



GREYSTONE
ENERGY SYSTEMS INC

CDD3 Series

Carbon Dioxide Transmitter

SETUP GUIDE MODBUS COMMUNICATION



Modbus Protocol

This section describes the implementation of the Modbus protocol used in the CO2/RH/T detector. It is intended to assist control system programmers who may need to add support to their systems to communicate with this device. The CO2/RH/T detector communicates on standard Modbus networks using RTU mode transmission. It operates as a slave device (address from 01 to 255) and expects a Modbus master device to transmit queries, which it will answer.

RTU Mode Message Format

Modbus Framing	8 bit binary
Data Bits	start bits --- 1 data bits --- 8 parity bits --- none, odd or even stop bits --- 1 or 2
Baud Rate	9600, 19200, 38400, 57600, 76800 or 115200
Duplex	Half duplex
Error Checking	Cyclical Redundancy Check (CRC) CRC-16 --- polynomial $x^{16}+x^{15}+x^2+x^0$ 0x8005 or reversed version 0xA001 or CRC-CITT --- polynomial $x^{16}+x^{12}+x^5+x^0$ 0x1021 or reversed version 0x8408
Latency	More than 3.5 characters --- minimum, 50, 100, 150, 200, 250, 300 or 350 mS

Framing Support and Bit Sequences

RTU Mode	Start	1	2	3	4	5	6	7	8	Stop	
	Start	1	2	3	4	5	6	7	8	Stop	Stop
	Start	1	2	3	4	5	6	7	8	Odd	Stop
	Start	1	2	3	4	5	6	7	8	Even	Stop

Modbus Register Addressing

Modbus Address	Typical Offset	Units	Data Type	Access	Notes
40001	+0		Bit	Read	16-bit integer, Unit Status Bit0 = 0 in normal status, 1 = in abnormal status, Bit1-15 unused
40002	+1	PPM	Word	Read	16-bit integer, CO2 Value 0 to 10,000ppm
40003	+2	%RH	Word	Read	16-bit integer, %RH Value x 10(multiplier = 10) 0 to 1000 for 0.0 to 100.0%RH
40004	+3	°F/°C	Word	Read	16-bit integer, Temperature Value x 10(multiplier = 10) 0-500 for 0.0 to 50.0°C, or 320 to 1220 for 32.0 to 122.0°F
40005	+4	%, %RH, ppm, °C, °F	Word	Read	16-bit integer, UP/DOWN Value °C, °F value is x 10
40006	+5		Word	Read	16-bit integer, Relay Status 0 = Inactivated, 1 = Activated,
40007	+6		Word	Read	16-bit integer, Override Status 0 = Inactivated , 1 = Activated
40008	+7	PPM	Word	R/W	16-bit integer, Relay Setpoint 500 to 1500 ppm, resolution=1ppm
40009	+8	PPM	Word	R/W	16-bit integer, Relay Hysteresis 25 to 200 ppm, resolution=1ppm
40010	+9	Seconds	Word	R/W	16-bit integer, Relay ON Delay 0 to 255s, resolution=1s
40011	+10	°F/°C	Word	R/W	16-bit integer, Temperature Offset -50 to 50 for -5.0 to 5.0 °C, or -100 to 100 for -10.0 to 10.0 °F , resolution=1 for 0.1°C/F
40012	+11	%RH	Word	R/W	16-bit integer, RH Offset -10 to 10 for -10 to 10%RH, resolution=1%RH
40013	+12	Meter	Word	R/W	16-bit integer, Altitude 0 to 2550 m, resolution=50m
40014	+13		Word	R/W	16-bit integer, Backlight Set 0=AUTO, 1= OFF, 2= ON
40015	+14		Word	R/W	16-bit integer, Display Modes 0=CO2, 1=CO2+RH, 2=CO2+T, 3=CO2+RH+T
40016	+15		Word	R/W	16-bit integer, Setpoint Modes 0=%, 1=°C1, 2=°C2, 3=°F1, 4=°F2, 5=%RH, 6=ppm
40017	+16		Word	R/W	16-bit integer, Temperature Units 0 = °C, 1 = °F
40018	+17		Word	R/W	16-bit integer, Auto Cal Enable 0 = Disable Auto Cal, 1 = Enable Auto Cal

40019	+18		Word	R/W	16-bit integer, Relay Test (through Modbus) 0 = Turn Relay Off ,1 =Turn Relay On (After test, Set 0 for relay normal operation)
40020	+19		Word	R/W	16-bit integer, Override Test (through Modbus) 0 = Turn Override Off, 1 = Turn Override On

Note that °C and °F integer values are used to represent a floating point number. Therefore the multiplier for these values is 10. The application program must divide the value by 10 to obtain the correct value. For example, reading a temperature value of 214 actually represents $214/10 = 21.4$ °C.

Function Codes (RTU mode)

0x03 --- Read holding registers

Query

Slave address (0x01 to 0xFF)	Function code (0x03)	Starting address MSB *	Starting address LSB	Quantity of registers MSB *	Quantity of registers LSB	CRC LSB	CRC MSB
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* Starting address = 0x0000 to 0x0013, Quantity of registers = 0x0001 to 0x0014

Response

Slave address (0x01 to 0xFF)	Function code (0x03)	Byte count 2N *	Register value MSB	Register value LSB	...	CRC LSB	CRC MSB
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* N= Quantity of registers

0x06 --- Write single register

Query

Slave address (0x01 to 0xFF)	Function code 0x06	Register address MSB *	Register address LSB	Register value MSB *	Register value LSB	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	Function code 0x06	Register address MSB *	Register address LSB	Register value MSB *	Register value LSB	CRC LSB	CRC MSB
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* Register address = 0x0007 to 0x0013, Registers value = 0x0000 to 0xFFFF

Exception response

Slave address (0x01 to 0xFF)	Function code + 0x80	Exception code * 0x01, 0x02 or 0x03	CRC LSB	CRC MSB
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* An exception response is only returned if the CRC is correct
Exception code 01 --- illegal function, 02 --- illegal address, 03 --- illegal data value

The RTU function codes supported by the CO2/RH/T are shown below.

0x03 --- Read holding registers

0x03 --- Read Unit Status

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x00	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	0x00	Status value	CRC LSB	CRC MSB
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Note, Status value =1 if any of CO2/RH/T sensor has error

0x03 --- Read CO2 PPM

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x01	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB (PPM)	Register value LSB (PPM)	CRC LSB	CRC MSB
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Note, Register value =-1000 if CO2 sensor has error

0x03 --- Read %RH

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x02	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB (%RH x10)	Register value LSB (%RH x10)	CRC LSB	CRC MSB
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Note, Register value =-1000 if RH sensor has error, and Register value =0 only if RH sensor is not installed

0x03 --- Read Temperature

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x03	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB (°F/°C x10)	Register value LSB (°F/°C x10)	CRC LSB	CRC MSB
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Note, Register value =-1000 if T sensor has error, and Register value =0 only if T sensor is not installed

0x03 --- Read Up_Down_Value

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x04	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value MSB	Register value LSB *	CRC LSB	CRC MSB
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Note, Register value =0 only if Setpoint is not installed

* Register value for	%	=	0 – 100, resolution=10%
	%RH	=	30 - 70, resolution=1%RH
	ppm	=	500 - 1500, resolution=50ppm
	°C1	=	180 - 240 (must/10), resolution=0.5°C
	°C2	=	100 - 450 (must/10), resolution=0.5°C
	°F1	=	670 - 730 (must /10), resolution=1°F
	°F2	=	500 - 1130 (must /10), resolution=1°F

0x03 --- Read Relay_Status

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x05	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value 0x00	Register value (0/1)	CRC LSB	CRC MSB
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Note, Register value =0 only if relay is not installed

0x03 --- Override_Status

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x06	0x00	0x01	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x02	Register value 0x00	Register value (0/1)	CRC LSB	CRC MSB
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Note, Register value =0 only if override is not installed

0x03 --- Read ALL REGISTERS

Query

Slave address (0x01 to 0xFF)	0x03	0x00	0x00 (Note 1)	0x00	0x05 (Note2)	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x03	0x0A (Note3)	Register value MSB	Register value LSB	CRC LSB	CRC MSB
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Note 1: The starting address (A) may be 0x0000 to 0x0013. The read multiple feature will read all registers from the starting address forward.

If the starting address is 0x0000 then registers 40001 to 40020 can be read. If the starting address is 0x0008 then registers 40009 to 40020 can be read.

Note 2: The quantity of registers (N) may be 0x0001 to 0x0014, but must be limited to 20 – A. If the starting address (A) is set to 0x0000 then N may be 0x0001 to 0x00014. If the starting address is set to 0x0008 then N may be 0x0001 to 0x000C.

Note 3: The byte count (B) will always be 2N. If the quantity of registers (N) is 0x0001 then B will be 0x02. If N is 0x0005 then B will be 0x0A.

0x06 --- Write single register

0x06 --- Write single register (RELAY_SETPOINT)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x07	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x07	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if relay is not installed

* Registers value = 0x01F4 to 0x05DC, corresponding to 500 to 1500 PPM, resolution=1PPM

0x06 --- Write single register (RELAY_HYSTERESIS)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x08	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x08	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if relay is not installed

* Registers value = 0x0019 to 0x00C8, corresponding to 25 to 200 PPM, resolution=1PPM

0x06 --- Write single register (RELAY_ON_DELAY)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x09	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x09	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if relay is not installed

* Registers value = 0x0000 to 0x00FF, corresponding to 0 to 255 seconds, resolution=1s

0x06 --- Write single register (TEMPERATURE_OFFSET)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0A	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0A	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if T sensor is not installed

* Registers value = 0xFFCE to 0x0032, corresponding to -50 to 50 for -5.0 to 5.0 °C, resolution=1 for 0.1°C; or
 Registers value = 0xFF9C to 0x0064, corresponding to -100 to 100 for -10.0 to 10.0 °F, resolution=1 for 0.1°F

0x06 --- Write single register (RH_OFFSET)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0B	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0B	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if RH sensor is not installed

* Registers value = 0xFFF6 to 0x00A, corresponding to -10 to +10 %RH, resolution=1%RH

0x06 --- Write single register (SENSOR_ALTITUDE)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0C	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0C	Register value MSB	Register value LSB*	CRC LSB	CRC MSB
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* Registers value = 0x0000 to 0x09F6, corresponding to 0 to 2550m, resolution=50m

0x06 --- Write single register (BACKLIGHT_SET)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0D	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0D	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if backlight sensor is not installed

* Registers value = 0x0000 to 0x0002, corresponding to 0 = AUTO, 1=OFF and 2 = ON

0x06 --- Write single register (DISPLAY_MODE)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0E	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0E	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if CO2 only

* Registers value = 0x0000 to 0x0003, corresponding to 0 = CO2 only, 1 = CO2 + RH, 2 = CO2 + T and 3 = CO2 + RH + T

0x06 --- Write single register (SETPOINT_MODE)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x0F	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x0F	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if setpoint is not installed

* Registers value = 0x0000 to 0x0006, corresponding to 0 = %, 1 = °C1, 2 = °C2, 3 = °F1, 4=°F2, 5=%RH and 6=ppm

0x06 --- Write single register (C/F)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x10	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x10	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if T sensor is not installed

* Registers value = 0x0000 to 0x0001, corresponding to 0 = °C and 1 = °F

0x06 --- Write single register (AUTO_CAL)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x11	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x11	0x00	Register value LSB*	CRC LSB	CRC MSB
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* Registers value = 0x0000 to 0x0001, corresponding to 0 = Disable Auto-Cal and 1 = Enable Auto-Cal (Default)

0x06 --- Write single register (RELAY_TEST)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x12	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x12	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if relay is not installed

* Registers value = 0x0000 to 0x0001, corresponding to 0 = Turn Relay OFF and 1 = Turn Relay ON, after test, Set to 0 for normal operation.

0x06 --- Write single register (OVERRIDE_TEST)

Query

Slave address (0x01 to 0xFF)	0x06	0x00	0x13	0x00	Register value LSB*	CRC LSB	CRC MSB
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Response

Slave address (0x01 to 0xFF)	0x06	0x00	0x13	0x00	Register value LSB*	CRC LSB	CRC MSB
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Note, N/A if override is not installed

* Registers value = 0x0000 to 0x0001, corresponding to 0 = Turn Override OFF and 1 = Turn Override ON.

Exception response

Slave address (0x01 to 0xFF)	Function code + 0x80	Exception code * 0x01, 0x02 or 0x03	CRC LSB	CRC MSB
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* An exception response is only returned if the CRC is correct
Exception code 01 --- illegal function, 02 --- illegal address, 03 --- illegal data value