Tolomatic™
EXCELLENCE *IN MOTION*

MODBUS RTU & TCP PROGRAMMER'S GUIDE

ACSI Servo Motor/Drive/Controller, ACS Servo & Stepper Drives

ACS Servo Drive, ACS Stepper Drive and ACSI Motor/Drive/Controller are DISCONTINUED. Replacements are not available. Use this manual for reference only.

Modbus

3600-4169_16

LINEAR SOLUTIONS MADE EASY

202210051606

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Modbus Overview 1

NOTE: This document is intended to provide information on the Modbus TCP protocol. Please reference the ACS Hardware/Installation Guide for all electrical and hardware installation, specifications and safety instructions.

1.1 Introduction

Modbus is an application layer messaging protocol, positioned at level 7 of the OSI model, that provides client/server communication between devices connected on different types of buses or networks. The Modbus protocol is a primary protocol for connection with variety of control devices including human machine interfaces (HMI), building management systems, industrial automation systems and PLCs. Tolomatic ACS Drive supports the Modbus TCP protocol which is Modbus protocol implemented over TCP/IP. Modbus TCP implementation facilitates multiple concurrent connections between Tolomatic ACS Drive and HMI/PLC devices.

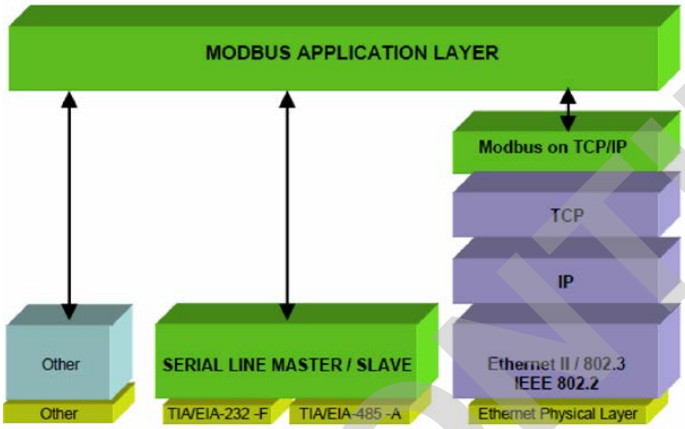

Figure 1-1: Modbus Application Layer

1.2 Network

A typical Modbus network has one master and one or more slave devices. A typical network in the factory would comprise of variety of complex devices such as HMIs, PLCs, motion controllers, bar code scanners to simple devices such as I/O. This configuration is represented in Figure 1-2.

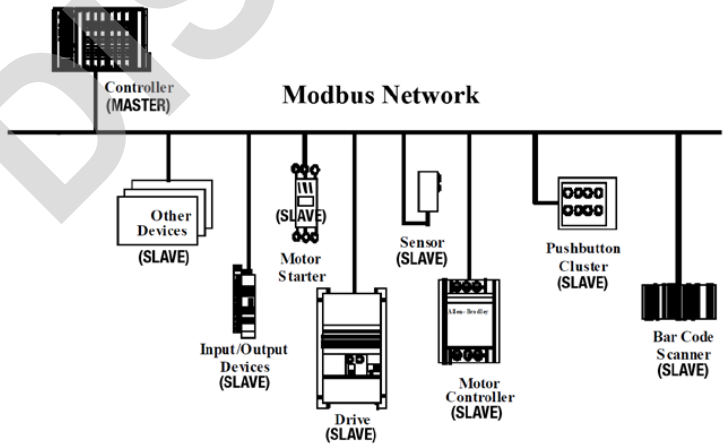

Figure 1-2: Modbus TCP Network Example

1.3 Definitions

Master (Client) – A Modbus Master (Client) is a device that uses services from Modbus Slave (Server) to perform tasks. Modbus Master (Client) is also the initiator of the request to which Modbus Slave (Server) reacts. HMI/PLCs are master devices in the Modbus network.

Slave (Server) – A Modbus Slave (Server) is a device that performs tasks that Modbus Master (Client) requests. Modbus Slave (Server) is also waiting for requests from Modbus Master (Client). The ACS Drive and controller is a slave device in the Modbus network.

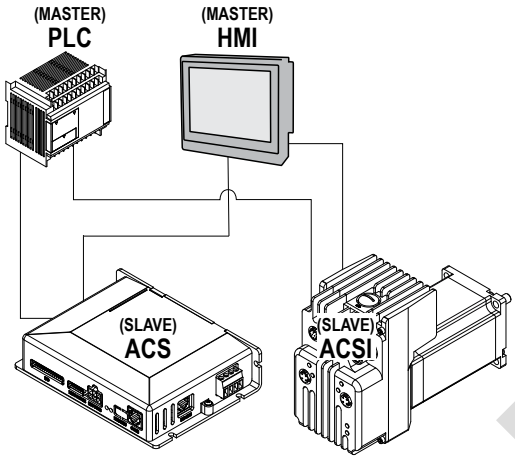

Figure 1-3: ACS or ACSI Drive as an Adapter Device.

Discrete Input – A discrete Input is single bit of read-only data provided by I/O system.

Coils – Coils are single bit read/write data that is alterable by an application program.

Input Registers – Input Registers are 16-bit, read-only data that can be provided by I/O system.

Holding Registers – Holding Registers are 16-bit, read/write data that can be altered by an application program.

1.4 References

[1] Modbus Application Protocol Specifications V.1.1.6 by Modbus - IDA

[2] Modbus Messaging on TCP Implementation Guide, Rev. 1.0b by Modus - IDA

[3] Modbus over Serial Line Specifications and Implementation Guide, V.1.02

ACS Modbus RTU Requirements 2

2.1 Definitions

ACS Drive & Controller comes in two configurations, Basic and Network (Ethernet). The basic drives have Modbus RTU capability. The network drives are Ethernet capable and support EtherNet/IP and Modbus TCP. The ACSI does not support Modbus RTU, however it does support Ethernet protocols. Refer to the following table for further clarification.

DESCRIPTION	MODEL	PART NUMBER	PROTOCOL SUPPORTED
ACS Stepper	ST1048 UD	3604-9665	Modbus RTU
ACS Stepper	ST1048 MD	3604-9667	Modbus TCP
ACS Servo	SV2048 UD	3604-9661	Modbus RTU
ACS Servo	SV2048 MD	3604-9663	Modbus TCP
ACSI Servo	ACSI23-1Q1-M ACSI34-1Q1-M	3604-9740 3604-9770	Modbus TCP

Table 2-1: ASC/ACSI protocols supported

2.2 RS-485 Cabling

Th ACS Stepper and Servo drive use standard RJ45 connectors and network CAT5 syle cables. ACSI uses circular M12 D-code 4 pin connectors. Please refer to the hardware manuals for further cable information. See appendix for network cable type and length specification.

DESCRIPTION	LITERATURE NUMBER
ACS Stepper Hardware and Installation Guide	3604-4183
ACS Servo Hardware and Installation Guide	3604-4181
ACSI Servo Hardware and Installation Guide	3604-4185

Table 2-2: ACS/ACSI Hardware and Installation Guides

2.3 Tolomatic Motion Interface (TMI) Requirement

The TMI is used to configure the ACS Drive including setting up communication.

PC HARDWARE MINIMUM REQUIREMENT	
Processor	1 GHz
RAM	512 MB
Disk Space	32-Bit 600 MB
Disk Space	64-Bit 1.5 GB
USB 2.0	1 USB Connection

Table 2-3: Hardware Requirements

The Tolomatic Motion Interface (TMI) is compatible with the following operating systems: Windows® 8, Windows® 7 and Windows® XP.

For all platforms, it is recommended that you upgrade to the latest Windows Service Pack and critical updates from the Windows Update Web Site at http://go.microsoft.com/fwlink/?LinkId=168461 to ensure the best compatibility and security.

The TMI software is not supported on IA-64-based (Itanium) systems.

2.4 Firmware Requirements

All firmware versions support these features.

3.1 Configuring Modbus RTU Mode (ACS Servo & Stepper Only)

ACS Drive configuration for Modbus RTU is a 3 step process:

1. Using Tolomatic Motion Interface (TMI) assign Modbus ID and baud rate.
2. (Optional) Power cycle the drive, if baud rate is changed from the default.
3. Using Tolomatic Motion Interface (TMI) set the drive to Modbus RTU mode.

For information related to setup or installation of Tolomatic Motion Interface please refer to the TMI User Manual.

Once the ACS Drive has been configured for the desired Actuator and Motor, Modbus RTU mode can be configured as desired communication option. User must setup Modbus Device ID (drop number) and baud rate. ACS Drive currently supports following serial configs:

SERIAL CONFIG	
Baud:	9600, 19200, 38400
Parity:	None
Stop Bits:	1
DTR Control:	Disabled
RTS Control:	Disabled
Word Length:	8

Table 3-1: Serial configuration

Figure 3-1 Configuring Device ID and Baud for Modbus RTU

Modbus Device ID can be changed from 0 to 247 inclusive. Changes in Modbus device ID take effect when user navigates away from Mode Setup tab.

Changes in the baud rate are effective after power cycling the ACS drive. TMI displays a note to the user as shown in Figure 3-2.

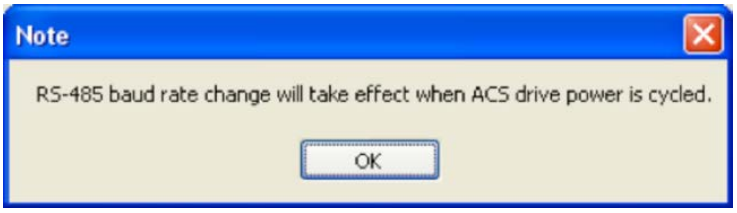

Figure 3-2 Modbus RTU Configuration Change Warning

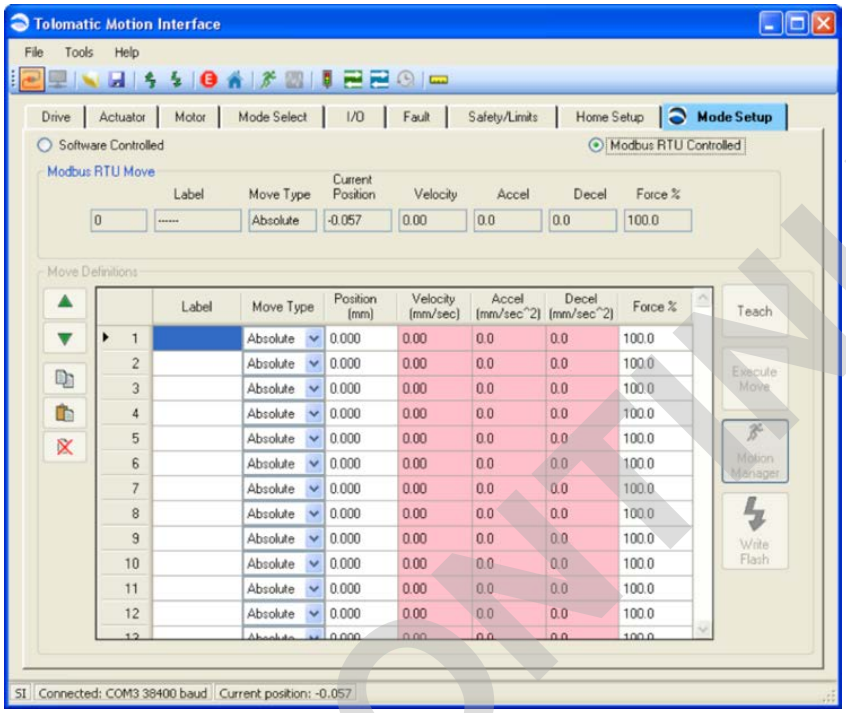

Figure 3-3 Modbus RTU Controlled

When Mode Select is configured for Modbus RTU operation, the Mode Setup tab will allow setup of up to 16 moves. The Modbus RTU Move GroupBox displays the most recently commanded move. Please note that the Current Position is displayed instead of the Position from the move table or the position sent over Modbus RTU. The reason for this is to be able to track the absolute position at all times. Move number 0 indicates a move commanded by the TMI Motion Manager or the Modbus RTU connection.

When the TMI user presses the Modbus RTU Controlled radio button in control indicator (as seen on the Drive Status Tool) will turn off and the TMI controls will be disabled. This keeps the TMI user from changing parameter values while the Modbus RTU is commanding movement.

When Modbus RTU is in control, the controls in the Mode Setup tab's Modbus RTU Move GroupBox show the most recent move commanded by the Modbus RTU master. Note that rather than displaying the commanded position, the Current Position is displayed. To return control to the TMI host, either press the Software Controlled radio button, or select one of the tabs other than Mode Setup.

Configuring ACS Drive for Modbus TCP 4

ACS Drive Configuration for Modbus TCP is a 2 step process:

1. Using Tolomatic Motion Interface (TMI), assign an IP Address, Subnet Mask and Gateway.
2. Using TMI set the drive to Modbus TCP mode.

For information related to setup or installation of Tolomatic Motion Interface, please refer to TMI User Manual.

4.1 Setup IP Address

Depending on your ACS Drive Type, you may have different configuration options for the Configure Ethernet tool menu. For more specifics about the various functions, see the Tolomatic Motion Interface User Manual.

Choose the Tools -> Ethernet menu selection or press the Configure Ethernet button in the toolstrip.

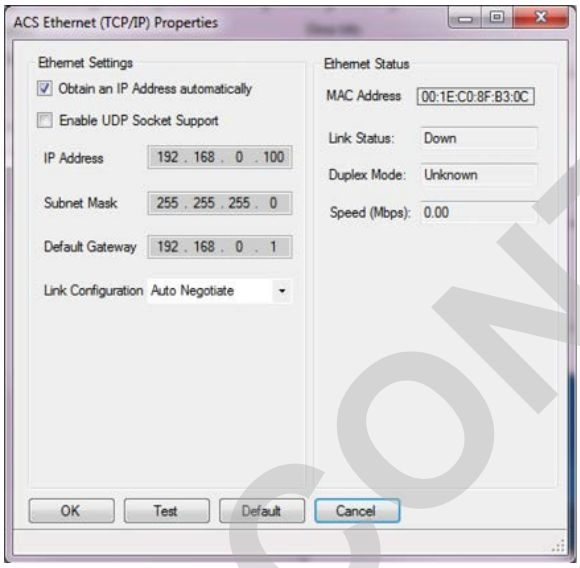

Figure 4-1: Ready to Manually Enter the IP Address

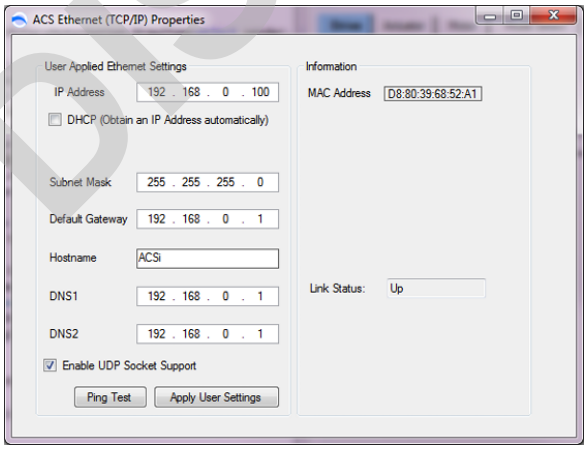

Figure 4-2: Ready to Manually Enter the IP Address for ACSI -MBTCP

Enter the IP address, Subnet Mask and Default Gateway parameters for the network. (The values shown above are the factory default values for the ACS drive. Typically, at least the IP address and Default Gateway will need to be changed for the network.)

To test the Ethernet settings, the Test button can be used to download the Ethernet settings to the ACS drive and when the Test button is pressed, TMI will download the settings to the ACS drive and initiate the PC to Ping the drive.

NOTE: An Ethernet cable must be connected from the PC to the ACS drive.

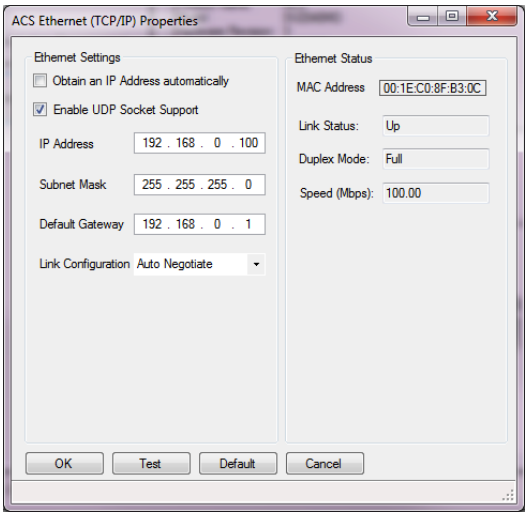

Figure 4-3: A Manually Entered IP Address, Ready to Test

If the Test worked, a screen will pop-up showing similar results to the following.

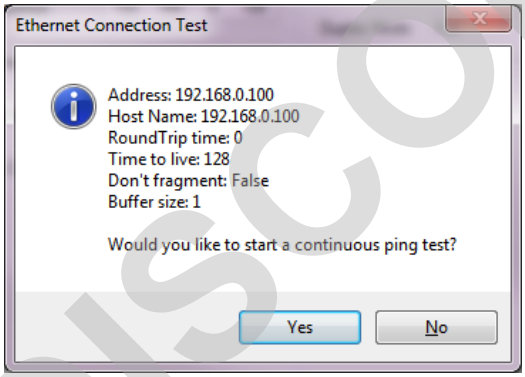

Figure 4-4: Testing Verifies a Successful Ethernet Connection

If the Test didn't work, (in this example, the Ethernet cable was unplugged from the ACS drive) an error dialog will be shown.

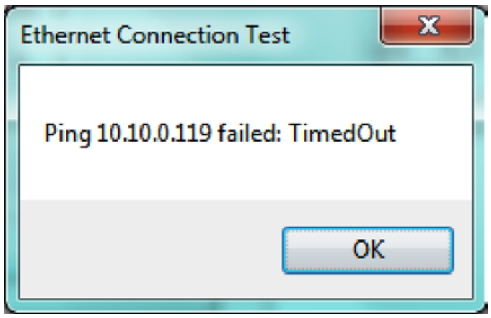

Figure 4-5: Testing Indicates a Failed Attempt for Ethernet Connection

To configure the ACS drive for a DHCP server in order to dynamically assign an IP Address:

- check the “Obtain an IP address automatically” checkbox
- click OK on the ACS Internet Protocol (TCP/IP) Properties dialog
- click the Disconnect button on the TMI Drive tab (or press the Disconnect from Drive button on the toolstrip)
- click Yes when asked “Update drive flash memory?”
- cycle ACS drive power (turn off then turn on)
- press the Connect button on the TMI Drive tab (or press the Connect to Drive button on the toolstrip)

When the Ethernet configuration tool is opened, the status bar informs the status of the DHCP address configuration process. This is not dynamically updated. To see the current status, press Cancel (or OK), wait a few seconds, then reopen this tool.

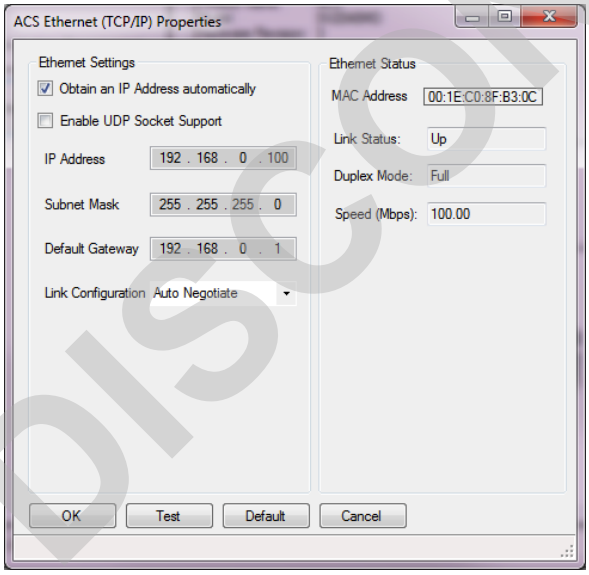

Figure 4-6: Obtaining an IP Address Automatically

If there is a problem and the ACS drive is unable to get an IP address from the DHCP server, the status bar will display the error message.

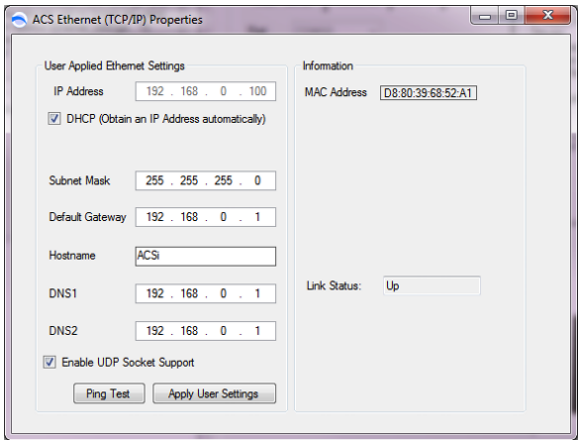

Figure 4-7: Failed DHC Configuration

When Ethernet configuration is complete, press OK.

4.2 Configure Modbus TCP Mode

Once the ACS Drive is correctly setup with IP address, mask and gateway, master Modbus devices can read data from the ACS Drive. By putting ACS Drive in Modbus TCP mode, the ACS drive is ready to accept commands from the Modbus master device.

In TMI, go to the Mode Select tab and select the Modbus TCP radio button as shown here:

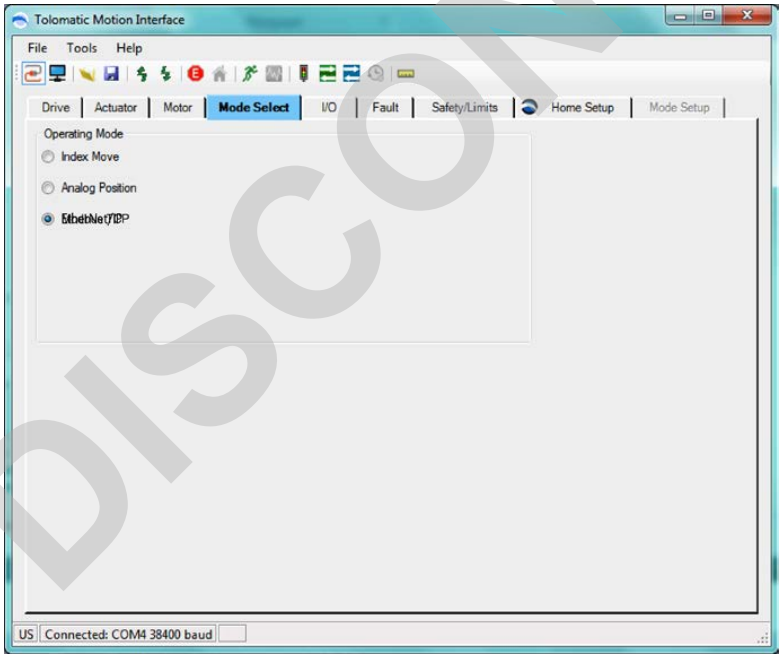

Figure 4-8: Selecting Operating Mode of ACS Drive

Clicking on any other tab or navigating away from the Mode Select tab will configure the ACS drive for Modbus TCP mode.

At this point, the ACS Drive is ready to be integrated with any master Modbus device.

5.1 Data Format

The ACS Drive and Modbus interface uses single-precision, 32-bit real numbers and 32-bit integer numbers in little endian format. Therefore, the PLC must write 32-bit hexadecimal value 0x12345687 as 2 separate 16-bit words: 0x5678 0x1234

DATA TYPE	DESCRIPTION
BOOLEAN	Individual Bit
INTEGER	Bit String (16-bits)
LONG	**Bit String (32-bits)
FLOAT	**IEEE 32-bit Single Precision Floating Point

****32-bit LONG or 32-Bit FLOAT are word swapped.**

Table 5-1: Data Types

5.2 Unit Number

Default unit number is 1;

6.1 Read Coils (01)

⚠ NOT SUPPORTED ON ACSI - MBTCP

This function code is used to read contiguous status of coils in the ACS Drive as shown in Table 6-1.

COIL(S)	DESCRIPTION	DATA TYPE	READ / WRITE
100	DIGITAL INPUT #1	BOOLEAN	Read Only
101	DIGITAL INPUT #2	BOOLEAN	Read Only
102	DIGITAL INPUT #3	BOOLEAN	Read Only
103	DIGITAL INPUT #4	BOOLEAN	Read Only
104	DIGITAL INPUT #5	BOOLEAN	Read Only
105	DIGITAL INPUT #6	BOOLEAN	Read Only
106	DIGITAL INPUT #7	BOOLEAN	Read Only
107	DIGITAL INPUT #8	BOOLEAN	Read Only

Table 6-1: Modbus Input Coils

6.2 Read Holding Register (03)

NOTE: Drive may not respond to invalid inputs.

This function code is used to read the contents of holding registers from in ACS Drive. Use the appropriate register table (6-2 or 6-3) for the part number of the ACS drive.

FOR ACS STEPPER & ACS SERVO (NOT ACSI)				
4X REGISTER(S)	**REGISTER(S)**	**DESCRIPTION**	**DATA TYPE**	**READ / WRITE**
414001	14001	Commands 0 = Disable Drive 5 = Home 1 = Enable Drive 8 = E-Stop 3 = Start Motion 17 = Stop	INTEGER	Read/Write
414002	14002	Move Select (0-16)	INTEGER	Read/Write
414003-414004	14003-14004	Target 0 Position (mm)	FLOAT	Read/Write
414005-414006	14005-14006	Target 0 Velocity (mm/s)	FLOAT	Read/Write
414007-414008	14007-14008	Target 0 Acceleration (mm/s^2)	FLOAT	Read/Write
414009-414010	14009-14010	Target 0 Deceleration (mm/s^2)	FLOAT	Read/Write
414011-414012	14011-14012	Target 0 Force (% of max)	FLOAT	Read/Write
414013	14013	**Reserved	INTEGER	NA
414014	14014	Target 0 Motion Type (Absolute or Incremental) Value / Motion Type: 0 Absolute; 1 Incremental Positive; 2 Incremental Negative; 5 Home; 6 No Action; 9 Force; 11 Incremental Positive (Rotary); 12 Incremental Negative (Rotary); 13 Velocity Forward (Rotary); 14 Velocity Reverse (Rotary); 16 Stop Move	INTEGER	Read/Write
414015	14015	**Reserved	INTEGER	NA
414016	14016	Digital Output Control Register (Only available if output is not configured in TMI) 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 Brake Output[1,2] Digital Output Control Register (Only available if output is not configured in TMI) 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 Digital Output 4[1] Digital Output 3[1] Digital Output 2 Digital Output 1	INTEGER	Read/Write

[1]Available only on ACS Stepper and ACS Servo Drives

[2]Only available when brake output is not configured in TMI

Table 6-2: Modbus Holding Registers for ACS Part # 3604-9661, 3604-9663, 3604-9665, 3604-9667

<table>
<tr><th colspan="5">FOR ACSI (NOT ACS STEPPER & ACS SERVO)</th></tr>
<tr><th>FUNCTION CODE</th><th>4X REGISTER(S)</th><th>REGISTER(S)</th><th>TYPE</th><th>VALUE</th></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404001</td><td>4001 LSB</td><td>UINT (8 BYTES)</td><td>Command
<table><tr><th>Value</th><th>Command</th></tr><tr><td>0</td><td>Disable / Clear</td></tr><tr><td>1</td><td>Enable / Clear</td></tr><tr><td>3</td><td>Start Motion</td></tr><tr><td>5</td><td>Home</td></tr><tr><td>8</td><td>Software Stop (E Stop)</td></tr><tr><td>9</td><td>Software Stop (E Stop)</td></tr><tr><td>17</td><td>Stop Motion (Using Profile Decel)</td></tr><tr><td>21</td><td>Home Here</td></tr></table></td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404001</td><td>4001 MSB</td><td>UINT (8 BYTES)</td><td>Move Select (0-16)</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404002</td><td>4002</td><td>---------</td><td>RESERVED</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404003-404004</td><td>4003-4004</td><td>REAL (FLOAT)</td><td>Target Position (For Move Select 0) (mm)</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404005-404006</td><td>4005-4006</td><td>REAL (FLOAT)</td><td>Target Velocity (For Move Select 0) (mm/s)</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404007-404008</td><td>4007-4008</td><td>REAL (FLOAT)</td><td>Target Acceleration (For Move Select 0) (mm/s^2)</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404009-404010</td><td>4009-4010</td><td>REAL (FLOAT)</td><td>Target Deceleration (For Move Select 0) (mm/s^2)</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404011-404012</td><td>4011-4012</td><td>REAL (FLOAT)</td><td>Target Force (For Move Select 0) (% of max)</td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404013-404014</td><td>4013-4014</td><td>LONG (DWORD)</td><td>Target Motion Type (For Move Select 0)
<table><tr><th>Value</th><th>Motion Type</th></tr><tr><td>0</td><td>Absolute</td></tr><tr><td>1</td><td>Incremental Positive</td></tr><tr><td>2</td><td>Incremental Negative</td></tr><tr><td>5</td><td>Home</td></tr><tr><td>6</td><td>No Action</td></tr><tr><td>9</td><td>Force</td></tr><tr><td>11</td><td>Incremental Positive (Rotary)</td></tr><tr><td>12</td><td>Incremental Negative (Rotary)</td></tr><tr><td>13</td><td>Velocity Forward (Rotary)</td></tr><tr><td>14</td><td>Velocity Reverse (Rotary)</td></tr><tr><td>16</td><td>Stop Move</td></tr></table></td></tr>
<tr><td>Write Single (6)
Write Multiple (16)
Read (3)</td><td>404015-404016</td><td>4015-4016</td><td>LONG (DWORD)</td><td>Digital Output (2 bits used out of 16)</td></tr>
</table>

Table 6-3: Modbus Holding Registers for ACSI - MBTCP

6.3 Read Input Status (04)

This function code is used to read contiguous input registers from the ACS Drive. Use the appropriate register table (6-4 or 6-5) for the part number of the ACS drive.

FOR ACS STEPPER & ACS SERVO (NOT ACSI)				
3X REGISTER(S)	**REGISTER(S)**	**DESCRIPTION**	**DATA TYPE**	**READ / WRITE?**
304001-304002	4001-4002	Current Position	FLOAT	Read Only
304003-304004	4003-4004	Drive Status (32 bitmap statuses)	LONG	Read Only
304005-304006	4005-4006	Drive Faults (32 bitmap faults)	LONG	Read Only
304007	4007	**Reserved	INTEGER	Read Only
304008	4008	Digital Input (8 bits used out of 32)	INTEGER	Read Only
304009	4009	**Reserved	INTEGER	Read Only
304010	4010	Digital Output (4 bits used out of 32) (ACS has 4 digital outputs)	INTEGER	Read Only
304011-304012	4011-4012	Analog Input (32-bit) (Remappable Register 1*)	FLOAT	Read Only
304013-304014	4013-4014	Analog Output (32-bits) (Remappable Register 2*)	FLOAT	Read Only

*As of ACS Stepper Firmware Version 1.8 +
ACS Servo Firmware Version 1.20 +

Table 6-4: Modbus Input Registers for ACS Part # 3604-9661, 3604-9663, 3604-9665, 3604-9667

<table>
<tr><th colspan="5">FOR ACSI (NOT ACS STEPPER & ACS SERVO)</th></tr>
<tr><th>FUNCTION CODE</th><th>3X REGISTER(S)</th><th>REGISTER(S)</th><th>TYPE</th><th>VALUE</th></tr>
<tr><td>Read (4)</td><td>304001-304002</td><td>4001-4002</td><td>REAL (FLOAT)</td><td>Current Position (mm)</td></tr>
<tr><td>Read (4)</td><td>304003-304004</td><td>4003-4004</td><td>LONG (DWORD)</td><td>Drive Status
<table>
<tr><th>Bit</th><th>Value</th></tr>
<tr><td>0</td><td>Drive Enable: 0 = Not Enabled; 1 = Enabled</td></tr>
<tr><td>1</td><td>Drive Homed: 0 = Not Homed; 1 = Homed</td></tr>
<tr><td>2</td><td>Drive In Motion: 0 = Motion Complete; 1 = In Motion</td></tr>
<tr><td>3</td><td>Software Stop: 0 = OFF; 1 = ON</td></tr>
<tr><td>4-19</td><td>(internal use)</td></tr>
<tr><td>20</td><td>Brake Not Active (0 - Brake Active)</td></tr>
<tr><td>21-25</td><td>(internal use)</td></tr>
<tr><td>26</td><td>Drive In Position: 1 =In Commanded Position</td></tr>
<tr><td>27-30</td><td>(internal use)</td></tr>
<tr><td>31</td><td>Drive Control: 0 = OFF (I/O, CTROFF), 1 = ON (Host, CTRON)</td></tr>
</table></td></tr>
<tr><td>Read (4)</td><td>304005-304006</td><td>4005-4006</td><td>LONG (DWORD)</td><td>Drive Faults
<table>
<tr><th>Bit</th><th>Value</th></tr>
<tr><td>0</td><td>Positive Limit (Safety)</td></tr>
<tr><td>1</td><td>Negative Limit (Safety)</td></tr>
<tr><td>2</td><td>Software Stop (Safety)</td></tr>
<tr><td>3</td><td>Position Error (Safety)</td></tr>
<tr><td>4</td><td>Feedback Error (Critical)</td></tr>
<tr><td>5</td><td>Overcurrent (Critical)</td></tr>
<tr><td>6</td><td>Motor Over Temp (Critical)</td></tr>
<tr><td>7</td><td>Drive Over Temp (Critical)</td></tr>
<tr><td>8</td><td>Drive Over Voltage (Critical)</td></tr>
<tr><td>9</td><td>Drive Under Voltage (Critical)</td></tr>
<tr><td>10</td><td>Flash Error (Critical)</td></tr>
<tr><td>11</td><td>I2T Limit (Safety)</td></tr>
<tr><td>12</td><td>Short Circuit (Critical)</td></tr>
<tr><td>13</td><td>Watchdog Reset (Critical)</td></tr>
</table></td></tr>
<tr><td>Read (4)</td><td>304007-304008</td><td>4007-4008</td><td>LONG (DWORD)</td><td>Digital Input (4 bits used out of 32)</td></tr>
<tr><td>Read (4)</td><td>304009-304010</td><td>4009-4010</td><td>LONG (DWORD)</td><td>Digital Output (2 bits used out of 32)</td></tr>
<tr><td>Read (4)</td><td>304011-304012</td><td>4011-4012</td><td>REAL (FLOAT)</td><td>Analog Input (Remappable Register 1*)</td></tr>
<tr><td>Read (4)</td><td>304013-304014</td><td>4013-4014</td><td>REAL (FLOAT)</td><td>Analog Output (Remappable Register 2*)</td></tr>
</table>

*As of ACSI Firmware Version 1.7 +

Table 6-5: Modbus Input Registers for ACSI, ACSI-MBTCP

ACS STEPPER DRIVE REMAPPABLE REGISTERS
Analog Input (Default Register 1)
Analog Output (Default Register 2)
Actual Position
Actual Position Error (with encoder)
Actual Velocity
Profile Position
Profile Velocity
Profile Acceleration
Profile Deceleration
Bus Voltage
Board Temperature (Drive)
Digital Inputs
Digital Outputs

Table 6-6 – ACS Stepper Drive Remappable Registers

ACS SERVO DRIVE/ACSI REMAPPABLE REGISTERS
Analog Input (Default Register 1)
Analog Output (Default Register 2)
Actual Position
Actual Position Error
Actual Velocity
Actual Velocity Error
Actual Current
Commanded Position
Commanded Velocity (Trajectory)
I2T Accumulation Value*
I2T Limit*
Bus Voltage
Board Temperature (Drive)
Digital Inputs
Digital Outputs

* When I2T Accumulation value exceeds limit, I2T fault occurs. Accumulation happens any time motor is running

Table 6-7 – ACS Servo Drive/ACSI Remappable Registers

7.1 Write Single Coil (05)

⚠ NOT SUPPORTED ON ACSI

COIL(S)	DESCRIPTION	DATA TYPE	READ / WRITE?
1100	DIGITAL OUTPUT #1	BOOLEAN	Read/Write
1101	DIGITAL OUTPUT #2	BOOLEAN	Read/Write
1102	DIGITAL OUTPUT #3	BOOLEAN	Read/Write
1103	DIGITAL OUTPUT #4	BOOLEAN	Read/Write

Table 7-1: Modbus Output Coils

7.2 Write Single Register (06)

This function code is used to write a single holding register in the ACS Drive as shown in Table 6-2.

7.3 Write Multiple Coils (15)

⚠ NOT SUPPORTED ON ACSI

This function code is used to force each coil in a sequence of coils to either ON or OFF in the ACS Drive as shown in Table 7-1.

7.4 Write Multiple Registers (16)

This function code is used to write a block of contiguous registers in the ACS Drive as shown in Table 6-2.

Drive Status 8

Drive status bits are accessed by reading Drive Status register. The interpretation of bits is shown in Table 8-1.

Drive Status	
BIT	**DESCRIPTION**
0	Drive Enable: 0 = Not Enabled; 1 = Enabled
1	Drive Homed: 0 = Not Homed; 1 = Homed
2	Drive In Motion: 0 = Motion Complete; 1 = In Motion
3	Software Stop: 0 = OFF; 1 = ON
4-19	(internal use)
20	Brake Not Active (0 - Brake Active)
21-25	(internal use)
26	Drive In Position: 1 =In Commanded Position
27-30	(internal use)
31	Drive Control: 0 = OFF (I/O, CTROFF), 1 = ON (Host, CTRON)

Table 8-1: Drive Status Bits

Drive fault bits are accessed by reading Drive Faults register. The interpretation of bits is shown in Table 9-1.

0= No Fault; 1= Fault

Drive Faults		
BIT	**DESCRIPTION**	
0	Positive Limit	(Safety)
1	Negative Limit	(Safety)
2	Software Stop	(Safety)
3	Position Error	(Safety)
4	Feedback Error	(Critical)
5	Overcurrent	(Critical)
6	Motor Overtemperature	(Critical)
7	Drive Overtemperature	(Critical)
8	Drive OverVoltage	(Critical)
9	Drive UnderVoltage	(Critical)
10	Flash Error	(Critical)
11	I2t (Servo)	(Safety)
12	Short Circuit (Servo)	(Critical)
13	Watchdog	(Critical)
14	Velocity Error	(Safety)
15-31	**Reserved	

Table 9-1: Drive Fault Bits

ACSI LED Indicators		
MOD LED	**NET LED**	**SYSTEM STATUS**
Off	Off	Now Power / Configuration
Red	Red	Power Up / Connecting (IP Not OK, Link Down
Red	Off	Connecting (IP not OK, Link Up)
Green Flashing	Red	Run (IP not OK, Link Down)
Green Flashing	Green	Run (IP OK, Link Up)

Table 9-2: ACSI LED Indicators

Appendix

A.1 Troubleshooting

SYMPTOM/TROUBLE	POSSIBLE CAUSE/RESOLUTION
No Ethernet Communication	1. Check the Ethernet cable. 2. Verify the Ethernet cable is plugged in securely. 3. Incorrect combination of IP Address, Subnet Mask or Gateway. Check with your network administrator to determine correct combination. 4. Try a different Ethernet port on the drive.
No Modbus RTU or TCP Connectivity	1. Check the Modbus RTU or TCP register map supplied with ACS Drive to ensure it is correctly mapped into your PLC or HMI configuration. 2. **Modbus RTU:** Check pin map of ACS RS-485 port and pin map of Modbus master RS-485 port. Make sure correct pins from master are connected to ACS. 3. **Modbus TCP:** Check to see if Ethernet communication can be established with the drive using the PING utility. 4. Check to see if Digital Outputs can be set/reset using Modbus TCP Digital Output Register using the 4X Register Set command or Holding Register command. If the Digital Outputs of the drive cannot be set or reset, then troubleshoot the Serial or Ethernet communication. 5. **Modbus RTU:** Check the baud rate set in the drive and Modbus master. 6. Advanced Troubleshooting Tip: Check the Ethernet packets received and sent to the PLC from and to the drive. 7. Verify the Communications poll rate does not exceed 100 Hz (10ms). Faster rates can cause connectivity issues. If problems continue try decreasing the poll rate.
Motion cannot be executed over Modbus RTU or TCP	1. Check to see if Drive Status, Drive Faults, Digital Inputs and Outputs can be queried over Modbus RTU or TCP. If drive is not sending them, then troubleshoot the Serial or Ethernet communication. 2. Check drive to ensure it is configured with Modbus communication mode using the Tolomatic Motion Interface (TMI) Software. 3. Check if the Digital Outputs can be set/reset using the Modbus RTU or TCP Registers. If the Digital Outputs of the drive cannot be set or reset, then troubleshoot the Serial or Ethernet communication. 4. **Modbus RTU:** Check the baud rate set in the drive and baud rate of master. 5. Advanced Troubleshooting Tip: Try Modbus TCP scanning software to interface with Tolomatic ACS Drive.
ACSI fails to reconnect after a network disconnect in DHCP mode	DHCP Server's IP address lease time should be at least 24 hours. Any shorter time period could result in the drive failing to request an IP address after disconnection

Table A-1: Troubleshooting

A.2 Ethernet Cabling

The selection of cable has a profound impact on network performance and reliability. Selecting the correct cable requires an understanding of the environment where the cable is installed.

Due to high data rate and reliability considerations, at the minimum, Cat5e cables should be used with the ACS drive. If the cables are made on site, they must be tested to meet performance criteria set according to TIA/EIA-568-B standard. This cable definition is the general cable requirements for copper and fiber cabling installations.

EtherNet/IP specifications limit the channel to 100 meters or up to 90 meters horizontal wiring with two 5-meter patch cords. Some applications will require longer patch cords. In these applications, the total length of horizontal wiring must be adjusted to compensate for the added loss of each connector pair and additional patch cord length beyond 10m.

$$\mathbf{C} = \frac{(102\text{-}\mathbf{H})}{(1 + \mathbf{D})} \quad (1)$$

Where:

C is the maximum combined length (m) of the work area cable, equipment cable, and patch cord.

H is the length (m) of the horizontal cable (H + C ≤= 100 m).

D is a de-rating factor for the patch cord type (0.2 for 24 AWG UTP/24 AWG ScTP and 0.5 for 26 AWG ScTP). The derating factors are based on COMMERCIAL cables. Other constructions, such as high flex, may have different performance. Consult the manufacturer for information.

W is the maximum length (m) of the work area cable.

T is the total length of horizontal, patch and equipment cords.

The maximum stranded cable length is limited to 85m for the channel with the standard 20% derating for standard stranded cables.

WIRE TYPE VERSUS LENGTH					
	D	H	W	C	T
PATCH CABLE GAUGE	PATCH DERATING	HORIZONTAL LENGTH (H+C<=100M)	PATCH LENGTH	TOTAL LENGTH PATCH AND EQUIPMENT	TOTAL LENGTH OF PATCH, EQUIPMENT AND HORIZONTAL
#24	0.2	100	0	0	100
#24	0.2	0	80	85	85
#24	0.2	25	59	64	89
#24	0.2	50	38	43	93
#26	0.5	0	63	68	68
#26	0.5	25	46	51	76
#26	0.5	50	30	35	85
#26	0.5	100	0	0	100

Table A-2: Cable Wire Type Versus Cable Length

Please refer to Section 8-9.2.3.6 of the ODVA EtherNet/IP Standard v. 1.11 for additional information.

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