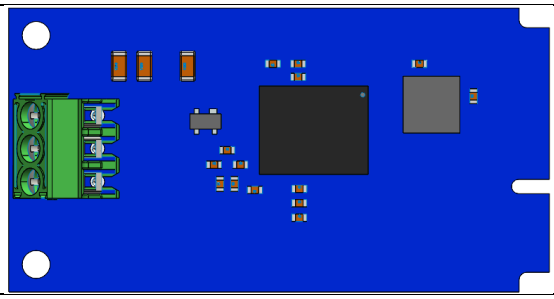
Installation and Operation Manual

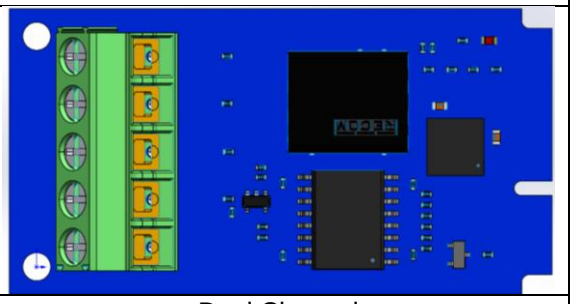
TMC4 Modbus Module
Single and Dual Channel Modbus RTU, Single Port ModbusTCP

1. Overview

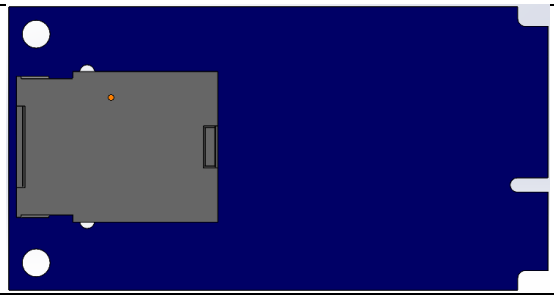
The Triac Modbus modules are a plug-in option module for use with the TMC4 controller providing communication with the TMC4 control card through Modbus RTU or ModbusTCP protocol. The TCP module, item TMC-4C006-002, is available with a single port connection. The RTU module is available in both a single isolated channel, item TMC-4C005-001, and dual isolated channel, item TMC-4C005-003. The dual channel module supports communication via two independent ports under one ID. This dual channel configuration is useful for operating physically redundant networks. Wiring, communication parameters, and best practices are all common between the single and dual channel module operation.



Single Channel
TMC-4C005-001



Dual Channel
TMC-4C005-003



ModbusTCP
TMC-4C006-002

1.1. Features

RTU Modules

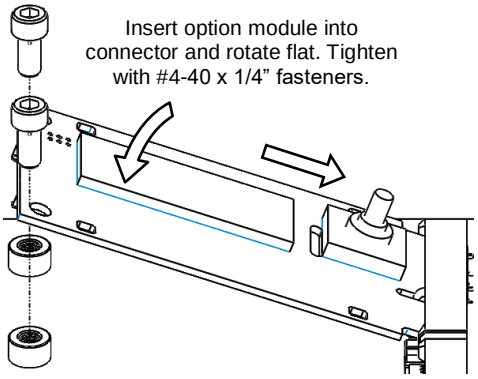
- Addresses from 1 to 246
- None, Odd or Even parity
- 9600, 19.2k, 57.6k, 115.2k baud rates

TCP Module

- IP parameters configurable via TMC4 menus or by terminal program with on-board USB connection
- Supports up to 8 concurrent connections.

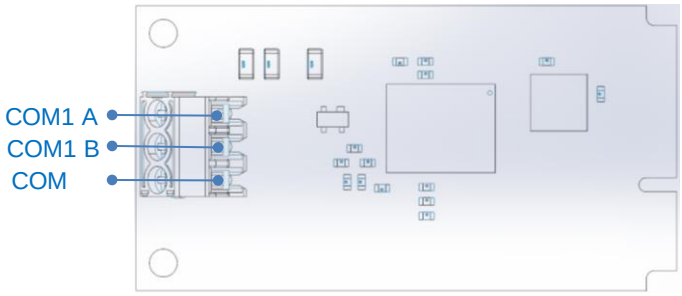
1.2. Installation

The TMC4 Modbus module is installed in the TMC4 control board option module slot using (2) 4-40 x 1/4" screws. Insert card edge in the mini PCI express connector and rotate module flat to secure with the screws.

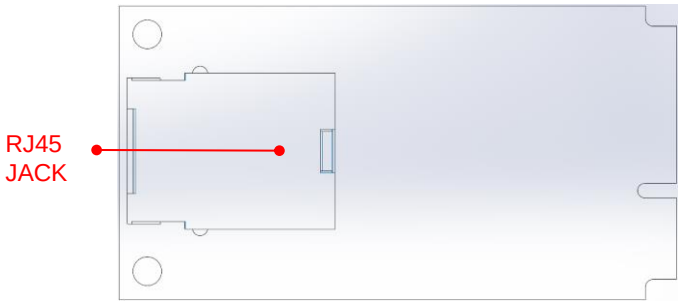


1.3. Wiring

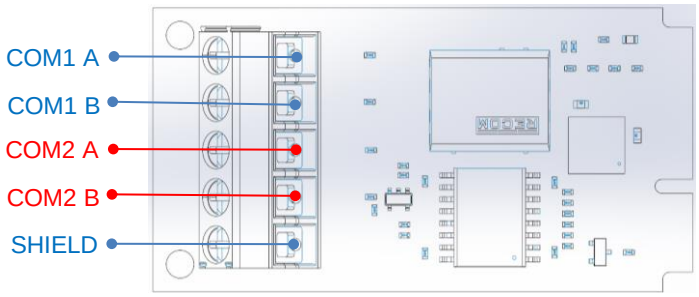
The wiring pinout for the RTU single channel and RTU dual channel module is shown below. The TCP module only requires RJ45 connection.



RTU Single Channel
TMC-4C005-001



ModbusTCP
TMC-4C006-002



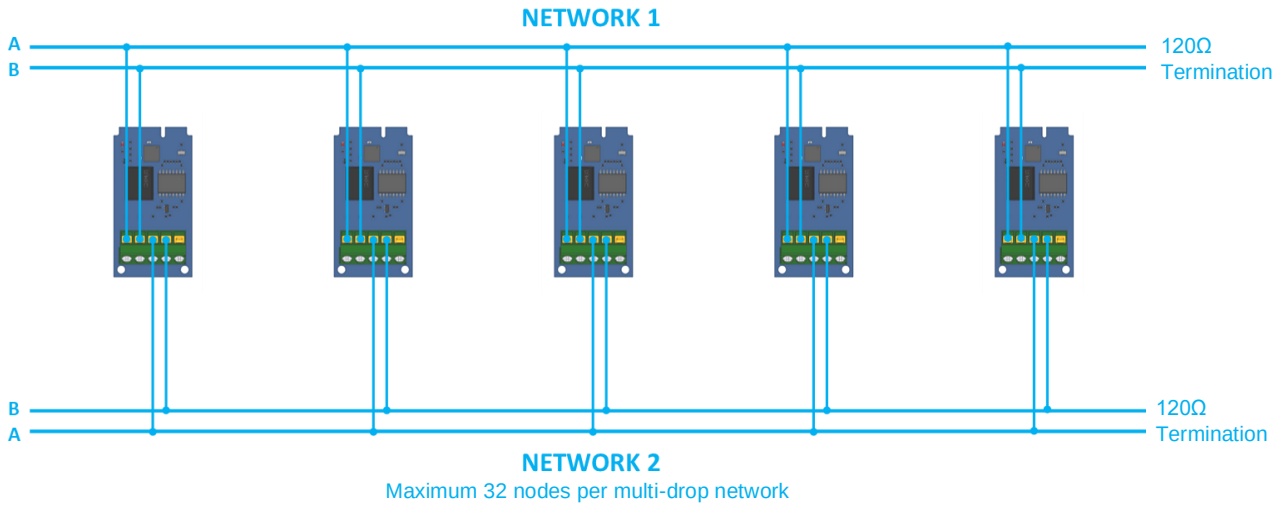
RTU Dual Channel
TMC-4C005-003

2. Network

Modbus RTU modules communicate over RS-485 network. For best results using either of the RTU modules, a RS-485 cable with recommended 120Ω characteristic impedance should be used for network wiring. For the dual channel RTU module, separate RS-485 communication cables must be used for both Network 1 and Network 2 as shown. For single channel RTU module, only Network 1 cabling is required.

A 120Ω termination resistance at master and last slave node on the network is required for best performance. Maximum number of nodes per multi-drop network should be limited to 32 nodes. If greater than 32 nodes are required on a network, repeaters should be utilized.

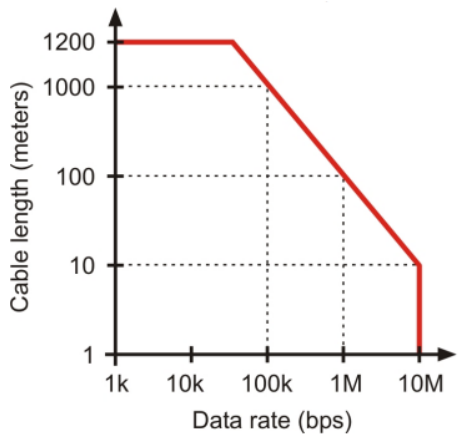
Polling nodes simultaneously on both ports for a dual channel network should be avoided. A minimum 500ms polling rate and delay of 20ms between polls of the same device on both channels is recommended.



ModbusTCP module implements the Modbus protocol onto a TCP/IP based communication. TCP module should be wired using standard Ethernet network components (switch etc.) and IT practices.

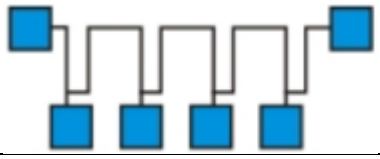
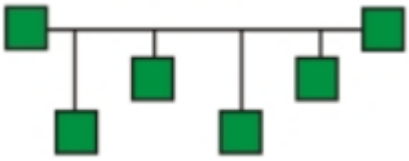
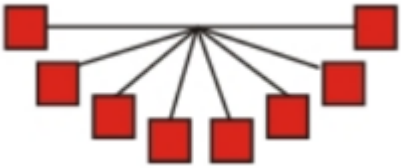
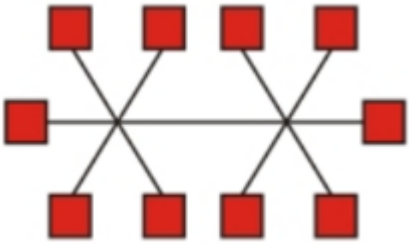
2.1. RTU Cable Length

The theoretical maximum cable length for RS-485 network is 1.2 km (3900 feet). This also includes the length of any network stubs used. Maximum cable length decreases as the data rate increases as shown below. Other considerations may decrease actual maximum cable length, such as characteristic impedance mismatch of cable to master.



2.2. Network Topology

The Modbus RTU module should be wired in either a daisy chain topology, or a bus/backbone with stubs for best results. If backbone with stubs topology is used, the length of stubs should be kept as short as possible. Star, ring, or combinations thereof, should be avoided. ModbusTCP module can be connected using any topology compatible with Ethernet networks such as star, ring, or combination thereof.

Network Type	RTU Module	TCP Module
Daisy Chain 	Yes	No
Bus or Backbone with Stubs 	Yes	No
Star 	No	Yes
Ring 	No	Yes
Backbone with Stars 	No	Yes

3. Setup

To operate with Modbus commands, the TMC4 controller must first be configured for Modbus RTU or ModbusTCP communication. Refer to TMC4 IOM for details.

- Set *Command Type* in the **COMMAND CONFIG** submenu to Comms.
- Set *Position Type* in the **POSITION CONFIG** submenu to either Limit Switch or Potentiometer depending on if on/off actuation or proportional/modulating actuation.
    - If operating as Potentiometer positioning, program the 0% and 100% positions in the *Calibrate Close* and *Calibrate Open* setting.
- Set *Communication Type* in the **COMMS CONFIG** submenu to Modbus RTU or ModbusTCP.
  Set communication settings such as unit address, baud rate and parity for RTU modules, and IP address, subnet mask and gateway for TCP modules in the **COMMS CONFIG** submenu.

NOTE: Cycle power to the TMC4 after communication settings are changed to ensure connection.

4. Operation

4.1. Limit Switch Positioning Operation

When operating with limit switches for on/off or two position control, the TMC4 *Position Type* setting in the **POSITION CONFIG** submenu should be set to Limit Switch. When operating in this mode, Bit 1 and Bit 2 in Register 40009 control the actuator direction and movement. The actuator can also be controlled by writing specific values to Register 40010.
Bits 1 – 4 in Register 40001, provide the feedback information about the travel direction and end of travel position of the actuator. Operating details are provided below.

OPERATION Register 40009, ***Action Bits/Flags 2***		
Bit 2	**Bit 1**	**Description**
0	x	De-energize motor outputs and stop actuator.
1	0	Energize motor outputs and drive actuator CW.
1	1	Energize motor outputs and drive actuator CCW.

OPERATION Register 40010, ***Command Position***	
Value	**Description**
0	Energize motor outputs and drive actuator CW.
500	De-energize motor outputs and stop actuator.
1000	Energize motor outputs and drive actuator CCW.

FEEDBACK Register 40001, ***Status Flags 1***						
Position			**Movement**		**Description**	
Bit 4	**Bit 3**		**Bit 2**	**Bit 1**	**Position**	**Movement**
0	0		0	0	Between limits	Stopped
0	0		0	1	Between limits	CCW
0	0		1	0	Between limits	CW
0	0		1	1	?	?
0	1		0	0	CCW limit	Stopped
0	1		0	1	?	?
0	1		1	0	CCW limit	CW (1)
0	1		1	1	?	?
1	0		0	0	CW limit	Stopped
1	0		0	1	CW limit	CCW (1)

(1) This state will be present immediately when reversing direction until the position cam disengages the position limit switch. If this state persists, it may indicate jam or obstruction condition.

Note that even though the motor stops when the destination travel limit switch is closed, the motor outputs of the control board remain energized until a stop command is written to Register 40009 or 40010.

In Register 40009, Bit 1 establishes the direction of actuator travel and Bit 2 energizes or de-energizes the motor output corresponding to the direction determined by Bit 1.

If Bit 1 = 0, the actuator is set to move in the CW direction. If Bit 1 = 1, the actuator is set to move in the CCW direction.

If Bit 2 = 0, the motor output is not energized. If Bit 2 = 1, the CW motor output is energized when Bit 1 = 0 and the CCW motor output is energized when Bit 1 = 1. Unless Bit 2 is cleared, the actuator will continue to move in the specified direction until the corresponding end of travel limit switch closes.

It is acceptable to change direction with Bit 1 while maintaining Bit 2 = 1. If the direction is changed while the actuator is moving, a short delay occurs before the actuator begins moving in the opposite direction.
Writing values into Register 40010 will automatically set Bit 1 and Bit 2 in Register 40009 according to the action specified.

CAUTION! *When writing to Bit 1 and Bit 2 of Register 40009, be careful not to change the other register bits.*

In Register 40001, Bit 1 and Bit 2 indicate the direction of travel. Bit 3 and Bit 4 indicate if the actuator is at the full CCW or full CW limit respectively.

While the actuator is moving in the CW direction, Bit 2 = 1. When the actuator reaches the CW end of travel limit switch, Bit 2 = 0 and Bit 4 = 1. The CW motor output is de-energized.

While the actuator is moving in the CCW direction, Bit 1 = 1. When the actuator reaches the CCW end of travel limit switch, Bit 1 = 0 and Bit 3 = 1. The CCW motor output is de-energized.

4.2. Potentiometer Positioning Operation

When operating with feedback potentiometer for proportional or modulating control, the TMC4 *Position Type* setting in the **POSITION CONFIG** submenu should be set to Potentiometer. In this mode, the actuator is controlled using the *Command Position* Register 40010, and the *Sensitivity/Deadband* Register 40013. Note, the deadband can also set by the on-board menus. The actual location of the actuator is indicated by the *Current Position* Register 40008.

When a new command position value is written to Register 40010, the new value is compared to the current position value in Register 40008. If the difference between the two values is greater than the sensitivity/deadband value in Register 40010, the actuator begins moving towards the new command position. When the current position value is within the limits of the command position and sensitivity/deadband value in Register 40010, the actuator is stopped.

Bit 1 and Bit 2 in Register 40001 are also used to indicate the direction of travel. If the actuator is moving in the CW direction, Bit 2 = 1. If the actuator is moving in the CCW direction, Bit 1 = 1. When the actuator reaches the command position value and is stopped, Bit 1 and Bit 2 will equal 0.

4.3. Obstruction or Jam Detection

When a move command is given by either setting Bit 1 and Bit 2 in Register 40009, or by writing valid value to Register 40010, a timer is immediately started. The timer continues to increment once every second. After each increment, the timer value is compared to the value set in Register 40011 for the *Travel Timeout*.

If the destination travel limit switch closes, or the position setpoint is reached before the timer value is greater than the value in Register 40011, the actuator is operating normally.

If the destination travel limit switch IS NOT closed, or the position setpoint is not reached before the timer value is greater than the value in Register 40011, a jam or obstruction has prevented the valve from operating properly. The active motor output is de-energized, and Bit 5 in Register 40001 is set.

5. Modbus

5.1. Function Codes

The TMC4 Modbus RTU and TCP modules are a Modbus slave that supports the following Modbus functions.

Code	Code (hex)	Code Definition
03	0x03	Read Holding Registers
16	0x10	Write Multiple Registers

Function 03 reads the contents of a contiguous block of holding registers. All registers, 40001-40017 are readable with this function.

Function 16 writes values into a sequence of adjacent holding registers. Only registers, 40009-40017 can be written to with this function.

5.2. Registers

All registers are 16 bits in length. When the register is addressed in the data communications, the register is assigned a hexadecimal value starting with 0x00. Therefore, registers numbered 40001-40017 are addressed as 0-16 in decimal, or 0x00 to 0x10 in hexadecimal resulting in the register always addressed one value below the specified decimal register number.

Register No.	Register Address	Address Name	16 bit / Digital Name	Unit	Scale	Range	Default	Read / Write
40001	0x00	STATUS FLAGS 1	INT					
		bit 1	CCW Movement	Bit	N/A	True/False	N/A	Read
		bit 2	CW Movement	Bit	N/A	True/False	N/A	Read
		bit 3	CCW Travel Limit	Bit	N/A	True/False	N/A	Read
		bit 4	CW Travel Limit	Bit	N/A	True/False	N/A	Read
		bit 5	Actuator Obstructed	Bit	N/A	True/False	N/A	Read
		bit 6	-	-	-	-	-	-
		bit 7	Control Mode	Bit	N/A	True/False	N/A	Read
		bit 8	Operating Mode	Bit	N/A	True/False	N/A	Read
		bit 9-16	-	-	-	-	-	-
40002	0x01	TOTAL POWER ON TIME HI / FIRMWARE VERSION	INT					
		bit 1-8	Total Power On Time (Upper Byte)	Hour	1	65,536 – 16,711,680 (0 – 16,777,215 when used with Register 40003)	0	Read
		bit 9-16	Firmware Version	Int.	1	0-255	N/A	Read
40003	0x02	TOTAL POWER ON TIME LO	INT	Hour	1	0 – 65,535 (0 – 16,777,215 when used with Register 40002 bits 1-8)	0	Read

40004	0x03	TOTAL MOTOR RUN TIME HI	INT					
		bit 1-8	Total Motor Run Time (Upper Byte)	Count	1	65,536 – 16,711,680 (0 – 16,777,215 when used with Register 40005)	0	Read
		bit 9-16	-	-	-	-	-	-
40005	0x04	TOTAL MOTOR RUN TIME LO	INT	Count	1	0 – 65,535 (0 – 16,777,215 when used with Register 40004 bits 1-8)	0	Read
40006	0x05	TOTAL MOTOR STARTS HI	INT					
		bit 1-8	Total Motor Starts (Upper Byte)	Count	1	65,536 – 16,711,680 (0 – 16,777,215 when used with Register 40007)	0	Read
		bit 9-16	-	-	-	-	-	-
40007	0x06	TOTAL MOTOR STARTS LO	INT	Count	1	0 – 65,535 (0 – 16,777,215 when used with Register 40006 bits 1-8)	0	Read
40008	0x07	CURRENT POSITION	INT	%	0.1	0-1000	N/A	Read
40009	0x08	ACTION BITS / STATUS FLAGS 2	INT					
		bit 1	Direction	Bit	N/A	True/False	N/A	Read / Write
		bit 2	Motor Output	Bit	N/A	True/False	N/A	Read / Write
		bit 3	Reset Actuator	Bit	N/A	True/False	N/A	Read / Write
		bit 4	-	-	-	-	-	-
		bit 5	-	-	-	-	-	-
		bit 6	-	-	-	-	-	-
		bit 7 bit 8	Fault Action	Bit	N/A	0,0 – In Place 0,1 – CCW 1,0 – CS 1,1 – To Position (40017)	0,0	Read / Write
		bit 9	Power Interrupt Flag	Bit	N/A	True/False	N/A	Read / Write
		bit 10	Reset Flag	Bit	N/A	True/False	N/A	Read / Write
		bit 11	-	-	-	-	-	-
		bit 12	Save To EEPROM	Bit	N/A	True/False	N/A	Read / Write
		bit 13	Fault Flag	Bit	N/A	True/False	N/A	Read / Write
		bit 14	-	-	-	-	-	-
		bit 15	-	-	-	-	-	-
		bit 16	-	-	-	-	-	-
40010	0x09	COMMAND POSITION	INT	%	0.1	0 – 1000 (Modulating) 0, 500, 1000 (Limit Switch)	N/A	Read / Write
40011	0x0A	TRAVEL TIMEOUT	INT	sec	1	5 - 255	60	Read / Write
40012	0x0B	RESERVE	-	-	-	-	-	-
40013	0x0C	SENSITIVITY	INT	%	0.1	1 - 25	5	Read / Write
40014	0x0D	COMMUNICATION TIMEOUT	INT	sec	0.01	100 - 10,000	1000	Read / Write
40015	0x0E	RESERVE	-	-	-	-	-	-
40016	0x0F	RESERVE	-	-	-	-	-	-
40017	0x10	FAULT POSITION	INT	%	0.1	0 - 1000	N/A	Read / Write

Status Flags 1 Register

Register Number	40001
Register Address	0x00
Read/Write	R

Unit	Scale	Range	Default
n/a	n/a	n/a	n/a

40001															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

The *Status Flags 1* register provides flags to indicate various status and operating conditions. The register bits are assigned the functionality provided below.

Bit	Description
Bit 1	CCW Movement bit indicates if the CCW motor output terminal is energized and is used to indicate CCW movement.
Bit 2	CW Movement bit indicates if the CW motor output terminal is energized and is used to indicate CW movement.
Bit 3	CCW Travel Limit bit indicates if the open travel limit switch is closed.
Bit 4	CW Travel Limit bit indicates if the close travel limit switch is closed.
Bit 5	Actuator Obstruction bit indicates if the time set in the Travel Timeout register 40011 has been exceeded before the actuator reaches its appropriate end of travel position.
Bit 6	Not used
Bit 7	Positioning Mode bit indicates if the Position Type in the menus is set to *Limit Switch* or *Potentiometer*. *Limit Switch* is for two position control using limit switches for position feedback. *Potentiometer* is used for proportional or modulating control using a potentiometer for position feedback.
Bit 8	Operating Mode bit indicates if the controller is in *Run* mode or *Configuration* mode. The controller is considered to be in configuration mode when entering into any of the configuration submenus.
Bit 9-16	Not used

Byte 1 (LSB)							
Bit 8	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**
Operating Mode	**Positioning Mode**	**-**	**Obstruction**	**CW Limit**	**CCW Limit**	**CW Move**	**CCW Move**
							0: Motor CCW output not on 1: Motor CCW output on
						0: Motor CW output not on 1: Motor CW output on	
					0: CCW limit switch not closed 1: CCW limit switch closed		
				0: CW limit switch not closed 1: CW limit switch closed			
			0: No obstruction detected 1: Obstruction detected				
		0: n/a 1: n/a					
	0: Position Type = Limit Switch 1: Position Type = Potentiometer						
0: Run mode 1: Configuration mode							

Byte 2 (MSB)							
Bit 16	**Bit 15**	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**
-	**-**	**-**	**-**	**-**	**-**	**-**	**-**
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Total Power On Time / Firmware

Register Number	40002 / 40003
Register Address	0x01 / 0x02
Read/Write	R

Unit	Scale	Range	Default
Hour	1	0 – 16,777,216 0x00000000 – 0x00FFFFFF	n/a
Version	1	0 – 255 0x00 – 0xFF	n/a

40002																40003															
Byte 2 (MSB)								Byte 1 (LSB)								Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
Firmware Version								Total Powered On Time																							
0 – 255								0 – 16,777,216 (hours)																							

The *Total Power on Time/Firmware* registers store the total time (in hours) the board has been powered on as well as the current version of the firmware. The firmware version is stored in the upper 8 bits of Register 40002. The lower 8 bits of Register 40002 and all 16 bits of Register 40003 contain the 24-bit value representing the time the board has been powered on, providing for between 0 and 16,777,216 hours. This value resets when board power is removed.

When reading the registers, the 8 bits in Register 40002 represent the most significant bits of the time, while all 16 bits in Register 40003 represent the least significant bits of the time. It is recommended to read both registers with the same command. In order to extract the length of time the board has been powered on, the upper 8 bits of Register 40002 must be masked off. In order to extract the firmware version, the lower 8 bits of Register 40002 must be masked off.

Total Motor Run Time

Register Number	40004 / 40005
Register Address	0x03 / 0x04
Read/Write	R

Unit	Scale	Range	Default
Hour	1	0 – 16,777,216 0x00000000 – 0x00FFFFFF	n/a

40004																40005															
Byte 2 (MSB)								Byte 1 (LSB)								Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
-								0 – 16,777,216 (hours)																							

The *Total Motor Run Time* registers store the total combined time (in hours) the CW and CCW motor outputs of the board have been energized. The lower 8 bits of Register 40004 and all 16 bits of Register 40005 contain the 24-bit value, providing for between 0 and 16,777,216 hours. This value resets when board power is removed.

When reading the registers, the 8 bits in Register 40004 represent the most significant bits of the time, while all 16 bits in Register 40005 represent the least significant bits of the time. It is recommended to read both registers with the same command.

Total Motor Starts

Register Number	40006 / 40007
Register Address	0x05 / 0x06
Read/Write	R

Unit	Scale	Range	Default
Count	1	0 – 16,777,216 0x00000000 – 0x00FFFFFF	n/a

40004																40005															
Byte 2 (MSB)								Byte 1 (LSB)								Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
-								0 – 16,777,216 (count)																							

The *Total Motor Starts* registers store the total count for number of times the CW and CCW motor outputs of the board have been energized. The lower 8 bits of Register 40006 and all 16 bits of Register 40007 contain the 24-bit value, providing for between 0 and 16,777,216 total number of starts. This value resets when board power is removed.

When reading the registers, the 8 bits in Register 40006 represent the most significant bits of the count, while all 16 bits in Register 40007 represent the least significant bits of the count. It is recommended to read both registers with the same command.

Current Position

Register Number	40008
Register Address	0x07
Read/Write	R

Unit	Scale	Range	Default
%	0.1	0 – 1000 0x0000 – 0x03E8	n/a

40008															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
0 – 1000															
0.0% to 100.0%															

The *Current Position* register is used to track the current actuator position in potentiometer positioning using a feedback potentiometer. The range is automatically scaled based on the calibrated 0% and 100% positions.

The values in the register span from 0 to 1000, which corresponds to 0.0% and 100.0% respectively. With 0.0% representing a fully closed actuator, and 100.0% representing a fully open actuator, a value of 674 represents the actuators is 67.4% open.

Action Bits/Flags 2 Register

Register Number	40009
Register Address	0x08
Read/Write	R / W

Unit	Scale	Range	Default
n/a	n/a	n/a	n/a

40009															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

The *Action Bits/Flags 2* register provides individual bits for multiple operation settings as well as resettable flags used to indicate various status changes.

Bit	Description
Bit 1	Direction bit sets the direction to move the actuator when using limit switch positioning. Use this bit with Bit 2 to move the actuator in on/off applications. The status of this bit determines which motor output is energized when Bit 2 is set.
Bit 2	Output Status bit energizes the motor output determined by Bit 1. Set the desired travel direction with Bit 1 and either turn on or off the motor output with this bit.
Bit 3	Reset bit resets registers 40001 (bits 1-6), 40009 (bits 1-4), 40010.
Bit 4-6	Not used
Bit 7 & 8	Fault Action bits determine the movement when the time between communication exceeds the Communication Timeout value in Register 40014. This can also be configured in the on-board menus.
Bit 9-16	Not used

Byte 1 (LSB)							
Bit 8	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**
Fault Action		**-**	**-**	**-**	**Reset**	**Motor Out Status**	**Direction**
							0: Move CW 1: Move CCW
						0: Motor output not energized 1: Motor output energized	
					0: No effect 1: Register reset sent		
				0: n/a 1: n/a			
			0: n/a 1: n/a				
		0: n/a 1: n/a					
(0,0): Fail in place (default) (0,1): Fail full CCW (1,0): Fail full CW (1,1): Fail to position (potentiometer positioning)							

Byte 2 (MSB)							
Bit 16	**Bit 15**	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**
-	**-**	**-**	**-**	**-**	**-**	**-**	**-**
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Command Position

Register Number	40010
Register Address	0x09
Read/Write	R / W

Unit	Scale	Range	Default
%	0.1	0 – 1000 (32,768 – 33,768) 0x0000 – 0x03E8 (0x8000 – 0x83E8)	n/a

40010															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
0 – 1000															
0.0% to 100.0%															

If a value outside of the acceptable range of 0 to 1000 is written, the actuator will not move. When control board has power applied, or is reset using Bit 3 in Register 40009, Bit 16 is set to 1 resulting in a value of 32,768 added to the value currently in the register. Setting Bit 16 forces the *Command Position* register value outside of the acceptable 0 to 1000 range and therefore prevents the actuator from moving. The actuator can be controlled again by writing another value between 0 and 1000.

The *Command Position* register is used to initiate an actuator move. When the board is configured for potentiometer positioning, the values span from 0 to 1000, corresponding to 0.0% and 100.0% respectively. Therefore, with 0.0% representing a fully closed actuator, and 100.0% representing a fully open actuator, a written value of 674 indicates a command to move the actuator to 67.4% open.

When the board is set to limit switch positioning, a 0 will move the actuator CW, a 500 will stop the actuator, and 1000 will move the actuator CCW.

Value	Description	Register 40009 bit equivalent
0	Energize motor outputs and drive actuator CW.	Bit 1 = 0, Bit 2 = 1
500	De-energize motor outputs and stop actuator.	Bit 1 = x, Bit 2 = 0
1000	Energize motor outputs and drive actuator CCW.	Bit 1 = 1, Bit 2 = 1

Travel Timeout

Register Number	40011
Register Address	0x0A
Read/Write	R / W

Unit	Scale	Range	Default
Second	1	5 – 255 0x0005 – 0x00FF	60

40011															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
5 – 255															
5 Seconds to 255 Seconds															

The *Travel Timeout* register is to determine a stall or obstruction condition identified by Bit 5 in Register 40001. The value stored in this register represents the maximum time allowed between energizing a motor output and reaching the command position or limit before identifying an obstruction. This value should typically be set greater than the normal travel time of the actuator from full open to full close.

Values in this register can be between 5 and 255 with each integer representing 1 second. The default value is set to 60 representing a time of 60 seconds.

Reserved

Register Number	40012
Register Address	0x0B
Read/Write	R / W

Unit	Scale	Range	Default
n/a	n/a	n/a	n/a

This register is currently not used.

Sensitivity/Deadband

Register Number	40013
Register Address	0x0C
Read/Write	R / W

Unit	Scale	Range	Default
%	0.1	1 – 25 0x0001 – 0x0019	5

40013															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
1 – 25															
1.0% to 2.5%															

The *Sensitivity/Deadband* register stores the necessary change between the value written to Register 40010 and the current value in Register 40008 before an actuator movement is initiated. It also represents the range outside of the setpoint the actuator will stop.

Values in this register can be between 1 and 25 with each integer representing 0.1%. The default value is set to 5 representing 0.5%. Using the default value of 0.5%, if the actuator position is at 50.0%, indicated by a value of 500 in Register 40008, the value written to Register 40010 must be greater than 505 or less than 495.

Communication Timeout

Register Number	40014
Register Address	0x0D
Read/Write	R / W

Unit	Scale	Range	Default
Second	0.01	100 – 10,000 0x0064 – 0x2710	1000

40014															
Byte 2 (MSB)								Byte 1 (LSB)							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
100 – 10,000															
0.1 Seconds to 100 Seconds															

The *Communication Timeout* register stores the maximum time allowed with no communication received from the master device before entering a fault condition. When this time is exceeded, the actuator will move to the position set by Bit 7 and Bit 8 in Register 40009.The master should communicate with each actuator on the bus within the time set in this register. Doing so will ensure the actuator moves to the fault position determined by Bit 7 and Bit 8 in Register 40009 only when an unintended lapse in communication is encountered.

Values in this register can be between 100 and 10,000 with each integer representing 0.01 seconds. The default value is set to 1000 representing 10 seconds.

Reserved

Register Number	40015
Register Address	0x0E
Read/Write	R / W

Unit	Scale	Range	Default
n/a	n/a	n/a	n/a

This register is currently not used.

Reserved

Register Number	40016
Register Address	0x0F
Read/Write	R / W

Unit	Scale	Range	Default
n/a	n/a	n/a	n/a

This register is currently not used.

Fault Position

Register Number	40017
Register Address	0x10
Read/Write	R / W

Unit	Scale	Range	Default
%	0.01	0 – 1000 0x0000 – 0x03E8	n/a

40017															
Byte 2 (MSB)								**Byte 1 (LSB)**							
B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
0 – 1000															
0.0% to 100.0%															

The *Fault Position* register is used in potentiometer positioning to set a position to move the actuator for a fault condition. The values in the register span from 0 to 1000, which corresponds to 0.0% and 100.0% respectively. With 0.0% representing a fully closed actuator, and 100.0% representing a fully open actuator, a value of 674 represents the actuator will fail to the 67.4% open position either from fault condition.

Failing to the position specified in this register when a fault condition occurs is achieved by setting both Bit 7 and Bit 8 in Register 40009 high.

Appendix A

Number System Conversion

DEC	OCT	HEX	BIN	DEC	OCT	HEX	BIN	DEC	OCT	HEX	BIN	DEC	OCT	HEX	BIN
0	000	00	0000 0000	16	020	10	0001 0000	32	040	20	0010 0000	48	060	30	0011 0000
1	001	01	0000 0001	17	021	11	0001 0001	33	041	21	0010 0001	49	061	31	0011 0001
2	002	02	0000 0010	18	022	12	0001 0010	34	042	22	0010 0010	50	062	32	0011 0010
3	003	03	0000 0011	19	023	13	0001 0011	35	043	23	0010 0011	51	063	33	0011 0011
4	004	04	0000 0100	20	024	14	0001 0100	36	044	24	0010 0100	52	064	34	0011 0100
5	005	05	0000 0101	21	025	15	0001 0101	37	045	25	0010 0101	53	065	35	0011 0101
6	006	06	0000 0110	22	026	16	0001 0110	38	046	26	0010 0110	54	066	36	0011 0110
7	007	07	0000 0111	23	027	17	0001 0111	39	047	27	0010 0111	55	067	37	0011 0111
8	010	08	0000 1000	24	030	18	0001 1000	40	050	28	0010 1000	56	070	38	0011 1000
9	011	09	0000 1001	25	031	19	0001 1001	41	051	29	0010 1001	57	071	39	0011 1001
10	012	0A	0000 1010	26	032	1A	0001 1010	42	052	2A	0010 1010	58	072	3A	0011 1010
11	013	0B	0000 1011	27	033	1B	0001 1011	43	053	2B	0010 1011	59	073	3B	0011 1011
12	014	0C	0000 1100	28	034	1C	0001 1100	44	054	2C	0010 1100	60	074	3C	0011 1100
13	015	0D	0000 1101	29	035	1D	0001 1101	45	055	2D	0010 1101	61	075	3D	0011 1101
14	016	0E	0000 1110	30	036	1E	0001 1110	46	056	2E	0010 1110	62	076	3E	0011 1110
15	017	0F	0000 1111	31	037	1F	0001 1111	47	057	2F	0010 1111	63	077	3F	0011 1111
64	100	40	0100 0000	80	120	50	0101 0000	96	140	60	0110 0000	112	160	70	0111 0000
65	101	41	0100 0001	81	121	51	0101 0001	97	141	61	0110 0001	113	161	71	0111 0001
66	102	42	0100 0010	82	122	52	0101 0010	98	142	62	0110 0010	114	162	72	0111 0010
67	103	43	0100 0011	83	123	53	0101 0011	99	143	63	0110 0011	115	163	73	0111 0011
68	104	44	0100 0100	84	124	54	0101 0100	100	144	64	0110 0100	116	164	74	0111 0100
69	105	45	0100 0101	85	125	55	0101 0101	101	145	65	0110 0101	117	165	75	0111 0101
70	106	46	0100 0110	86	126	56	0101 0110	102	146	66	0110 0110	118	166	76	0111 0110
71	107	47	0100 0111	87	127	57	0101 0111	103	147	67	0110 0111	119	167	77	0111 0111
72	110	48	0100 1000	88	130	58	0101 1000	104	150	68	0110 1000	120	170	78	0111 1000
73	111	49	0100 1001	89	131	59	0101 1001	105	151	69	0110 1001	121	171	79	0111 1001
74	112	4A	0100 1010	90	132	5A	0101 1010	106	152	6A	0110 1010	122	172	7A	0111 1010
75	113	4B	0100 1011	91	133	5B	0101 1011	107	153	6B	0110 1011	123	173	7B	0111 1011
76	114	4C	0100 1100	92	134	5C	0101 1100	108	154	6C	0110 1100	124	174	7C	0111 1100
77	115	4D	0100 1101	93	135	5D	0101 1101	109	155	6D	0110 1101	125	175	7D	0111 1101
78	116	4E	0100 1110	94	136	5E	0101 1110	110	156	6E	0110 1110	126	176	7E	0111 1110
79	117	4F	0100 1111	95	137	5F	0101 1111	111	157	6F	0110 1111	127	177	7F	0111 1111

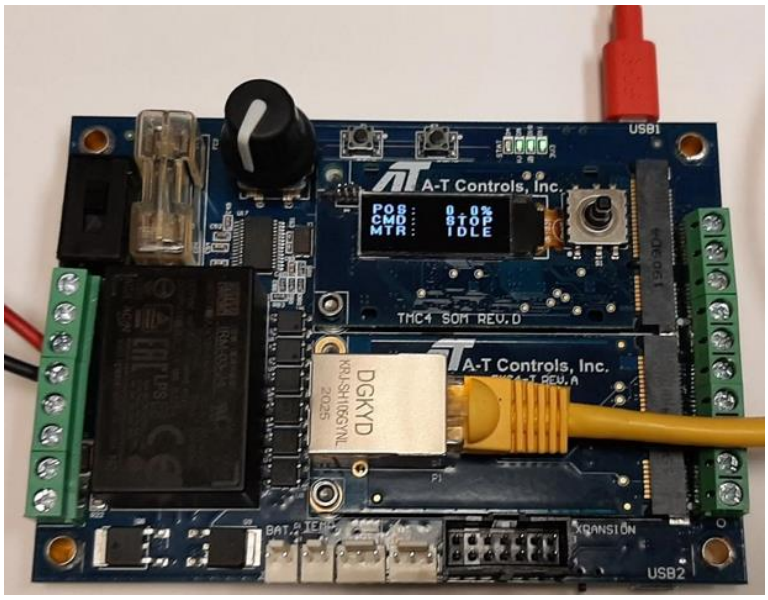
DEC	OCT	HEX	BIN	DEC	OCT	HEX	BIN	DEC	OCT	HEX	BIN	DEC	OCT	HEX	BIN
128	200	80	1000 0000	144	220	90	1001 0000	160	240	A0	1010 0000	176	260	B0	1011 0000
129	201	81	1000 0001	145	221	91	1001 0001	161	241	A1	1010 0001	177	261	B1	1011 0001
130	202	82	1000 0010	146	222	92	1001 0010	162	242	A2	1010 0010	178	262	B2	1011 0010
131	203	83	1000 0011	147	223	93	1001 0011	163	243	A3	1010 0011	179	263	B3	1011 0011
132	204	84	1000 0100	148	224	94	1001 0100	164	244	A4	1010 0100	180	264	B4	1011 0100
133	205	85	1000 0101	149	225	95	1001 0101	165	245	A5	1010 0101	181	265	B5	1011 0101
134	206	86	1000 0110	150	226	96	1001 0110	166	246	A6	1010 0110	182	266	B6	1011 0110
135	207	87	1000 0111	151	227	97	1001 0111	167	247	A7	1010 0111	183	267	B7	1011 0111
136	210	88	1000 1000	152	230	98	1001 1000	168	250	A8	1010 1000	184	270	B8	1011 1000
137	211	89	1000 1001	153	231	99	1001 1001	169	251	A9	1010 1001	185	271	B9	1011 1001
138	212	8A	1000 1010	154	232	9A	1001 1010	170	252	AA	1010 1010	186	272	BA	1011 1010
139	213	8B	1000 1011	155	233	9B	1001 1011	171	253	AB	1010 1011	187	273	BB	1011 1011
140	214	8C	1000 1100	156	234	9C	1001 1100	172	254	AC	1010 1100	188	274	BC	1011 1100
141	215	8D	1000 1101	157	235	9D	1001 1101	173	255	AD	1010 1101	189	275	BD	1011 1101
142	216	8E	1000 1110	158	236	9E	1001 1110	174	256	AE	1010 1110	190	276	BE	1011 1110
143	217	8F	1000 1111	159	237	9F	1001 1111	175	257	AF	1010 1111	191	277	BF	1011 1111
192	300	C0	1100 0000	208	320	D0	1101 0000	224	340	E0	1110 0000	240	360	F0	1111 0000
193	301	C1	1100 0001	209	321	D1	1101 0001	225	341	E1	1110 0001	241	361	F1	1111 0001
194	302	C2	1100 0010	210	322	D2	1101 0010	226	342	E2	1110 0010	242	362	F2	1111 0010
195	303	C3	1100 0011	211	323	D3	1101 0011	227	343	E3	1110 0011	243	363	F3	1111 0011
196	304	C4	1100 0100	212	324	D4	1101 0100	228	344	E4	1110 0100	244	364	F4	1111 0100
197	305	C5	1100 0101	213	325	D5	1101 0101	229	345	E5	1110 0101	245	365	F5	1111 0101
198	306	C6	1100 0110	214	326	D6	1101 0110	230	346	E6	1110 0110	246	366	F6	1111 0110
199	307	C7	1100 0111	215	327	D7	1101 0111	231	347	E7	1110 0111	247	367	F7	1111 0111
200	310	C8	1100 1000	216	330	D8	1101 1000	232	350	E8	1110 1000	248	370	F8	1111 1000
201	311	C9	1100 1001	217	331	D9	1101 1001	233	351	E9	1110 1001	249	371	F9	1111 1001
202	312	CA	1100 1010	218	332	DA	1101 1010	234	352	EA	1110 1010	250	372	FA	1111 1010
203	313	CB	1100 1011	219	333	DB	1101 1011	235	353	EB	1110 1011	251	373	FB	1111 1011
204	314	CC	1100 1100	220	334	DC	1101 1100	236	354	EC	1110 1100	252	374	FC	1111 1100
205	315	CD	1100 1101	221	335	DD	1101 1101	237	355	ED	1110 1101	253	375	FD	1111 1101
206	316	CE	1100 1110	222	336	DE	1101 1110	238	356	EE	1110 1110	254	376	FE	1111 1110
207	317	CF	1100 1111	223	337	DF	1101 1111	239	357	EF	1110 1111	255	377	FF	1111 1111

Appendix B

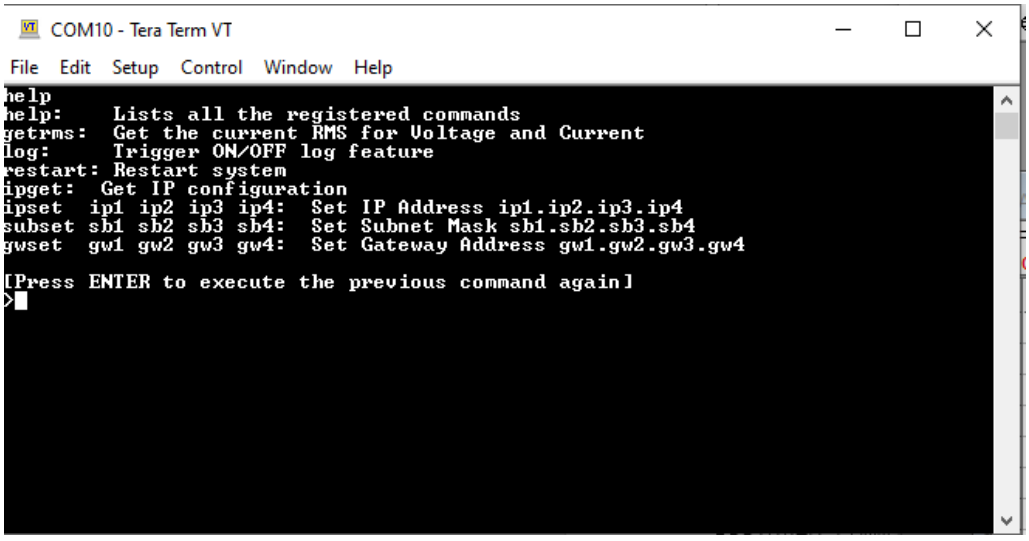
ModbusTCP Configuration via Terminal Program

The IP settings for the TMC4 with ModbusTCP module can be configured using the standard on-board menus. However, the TMC4 can also be configured using a computer terminal interface program through the USB connection. Note the ModbusTCP is only compatible with firmware versions 2.03 and later.

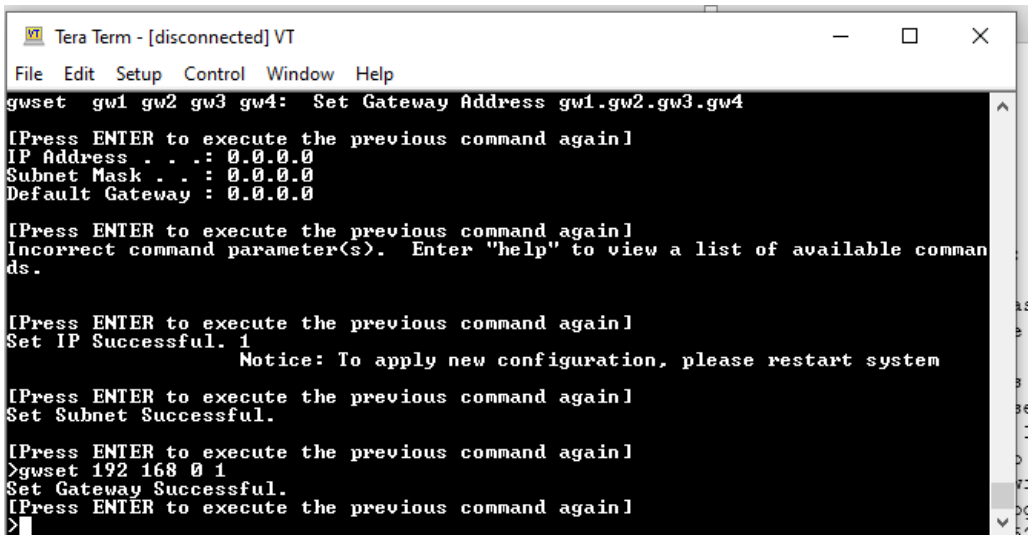
1. Install ModbusTCP module in the TMC4 module slot.
2. Power on the TMC4.



3. Set the command type to “Comms” and ensure the communication type is set for ModbusTCP.
4. Configure the IP settings to match the user network via USB to the TMC4 micro USB connection.
    a. Connect USB to micro USB cable between TMC4 and PC.
    b. Once new serial port is assigned to the TMC4, open a terminal program (TeraTerm, Putty, etc.) under the newly assigned comm port with parameters: 115200-8-N-1
    c. In the terminal, type “help” to see the available commands



5. To read the current IP settings, type “ipget”
6. To set IP address, type “ipset 192 168 0 101” to set IP address to 192.168.0.101
7. To set subnet mask, type “subset 255 255 255 0” to set mask to 255.255.255.0
8. To set gateway IP, type “gwset 192 168 0 1” to set gateway to 192.168.0.1
9. The TMC4 confirms the change is successful after each command.



10. Cycle power to the TMC4 to complete configuration of the new network settings.
11. TMC4 is now ready for ModbusTCP communications. Use a ModbusTCP master with the IP set as per above and use TCP port 502.

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