TechNote

Model 5100 TCP Slave and RTU Serial Server Configuration

32

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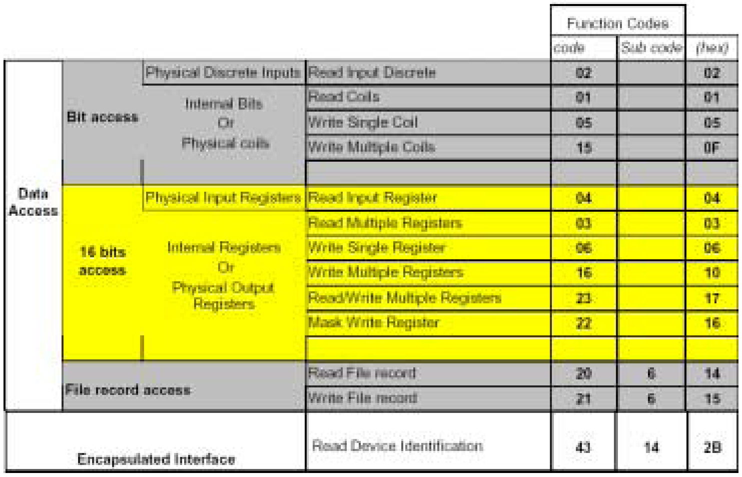
Modbus

The Modbus Protocol is a messaging structure developed by Modicon in 1979. It is used for master-slave/client-server communication between intelligent devices and has become an industry standard. Details of the protocol may be found at the web site www.modbus.org for further details. There are numerous deviations of the Modbus protocol of which the 5100 supports those described within this document. Tools used to test the protocol are available from a number of sources. The 5100 was tested using those available from www.win-tech.com, namely their ModScan32 for RTU Slave testing and ModSim32 for Master. This document discusses the configuration and testing when using Modbus TCP Slave (server) to interact with the 5100, while at the same time connecting to COM1 with a serial cable running the Modbus RTU Serial protocol. Note on both connections the 5100 operates as a slave (server), returning information as requested by the polling master.

Modbus TCP Slave

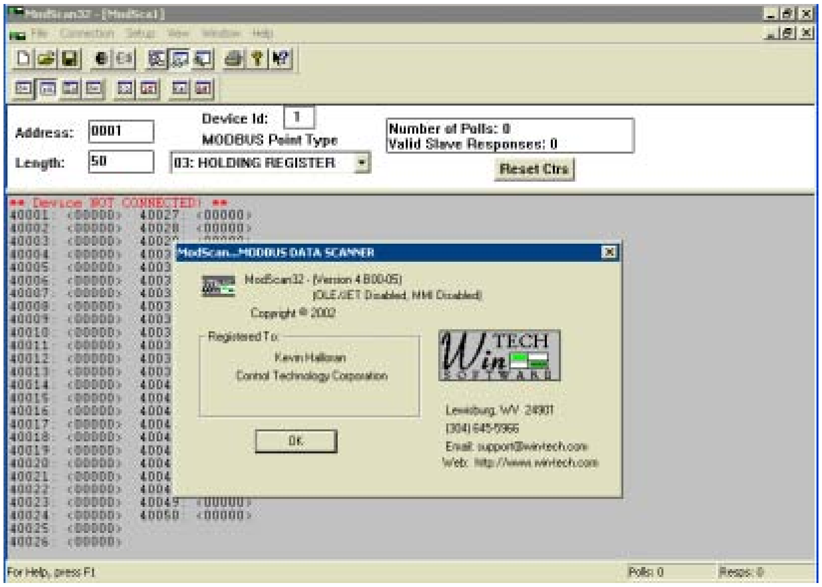
The Modbus TCP Slave protocol allows a TCP master to periodically poll the 5100 to collect desired information. The protocol allows for interfaces to such things as coils, analog, register, etc. Since the 5100 is able to access anything via its register interface, only the Holding Register commands are supported; Write Single Register (function code 0x06), Write Multiple Registers (function code 0x10), and Read Holding Registers (0x03).



				Function Codes		
				code	Sub code	(hex)
Data Access	Bit access	Physical Discrete Inputs	Read Input Discrete	02		02
		Internal Bits Or Physical coils	Read Coils	01		01
			Write Single Coil	05		05
			Write Multiple Coils	15		0F
	16 bits access	Physical Input Registers	Read Input Register	04		04
		Internal Registers Or Physical Output Registers	Read Multiple Registers	03		03
			Write Single Register	06		06
			Write Multiple Registers	16		10
			Read/Write Multiple Registers	23		17
			Mask Write Register	22		16
	File record access		Read File record	20	6	14
			Write File record	21	6	15
Encapsulated Interface			Read Device Identification	43	14	2B

Figure 1.1: Modbus Function codes from Modbus.org, Modbus Application Protocol Specification, May 8, 2002

You should also note that Modbus registers are 16 bits in width and that of the 5100 are 32 bits, since Modbus is Big Endean, this means reading register 1 in the 5100, the high 16 bits equates to Modbus register 1 and the low 16 bits to Modbus register 2. Modbus register 3 would be the high 16 bits of the 5100 register #2. A maximum of 50 Modbus registers can be read at once, or 25 5100 sequential registers. As a demonstration of the functionality of the 5100 Modbus TCP/Slave interface, this section details the interface of Win-Tech's ModScan32 software and how it applies with regard to our product. As mentioned before, we only support the Holding Register interface. Upon installation of ModScan32 a screen such as Figure 1.2 will appear. Note that the Address field is set to 1, but the display screen starts at 40001. This is Modbus nomenclature. Address of 1 is the same as the upper 16 bits of the 5100 register 1. Note Length is set to 50, the maximum allowable number of Modbus registers in a single read. Device ID is ignored since TCP is point to point.


ModScan32 - [ModSca1]
File Connection Setup View Window Help
Reset Ctrs
ModScan...MODBUS DATA SCANNER
OK
For Help, press F1

Address: 0001
Length: 50
Device Id: 1
MODBUS Point Type: 03: HOLDING REGISTER
Number of Polls: 0
Valid Slave Responses: 0

```
** Device NOT CONNECTED! **
40001: <00000>  40027: <00000>
40002: <00000>  40028: <00000>
40003: <00000>
...
40023: <00000>  40049: <00000>
40024: <00000>  40050: <00000>
40025: <00000>
40026: <00000>
```

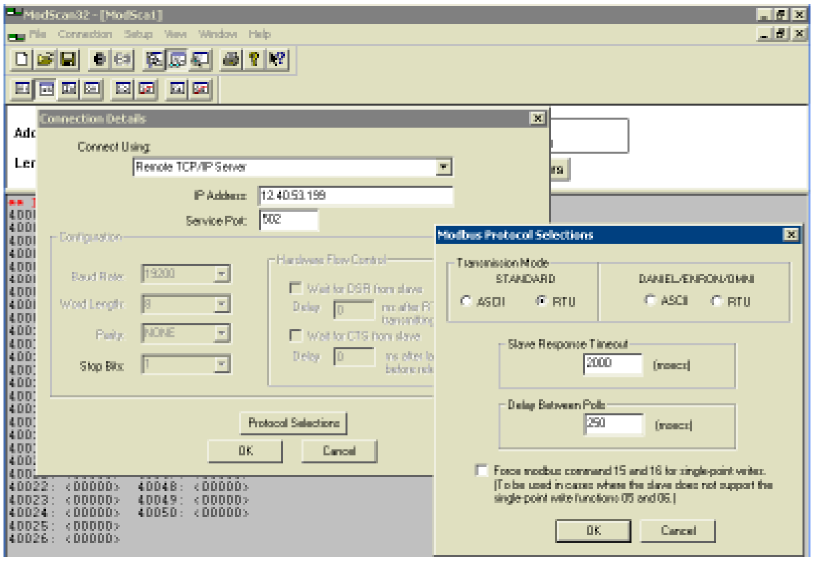
ModScan32 - (Version 4.B00-05)
(OLE/JET Disabled, MMI Disabled)
Copyright © 2002
Registered To:
Kevin Halloran
Control Technology Corporation

Lewisburg, WV 24901
(304) 645-5966
Email: support@wintech.com
Web: http://www.wintech.com

Polls: 0 Resps: 0

Figure 1.2: ModScan32 Master Scanning Program (only Holding Register supported)

Figure 1.3 shows the setup for an interface to a 5100 with a TCP address of 12.40.53.199 and the Modbus Slave running a server on the standard port of 502:



Connect Using: Remote TCP/IP Server
IP Address: 12.40.53.199
Service Port: 502

Configuration
Baud Rate: 19200
Word Length: 8
Parity: NONE
Stop Bits: 1

Hardware Flow Control
□ Wait for DSR from slave
Delay 0 ms after RTS before transmitting
□ Wait for CTS from slave
Delay 0 ms after last char before releasing RTS

Transmission Mode
STANDARD: ○ ASCII ● RTU
DANIEL/ENRON/OMNI: ○ ASCII ○ RTU

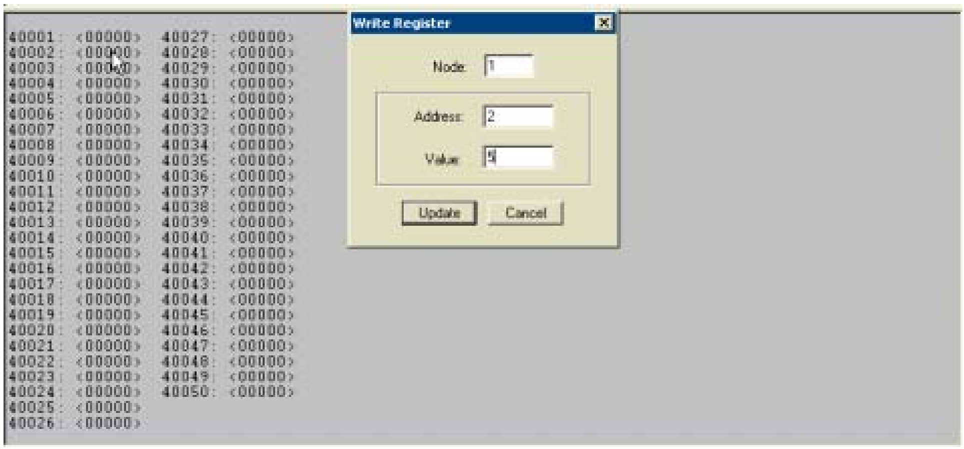
Slave Response Timeout: 2000 (msecs)
Delay Between Polls: 250 (msecs)

□ Force modbus command 15 and 16 for single-point writes. (To be used in cases where the slave does not support the single-point write functions 05 and 06.)

```
40022: <00000>  40048: <00000>
40023: <00000>  40049: <00000>
40024: <00000>  40050: <00000>
40025: <00000>
40026: <00000>
```

Figure 1.3: ModScan32 Master Scanning Program TCP Connection Setup

In order to do a single register write to a Modbus 16 bit register double click that register. Below shows changing Modbus register 40002 (Address 2) to a value of 5, this would translate to the lower 16 bits of Quickstep register 1. Remember Modbus Address 1 is the upper 16 bits.



```
40001: <00000>  40027: <00000>
40002: <00000>  40028: <00000>
40003: <00000>  40029: <00000>
40004: <00000>  40030: <00000>
40005: <00000>  40031: <00000>
40006: <00000>  40032: <00000>
40007: <00000>  40033: <00000>
40008: <00000>  40034: <00000>
40009: <00000>  40035: <00000>
40010: <00000>  40036: <00000>
40011: <00000>  40037: <00000>
40012: <00000>  40038: <00000>
40013: <00000>  40039: <00000>
40014: <00000>  40040: <00000>
40015: <00000>  40041: <00000>
40016: <00000>  40042: <00000>
40017: <00000>  40043: <00000>
40018: <00000>  40044: <00000>
40019: <00000>  40045: <00000>
40020: <00000>  40046: <00000>
40021: <00000>  40047: <00000>
40022: <00000>  40048: <00000>
40023: <00000>  40049: <00000>
40024: <00000>  40050: <00000>
40025: <00000>
40026: <00000>
```

Write Register

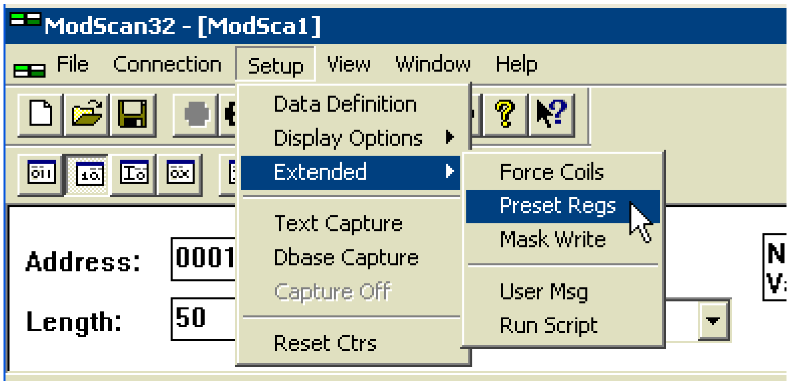
Node: 1

Address: 2

Value: 5

Figure 1.4: Single register write, value 5 to 40002

Changing a number of register all at once is known as a Write Multiple Register access. This can be done using the Extended Access option:



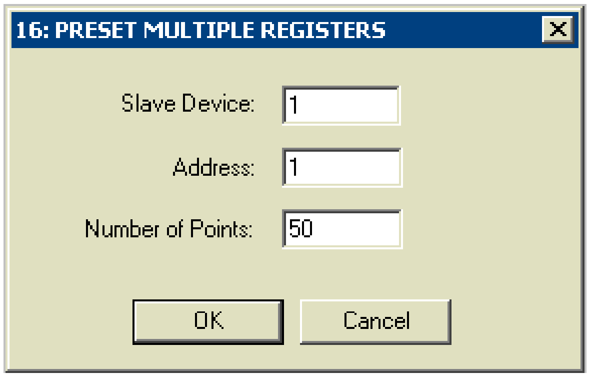
ModScan32 - [ModSca1]

Address: 0001

Length: 50

Figure 1.5: Write Multiple register (Preset Regs) selection

The Preset Multiple Registers will appear. Note that in TCP the 5100 ignores any slave or node identifiers since it is a single device and not acting as a gateway. Set the Modbus register you wish to start changes with and the number of registers to change, up to a maximum of that you are viewing:



16: PRESET MULTIPLE REGISTERS

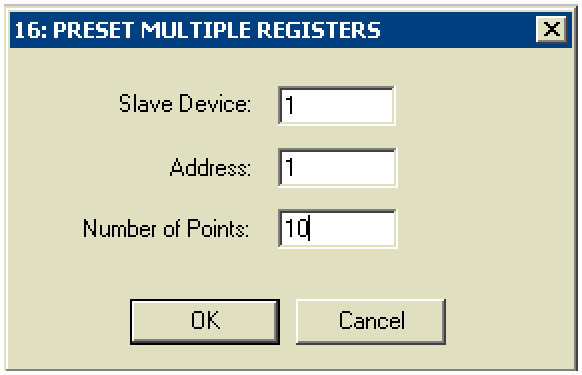
Slave Device: 1

Address: 1

Number of Points: 50

Figure 1.6: Preset Multiple register dialog

In this case we will change Addresses 1 to 10 to sequential numbers 1 to 10:



16: PRESET MULTIPLE REGISTERS

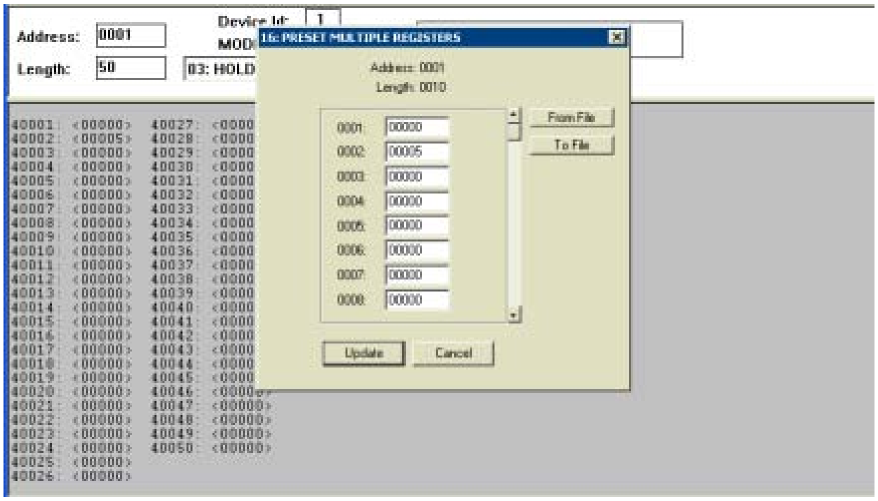
Slave Device: 1

Address: 1

Number of Points: 10

Figure 1.7: Select number of multiple writes to do

As shown below the current register values are displayed in the dialog box.



Address: 0001

Length: 50

Device Id: 1

03: HOLD

```
40001: <00000>  40027: <0000
40002: <00005>  40028: <0000
40003: <00000>  40029: <0000
40004: <00000>  40030: <0000
40005: <00000>  40031: <0000
40006: <00000>  40032: <0000
40007: <00000>  40033: <0000
40008: <00000>  40034: <0000
40009: <00000>  40035: <0000
40010: <00000>  40036: <0000
40011: <00000>  40037: <0000
40012: <00000>  40038: <0000
40013: <00000>  40039: <0000
40014: <00000>  40040: <0000
40015: <00000>  40041: <0000
40016: <00000>  40042: <0000
40017: <00000>  40043: <0000
40018: <00000>  40044: <0000
40019: <00000>  40045: <0000
40020: <00000>  40046: <0000
40021: <00000>  40047: <00000>
40022: <00000>  40048: <00000>
40023: <00000>  40049: <00000>
40024: <00000>  40050: <00000>
40025: <00000>
40026: <00000>
```

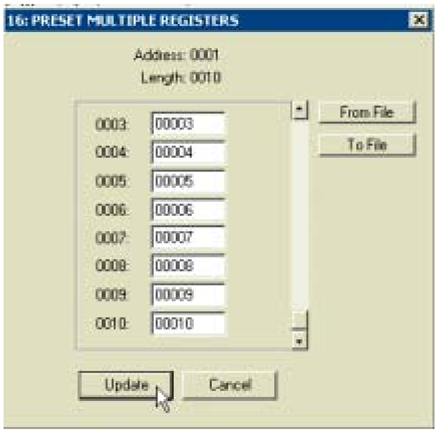
16: PRESET MULTIPLE REGISTERS

Address: 0001
Length: 0010

0001: 00000
0002: 00005
0003: 00000
0004: 00000
0005: 00000
0006: 00000
0007: 00000
0008: 00000

Figure 1.8: Preset Multiple register dialog viewing existing values

Note below that each register value has been changed, also we scrolled down so we could get to register 10. Click Update and note the changed register values from the previous display, 40002 is no longer 5 but now 2.



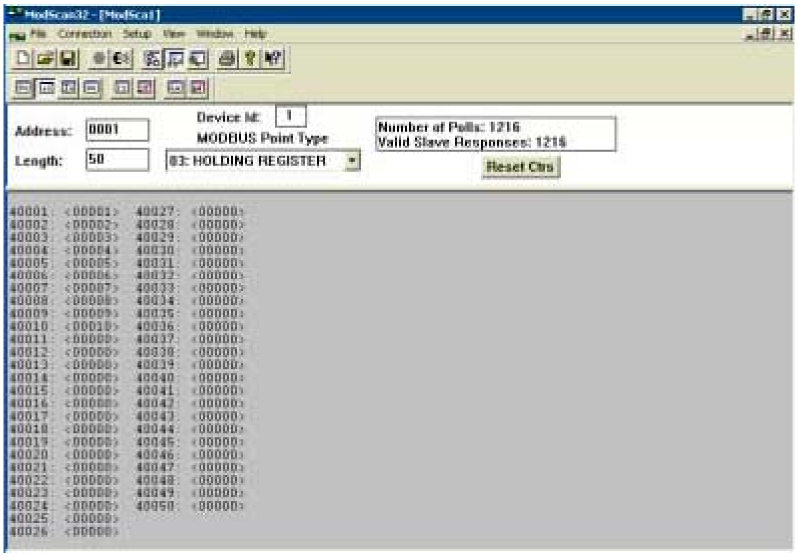
16: PRESET MULTIPLE REGISTERS

Address: 0001
Length: 0010

0003: 00003
0004: 00004
0005: 00005
0006: 00006
0007: 00007
0008: 00008
0009: 00009
0010: 00010

Figure 1.9: Preset Multiple new values entered

Upon clicking the Update key, the new values are written to the 5100 registers and new values read back using the Read Multiple Register command.

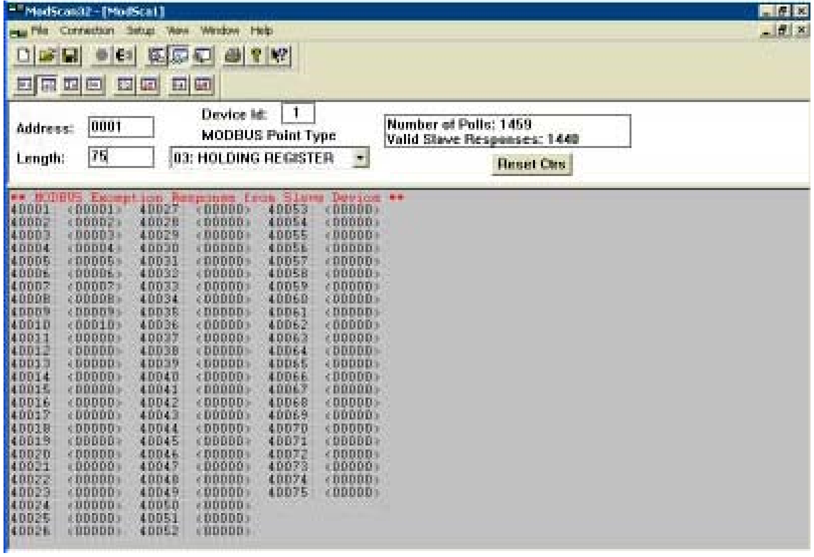


```
Address:  0001        Device Id: 1            Number of Polls: 1216
                      MODBUS Point Type       Valid Slave Responses: 1216
Length:   50          03: HOLDING REGISTER
                                              Reset Ctrs

40001: <00001>  40027: <00000>
40002: <00002>  40028: <00000>
40003: <00003>  40029: <00000>
40004: <00004>  40030: <00000>
40005: <00005>  40031: <00000>
40006: <00006>  40032: <00000>
40007: <00007>  40033: <00000>
40008: <00008>  40034: <00000>
40009: <00009>  40035: <00000>
40010: <00010>  40036: <00000>
40011: <00000>  40037: <00000>
40012: <00000>  40038: <00000>
40013: <00000>  40039: <00000>
40014: <00000>  40040: <00000>
40015: <00000>  40041: <00000>
40016: <00000>  40042: <00000>
40017: <00000>  40043: <00000>
40018: <00000>  40044: <00000>
40019: <00000>  40045: <00000>
40020: <00000>  40046: <00000>
40021: <00000>  40047: <00000>
40022: <00000>  40048: <00000>
40023: <00000>  40049: <00000>
40024: <00000>  40050: <00000>
40025: <00000>
40026: <00000>
```

Figure 1.10: New values written and read back, Quickstep registers 1 to 5, Modbus 1 to 10

Should any errors occur a Modbus exception will occur. One such common error is attempting to read too many registers or illegal registers. Below is what is returned if > 50 Modbus registers are attempted:

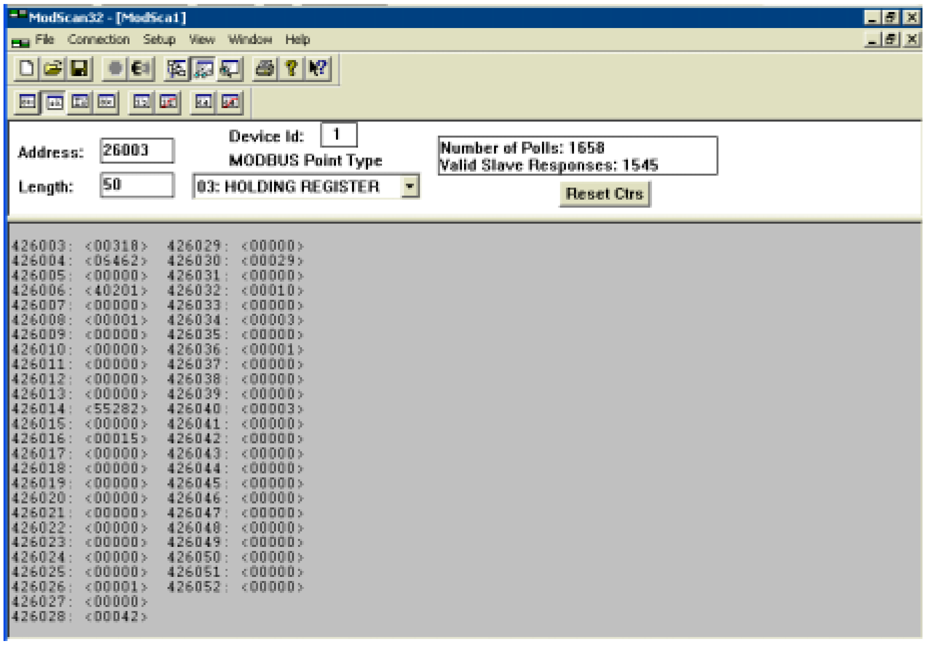


```
Address:  0001        Device Id: 1            Number of Polls: 1459
                      MODBUS Point Type       Valid Slave Responses: 1440
Length:   75          03: HOLDING REGISTER
                                              Reset Ctrs

** MODBUS Exception Response from Slave Device **
40001: <00001>  40027: <00000>  40053: <00000>
40002: <00002>  40028: <00000>  40054: <00000>
40003: <00003>  40029: <00000>  40055: <00000>
40004: <00004>  40030: <00000>  40056: <00000>
40005: <00005>  40031: <00000>  40057: <00000>
40006: <00006>  40032: <00000>  40058: <00000>
40007: <00007>  40033: <00000>  40059: <00000>
40008: <00008>  40034: <00000>  40060: <00000>
40009: <00009>  40035: <00000>  40061: <00000>
40010: <00010>  40036: <00000>  40062: <00000>
40011: <00000>  40037: <00000>  40063: <00000>
40012: <00000>  40038: <00000>  40064: <00000>
40013: <00000>  40039: <00000>  40065: <00000>
40014: <00000>  40040: <00000>  40066: <00000>
40015: <00000>  40041: <00000>  40067: <00000>
40016: <00000>  40042: <00000>  40068: <00000>
40017: <00000>  40043: <00000>  40069: <00000>
40018: <00000>  40044: <00000>  40070: <00000>
40019: <00000>  40045: <00000>  40071: <00000>
40020: <00000>  40046: <00000>  40072: <00000>
40021: <00000>  40047: <00000>  40073: <00000>
40022: <00000>  40048: <00000>  40074: <00000>
40023: <00000>  40049: <00000>  40075: <00000>
40024: <00000>  40050: <00000>
40025: <00000>  40051: <00000>
40026: <00000>  40052: <00000>
```

Figure 1.11: Modbus Exception Example > 50 registers

Editing the 75 appropriately will update the error. Below is an example of displaying registers in the 13002 block of the controller. 13002 is the system tic counter, real time clock/date values can also be seen incrementing in other register dynamically. Note that 26003 is the high 16 bits of 13002 and 26004 (13002 X 2) is the base lower 16 bits.



Address: 26003
Length: 50
Device Id: 1
MODBUS Point Type: 03: HOLDING REGISTER
Number of Polls: 1658
Valid Slave Responses: 1545

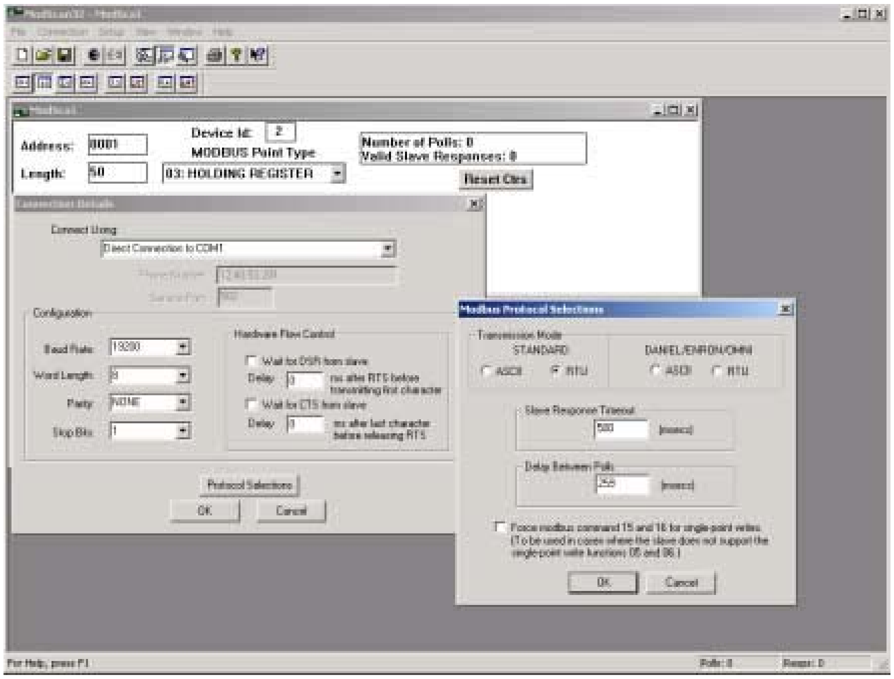
```
426003: <00318>  426029: <00000>
426004: <05462>  426030: <00029>
426005: <00000>  426031: <00000>
426006: <40201>  426032: <00010>
426007: <00000>  426033: <00000>
426008: <00001>  426034: <00003>
426009: <00000>  426035: <00000>
426010: <00000>  426036: <00001>
426011: <00000>  426037: <00000>
426012: <00000>  426038: <00000>
426013: <00000>  426039: <00000>
426014: <55282>  426040: <00003>
426015: <00000>  426041: <00000>
426016: <00015>  426042: <00000>
426017: <00000>  426043: <00000>
426018: <00000>  426044: <00000>
426019: <00000>  426045: <00000>
426020: <00000>  426046: <00000>
426021: <00000>  426047: <00000>
426022: <00000>  426048: <00000>
426023: <00000>  426049: <00000>
426024: <00000>  426050: <00000>
426025: <00000>  426051: <00000>
426026: <00001>  426052: <00000>
426027: <00000>
426028: <00042>
```

Figure 1.12: Display of 5100 system tic, dynamically updating

Modbus Serial RTU

The Modbus Serial RTU protocol functions exactly like that of Modbus TCP with regards to how to access information and ModScan32 operation (see figure 1.13 for serial port setup versus TCP). There are some key differences since an RS232 connection is used versus a network connection. They are as follows:

1. Only COM1 can be used for the Modbus Serial RTU protocol. COM2 uses an intelligent controller chip that does not currently support the protocol. COM2 support may be added in the future.
2. The virtual TCP communication ports (when interacting with a terminal server) may also be used but only for point to point operations with a single address present. In other words the communications traffic of other Modbus nodes should not be present (can be on COM1). This is necessary because Modbus specifies a 3.5 character quiet time between packets and a maximum of 1.5 intercharacter delay during the continuous transmission of a packet data stream. The virtual ports cannot guarantee these timing constraints, although from a high level protocol viewpoint, the ports do comply.
3. By default the Modbus protocol is disabled on the serial and virtual ports at power-up. To enable the port it must be the active port in the 12000 register and the Modbus Slave address value must be written to register 12320. Note that by default the slave port address is 2 and that any value written as the Modbus slave address will be that used on all serial ports, system wide. Note that writing a value of 0 to 12320 will disable Modbus on that port only and not affect the system wide address.
4. When Modbus is enabled on a serial port using CTCMON no further communications will be available on that port except with Modbus. In other words you will lose your CTCMON link if talking on the same port.



Address: 0001
Device Id: 2
MODBUS Point Type: 03: HOLDING REGISTER
Length: 50
Number of Polls: 0
Valid Slave Responses: 0

Connect Using: Direct Connection to COM1

Configuration
Baud Rate: 19200
Word Length: 8
Parity: NONE
Stop Bits: 1

Hardware Flow Control
□ Wait for DSR from slave
Delay 0 ms after RTS before transmitting first character
□ Wait for CTS from slave
Delay 0 ms after last character before releasing RTS

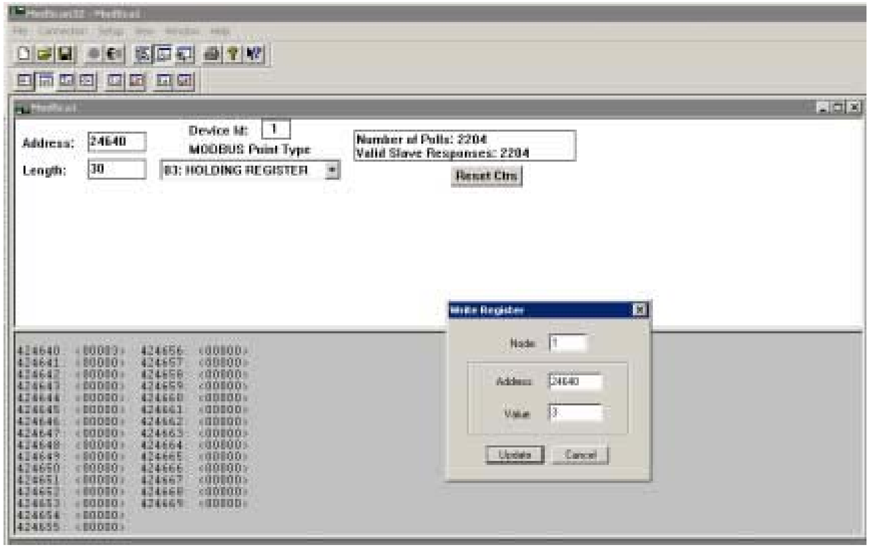
Transmission Mode
STANDARD ○ ASCII ● RTU
DANIEL/ENRON/OMNI ○ ASCII ○ RTU

Slave Response Timeout: 500 (msecs)
Delay Between Polls: 250 (msecs)

□ Force modbus command 15 and 16 for single-point writes. (To be used in cases where the slave does not support the single-point write functions 05 and 06.)

Figure 1.13: ModScan32 Master Scanning Program Serial Connection Setup

Since at power up Modbus is disabled on the COM1 serial port, it must be enabled by writing the desired Modbus address the 5100 is to respond to. This is written to register 12320. Typically done via a Quickstep program, for test purposes it can be also be done with CTCMON or in the test case presented here, via the Modbus TCP Connection. When done with the TCP connection simply do a write operation to Modbus address 24640 (12320 X 2) of the desire serial RTU address and COM1 will immediately respond to Modbus requests.



Address: 24640
Device Id: 1
MODBUS Point Type: 03: HOLDING REGISTER
Length: 30
Number of Polls: 2204
Valid Slave Responses: 2204

```
424640: <00003>  424656: <00000>
424641: <00000>  424657: <00000>
424642: <00000>  424658: <00000>
424643: <00000>  424659: <00000>
424644: <00000>  424660: <00000>
424645: <00000>  424661: <00000>
424646: <00000>  424662: <00000>
424647: <00000>  424663: <00000>
424648: <00000>  424664: <00000>
424649: <00000>  424665: <00000>
424650: <00000>  424666: <00000>
424651: <00000>  424667: <00000>
424652: <00000>  424668: <00000>
424653: <00000>  424669: <00000>
424654: <00000>
424655: <00000>
```

Write Register
Node: 1
Address: 24640
Value: 3

Figure 1.14: ModScan32 Master TCP changing RTU serial address to 3

Above shows device address 3 being written to Modbus register 24620, thereby setting the address for COM1 to respond to. Device ID #1 is connected via TCP.

Test Summary

1. Visit www.win-tech.com and download/install ModScan32 per their instructions.
2. Install CTCMON and set the appropriate IP address, subnet mask, and gateway (if needed) within the Model 5100 via the serial port. Details are below for the proper register settings:

   ### *Assigning IP Address, Subnet Mask, and Gateway Address*

   To communicate using UDP, TCP/IP, or Modbus/TCP, an IP address and Subnet Mask must be set on the controller. If the controller is to communicate with devices that are not part of the local subnet, then a Gateway Address must also be set. To determine the IP address to be used, consult your IT department.

   a. Set the IP Address in 20048-20051
      If IP Address is 12.40.53.200:
      20048 = 12
      20049 = 40
      20050 = 53
      20051 = 200
   b. Set the Subnet Mask in 20064-20067:
      If Subnet Mask is 255.255.0.0:
      20064 = 255
      20065 = 255
      20066 = 0
      20067 = 0
   c. Set the Gateway, 20080-20083, a gateway of 0 (default), disables it.
      Gateway 12.40.53.204
      20080 = 12
      20081 = 40
      20082 = 53
      20083 = 204
   d. After setting the appropriate IP information write a 1 to register 20096 (this may respond with an error, that is normal and can be ignored). This writes the new values to Flash (and deletes the 5100.ini file).
   e. Cycle the controller power. Changes will be effective on power up.
3. Invoke ModScan32 and configure as per figure 1.2 and 1.3 for TCP operation.
4. With TCP communications established poke the Serial RTU address into Modbus register 24620. This is done by double clicking that address on the ModScan32 screen whereupon the Write Register dialog will appear, figure 1.14. COM1 is now running the RTU Serial protocol and will only respond to the address value entered. Make sure you are set for Holding Registers and the Length field is less than or equal to 50.
5. Invoke another copy of ModScan32 on the same or different computer, with the serial port (COM1) connected to the 5100. Configure as per figure 1.13.
6. Modify values as desired by double clicking the screen. As changes are made via RTU serial they will appear on the TCP side, and vice versa.