Modbus protocol

MODBUS SERIAL COMMUNICATIONS

Overview

Modbus protocol is a widely used and well-documented communications method. It provides a simple and effective means of programming our various products.

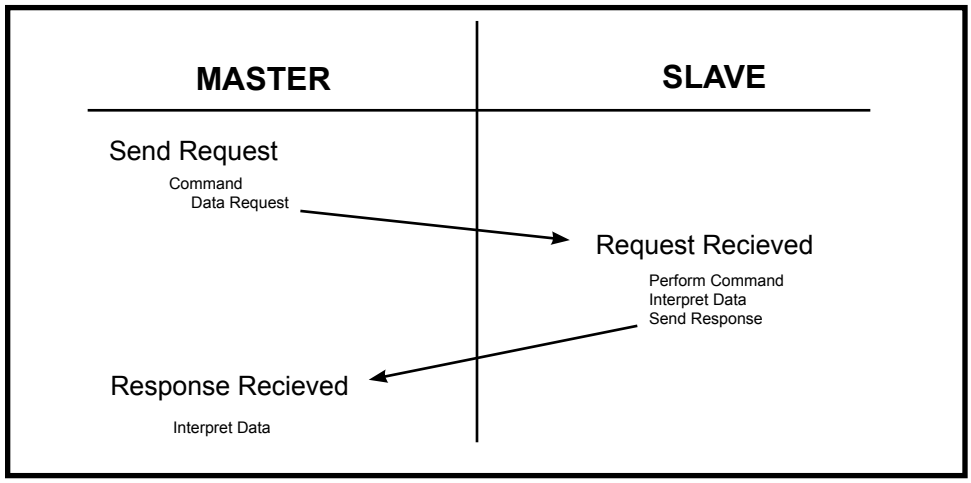
The device communications follow a routine of queries issued by the master (your product) and our devices (the slaves). Modbus has various command types, we use only the **READ** , **WRITE** commands, type 3 and type 5 commands in the Modbus parlance. The master will prepare a packet comprised of the target address, command type (read or write), the starting address and number of bytes to be accessed, and finally a CRC for error detection.

All devices are set to communicate over RS485 network using 1.2k through 115.2 kbaud, N81 byte structure. Normal RS485 distance, termination and cabling rules apply. Physical layer is standard twisted pair + ground cabling. A shield is optional.

A typical Modbus packet looks like this:

Byte1	Device ID, the destination address for a particular message
Byte2	Function
Byte3	Starting address of the particular storage register(s) to be read or written, hi byte,
Byte4	Starting address low byte
Byte5	No. of registers to read/write (hi byte)
Byte6	No. of registers to read/write (low byte)
Byte7	CRC hi byte
Byte8	CRC low byte

During normal operation, the slave will immediately send a response to the master request.



[Notice]: Most errors during message transfer are timeout errors. This is because bytes being distorted or missing will not trigger a response resulting in a timeout error.

Software tools can be found at: http://www.modbustools.com/modbus_poll.asp
If your application can read & write bytes to a separate PC running the 'Modbus Slave' application, you will be able to read & write bytes to the modules.
Note: When using the Modbus Poll software, addressing should be set to "Protocol Addresses (Base 0)" under the "Display" menu.

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Modbus Examples

READ Command (0x03):

This function is used to read the contents of multiple memory registers. The master to the Modbus must specify, the device ID, it's starting register and quantity of register desired. By convention if a data were to contain 2 byte, we would first send the Hi byte and then the Lo byte.

The master to the Modbus network will issue a read command:
- Device ID=18
- Read 6 bytes of data
- Starting at register number 100 (64h)

Byte #	Field Name (Hex)	Data	Description
Byte1	Slave Address	12	Modules with ID18 will be read
Byte2	Function	03	Read operation
Byte3	Starting Address Hi	00	
Byte4	Starting Address Lo	64	Reading starting from register #100
Byte5	No. of Register to read Hi	00	
Byte6	No. of Register to read Lo	03	Read a total of 3 registers
Byte7	Error Check (CRC) HI byte	46	The CRC is calculated using the CRC
Byte8	Error Check (CRC) LO byte	B7	routine described below

The slave device with ID=11 will answer the master within a few milliseconds with the following response.

Byte #	Field Name (Hex)	Data	Description
Byte1	Slave Address	12	Slave with ID18 is responding
Byte2	Function	03	we're responding to a read command
Byte3	Byte Count	06	6 bytes are coming
Byte4	Data1 Hi	00	byte1 of the data
Byte5	Data1 Lo	00	byte2 of the data
Byte6	Data2 Hi	00	byte3 of the data
Byte7	Data2 Lo	00	byte4 of the data
Byte8	Data3 Hi	00	byte5 of the data
Byte9	Data3 Lo	00	byte6 of the data
Byte10	Error Check (CRC) HI byte	XX	The CRC is calculated using the CRC
Byte11	Error Check (CRC) LO byte	XX	routine described below

Example of the Read Command

The Master sends the Read querie:

Slave Address	Function	Starting Address Hi	Starting Address Lo	No. of Regs Hi	No. of Regs Lo	CRC Hi Byte	CRC Lo Byte
12	3	0	(64h) 100	0	3	46	B7

The device node sends back the following response:

Slave Address	Function	Byte Count	Data1 Hi	Data1 Lo	Data2 Hi	Data2 Lo
12	3	6	(00h) 0	(00h) 0	(00h) 0	(00h) 0

Data3 Hi	Data3 Lo	CRC Hi Byte	CRC Lo Byte			
(00h) 0	(00h)	xx	xx			

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WRITE command (0x06):

This function is used to write to a single memory register. The master of the Modbus must specify the device ID, its register address to be written and the data desired.

The master to the Modbus network will issue a write command:
- Device ID=18
- Write to address 18
- Enter data 3 (03h)

Byte #	Field Name (Hex)	Data	Description
Byte1	Slave Address	12	destination address
Byte2	Function	06	this is a write command
Byte3	Register Address Hi	00	address which will be written to, hi byte
Byte4	Register Address Lo	01	address which will be written to, low byte
Byte5	Data Hi	00	data that we are writing, hi byte
Byte6	Data Lo	03	data we are writing, low byte
Byte7	Error Check (CRC) HI byte	XX	The CRC is calculated using the CRC
Byte8	Error Check (CRC) LO byte	XX	routine described below

The slave device with ID=11 will answer the master within a few milliseconds with the following response.

Byte #	Field Name (Hex)	Data	Description
Byte1	Slave Address	12	destination address
Byte2	Function	06	this is a write command
Byte3	Register Address Hi	00	address which will be written to, hi byte
Byte4	Register Address Lo	01	address which will be written to, low byte
Byte5	Data Hi	00	data that we are writing, hi byte
Byte6	Data Lo	03	data we are writing, low byte
Byte7	Error Check (CRC) HI byte	XX	The CRC is calculated using the CRC
Byte8	Error Check (CRC) LO byte	XX	routine described below

[Notice]: In this case the Slave device just sends back the message to let the Master know the query has been properly received.

Example of the Write Command

The Master sends the Write querie:

Slave Address	Function	Register Address Hi	Register Address Lo	Data Hi	Data Lo	CRC Hi Byte	CRC Lo Byte
			(01h)				
12	6	0	1	0	3	xx	xx

The device node sends back the following response:

Slave Address	Function	Register Address Hi	Register Address Lo	Data Hi	Data Lo	CRC Hi Byte	CRC Lo Byte
			(01h)				
12	6	0	1	0	3	xx	xx

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CRC Error Correcting Details

For programmers familiar with error detection schemes, CRC calculations will be familiar turf. For programmers new to Modbus we will offer sample source code in Visual C and Cbuilder to get your application started. For embedded platforms we can provide some sample Modbus code on request. The following is a collection of code snippets to get your application started.

```
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, 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, 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
} ;

/* Table of CRC values for low–order byte */
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
} ;
```

For example: to calculate the crc of the data in the message stored in memory location *puchMsg

```
unsigned short CRC16 (unsigned char *puchMsg, unsigned char usDataLen)
{
    unsigned char uchCRCHi = 0xFF ; /* high byte of CRC initialized */
    unsigned char uchCRCLo = 0xFF ; /* low byte of CRC initialized */
    unsigned uIndex ; /* will index into CRC lookup table */
    while (usDataLen--) /* pass through message buffer */
    {
        uIndex = uchCRCHi ^ *puchMsg++ ; /* calculate the CRC */
        uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex] ;
        uchCRCLo = auchCRCLo[uIndex] ;
    }
    return (uchCRCHi << 8 | uchCRCLo) ;

}
```

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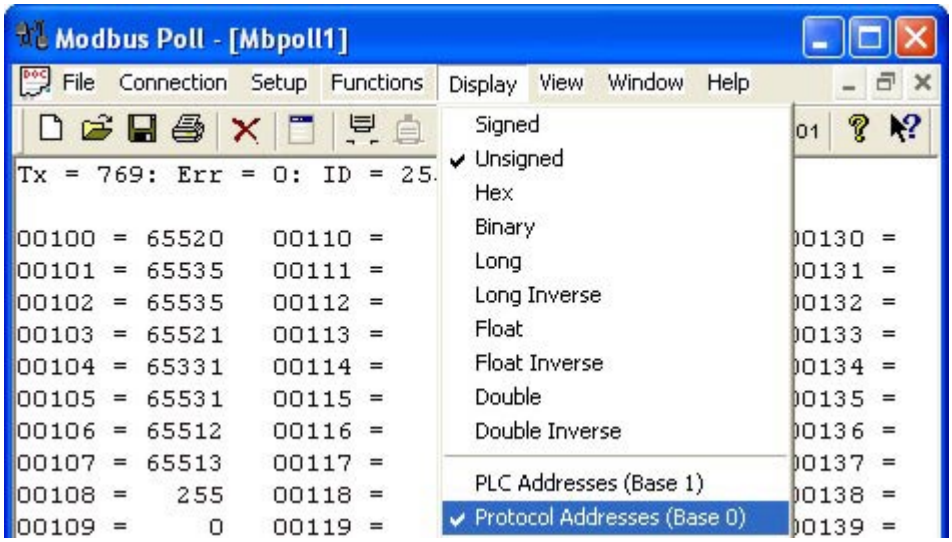
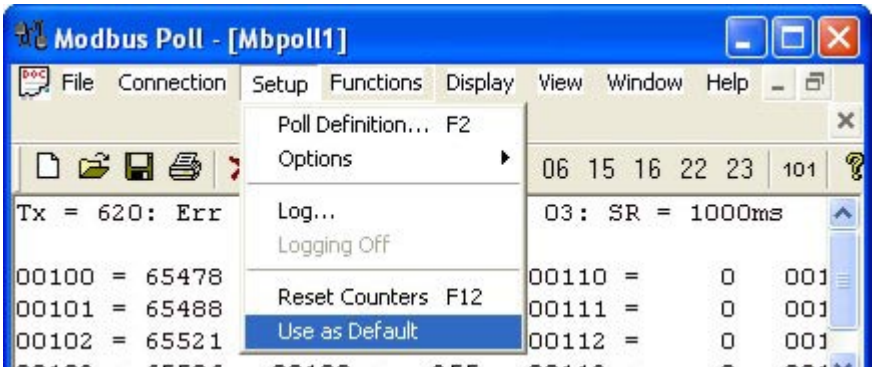
Modbus Poll Software

Modbus Poll is a simple modbus communications tool developed by Witte Communications http://www.modbustools.com/modbus_poll.asp that can be used to read and write registers of modbus devices. The following is a brief set of instructions for communicating with a device.

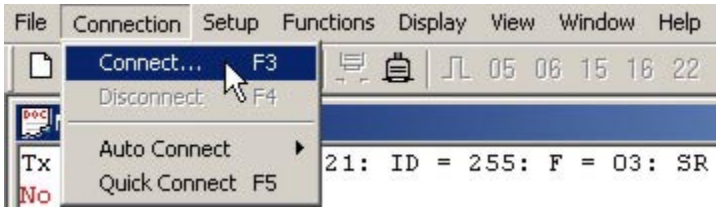
The first time Modbus Poll is used, it should be set to base 0 addressing. This is done by selecting “Protocol Addressing (Base 0) “ from the Display menu:



It is a good idea to then save this as a default so that addressing protocol does not need to be selected each time the program is run. Saving the default setting is done from the Setup menu:



At this point, the connection to the device needs to be established. Select “Connect...” from the Connection menu:



The default connections settings should be as follows:

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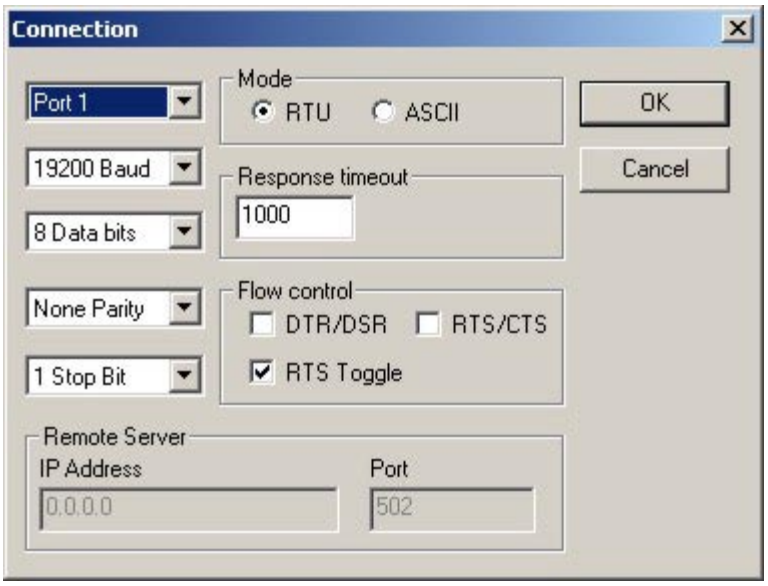
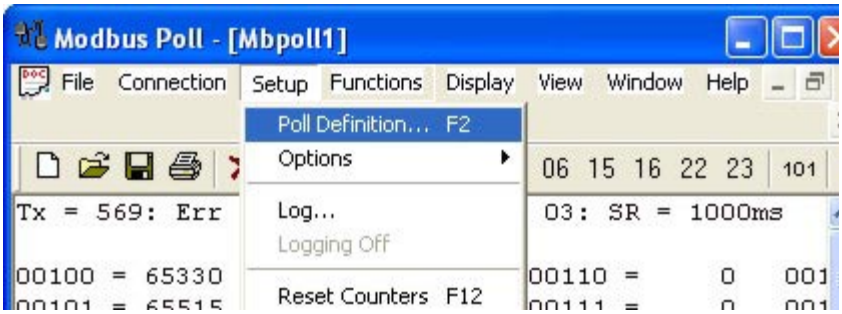
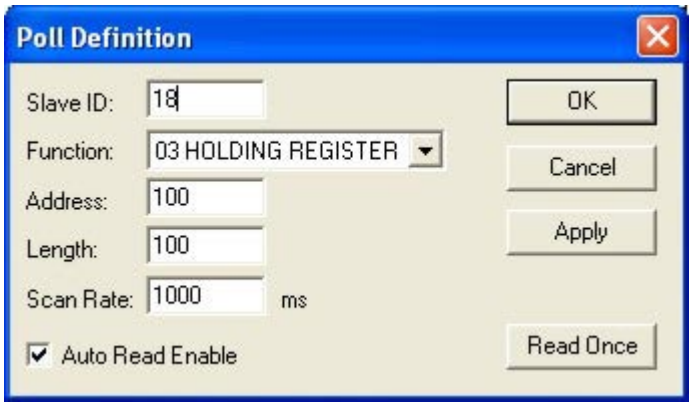


After the connection is established, it is necessary to setup the poll definitions. This is done by selecting “Poll Definition...” from the Setup menu:



Within the Poll Definitions dialog window, there are several parameters that need to be set.

Slave ID is the modbus address of the device being read or written. (255 is the generic address to which all devices will respond.)
Function should be set as 03 HOLDING REGISTER.
Address is the starting address of the registers to be read.
Length is the number of registers to be read.
Scan Rate is the frequency with which the device will be polled.



Once the Poll Definitions have been setup and applied, the main window will show a list of each register address and its corresponding value.

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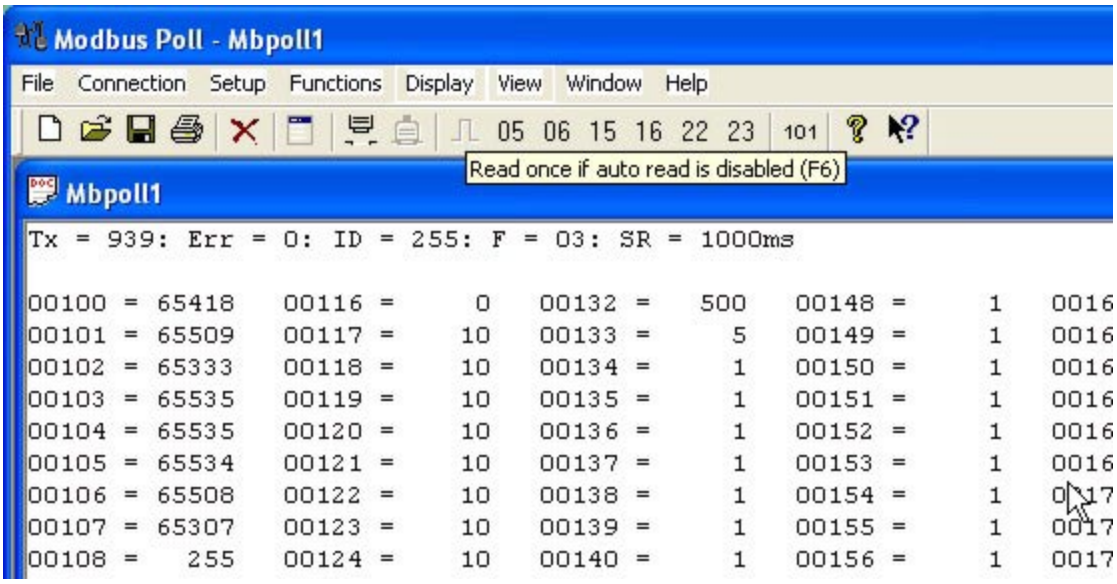
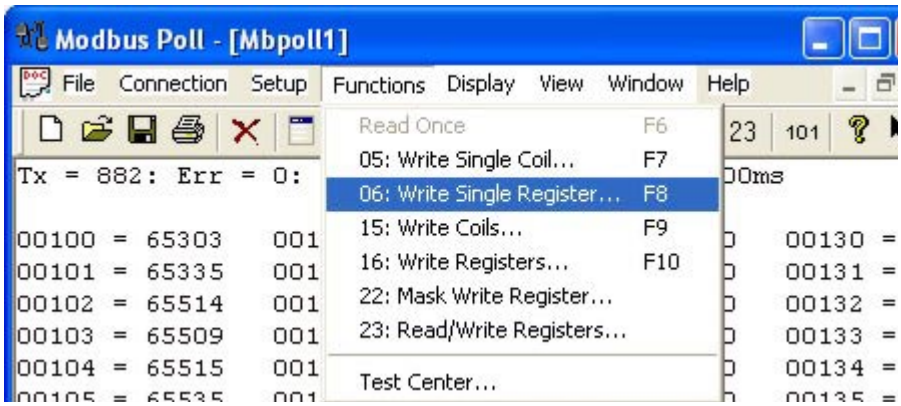


In order to write a value to a specific register, select “06 Write Single Register...” from the Functions menu:



Slave ID is the modbus address of the device. Address is the address of the register that will be written. Value is the value being written.