	I0>> Trip	-	7197	0x03	R/W	0000 – 001F	
16	TCS	-	7198	0x03	R/W	0000 – 001F	
17	SIGNAL 1	-	7199	0x03	R/W	0000 – 001F	
18	SIGNAL 2	-	7200	0x03	R/W	0000 – 001F	
19	SIGNAL 3	-	7201	0x03	R/W	0000 – 001F	
20	I2>Start	-	7202	0x03	R/W	0000 – 001F	
21	I2>Trip	-	7203	0x03	R/W	0000 – 001F	
22	I2/I1>Start	-	7204	0x03	R/W	0000 – 001F	
23	I2/I1>Trip	-	7205	0x03	R/W	0000 – 001F	
24	3 Ith > Trip	-	7206	0x03	R/W	0000 – 001F	
25	3 Ith > Alarm	-	7207	0x03	R/W	0000 – 001F	
26	3 Ith > BlkCl	-	7208	0x03	R/W	0000 – 001F	

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value

27	0->I Close	-	7209	0x03	R/W	0000 – 001F	
28	0->I InPro	-	7210	0x03	R/W	0000 – 001F	
29	0->I Final Tr	-	7211	0x03	R/W	0000 – 001F	
30	0->I Blocked	-	7212	0x03	R/W	0000 – 001F	
31	BF Stage 1	-	7213	0x03	R/W	0000 – 001F	
32	BF Stage 2	-	7214	0x03	R/W	0000 – 001F	
33	BF RecTrip	-	7215	0x03	R/W	0000 – 001F	

2.5.8 Relay Configuration parameters

Table 27: Relay Configuration parameters

Sr. No.	Parameter description	Modbus Address		Function code	Read / Write ***	Range Value in [HEX] (value in decimal for reference)	Default value
1	Application configuration	-	4861	0x03	(R)	0001 = “A” 0002 = “B” 0003 = “C” 0004 = “D”	-
2	Base Board Software Version	-	4862	0x03	(R)	0000-270F (0 – 9999)	02.20
3	Base Board Software Sub Version	-	4863	0x03	(R)	0000-0063 (0-99)	00
4	Model Type	32	4864	0x03	(R)	0=CEI 0-16 1= IEC	1
5	Nominal Current	33*	4865	0x03	(R)	For 250 A Sensor Type: 0000=40A 0001=80A 0002=250A 0003=1250A For 80 A Sensor Type: 0000=12.8A 0001=25.6A 0002=80A 0003=400A	-
6	Product Name	34	4866	0x03	(R)	0000= REF 0001= REJ	-
7	Earth Type(I0 Measurement)	35	4867	0x03 0x06 or 0x10	(R) (W)	0000 = Internal Calculation 0001= External Measurement	1

Sr. No.	Parameter description	Modbus Address		Function code	Read / Write ***	Range Value in [HEX] (value in decimal for reference)	Default value

8	Base Board Software Version	36	4868	0x03	(R)	0000-270F (0 – 9999)	02.20
9	Phase Trip counter	37	4869	0x03	(R)	0000-270F (0 – 9999)	-
10	Earth Trip counter	38	4870	0x03	(R)	0000-270F (0 – 9999)	-
11	Frequency	39	4871	0x03 0x06 or 0x10	(R) (W)	0000= 50 Hz 0001 = 60 Hz	0
12	Comm. Board Software Version	40	4872	0x03	(R)	0000-270F (0 – 9999)	00.00
13	Comm. Board Software Sub Version	-	4873	0x03	(R)	0000-0063 (0-99)	00
14	TCS Operating Time (in Second)	42	4874	0x03 0x06 or 0x10	(R) (W)	0001 – 012C (1-300)	
15	Reserved	43	4875	-	-	-	-
16	TCS Block/Unblock	44	4876	0x03 0x06 or 0x10	(R) (W)	0000=TCS Unblock 0001=TCS Block	0
17	Analogue Input type	52	4884	0x03	(R)	0000=Sensor 0001=1A CT 0005=5A CT	-
18	Phase CT primary	53**	4885	0x03 0x06 or 0x10	(R) (W)	0014 – 270F (20-9999)	1000
19	Earth CT secondary	54	4886	0x03	(R)	0001=1A 0005=5A	-
20	Earth CT primary	55	4887	0x03 0x06 or 0x10	(R) (W)	0014 – 270F (20-9999)	1000
21	I>Block	-	4888	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
22	I>>Block	-	4889	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
23	I>>>Block	-	4890	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
24	I0>Block	-	4891	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
25	I0>>Block	-	4892	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0

Sr. No.	Parameter description	Modbus old Address	Modbus New Address	Function code	Read / Write	Range Values in [HEX]	Default value

26	I2>Block	-	4893	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
27	I2/I1>Block	-	4894	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
28	BF Blocking	-	4895	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
29	3I>/I0 - I>Block	-	4896	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
30	3I>/I0 - I>>Block	-	4897	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
31	3I>/I0 - I>>>Block	-	4898	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
32	3I>/I0 - I0>Block	-	4899	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
33	3I>/I0 - I0>>Block	-	4900	0x03 0x06 or 0x10	(R) (W)	0000=No 0001=Yes	0
34	Thermal Protection Block	-	4901	0x03 0x06 or 0x10 0x06 or 0x10	(R) (W) (W)	0000=No 0001=Yes	0

* address 33 (0x0021) is applicable to REF601 R2.2 FP1 SENSOR variant only. In case of CT variant Illegal Data Address Exception Code (0x02) will be generated.

** Data value range of address 53 is applicable to CT variant only. In case of SENSOR variant 80 & 250 only will be Data Value

.*** “COM Admin Level” in IED must be “YES” for Relay Configuration Write.

2.5.9 Event log to address mapping

Table 28: Event log to address mapping

Sr. No.	Parameter	Parameter description	Modbus Address	Function code	Read / Write	Comments
1	Event1	Event type and sub-type*	768	0x04	(R)	Latest Event
2		DD/MM/	769	0x04	(R)	

3		YY:HH/	770	0x04	(R)	
4		MM/SS:	771	0x04	(R)	
5		mSec	772	0x04	(R)	
6		Reserved	773	0x04	(R)	
7		Reserved	774	0x04	(R)	
8		Reserved	775	0x04	(R)	
9		Event type and sub-type*	776 to 1552	0x04	(R)	
10		DD/MM/	777 to 1553	0x04	(R)	
11		YY:HH/	778 to 1554	0x04	(R)	
12	Event 2 to 99	MM/SS:	779 to 1555	0x04	(R)	
13		mSec	780 to 1556	0x04	(R)	
14		Reserved	781 to 1557	0x04	(R)	
15		Reserved	782 to 1558	0x04	(R)	
16		Reserved	783 to 1559	0x04	(R)	
17		Event type and sub-type*	1560	0x04	(R)	
18		DD/MM/	1561	0x04	(R)	
19		YY:HH/	1562	0x04	(R)	
20	Event 100	MM/SS:	1563	0x04	(R)	
21		mSec	1564	0x04	(R)	
22		Reserved	1565	0x04	(R)	
23		Reserved	1566	0x04	(R)	
24		Reserved	1567	0x04	(R)	

Each Event Log from Event 1 to Event 100 contains the Event type and Sub-Type with Time stamp (DD/MM/YY & HH/MM/SS/mSec) at the time of event, as shown in the following table. *For Event type and sub type see below table

Table 29: Event log data – Event Type & Sub-Type description

Event Type	Event – Event Sub Type
EMPTY	00 – 00
Breaker Open	01 – 00
Breaker Close	02 – 00
Reset	03 – 00
Remote Trip	04 – 00
IRF	05 - 01 to 05-128*
Unit Ready	06 – 00
Setting I>	08 – 01
Setting t>	08 – 02

Event Type	Event – Event Sub Type
Setting I>>	08 – 03
Setting t>>	08 – 04
Setting I>>>	08 – 05
Setting t>>>	08 – 06
Setting I0>	08 – 07
Setting t0>	08 – 08
Setting I0>>	08 – 09

Setting t0>>	08 – 10
Setting I2>	08-11
Setting tI2>	08-12
Setting I2/I1>	08-13
Setting tI2/I1>	08-14
Setting 3Ith>F0	08-15
Setting 3Ith>Ib	08-16
Setting 3Ith>t^	08-17
Setting 3Ith>tds	08-18
Setting 3Ith>tdr	08-19
Setting 3Ith>Falm	08-20
Setting 3Ith>Ftrp	08-21
Setting 3Ith>Fsrtinhibit	08-22
Setting 3Ith>FEM	08-23
Setting 3Ith>Mode	08-24
Setting 3Ith>Mode FpowerOFF	08-25
Setting 3I>/I0>BF Icbfp	08-26
Setting 3I>/I0>BF I0cbfp	08-27
Setting 3I>/I0>BF t Retrip	08-28
Setting 3I>/I0>BF t Backup	08-29
Setting O→I Str Mode	08-30
Setting O→I CB Ready	08-31
Setting O→I # of Cycle	08-32
Setting O→I Pulse tp	08-33
Setting O→I Cyclet1	08-34
Setting O→I Cyclet2	08-35
Setting O→I Cyclet3	08-36
Setting O→I Cyclet4	08-37
Setting O→I Reclaim tr	08-38
Setting O→I Block tb	08-39
Setting O→I Activate t	08-40
Setting SG No.	08-41
Setting SG Act.	08-42
Setting SG Edt.	08-43
TCS fault↑	10 - 00
Memory Read Fail	11 – 00
External Block Activation	16 – 00
CB Open Position	17 – 00
CB Close Position	18 – 00
CB Maintenance	19 – 00
Hardware Test	20 – 00
BO Test	21 – 00

Event Type	Event – Event Sub Type
Functional Test	22 – 00
Power Off	23 – 00
BI1 Activation	24 – 00
BI1 Deactivation	25 – 00
BI2 Activation	26 – 00
BI2 Deactivation	27 – 00
BI3 Activation	28 – 00
BI3 Deactivation	29 – 00

BI4 Activation	30 – 00
BI4 Deactivation	31 – 00
Count value	32 – 00
Start I2>↑	33 – 00
Start I2>↓	34 – 00
Trip I2>↑	35 – 00
Trip I2>↓	36 – 00
Start I2/I1>↑	37 – 00
Start I2/I1>↓	38 – 00
Trip I2/I1>↑	39 – 00
Trip I2/I1>↓	40 – 00
3Ith>Alarm↑	41– 00
3Ith>Alarm↓	42 – 00
3Ith>Trip↑	43 – 00
3Ith>Trip↓	44 – 00
3Ith>Blk Cls↑	45 – 00
3Ith>Blk Cls↓	46 – 00
BF Stage1↑	47 – 00
BF Stage1 ↓	48 – 00
BF Stage2↑	49 – 00
BF Stage2↓	50 – 00
BF RecTrip BO↑	51 – 00
BF RecTrip BO↓	52 – 00
BF RecTrip BI↑	53 - 00
O→I Started↑	54 – 00
O→I Stopped↑	55 – 00
O→I FinalTr↑	56 – 00
O→I close1↑	57 – 00
O→I close2↑	58 – 00
O→I close3↑	59 – 00
O→I close4↑	60 – 00
O→I Blocked↑	61 – 00
O→I Blocked↓	62 – 00
TCS fault ↓	63 – 00
Start I>>>↑	64 – 01
Start I>>↑	64 – 02
Start I>↑	64 – 03
Start I0>>↑	64 – 04
Start I0>↑	64 – 05

Event Type	Event – Event Sub Type
Start I>>>↓	65 – 01
Start I>>↓	65 – 02
Start I>↓	65 – 03
Start I0>>↓	65 – 04
Start I0>↓	65 – 05
Trip I>>>↑	66 - 01
Trip I>>↑	66 – 02
Trip I>↑	66 – 03

Trip I0>>↑	66 – 04
Trip I0>↑	66 – 05
Trip I>>>↓	67 – 01
Trip I>>↓	67 – 02
Trip I>↓	67 – 03
Trip I0>>↓	67 – 04
Trip I0>↓	67 – 05
External Block Deactivation	68
CB POS OPN↓	69
CB POS CLS↓	70
CB Maint↓	71
Start↑	72
Start↓	73
Trip↑	74
Trip↓	75
Factory Default	76

* Sub-Type of Event IRF is briefly explained in below table.

The Event Type and Sub-Type is a 2 byte field. Bit positions 0 - 7 form the byte 1 for Event Type and bit position 8 - 15 forms byte 2 for Event Sub-Type. For e.g. in case of IRF, the event type and sub type shall follow as explained below:

Table 30: Byte 1: Event Type

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	1	0	1

Table 31: Byte 2: Event Sub-Type

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0

The description of each bit of Byte 2 is explained in the below table.

Table 32: Event log – Sub-Type mapping for IRF

Bit position	Value (1 = SET, 0 = CLEAR)	Description
0	0-1	Flash Faulty
1	0-1	Power On Ram Faulty
2	0-1	Run Time Ram Faulty
3	0-1	VC Check Fault
4	0-1	Power On EEPROM Faulty
5	0-1	Run Time EEPROM Faulty
6	0-1	Gain Check Fault

7	0-1	TRIP Fault

IRF 001: Flash Faulty.

IRF 064: Gain Check Fault.

IRF 005: Run Time Ram Faulty and Flash Faulty.

2.5.10 Fault Record log to address mapping

Table 33: Fault Record log to address mapping

Sr. No.	Parameter description	Modbus Address	Function code	Read / Write	Range	Default value
1	Fault Record 1	0000 - 0027	0x04	(R)	-	-
2	Fault Record 2	0028 - 0055	0x04	(R)	-	-
3	Fault Record 3	0056 - 0083	0x04	(R)	-	-
4	Fault Record 4	0084 - 0111	0x04	(R)	-	-
5	Fault Record 5	0112 – 0139	0x04	(R)	-	-

The Fault Record 1 contains 5 instances current values with 1 Pre-Start, Start along with Time Stamp, Trip along with Time Stamp and 2 Post-Trip values.

An example to read the above Record is as follows:

Example: Read Fault Record 1 (Address 0000 – 0027)

Address Range	Data Log Mapping	Description
0	Current I1 of 1st Value	Value at tstart – 100mSec
1	Current I2 of 1st Value	
2	Current I3 of 1st Value	
3	Current I0 of 1st Value	
4	Current I1 of 2nd Value	Value at tstart with Time Stamp
5	Current I2 of 2nd Value	
6	Current I3 of 2nd Value	
7	Current I0 of 2nd Value	
8	DD/MM/	
9	YY:HH/	
10	MM/SS:	
11	mSec	

Address Range	Data Log Mapping	Description
12	Current I1 of 3rd Value	Value at ttrip withTime Stamp
13	Current I2 of 3rd Value	
14	Current I3 of 3rd Value	
15	Current I0 of 3rd Value	
16	DD/MM/	
17	YY:HH/	
18	MM/SS:	
19	mSec	

20	Current I1 of 4th Value	Value at ttrip + 80mSec
21	Current I2 of 4th Value	
22	Current I3 of 4th Value	
23	Current I0 of 4th Value	
24	Current I1 of 5th Value	Value at ttrip + 200mSec
25	Current I2 of 5th Value	
26	Current I3 of 5th Value	
27	Current I0 of 5th Value	

Section 3 Modbus diagnostics and Profile

3.1 Modbus Diagnostics

Possible faults in:

RS485

Are the termination resistors placed at the end of the line?

Is the line polarity correct? Are the lines swapped accidently?

Is the maximum line length exceeded?

Modbus Communication parameters

Is baud rate correctly s

Are the parity and the stop bits correctly set?

Is the slave address correct?

Are there two devices with the same address in the system? If yes, fix it!

Modbus master

Is the request to response timeout correct?

Is the Modbus silent interval between two telegrams > 3.5 character times?

Notice that the slave device will not give any response when it is addressed with a broadcast (slave address = 0).

Modbus slave

- Does the device have a unique Modbus address (recommendation: shall be different than the factory default address (001))?
- Is the function code supported by the device?
- Does the request have a valid address?
- Does the request have a valid quantity of coils, inputs, and registers?
- Is the power supply turned on for the Relay unit?

3.2 Appendix-A Modbus Profile Checklist

Table 34: Supported function codes

Function Code Name	Function Code (HEX)	Supported
Read coil Status	01	Yes
Read Input Status	02	Yes
Read Holding Register	03	Yes
Read Input Registers	04	Yes
Force Single Coil	05	Yes
Preset Single Register	06	Yes
Read Exception Status	07	No
Diagnostics	08	Yes
Fetch Comm. Event Counter	0B	No
Fetch Comm. Event Log	0C	No
Force Multiple Coils	0F	No
Preset Multiple Registers	10	No
Report Slave ID	11	No
Read General Reference	14	No
Write General Reference	15	No
Mask Write 4x Register	16	No
Read/Write 4x Registers	17	No

Table 35: Supported exception responses

Exception Response	Function Code (HEX)	Supported
Illegal Function	01	Yes
Illegal Data address	02	Yes
Illegal Data Value	03	Yes
Slave Device Failure	04	No
Acknowledge	05	No
Slave Device Busy	06	Yes
Negative Acknowledge	07	No
Memory Parity Error	08	Yes

Table 36: Supported data types

Data Type	Supported
Digital input	Yes
Coil	Yes
Input register	Yes
Holding register	Yes
General reference	No
Name Supported	No

3.3 Abbreviations

ASCII	American Standard Code for Information Interchange
CRC	Cyclic Redundancy Check
BI	Binary Input
BO	Binary Output
HMI	Human-machine interface
RTU	Remote Terminal Unit
TCS	Trip Circuit Supervision

3.4 Appendix-B Reference Documents

REF601Application Manual	1MDU07212-YN C
REF601 Product Guide	1MDB07212-YN C

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