HRI-R40 / HRI-W40 *INSULATION RESISTANCE MONITOR FOR MEDICAL ROOM USE*

MODBUS-RTU COMMUNICATION PROTOCOL

MODBUS PROTOCOL
Modbus is a master-slave communication protocol able to support up to 247 slaves organized as a bus or as a star network;
The physical link layer can be RS232 for a point to point connection or RS485 for a network.
The communication is half-duplex.
The network messages can be Query-Response or Broadcast type.
The Query-Response command is transmitted from the Master to an established Slave and generally it is followed by an answering message.
The Broadcast command is transmitted from the Master to all Slaves and is never followed by an answer.

MODBUS use two modes for transmission.
A) ASCII Mode: uses a limited character set as a whole for the communication.

B) RTU Mode: binary, with time frame synchronization, faster than the ASCII Mode, uses half so long data block than the ASCII Mode.

HRI-R40 / HRI-W40 analyzers employ RTU mode.

GENERIC MESSAGE STRUCTURE:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	DATA FIELD	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker
ADDRESS FIELD = Includes device address in which you need to communicate in Query-Response mode. In case the message is a Broadcast type it includes 00.
FUNCTION CODE = Includes the operation code that you need to perform.
DATA FIELD = Includes the data field.
ERROR CHECK = Field for the error correction code.
END OF FRAME = End message marker.

Mode RTU communication frame structure:
START OF FRAME = silence on line for time >=4 characters
ADDRES FIELD = 1 character
FUNCTION CODE = 1 character
DATA FIELD = N characters
ERROR CHECK = 16 bit CRC
END OF FRAME = silence on line for time >=4 characters

Wait time for response :
- typical: 500 mS
- worst case: 550 mS.

CRC GENERATION

Example of the CRC-16 generation with "C" language:

```
static unsigned char auchCRCHi [ ] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40
} ;

static unsigned char auchCRCLo [ ] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0X2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
0x40
}

unsigned short CRC16 (ptMsg, usDataLen)
unsigned char *ptMsg;                    / * message to calculate CRC upon * /
unsigned short usDataLen;                  / * number of bytes in message * /
{
      unsigned char uchCRCHi = 0xFF;          / * CRC high byte * /
      unsigned char uchCRCLo =0xFF;           / * CRC low byte * /
      unsigned uIndex;

      while (usDataLen--)                  / * pass through message buffer * /
      {
         uIndex = uchCRCHi ^ *ptMsg++;            /.* calculate the CRC * /
         uchCRCHi = uchCRCLo ^ auchCRCHi [ uIndex ] ;
         uchCRCLo = auchCRCLo [ uIndex ]
      }
      return (uchCRCHi « 8 | uchCRCLo ) ;
}
```

Note: The"Error Check (CRC)" field must be computed referring to the characters from the first of ADDR to the last of DATA inclusive.

READING OF THE REGISTERS (Function Code $ 03)
Reads the binary contents of holding registers (2X references) in the slave.
Broadcast is not supported.
The Query message specified the starting register and quantity of register to be read.

QUERY:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	START ADDRESS	No. OF REGISTERS	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (03 HEX) (1 byte).
START ADDRESS = First register address to be read (2 byte).
No. OF REGISTERS = Number of registers (max 32) to be read (4 bytes for 1 measure value).
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

WARNING:
It is possible to read more than one variable at the same time (max 16) only if their addresses are consecutive and the variables on the same line cannot be divided.

The register data in the response message are packet 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.

RESPONSE:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	No. OF BYTES	D0, D1, …, Dn	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1byte).
FUNCTION CODE = Operation code (03 HEX) (1 Byte).
No. OF SEND BYTES = Number of data bytes (00...?? HEX) (1 byte). 1 register requires 2 data bytes.
D0, D1, .., Dn = data bytes (00...?? HEX) (Nr. of register x 2 = n. byte).
ERROR CHECK = Check sum.
END OF FRAME = End message marker .

See the TABLE OF HRI-R40 / HRI-W40 REGISTERS to the section 5 and the EXAMPLE to the section 6.

SETUP OF THE HRI-R40 / HRI-W40 PARAMETERS (Function Code $ 10)
Write values into a sequence of holding registers (2X references).

WARNING: It is possible to write more than one variable at the same time only if their addresses are consecutive and the variables on the same line cannot be divided. (max of 4 consecutive register on the same message).

QUERY:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	START ADDRESS	No. OF REGISTERS	No. OF BYTES	D0, D1, ..., Dn	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (10 HEX) (1 byte).
START ADDRESS = First register address to be written (2 byte).
No. OF REGISTER = Number of registers to be written (1 to 4,...) (2 byte).
No. OF BYTES = Number of data bytes (HEX) (1 byte): 1register requires 2 data bytes.
D0,D1,..,Dn = Data bytes (00...? HEX) (1 byte) (Nr.of register x 2 = n. byte).
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

The normal response returns the slave address, function code, starting address and quantity of register preset.

RESPONSE:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	START ADDRESS	No. OF REGISTERS	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (10 HEX) (1 byte).
START ADDRESS = First register address to be written (2 byte).
No. OF REGISTER = Number of registers to be written (2 byte).
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

See the TABLE OF HRI-R40 / HRI-W40 REGISTERS to the sect. 5 and see the EXAMPLE to the sect. 6.

DIAGNOSTIC (Function Code $ 08)
This function provides a test for checking the communication system.
Broadcast is not supported.
The instrument's protocol has only the sub-function 0 of the diagnostics sub-functions set of the standard modbus protocol.
The Query and the Response messages are the following:

QUERY:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	SUB FUNCTION	DATA	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (08 HEX) (1 byte).
SUB FUNCTION = Sub-function 0 (00 00 hex) (2 byte).
DATA = Max 10 data bytes.
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

RESPONSE:
The response must be the loopback of the same data.

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	SUB FUNCTION	DATA	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (08 HEX) (1 byte).
SUB FUNCTION = Sub-function 0 (00 00 hex) (2 byte).
DATA = Data bytes.
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

DIAGNOSTIC EXAMPLE

QUERY

Field Name	Example (Hex)
Slave Address	01
Function Code	08
Sub-function Hi	00
Sub-function Lo	00
Data Hi	F1
Data Lo	A7
Error Check (CRC)	??
	??

RESPONSE

Field Name	Example (Hex)
Slave Address	01
Function Code	08
Sub-function Hi	00
Sub-function Lo	00
Data Hi	F1
Data Lo	A7
Error Check (CRC)	??
	??

REPORT SLAVE ID (Function Code $ 11)
This function returns the type of the instrument and the current status of the slave run indicator.
Broadcast is not supported.
The Query and the Response messages are the following:

QUERY:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (11 HEX) (1 byte).
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

RESPONSE:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	BYTE COUNT	SLAVE ID	RUN INDICATOR STATUS	ADDITIONAL DATA	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (01...F7 HEX) (1 byte).
FUNCTION CODE = Operation code (11 HEX) (1 byte).
BYTE COUNT = Number of data bytes (16 HEX) (1 byte).
SLAVE ID = Slave ID identifier (50 HEX) (1 byte).
RUN INDICATOR STATUS = Run indicator status (FF HEX) (1 byte).
DATA = Data bytes.
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

The normal response has the slave ID identifier (50 HEX) and the run indicator status (FF HEX) plus 20 data bytes (byte count is 22, 16 Hex). Last four data bytes carry firmware version (bytes 19 ,20) and bit-mapped options installed on HRI-R40 / HRI-W40 (bytes 17,18).

Byte 17 mapped bit (Value = 1 : -> option installed):
Bit 0 Pulse output (Energy)
Bit 1 Neutral Current Input
Bit 5 Digital Output for Alarm function.
Bit 7: Double tariff function (Time Bands)
Bit 2,3,4,6 No meaning
Byte 18 mapped bit (Value = 1 : -> option installed):
Bit 1 Analog output
Other bits: No meaning

REPORT SLAVE ID EXAMPLE

QUERY

Field Name	Example (Hex)
Slave Address	01
Function Code	11
Error Check (CRC)	??
	??

RESPONSE

Field Name	Example (Hex)
Slave Address	01
Function Code	11
Byte count	02
Slave ID	50
Run indicator status	FF
Data	20 data bytes
Error Check (CRC)	??
	??

ERROR MESSAGE FROM SLAVE TO MASTER
When a slave device receives a not valid query, it does transmit an error message.

RESPONSE:

START OF FRAME	ADDRESS FIELD	FUNCTION CODE	ERROR CODE	ERROR CHECK	END OF FRAME

START OF FRAME = Starting message marker.
ADDRESS FIELD = HRI-R40 / HRI-W40 device address (00...FF HEX) (1 byte).
FUNCTION CODE = Operation code with bit 7 high (1 byte).
ERROR CODE = Message containing communication failure (1 byte).
ERROR CHECK = Check sum.
END OF FRAME = End message marker.

ERROR EXAMPLE

QUERY

Field Name	Example (Hex)
Slave Address	01
Function Code	03
Starting Address Hi	00
Starting Address Lo	00
Number Of Word Hi	00
Number Of Word Lo	05
Error Check (CRC)	??
	??

RESPONSE

Field Name	Example (Hex)
Slave Address	01
Function Code	83 (1)
Error Code	02 (2)
Error Check (CRC)	??
	??

(1):Function Code transmitted by master with bit 7 high.
(2): Error type:
01= Illegal Function
02= Illegal data address
03= Illegal data value

TABLE OF HRI-R40 / HRI-W40 REGISTERS
The following table shown all the HRI-R40 / HRI-W40 registers.

MEASURED VALUES (Function code $ 03)

VALUE OF INSULATION RESISTENCE			
Register HEX	Word	Description	U.M.
$1200	1	INSULATION RESISTENCE	[kOhm]
NOTE: These registers return values from 0 (0x0000) to 1500 (0x05DC)			

VALUE OF IMPEDANCE			
Register HEX	Word	Description	U.M.
$1201	1	IMPEDANCE	[kOhm]
NOTE: These registers return values from 0 (0x0000) to 1500 (0x05DC) If measure is disable these registers returns 1500 (0x05DC)			

VALUE OF TEMPERATURE 1 FOR PT100			
Register HEX	Word	Description	U.M.
$1202	1	TEMPERATURE FOR PT100	[°C]
NOTE: These registers return values from 0 (0x0000) to 200 (0x00C8) If measure is disable these registers returns 0 (0x0000)			

VALUE OF TEMPERATURE 2 FOR PT100			
Register HEX	Word	Description	U.M.
$1203	1	TEMPERATURE FOR PT100	[°C]
NOTE: These registers return values from 0 (0x0000) to 200 (0x00C8) If measure is disable these registers returns 0 (0x0000)			

VALUE OF CURRENT			
Register HEX	Word	Description	U.M.
$1204	1	CURRENT	[Amp]
NOTE: These registers return values from 0.1 to 99.9 If measure is disable these registers returns 0 (0x0000)			

MR MODE R			
Register HEX	Word	Description	U.M.
$1205	1	MODE R	[-]
Byte LSB of register 0x1205: fixed 1 Byte MSB of register 0x1205: Bit 0 ($01): set if low INSULATION alarm is active Bit 5 ($20): set if link fail alarm is active			

MR MODE Z			
Register HEX	Word	Description	U.M.
$1206	1	MODE Z	[-]
Byte LSB of register 0x1206: Value: 0 = measure disable 1 = measure enable Byte MSB of register 0x1206: Bit 1 ($02): set if impedance alarm is active			

MR MODE TEMPERATURE 1			
Register HEX	Word	Description	U.M.
$1206	1	MODE Z	[-]
Byte LSB of register 0x1206: Value: 0 = measure disable 1 = measure enable Byte MSB of register 0x1206: Bit 1 ($02): set if impedance alarm is active			

MR MODE TEMPERATURE 1

Register HEX	Word	Description	U.M.
$1207	1	MODE TEMPERATURE 1	[-]

Byte LSB of register 0x1207: Value: 0 = input disable
1 = input enable for PTC
2 = input enable for PT100

Byte MSB of register 0x1207 for PT100 (LSB = 2): Value: $0 = PT100 OK: Input is right connect
$10= PT100 FAILURE: Input is shorted
$E0 = PT100 FAILURE: Input is open

Byte MSB of register 0x1207 for PT100 (LSB = 1): Value: $B0 = PTC in OFF (instantaneous temperature is UNDER the PTC working temperature)
$80 = PTC in ON (instantaneous temperature is OVER the PTC working temperature)
$FF = indefinite state of the PTC, probably in the phase of commutation from one state to the other

MR MODE TEMPERATURE 2

Register HEX	Word	Description	U.M.
$1208	1	MODE TEMPERATURE 2	[-]

Byte LSB of register 0x1208: Value: 0 = input disable
1 = input enable for PTC
2 = input enable for PT100

Byte MSB of register 0x1208 for PT100 (LSB = 2): Value: $0 = PT100 OK: Input is right connect
$10= PT100 FAILURE: Input is shorted
$E0 = PT100 FAILURE: Input is open

Byte MSB of register 0x1208 for PT100 (LSB = 1): Value: $B0 = PTC in OFF (instantaneous temperature is UNDER the PTC working temperature)
$80 = PTC in ON (instantaneous temperature is OVER the PTC working temperature)
$FF = indefinite state of the PTC, probably in the phase of commutation from one state to the other

MR MODE A

Register HEX	Word	Description	U.M.
$1209	1	MODE_A	[-]

Byte LSB of register 0x1209: Value: 0 = input disable
1 = input enable

Byte MSB of register 0x1209: not used; fixed 0

STATUS ALARMS

Register HEX	Word	Description	U.M.
$120A	1	STATUS ALARMS	[-]

Byte LSB of register 0x120A: Value: bit 0 values out of threshold RESISTENCE
bit 1values out of threshold IMPEDENCE
bit 2 values out of threshold TEMPERATURE 1
bit 3 values out of threshold TEMPERATURE 2
bit 4 values out of threshold CURRENT
bit 5 values out of threshold LINK FAILURE

Byte MSB of register 0x120A: not used; fixed 0

ENABLE ALARMS

Register HEX	Word	Description	U.M.
$120B	1	ENABLE ALARMS	[-]

Byte LSB of register 0x120B: Value: bit 1 IMPEDENCE alarm enable
bit 2 TEMPERATURE 1 alarm enable
bit 3 TEMPERATURE 2 alarm enable
bit 4 CURRENT alarm enable

Byte MSB of register 0x1209: not used; fixed 0

MODE AUXILIARY RELAY			
Register HEX	Word	Description	U.M.
$120C	1	AUXILIARY RELAY	[-]
Byte LSB of register 0x120C: Value: bit 0 values out of threshold RESISTENCE bit 1 values out of threshold IMPEDENCE bit 2 values out of threshold TEMPERATURE 1 bit 3 values out of threshold TEMPERATURE 2 bit 4 values out of threshold CURRENT bit 5 values out of threshold LINK FAILURE Byte MSB of register 0x120C: not used; fixed 0			

MODE STATUS REMOTE PANEL			
Register HEX	Word	Description	U.M.
$120D	1	STATUS REMOTE PANEL	[-]
Status of connected PR4/QSD-DIG panels Value of the bit: bit 6 LED signalling: low active INSULATION bit 5 ACOUSTIC signalling: low active INSULATION bit 4 active signalling overload bit 3 activated the simulated test			

SETUP FREQUENCY			
Register HEX	Word	Description	U.M.
$120E	1	FREQUENCY	[-]
Frequency of electrical network: Possible Value: 50 or 60 Hz			

Note: the register $120F not used, return fixed value 0

SETUP OF THRESHOLD RESISTIVE INSULATION			
Register HEX	Word	Description	U.M.
$1210	1	THRESHOLD RESISTIVE INSULATION	[kOhm]
Set up value of threshold alarm for low resistive INSULATION NOTE: These registers return values from 50 (0x0032) to 400 (0x0190)			

SETUP OF THRESHOLD IMPEDANCE INSULATION			
Register HEX	Word	Description	U.M.
$1211	1	THRESHOLD IMPEDANCE INSULATION	[kOhm]
Set up value of threshold alarm for low impedance INSULATION NOTE: These registers return values from 50 (0x0032) to 400 (0x0190)			

SETUP OF THRESHOLD TEMPERATURE 1			
Register HEX	Word	Description	U.M.
$1212	1	THRESHOLD TEMPERATURE 1	[°C]
Set up value of threshold alarm for temperature 1 input NOTE: These registers return values from 30 (0x001E) to 200 (0x00C8)			

SETUP OF THRESHOLD TEMPERATURE 2			
Register HEX	Word	Description	U.M.
$1213	1	THRESHOLD TEMPERATURE 2	[°C]
Set up value of threshold alarm for temperature 2 input NOTE: These registers return values from 30 (0x001E) to 200 (0x00C8)			

SETUP OF THRESHOLD CURRENT			
Register HEX	Word	Description	U.M.
$1214	1	THRESHOLD CURRENT	[Amp]
Set up value of threshold alarm for current input NOTE: These registers return values from 0,1 to 99,9			

EXAMPLE READ VALUE OF INSULATION RESISTENCE

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1200H)
00H
00H Nr of Register requested
01H
81H CRC
72H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
04H Follow the bytes of data
E2H
3AH CRC
CDH CRC

EXAMPLE READ VALUE OF TEMPERATURE 1 FOR PT100

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1202H)
02H
00H Nr of Register requested
01H
20H CRC
B2H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
01H
79H CRC
84H CRC

EXAMPLE READ SETUP OF THRESHOULD RESISTIVE INSULATION

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (120AH)
0AH
00H Nr of Register requested
01H
A1H CRC
70H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
48H
B8H CRC
72H CRC

EXAMPLE READ SETUP OF THRESHOULD IMPEDANCE INSULATION

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (120BH)
0BH
00H Nr of Register requested
01H
F0H CRC
B0H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
0EH
39H CRC
80H CRC

EXAMPLE READ SETUP OF THRESHOULD IMPEDANCE INSULATION

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1211H)
11H
00H Nr of Register requested
01H
D1H CRC
77H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
32H
39H CRC
91H CRC

EXAMPLE READ SETUP OF THRESHOULD TEMPERATURE 1

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1212H)
12H
00H Nr of Register requested
01H
21H CRC
77H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
1EH
38H CRC
4CH CRC

EXAMPLE READ SETUP OF THRESHOULD TEMPERATURE 2

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1213H)
13H
00H Nr of Register requested
01H
70H CRC
B7H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
1EH
38H CRC
4CH CRC

EXAMPLE READ SETUP OF THRESHOULD CURRENT

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1214H)
14H
00H Nr of Register requested
01H
C1H CRC
76H CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
02H Nr. of send bytes
00H Follow the bytes of data
25H
B8H CRC
44H CRC

EXAMPLE READ ALL REGISTERS

Stream data send to HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
12H Address of register requested (1214H)
00H
00H Nr of Register requested (ALL 21 REGISTERS)
15H
81H CRC
7DH CRC

Response from HRI-R40 / HRI-W40 (H suffix mean hex data format):

01H HRI-R40 / HRI-W40 address
03H Read function
2AH Nr. of send bytes
04H Follow the bytes of data
E2H
04H
E2H
04H
00H
01H
00H
01H
00H
00H
00H
01H
00H
10H
……
B8H CRC
44H CRC

Note: the register $120F not used, return fixed value 0

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