THE MODBUS COMMUNICATION PROTOCOL FOR DATA STREAM DIGITAL TRANSDUCERS

(RTU MODE)

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1. Configuration of the Transducers

The Modbus protocol for series CRD is completely compatible with MODBUS developed by Gould Modicon for use in Modicon PLC Systems.

Transducers are configured at factory default as:

Address: 0x01. Baudrate: 9600. Check bit: none. Stop bit: 1 bit

2. Modbus RTU Function Codes

Modbus protocol for series CRD supports three basic function codes:

Function Code (Hexadecimal)	Description
0x03	Read multiple registers
0x06	Write single register
0x10	Write multiple registers

2.1 Format of Message

The length of each register is 16 bits (2 bytes). If the returned number of bytes is odd, such as Transducer Name or Software Revision, the lowest byte will be padded with null character (0x00).

Read Multiple Registers (0x03)

Message structure from master equipment:

Description	Data	Number of bytes
$Address\ of\ Slave\ Equipment$	0x01 – 0xFF	1 byte
$Function\ Code$	0x03	1 byte
$Address\ of\ first\ register_{Note\ 1}$	0x01 – 0xFF	2 bytes
$Quantity\ of\ registers_{Note\ 1}$		2 bytes
$CRC\ Code_{Note\ 2}$		2 bytes

Response structure from slave equipment:

Description	Data	Number of bytes
$Address\ of\ Slave\ Equipment$	0x01 – 0xFF	1 byte
$Function\ Code$	0x03	1 byte
$Byte\ Count$	$2\ x\ N^*$	1 byte
$Content\ of\ registers\ (Data)_{Note\ 1}$		$2\ x\ N^*$ bytes
$CRC\ Code_{Note\ 2}$		2 bytes

Write Single Register (0x06)

Message structure from master equipment:

Description	Data	Number of bytes
$Address\ of\ Slave\ Equipment$	0x01 – 0xFF	1 byte
$Function\ Code$	0x06	1 byte
$Address\ of\ register_{Note\ 1}$	0x01 – 0xFF	2 bytes
$Data\ Byte\ Count$	0x02	1 byte
$Data\ to\ be\ written_{Note\ 1}$		2 bytes
$CRC\ Code_{Note\ 2}$		2 bytes

Response structure from slave equipment:

Description	Data	Number of bytes
$Address\ of\ Slave\ Equipment$	0x01 – 0xFF	1 byte
$Function\ Code$	0x06	1 byte
$Address\ of\ register_{Note\ 1}$	0x01 – 0xFF	2 bytes
$Data\ Byte\ Count$	0x02	1 byte
$Data\ to\ be\ written_{Note\ 1}$		2 bytes
$CRC\ Code_{Note\ 2}$		2 bytes

The response message from the slave equipment echoes the message structure from the master, acknowledging the message.

Write Multiple Registers (0x10)

Message structure from master equipment:

Description	Data	Number of bytes
$Address\ of\ Slave\ Equipment$	0x01 – 0xFF	1 byte
$Function\ Code$	0x10	1 byte
$Address\ of\ first\ register_{Note\ 1}$	0x01 – 0xFF	2 bytes
$Quantity\ of\ registers_{Note\ 1}$		2 bytes
$Data\ Byte\ Count$	$2\ x\ N^*$	1 byte
$Data\ to\ be\ written_{Note\ 1}$		$2\ x\ N^*$ bytes
$CRC\ Code_{Note\ 2}$		2 bytes

Response Structure from slave equipment:

Description	Data	Number of bytes
$Address\ of\ Slave\ Equipment$	0x01 – 0xFF	1 byte
$Function\ Code$	0x10	1 byte
$Address\ of\ first\ register_{Note\ 1}$		2 bytes
$Quantity\ of\ registers_{Note\ 1}$		2 bytes
$CRC\ Code_{Note\ 2}$		2 bytes

$$N^* = Quantity\ of\ registers$$

Note 1: For Address of register, Quantity of registers and Contents of registers (Data), their high order byte is before the low order byte.

Note 2: For CRC code, the low order byte is before the high order byte.

2.2 Broadcast Commands

Modbus protocol for CRD series does support broadcast commands to write address and baudrate as well as to clear the energy totalizer. When using a broadcast command, the Write Multiple Registers message structure must be used with a quantity of registers equal to 1.

A broadcast command does not return a response.

****WARNING**** **- Using the set address/baudrate with a broadcast command on a multidrop bus can cause unwanted communication errors.**

3. Modbus Register Map

Static registers across all Modbus protocol for series CRD:

Address	Contents of register	Quantity of registers	Attribute of register	Range of Data
0x0020	Address and Baudrate	1	Read/Write	Address (0x01 – 0xF7) Baudrate (03-0A)
0x0021	Transducer Name	5 – 7	Read Only	Dependent of part number
0x0028	Software Revision	3	Read Only	Vx.zz
0x00A7	Clear energy data	1	Write	0x0000

Baudrate codes: 0x03 – 1200 bps, 0x04 – 2400 bps, 0x05 – 4800 bps, 0x06 – 9600 bps, 0x07 – 19200 bps, 0x08 – 38400 bps, 0x09 – 57600 bps, 0x0A – 115200 bps

Note: 0x06 – 9600 Factory default.

Electrical parameter data registers are part number dependent and are listed in Appendix A.

4. Data

4.1 Format of data

2 bytes Sign + Data (no sign for AC voltage and AC Current)

Range of Data: 0 – 10000 (Voltage and Current)
-10000 - 10000 (Watts, Vars and Power Factor)
0 – 65000 (Frequency)
0x80000000 - 0x7FFFFFFF (Active and Reactive Energy)

Meaning of data: 10000 corresponds to the nominal input value. For example, when the rated input current is 5.000 Amps AC, the expected output value is 10000 Decimal (0x2710 Hexadecimal). 2.500 Amps AC corresponds to 5000 Decimal (0x1388 Hexadecimal).

4.2 Calculation of power

$Watts = \frac{(X_p * V_r * I_r)}{10000}$ $Var = \frac{(X_q * V_r * I_r)}{10000}$ for single phase

$Watts = 3 * \frac{(X_p * V_r * I_r)}{10000}$ $Var = 3 * \frac{(X_q * V_r * I_r)}{10000}$ for 3-phase, 4-wire

$Watts = \sqrt{3} * \frac{(X_p * V_r * I_r)}{10000}$ $Var = \sqrt{3} * \frac{(X_q * V_r * I_r)}{10000}$ for 3-phase, 3-wire

4.3 Calculation of Energy

$kWh = \frac{E_p * V_r * I_r}{(10000 * 3600)}$ $kVarh = \frac{E_q * V_r * I_r}{(10000 * 3600)}$ for single phase

$kWh = 3 * \frac{E_p * V_r * I_r}{(10000 * 3600)}$ $kVarh = 3 * \frac{E_q * V_r * I_r}{(10000 * 3600)}$ for 3-phase, 4-wire

$kWh = \sqrt{3} * \frac{E_p * V_r * I_r}{(10000 * 3600)}$ $kVarh = \sqrt{3} * \frac{E_q * V_r * I_r}{(10000 * 3600)}$ for 3-phase, 3-wire

4.4 Calculation of frequency

$$Frequency = \frac{f}{1000}$$

4.5 Calculation of current and voltage

$$Voltage = \frac{v}{10000} * V_r \qquad Current = \frac{i}{10000} * I_r$$

$X_p = The\ active\ power\ measured\ by\ the\ sensor$ $X_q = The\ reactive\ power\ measured\ by\ the\ sensor$

$V_r = Rated\ voltage\ of\ the\ sensor$ $I_r = Rated\ current\ of\ the\ sensor$

$E_p = Active\ Energy\ measured\ by\ the\ sensor$ $E_q = Reactive\ Energy\ measured\ by\ the\ sensor$

$f = Frequency\ measured\ by\ the\ sensor$ $v = Voltage\ measured\ by\ the\ sensor$

$i = Current\ measured\ by\ the\ sensor$

Appendix A

Electrical parameter data registers by part number:

Note: All Current and Voltage readings are True RMS. Power Factor on multi-phase parts is an average of all 3 phases. Frequency reading is of phase A for all CRD5100 series.

Note: Electrical Data outside of the bounds of the part number dependent registers may contain erroneous data

CRD5110

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Voltage Phase A	1	Read Only	0 – 10000
0x0011	Current Phase A	1	Read Only	0 – 10000
0x0012	Active Power	1	Read Only	-10000 - 10000
0x0013	Reactive Power	1	Read Only	-10000 – 10000
0x0014	Power Factor	1	Read Only	-10000 – 10000
0x0015	Frequency	1	Read Only	0 - 65000
0x0016	Active Energy	2	Read Only	0x80000000 – 0x7FFFFFFF
0x0018	Reactive Energy	2	Read Only	0x80000000 – 0x7FFFFFFF

CRD5150

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Voltage Phase A	1	Read Only	0 – 10000
0x0011	Current Phase A	1	Read Only	0 – 10000
0x0012	Voltage Phase B	1	Read Only	0 – 10000
0x0013	Current Phase B	1	Read Only	0 – 10000
0x0014	Active Power	1	Read Only	-10000 - 10000
0x0015	Reactive Power	1	Read Only	-10000 – 10000
0x0016	Power Factor	1	Read Only	-10000 – 10000
0x0017	Frequency	1	Read Only	0 - 65000
0x0018	Active Energy	2	Read Only	0x80000000 – 0x7FFFFFFF
0x001A	Reactive Energy	2	Read Only	0x80000000 – 0x7FFFFFFF

CRD5170

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Voltage Phase A	1	Read Only	0 – 10000
0x0011	Current Phase A	1	Read Only	0 – 10000
0x0012	Voltage Phase B	1	Read Only	0 – 10000
0x0013	Current Phase B	1	Read Only	0 – 10000
0x0014	Voltage Phase C	1	Read Only	0 – 10000
0x0015	Current Phase C	1	Read Only	0 – 10000
0x0016	Active Power	1	Read Only	-10000 - 10000
0x0017	Reactive Power	1	Read Only	-10000 – 10000
0x0018	Power Factor	1	Read Only	-10000 – 10000
0x0019	Frequency	1	Read Only	0 - 65000
0x001A	Active Energy	2	Read Only	0x80000000 – 0x7FFFFFFF
0x001C	Reactive Energy	2	Read Only	0x80000000 – 0x7FFFFFFF

CRD4110

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Current Phase A	1	Read Only	0 – 10000
0x0011	Frequency Phase A	1	Read Only	0 – 65000

CRD4150

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Current Phase A	1	Read Only	0 – 10000
0x0011	Current Phase B	1	Read Only	0 – 10000
0x0012	Frequency Phase A	1	Read Only	0 – 65000
0x0013	Frequency Phase B	1	Read Only	0 – 65000

CRD4170

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Current Phase A	1	Read Only	0 – 10000
0x0011	Current Phase B	1	Read Only	0 – 10000
0x0012	Current Phase C	1	Read Only	0 – 10000
0x0013	Frequency Phase A	1	Read Only	0 – 65000
0x0014	Frequency Phase B	1	Read Only	0 – 65000
0x0015	Frequency Phase C	1	Read Only	0 – 65000

CRD4510

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Voltage Phase A	1	Read Only	0 – 10000
0x0011	Frequency Phase A	1	Read Only	0 – 65000

CRD4550

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Voltage Phase A	1	Read Only	0 – 10000
0x0011	Voltage Phase B	1	Read Only	0 – 10000
0x0012	Frequency Phase A	1	Read Only	0 – 65000
0x0013	Frequency Phase B	1	Read Only	0 – 65000

CRD4570

Address (Hex)	Content of Register	Quantity of Registers	Attribute of register	Range of Data
0x0010	Voltage Phase A	1	Read Only	0 – 10000
0x0011	Voltage Phase B	1	Read Only	0 – 10000
0x0012	Voltage Phase C	1	Read Only	0 – 10000
0x0013	Frequency Phase A	1	Read Only	0 – 65000
0x0014	Frequency Phase B	1	Read Only	0 – 65000
0x0015	Frequency Phase C	1	Read Only	0 - 65000