

## MODBUS CONNECTIVITY

### Delcom and Modbus

Modbus is used to read data from the sensors and send commands. The user can read the sensor value, temperatures, serial number, and range. The user has the ability to change the range, zero the sensors and change the IP settings.

Delcom uses Modbus/TCP and supports both static and dynamic IP addresses. There is a RJ-45 LAN jack on the back of the 873 module for connection.

### Introduction to Modbus

Modbus is a serial communication protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). The development and update of Modbus protocols has been managed by the Modbus Organization since April 2004, when Schneider Electric transferred rights to that organization.

### Modbus Communication

Modbus can be implemented within various physical layers and associated protocols, such as RS-232 or Ethernet/TCP/IP. Modbus implemented within Ethernet/TCP/IP is known as Modbus/TCP. The Delcom system uses Modbus/TCP. With Modbus/TCP, a Modbus server is identified by its IP address, which is dynamically assigned by the local network's DHCP server or statically set in the device. To connect to a Modbus/TCP server, the user must open a TCP connection over port 502. Most PLC clients will handle this interaction.

All Modbus commands contain checksum information to allow the recipient to detect transmission errors. The basic Modbus commands can instruct an RTU to change the value in one of its registers, control or read an I/O port, and command the device to send back one or more values contained in its registers. In Modbus terminology, read-only registers are known as *input registers*, read/write registers are known as *holding registers*, and single bit values (read and/or write) are known as *coils*. The Delcom system implements input registers for sensor readings, and coils for instrument status and control.

### IP Address

From a networking standpoint, there are two options pertaining to IP endpoint addresses: DHCP and static IP. The interface unit supports both a static IP address and DHCP. For a static IP, the device uses the IP address saved in the device. Modbus

commands are used to set or change the static address, subnet, gateway and dns. For DHCP, the user's network assigns the IP address of the Delcom system. This is called a dynamic IP address. Depending on the user's DHCP server, it is possible for the DHCP server to associate the Delcom system's MAC address with a specific IP address. This would ensure the same IP address is assigned to the Delcom system every time it powers on. Modbus commands can be used to switch between static and dynamic IP addresses.

## Modbus TCP frame format

A Modbus frame is composed of an Application Data Unit (ADU), which encloses a Protocol Data Unit (PDU):[9].

- ADU = Address + PDU + error check
- PDU = Function code + data

Name	Length (bytes)	Function
Transaction identifier	2	For synchronization between messages of server and client
Protocol identifier	2	Zero for Modbus/TCP
Length field	2	Number of remaining bytes in this frame
Unit identifier	1	Slave address (255 if not used)
Function code	1	Function codes as in other variants
Data bytes	<i>n</i>	Data as response or commands

## Reading Delcom Data

Sensor values, temperatures and serial numbers are read with Modbus code 04. Sensors are listed in order of serial number; sensor 1 has the lowest serial number.

### Values

The sensor value is sent in four registers. Each register represents two characters. The final value is represented by an eight character string in the units specified by the user. Units are set using the PC software.

1. Convert each register's hex value into two ascii characters.
2. Concatenate the 8 characters into a string. This results in the final value.

Read using Modbus code 04 (0x04)					
Register (dec)	Register (hex)	Address (3xxxx)	Sensor	Return Example (hex)	Convert from hex to ascii
1	1	30002	1	0x0030	0x00 = ' '

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					0x30 = '0'
2	2	30003	1	0x2E31	0x2E = '.' 0x31 = '1'
3	3	30004	1	0x3233	0x32 = '2' 0x33 = '3'
4	4	30005	1	0x3400	0x34 = '4' 0x00 = ''
<b>Final value: 0.1234</b>					

## Temperatures

There is a temperature sensor in the top sensor head, bottom sensor head, and on the sensor circuit board. Each temperature value is returned in two registers. The final temperature value is in degrees Celsius.

1. Convert each hex register to two ascii characters.
2. Concatenate the four characters to represent a new hex number.
3. Convert the new hex number to decimal and divide by 128. This results in the final temperature in degrees Celsius.

<i>Read using Modbus code 04 (0x04)</i>					
Register (dec)	Register (hex)	Address (3xxxx)	Sensor	Return Example (hex)	Convert from hex to ascii
5	5	30006	1	0x3045	0x30 = '0' 0x45 = 'E'
6	6	30007	1	0x4331	0x43 = 'C' 0x31 = '1'
				<b>Hex to Dec</b>	0x0EC1 = 3777
				<b>Divide by 128</b>	<b>29.508</b>

## Serial Numbers

Each sensor is given a unique, four digit serial number.

1. Convert each hex register to two ascii characters.
2. Concatenate the four characters to represent a new hex number.
3. Convert the new hex number to decimal. This results in the serial number.

<i>Read using Modbus code 04 (0x04)</i>					
Register (dec)	Register (hex)	Address (3xxxx)	Sensor	Return Example (hex)	Convert from hex to ascii
11	B	30012	1	0x3034	0x30 = '0' 0x34 = '4'
12	C	30013	1	0x3339	0x33 = '3' 0x39 = '9'
				<b>Hex to Dec</b>	0x0439 = 1081

## Sending Commands

The user can change range and zero the sensors. This information is written using Modbus code 0x05 and read using Modbus code 0x01. For the range coils, 0 represents low range and 1 represents high range. The zero coils will always read 0. Write 1 to zero the sensor(s). It is possible to change the range of the sensors individually or all at once. Likewise, it is possible to zero a single sensor or zero all sensors connected.

Read using Modbus code 01 (0x01) Write using Modbus code 05 (0x05)					
Coil (decimal)	Coil (hex)	Address (0xxxx)	Sensor	Item	Value
1	1	00002	1	Range	0 = Low range 1 = High range
2	2	00003	1	Zero	Write 1 to zero Will always read 0
17	11	00018	2	Range	0 = Low range 1 = High range
18	12	00019	2	Zero	Write 1 to zero Will always read 0
9969	26F1	09970	All	Range	0 = Low range 1 = High range
9970	26F2	09971	All	Zero	Write 1 to zero all instruments Will always read 0

## IP Settings

The Delcom unit has the ability to use a static IP address or a DHCP address. The user can switch between the two IP options and set the IP address, subnet, gateway, and DNS with Modbus commands or with the Delcom Software.

On power up, the LCD will display either *DHCP* or *StaticIP*. If using a static IP address, the address will be displayed on the LCD following the *StaticIP* message. If using DHCP, ping delcom-inst to find the dynamic IP address.

### Delcom Software IP Settings

The IP settings are found in the Delcom software under *Settings > IP Settings*. The current mode (static or dynamic) is shown along with the current IP address.

IP Settings

1. Enter the IP values and click *Set*.  
 2. Click *Reboot* after changing the settings.  
 The sensor will not use the new settings until it has been rebooted.

☐ DHCP  
☒ Static

IP Address: 192      168      10      44

Static IP	192	168	10	44
Subnet	255	255	255	0
Gateway	192	168	10	1
DNS	192	168	10	1

Set    Reboot    Close

To change the settings, enter the new settings in the appropriate boxes and click the desired mode. Click *Set* then *Reboot*. The sensor will restart with the updated settings.

### Switching in between Static and DHCP through Modbus

The IP settings are changed with Modbus code 05. The settings can be read using code 01.

1. Write *0* or *1* to coil 134. Write *1* to use DHCP. Write *0* to use a static IP address.
2. If switching to static, set the IP parameters using Modbus code 16 (see *Setting IP Parameters*).
3. Write *1* to coil 133. This saves the values in the EE memory.
4. Write *1* to coil 132 to reboot the instrument. The instrument will not switch to the new values until it has been restarted. The instrument will power up with the values stored in memory.

Write using Modbus code 05 (0x05)				
Read using Modbus code 01 (0x01)				
Coil (decimal)	Coil (hex)	Address (0xxxx)	Item	Value
9971	26F3	09972	Reboot	Write <i>1</i> to reboot
9972	26F4	09973	Write to EE memory	Write <i>1</i> to write the settings to memory
9973	26F5	09974	0: Static IP	Write <i>0</i> to use a static IP address
			1: DHCP	Write <i>1</i> to use DHCP

## Setting the IP Parameters through Modbus

The user can set the IP address, subnet, gateway, and DNS. These are written with Modbus code 16 and read with code 03. Each value is stored in two registers. The IP address 192.168.1.10 is represented by 0xC0A8 and 0x010A. 192 decimal is equal to 0xC0 hex, 168 decimal is 0xA8 hex, 1 decimal is 0x01, and 10 decimal is 0x0A.

1. Write the desired values to the registers according to the chart below.
2. Save the values in the EE memory. Using Modbus code 05, write 1 to coil 133
3. In order to use the new values, restart the instrument. Using Modbus code 5, write 1 to coil 132. The instrument will power up with the values stored in memory.

<i>Write using Modbus code 16 (0x10)</i>					
<i>Read using Modbus code 03 (0x03)</i>					
Register (decimal)	Register (hex)	Address (4xxxx)	Item	Value	
19	13	40020	IP Address MSB	0x00C0	Default of 192.168.1.10 (0xC0 = 192 decimal)
20	14	40021		0x00A8	
21	15	40022		0x0001	
22	16	40023		0x000A	
23	17	40024	Subnet MSB	0x00FF	Default of 255.255.0.0
24	18	40025		0x00FF	
25	19	40026		0x0000	
26	1A	40027		0x0000	
27	1B	40028	Gateway MSB	0x00C0	Default of 192.168.0.0
28	1C	40029		0x00A8	
29	1D	40030		0x0000	
30	1E	40031		0x0000	
31	1F	40032	DNS MSB	0x00C0	Default of 192.168.1.1
32	20	40033		0x00A8	
33	21	40034		0x0001	
34	22	40035		0x0001	

## Manually reset to DHCP

The instrument can be manually reset to DHCP by holding down the red **ZERO** button during power up. The red **ZERO** button is located on the front of the 873 interface module. The message **GO DHCP** should flash across the LCD.

## Address tables

### Address table for reading information

<i>Read with Modbus code 0x04</i>				
<i>Not writeable</i>				
Register (dec)	Register (hex)	Address (3xxxx)	Sensor	Item
1	1	30002	1	value
2	2	30003	1	value
3	3	30004	1	value
4	4	30005	1	value
5	5	30006	1	temperature, top
6	6	30007	1	temperature, top
7	7	30008	1	temperature, board
8	8	30009	1	temperature, board
9	9	30010	1	temperature, bottom
10	A	30011	1	temperature, bottom
11	B	30012	1	serial number
12	C	30013	1	serial number
17	11	30018	2	value
18	12	30019	2	value
19	13	30020	2	value
20	14	30021	2	value
21	15	30022	2	temperature, top
22	16	30023	2	temperature, top
23	17	30024	2	temperature, board
24	18	30025	2	temperature, board
25	19	30026	2	temperature, bottom
26	1A	30027	2	temperature, bottom
27	1B	30028	2	serial number
28	1C	30029	2	serial number
33	21	30034	3	value
34	22	30035	3	value
35	23	30036	3	value
36	24	30037	3	value
37	25	30038	3	temperature, top
38	26	30039	3	temperature, top
39	27	30040	3	temperature, board
40	28	30041	3	temperature, board
41	29	30042	3	temperature, bottom
42	2A	30043	3	temperature, bottom
43	2B	30044	3	serial number

44	2C	30045	3	serial number
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### Address table for reading information (cont.)

Read with Modbus code 04 (0x04) Not writeable				
Register (dec)	Register (hex)	Address (3xxxx)	Sensor	Item
49	31	30050	4	value
50	32	30051	4	value
51	33	30052	4	value
52	34	30053	4	value
53	35	30054	4	temperature, top
54	36	30055	4	temperature, top
55	37	30056	4	temperature, board
56	38	30057	4	temperature, board
57	39	30058	4	temperature, bottom
58	3A	30059	4	temperature, bottom
59	3B	30060	4	serial number
60	3C	30061	4	serial number
65	41	30066	5	value
66	42	30067	5	value
67	43	30068	5	value
68	44	30069	5	value
69	45	30070	5	temperature, top
70	46	30071	5	temperature, top
71	47	30072	5	temperature, board
72	48	30073	5	temperature, board
73	49	30074	5	temperature, bottom
74	4A	30075	5	temperature, bottom
75	4B	30076	5	serial number
76	4C	30077	5	serial number
81	51	30082	6	value
82	52	30083	6	value
83	53	30084	6	value
84	54	30085	6	value
85	55	30086	6	temperature, top
86	56	30087	6	temperature, top
87	57	30088	6	temperature, board
88	58	30089	6	temperature, board
89	59	30090	6	temperature, bottom
90	5A	30091	6	temperature, bottom



91	5B	30092	6	serial number
92	5C	30093	6	serial number

#### Address table for reading information (cont.)

<i>Read with Modbus code 04 (0x04)</i>				
<i>Not writeable</i>				
<b>Register (dec)</b>	<b>Register (hex)</b>	<b>Address (3xxxx)</b>	<b>Sensor</b>	<b>Item</b>
97	61	30098	7	value
98	62	30099	7	value
99	63	30100	7	value
100	64	30101	7	value
101	65	30102	7	temperature, top
102	66	30103	7	temperature, top
103	67	30104	7	temperature, board
104	68	30105	7	temperature, board
105	69	30106	7	temperature, bottom
106	6A	30107	7	temperature, bottom
107	6B	30108	7	serial number
108	6C	30109	7	serial number
113	71	30114	8	value
114	72	30115	8	value
115	73	30116	8	value
116	74	30117	8	value
117	75	30118	8	temperature, top
118	76	30119	8	temperature, top
119	77	30120	8	temperature, board
120	78	30121	8	temperature, board
121	79	30122	8	temperature, bottom
122	7A	30123	8	temperature, bottom
123	7B	30124	8	serial number
124	7C	30125	8	serial number

### Address table for sending range and zero commands

<i>Read with Modbus code 0x01</i> <i>Write with Modbus code 0x05</i>					
Coil (dec)	Coil (hex)	Address (0xxxx)	Sensor	Item	Value
1	1	00002	1	range	0 (low) or 1 (high)
2	2	00001	1	zero	write 1 to zero, will always read 0
17	11	00018	2	range	0 (low) or 1 (high)
18	12	00019	2	zero	write 1 to zero, will always read 0
33	21	00034	3	range	0 (low) or 1 (high)
34	22	00035	3	zero	write 1 to zero, will always read 0
49	31	00050	4	range	0 (low) or 1 (high)
50	32	00051	4	zero	write 1 to zero, will always read 0
65	41	00066	5	range	0 (low) or 1 (high)
66	42	00067	5	zero	write 1 to zero, will always read 0
81	51	00082	6	range	0 (low) or 1 (high)
82	52	00083	6	zero	write 1 to zero, will always read 0
97	61	00098	7	range	0 (low) or 1 (high)
98	62	00099	7	zero	write 1 to zero, will always read 0
113	71	00114	8	range	0 (low) or 1 (high)
114	72	00115	8	zero	write 1 to zero, will always read 0
9969	82	09970	all	range	write 0 (low) or 1 (high), will always read 0
9970	83	09971	all	zero	write 1 to zero all, will always read 0

### Address table for sending IP commands

<i>Write using Modbus code 05 (0x05)</i> <i>Read using Modbus code 01 (0x01)</i>				
Coil (decimal)	Coil (hex)	Address (0xxxx)	Item	Value
9971	26F3	09972	Reboot	Write 1 to reboot
9972	26F4	09973	Write to EE memory	Write 1 to write the settings to memory
9973	26F5	09974	0: Static IP 1: DHCP	Write 0 to use a static IP address Write 1 to use DHCP

## Address table for setting IP parameters

Write using Modbus code 16 (0x10) Read using Modbus code 03 (0x03)					
Register (decimal)	Register (hex)	Address (4xxxx)	Item	Value	
19	13	40020	IP Address MSB	0x00C0	Default of 192.168.1.10 (0xC0 = 192 decimal)
20	14	40021		0x00A8	
21	15	40022		0x0001	
22	16	40023		0x000A	
23	17	40024	Subnet MSB	0x00FF	Default of 255.255.0.0
24	18	40025		0x00FF	
25	19	40026		0x0000	
26	1A	40027		0x0000	
27	1B	40028	Gateway MSB	0x00C0	Default of 192.168.0.0
28	1C	40029		0x00A8	
29	1D	40030		0x0000	
30	1E	40031		0x0000	
31	1F	40032	DNS MSB	0x00C0	Default of 192.168.1.1
32	20	40033		0x00A8	
33	21	40034		0x0001	
34	22	40035		0x0001	

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