YASKAWA

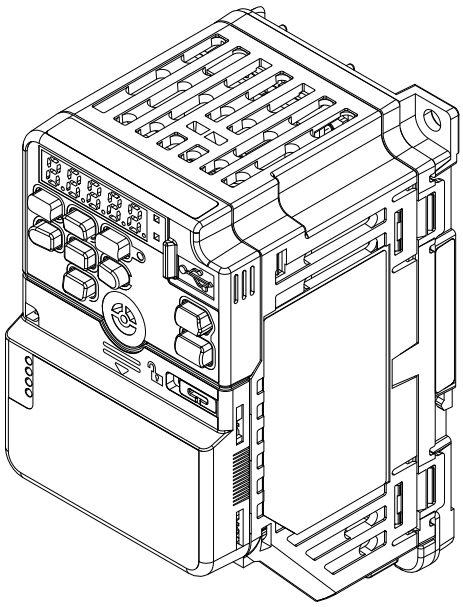
YASKAWA AC Drive GA501

Modbus TCP/IP

Technical Manual

Model CIPR-GA51xxxxxxxxx

To correctly use the product, read this manual thoroughly and keep it for easy reference, inspection, and maintenance.
Make sure that the end user receives this manual.



MANUAL NO. SIEP C710617 4WA

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1 Preface and Safety

YASKAWA Electric supplies component parts for use in a wide variety of industrial applications. The selection and application of YASKAWA products remain the responsibility of the equipment designer or end user.

YASKAWA accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any YASKAWA product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All products designed to incorporate a component part manufactured by YASKAWA must be supplied to the end user with appropriate warnings and instructions as to the safe use and operation of that part. Any warnings provided by YASKAWA must be promptly provided to the end user. YASKAWA offers an express warranty only as to the quality of its products in conforming to standards and specifications published in the manual. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS OFFERED. YASKAWA assumes no liability for any personal injury, property damage, losses, or claims arising from misapplication of its products.

◆ Applicable Documentation

Document	Description
YASKAWA AC Drive GA501 Modbus TCP/IP Technical Manual Manual No.: SIEP C710617 4W (This book)	The Technical Manual contains detailed information about the Modbus TCP/IP protocol. For questions, contact Yaskawa or a Yaskawa representative.
YASKAWA AC Drive GA501 Manuals	Drive manuals contain basic installation and wiring information in addition to detailed parameter setting, fault diagnostic, and maintenance information. The manuals also include important information about parameter settings and tuning the drive. The drive product Quick Setup Procedures/Quick Start Guides are packaged with the drive. The most recent versions of these documents are available for download on these documentation websites; U.S.: https://www.yaskawa.com/ga501manuals, Europe: https://www.yaskawa.eu.com/manuals/ga501, China: https://yaskawa.com.cn/manual/ga501g5e.aspx?from=NTdfNF80, Asia: https://dlc.e-mechatronics.com/dqr/qr/ga501en_AT.html. Refer to the back cover of these documents for other locations. For questions, contact Yaskawa or a Yaskawa representative.

◆ Glossary

Terms	Definition
Keypad	• HOA Operator • LCD Operator • LED Operator • HOA Keypad • LCD Keypad • LED Keypad
Hex. (Example: 900 (Hex.))	Identifies a unit for hexadecimal number format.

◆ Registered Trademarks

- Modbus TCP/IP is a trademark of Modbus-IDA.
- EtherNet/IP is a registered trademark of Open DeviceNet Vendor Association, Inc. (ODVA).
- EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
- PROFINET is a registered trademark of PROFIBUS Nutzerorganisation e.V. (PNO).
- BACnet is a trademark of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- MECHATROLINK-4 is a trademark of the MECHATROLINK Members Association (MMA).
- Ethernet is a registered trademark of FUJIFILM Business Innovation Corp.
- Trademarks are the property of their respective owners.

◆ Supplemental Safety Information

Read and understand this manual before installing, operating, or servicing this product. The product must be installed according to this manual and local codes.

The following conventions are used to indicate safety messages in this manual. Failure to heed these messages could result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

⚠ DANGER *This signal word identifies a hazard that will cause serious injury or death if you do not prevent it.*

⚠ WARNING *This signal word identifies a hazard that can cause death or serious injuries if you do not prevent it.*

⚠ CAUTION *This signal word identifies a hazard that can cause minor or moderate injuries if you do not prevent it.*

NOTICE *This signal word identifies a property damage message that is not related to personal injury.*

■ Section Safety

General Precautions
• The diagrams in this section may include options and drives without covers or safety shields to illustrate details. Be sure to reinstall covers or shields before operating any devices. The option should be used according to the instructions described in this manual. • The diagrams in this manual are provided as examples only and may not pertain to all products covered by this manual. • The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual. • Contact Yaskawa or a Yaskawa representative and provide the manual number shown on the front cover to order new copies of the manual.

⚠ DANGER *Do not ignore the safety messages in this manual. If you ignore the safety messages in this manual, it will cause serious injury or death. The manufacturer is not responsible for injuries or damage to equipment.*

⚠ WARNING *Electrical Shock Hazard. Do not modify the drive circuitry. Failure to obey can cause serious injury or death, or cause damage to the drive and will void warranty. Yaskawa is not responsible for modifications of the product made by the user.*

NOTICE *Damage to Equipment. Do not use steam or other disinfectants to fumigate wood for packaging the drive. Use alternative methods, for example heat treatment, before you package the components. Gas from wood packaging fumigated with halogen disinfectants, for example fluorine, chlorine, bromine, iodine or DOP gas (phthalic acid ester), can cause damage to the drive.*

2 Overview

This drive provides a communications connection between the drive and a Modbus TCP/IP network.

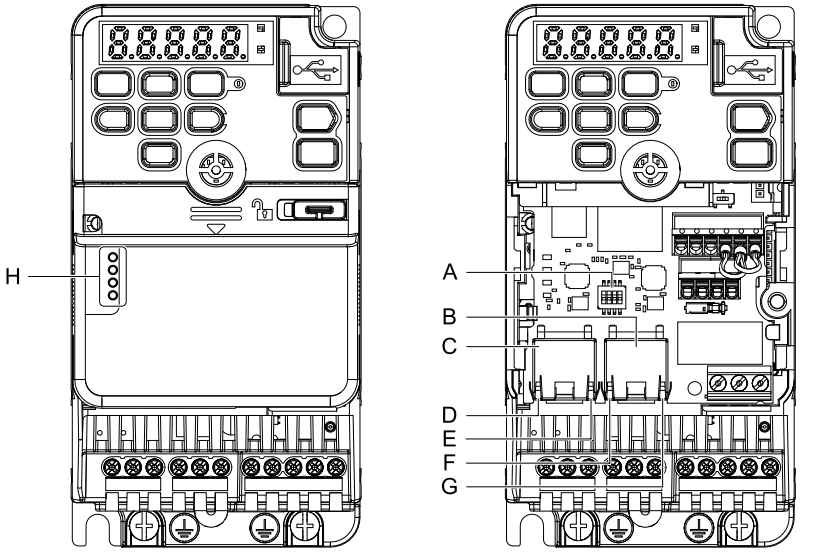
The controller can do these functions:

- Operate the drive
- Monitor the drive operation status
- Change drive parameter settings

Modbus TCP/IP is a communications link to connect industrial devices (such as smart motor controllers, operator interfaces, and variable frequency drives) as well as control devices (such as programmable controllers and computers) to a network. Modbus TCP/IP is an open network standard.

3 Component Names

◆ PCB



A - DIP switch S1
B - Ethernet connector CN1B (Port 2) (RJ45)
C - Ethernet connector CN1A (Port 1) (RJ45)
D - Port 1 LED (LINK/ACT) *1*
E - Port 1 LED (10/100) *1*
F - Port 2 LED (LINK/ACT) *1*
G - Port 2 LED (10/100) *1*
H - Communication status LEDs *1*

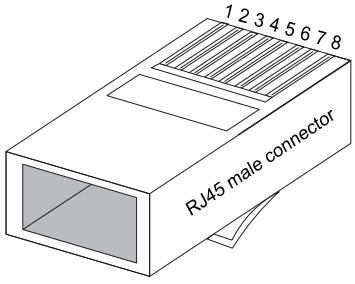
Figure 3.1 PCB Components

*1 Refer to *Communication LED States on page 8* for more information about the LEDs.

◆ Communication Connector

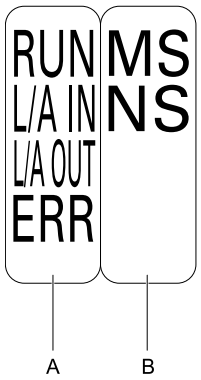
Ports CN1A (Port 1) and CN1B (Port 2) are connection points for male 8-way Ethernet modular RJ45 connectors on customer-supplied communication cables.

Table 3.1 Male 8-way Ethernet Modular Connector (Customer-Supplied)

Male 8-way Ethernet Modular Connector	Pin	Description
	1 (Pair 2)	Transmit data (TXD) +
	2 (Pair 2)	Transmit data (TXD) -
	3 (Pair 3)	Receive data (RXD) +
	4 (Pair 1)	Not used
	5 (Pair 1)	Not used
	6 (Pair 3)	Receive data (RXD) -
	7 (Pair 4)	Not used
	8 (Pair 4)	Not used

◆ Communication LED States

Use LED label B when you use Modbus TCP/IP.



A - For EtherCAT

B - For Modbus TCP/IP, EtherNet/IP, PROFINET, BACnet/IP, MECHATROLINK-4

Figure 3.2 Communication LED Labels

Wait 2 seconds minimum for the power-up diagnostic process to complete before you verify the LED states. Table 3.2 shows the operating status of the LEDs after the power-up diagnostic LED sequence is complete.

Table 3.2 Communication LED States

LED Name	Indication		Operating State	Description
	Color	State		
MS (Module Status)	-	OFF	Power supply off	There is no power to the drive.
	Green	ON	Operating	The communication network is operating normally.
	Green	Flashing	Initializing	The communication network is configuring an IP address.
	Red	ON	Fatal error occurred	The drive detected a fatal (unrecoverable) error.
	Red	Flashing	Non-fatal error occurred	The drive detected a non-fatal (recoverable) error.
NS (Network Status)	-	OFF	Power supply OFF or Offline	-
	Green	ON	Online communications established	The drive is online and has established connections.
	Green	Flashing	Control connection active	The drive is online and has an established and active control connection.
	Red	ON	Communications error (fatal)	The drive detected a duplicate IP address, has a bad IP address configuration, or timed out the communications between the controller.
10/100	-	OFF	10 Mbps is established	-
	Green	ON	100 Mbps is established	
LINK/ACT	-	OFF	Link is not established	
	Green	ON	Link is established	
	Green	Flashing	Link is established and there is network activity	

4 Installation

◆ Section Safety

⚠ DANGER *Electrical Shock Hazard. Do not examine, connect, or disconnect wiring on an energized drive. Before servicing, disconnect all power to the equipment and wait for the time specified on the warning label at a minimum. The internal capacitor stays charged after the drive is de-energized. The charge indicator LED extinguishes when the DC bus voltage decreases below 50 Vdc. When all indicators are OFF, measure for dangerous voltages to make sure that the drive is safe. If you do work on the drive when it is energized, it will cause serious injury or death from electrical shock.*

⚠ WARNING *Electrical Shock Hazard. Do not operate the drive when covers are missing. Replace covers and shields before you operate the drive. Use the drive only as specified by the instructions. Some figures in this section include drives without covers or safety shields to more clearly show the inside of the drive. If covers or safety shields are missing from the drive, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Only let approved personnel install, wire, maintain, examine, replace parts, and repair the drive. If personnel are not approved, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch circuit boards while the drive is energized. If you touch the internal components of an energized drive, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Do not use damaged wires, put too much force on the wiring, or cause damage to the wire insulation. Damaged wires can cause serious injury or death.*

⚠ WARNING *Fire Hazard. Tighten all terminal screws to the correct tightening torque. Connections that are too loose or too tight can cause incorrect operation and damage to the drive. Incorrect connections can also cause death or serious injury from fire.*

NOTICE *Damage to Equipment. When you touch the product, make sure that you observe correct electrostatic discharge (ESD) procedures. If you do not follow procedures, it can cause ESD damage to the drive circuitry.*

NOTICE *Damage to Equipment. Do not de-energize the drive while the drive is outputting voltage. Incorrect equipment sequencing can cause damage to the drive.*

NOTICE *Do not operate a drive or connected equipment that has damaged or missing parts. You can cause damage to the drive and connected equipment.*

NOTICE *Use Yaskawa connection cables or recommended cables only. Incorrect cables can cause the drive to function incorrectly.*

NOTICE *Damage to Equipment. Correctly connect the connectors. Incorrect connections can cause malfunction or damage to the equipment.*

NOTICE *Damage to Equipment. Make sure that all connections are correct after you install the drive and connecting peripheral devices. Incorrect connections can cause damage to the product.*

◆ Settings for DIP Switch S1

Use DIP switch S1 on the PCB to select the communication protocol.

Use non-conductive tweezers or a tool with a tip width of approximately 0.5 mm (0.02 in) to set DIP switch S1.

Figure 4.1 shows the default settings for DIP switch S1.

Note:

Remove the front cover to set DIP switch S1.

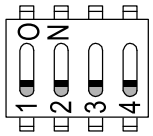


Figure 4.1 Default Settings for DIP Switch S1

When you use Modbus TCP/IP, set DIP switch S1 as shown in Figure 4.2.

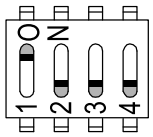


Figure 4.2 Settings for DIP Switch S1

◆ Communication Cable Specifications

Yaskawa recommends using shielded Cat5e cable. The Yaskawa warranty does not cover other cable types.

Note:

The maximum Ethernet cable length is 100 m (328 ft).

■ Communication Topology Specifications

When you use Modbus TCP/IP, drives can be connected to network in a star, ring, or line topology.

- Star Topology
  Use either one of the communication connectors CN1A (Port 1) or CN1B (Port 2).
- Daisy-Chained Topology
  Use the communication connectors CN1A (Port 1) and CN1B (Port 2) at the same time. A switch is not necessary for this connection.
- Ring Topology

Use both communication connectors CN1A (Port 1) and CN1B (Port 2) to create a ring. Ring topologies will use the RSTP protocol.

Note:

For Ring Topology connections, enable the RSTP function with reference to *Rapid Spanning Tree Protocol (RSTP) on page 33* (The default setting is enabled.)

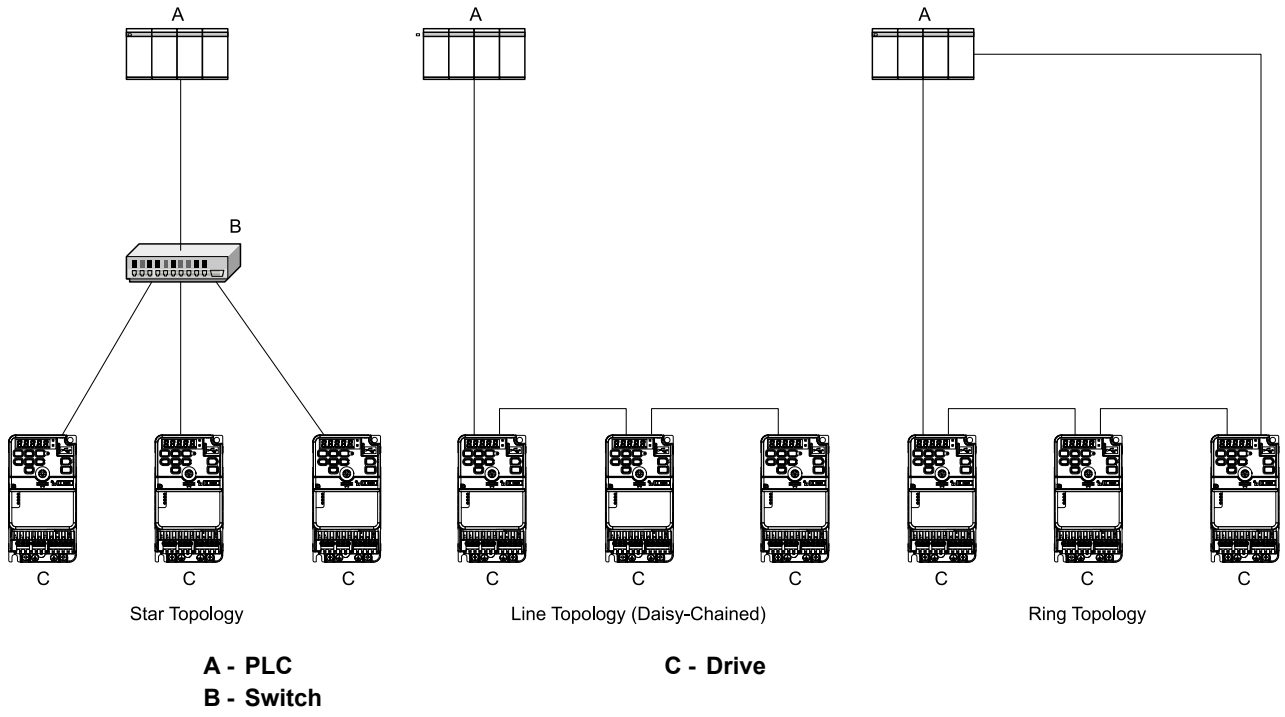


Figure 4.3 Communication Cable Wiring

5 Related Drive Parameters

These parameters set the drive for operation with Modbus TCP/IP. Make sure that the parameter settings in this table are correct before you start network communications.

Note:

Hex.: MEMOBUS addresses that you can use to change parameters over network communication are represented in hexadecimal numbers.

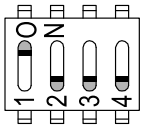
No. (Hex.)	Name	Description	Default (Range)
b1-01 (0180)	Frequency Reference Selection 1	Selects the input method for frequency reference. 0 : Keypad 1 : Analog Input 2 : USB 3 : Ethernet **Note:** Set *b1-01 = 3* to use Ethernet to control the frequency reference of the drive.	3 (0 - 3)
b1-02 (0181)	Run Command Selection 1	Sets the input method for the Run command. 0 : Keypad 1 : Digital Input 2 : USB 3 : Ethernet **Note:** Set *b1-02 = 3* to start and stop the drive with Ethernet.	3 (0 - 3)
F6-01 (03A2)	Communication Error Selection	Selects drive response when the drive detects a *bUS [Ethernet Communication Error]* error during communications. 0 : Ramp to Stop 1 : Coast to Stop 2 : Fast Stop (Use C1-09) 3 : Alarm Only 4 : Alarm (Run at *d1-04*) 5 : Alarm - Ramp Stop	1 (0 - 5)

No. (Hex.)	Name	Description	Default (Range)
		Note: • When you set this parameter to *3* or *4*, the drive will continue operation after it detects a fault. Separately prepare safety protection equipment and systems, for example fast-stop switches. • Changes to this parameter take effect immediately. It is not necessary to cycle power on the drive.	
F6-02 (03A3)	Comm External Fault (EF0) Detect	Selects the conditions at which *EF0 [Ethernet External Fault]* is detected. 0 : Always Detected 1 : Detected during RUN Only	0 (0, 1)
F6-03 (03A4)	Comm External Fault (EF0) Select	Selects the operation of the drive when *EF0 [Ethernet External Fault]* is detected. 0 : Ramp to Stop 1 : Coast to Stop 2 : Fast Stop (Use C1-09) 3 : Alarm Only **Note:** When you set this parameter to *3*, the drive will continue operation after it detects a fault. Separately prepare safety protection equipment and systems, for example fast stop switches.	1 (0 - 3)
F6-06 (03A7)	Torque Limit by Comm. Ethernet	Selects whether to enable or disable the torque reference and torque limit received from Ethernet. 0 : Disabled 1 : Enabled **Note:** • Parameter is available when *A1-02 = 2, 6, 8 [Control Method Selection = Open Loop Vector PM Advanced Open Loop Vector, EZ Vector Control]*. The drive reads this value as the Torque Limit. • If the PLC does not supply a torque reference or torque limit when *F6-06 = 1 [Torque Limit by Comm. Ethernet = Enabled]*, the motor cannot rotate.	0 (0, 1)
F6-07 (03A8)	Multi-Step Ref @ NetRef/ ComRef	0 : Disable Multi-Step References 1 : Enable Multi-Step References	1 (0, 1)
F6-08 (036A)	Comm Parameter Reset @Initialize	Selects whether communication-related parameters *F6-xx and F7-xx* are set back to original default values when you use parameter *A1-03 [Initialize Parameters]* to initialize the drive. 0 : No Reset - Parameters Retained 1 : Reset - Back to Factory Default **Note:** When you set *F6-08* to *1* and you then use *A1-03* to initialize the drive, the drive will not change this setting value.	0 (0, 1)
F6-14 (03BB)	Bus Error Auto Reset	Enables and disables the automatic reset of a *bUS [Ethernet Communication Error]* fault. 0 : Disabled 1 : Enabled **Note:** Changes to this parameter take effect immediately. It is not necessary to cycle power on the drive.	0 (0, 1)
F6-15 (0B5B)	Ethernet Parameters Reload	Sets when the drive will activate the *F6-xx/F7-xx* Ethernet-related parameters that you changed. Use this parameter as an alternative to cycling power to the drive to active parameters. 0 : Reload at Next Power Cycle 1 : Reload Now 2 : Cancel Reload Request **Note:** • *F6-15* is reset to *0* after setting *1* or *2*. • Changes to this parameter take effect immediately. It is not necessary to cycle power on the drive.	0 (0 - 2)
F7-01 (03E5)	IP Address 1	Sets the static/fixed IP address. Sets the most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	192 (0 - 255)
F7-02 (03E6)	IP Address 2	Sets the static/fixed IP address. Sets the second most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	168 (0 - 255)
F7-03 (03E7)	IP Address 3	Sets the static/fixed IP address. Sets the third most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	1 (0 - 255)
F7-04 (03E8)	IP Address 4	Sets the static/fixed IP address. Sets the fourth most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique.	20 (0 - 255)

No. (Hex.)	Name	Description	Default (Range)
		• You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	
F7-05 (03E9)	Subnet Mask 1	Sets the static/fixed Subnet Mask. Sets the most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	255 (0 - 255)
F7-06 (03EA)	Subnet Mask 2	Sets the static/fixed Subnet Mask. Sets the second most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	255 (0 - 255)
F7-07 (03EB)	Subnet Mask 3	Sets the static/fixed Subnet Mask. Sets the third most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	255 (0 - 255)
F7-08 (03EC)	Subnet Mask 4	Sets the static/fixed Subnet Mask. Parameter F7-08 sets the fourth most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	0 (0 - 255)
F7-09 (03ED)	Gateway Address 1	Sets the static/fixed Gateway address. Sets the most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	192 (0 - 255)
F7-10 (03EE)	Gateway Address 2	Sets the static/fixed Gateway address. Sets the second most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	168 (0 - 255)
F7-11 (03EF)	Gateway Address 3	Sets the static/fixed Gateway address. Sets the third most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	1 (0 - 255)
F7-12 (03F0)	Gateway Address 4	Sets the static/fixed Gateway address. Parameter F7-12 sets the fourth most significant octet. **Note:** • This parameter is only effective when *F7-13 = 0 [Address Mode at Startup = Static]*. • All IP Addresses must be unique. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	1 (0 - 255)
F7-13 (03F1)	Address Startup Mode	Selects how the IP address is set. 0 : Static (Use F7-01 to F7-12 to set.) 1 : BOOTP (Use network address.) 2 : DHCP (Use network address.) **Note:** You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	2 (0 - 2)
F7-14 (03F2)	Duplex Mode Selection	Sets duplex mode settings (Port 1 (CN1A)/Port 2 (CN1B)). 0 : Half/Half (Half Duplex/Half Duplex) 1 : Auto/Auto (Auto Negotiation/Auto Negotiation) 2 : Full/Full (Full Duplex/Full Duplex) 3 : Half/Auto (Half Duplex/Auto Negotiation) 4 : Half/Full (Half Duplex/Full Duplex) 5 : Auto/Half (Auto Negotiation/Half Duplex) 6 : Auto/Full (Auto Negotiation/Full Duplex) 7 : Full/Half (Full Duplex/Half Duplex) 8 : Full/Auto (Full Duplex/Auto Negotiation) **Note:** You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	1 (0 - 8)
F7-15 (03F3)	Communication Speed Selection	Sets the communications speed (Port 1 (CN1A)/Port 2 (CN1B)). 10 : 10/10 Mbps (10 Mbps/10 Mbps)	10 (10 - 102)

No. (Hex.)	Name	Description	Default (Range)
		100 : 100/100 Mbps (100 Mbps/100 Mbps) 101 : 10/100 Mbps (10 Mbps/100 Mbps) 102 : 100/10 Mbps (100 Mbps/10 Mbps) **Note:** • *F7-15* is only effective when the port is set to half or full duplex in *F7-14 [Duplex Mode Selection]*. • You must cycle power to the drive or set *F6-15 = 1 [Ethernet Parameters Reload = Reload Now]* for the changes to take effect.	
F7-16 (03F4)	Timeout Value	Sets the detection time for a communications timeout. **Note:** • Set this parameter to *0.0* to disable the connection timeout function. • Changes to this parameter take effect immediately. It is not necessary to cycle power on the drive.	0.0 s (0.0 s - 30.0 s)
H5-11 (043C)	Communications ENTER Function Selection	Sets when an Enter command is necessary to use Modbus TCP/IP communications to change parameter values. 0 : Parameter changes are activated when ENTER command is written 1 : Parameter changes are activated immediately. No ENTER command is necessary. **Note:** Changes to this parameter take effect immediately. It is not necessary to cycle power on the drive.	1 (0, 1)

Table 5.1 Modbus TCP/IP Monitor

No.	Name	Description	Range
U4-75	Ethernet Protocol	Shows the setting of DIP switch S1. • 71 (Setting to use Modbus TCP/IP (1: ON, 2: OFF, 3: OFF, 4: OFF))  • 00 to 70, 72 to FF (Setting to use other than Modbus TCP/IP) **Note:** Modbus TCP/IP will not operate with these setting values.	00 - FF (Hex.)
U4-76 - U4-78	MAC Address 1	Shows the main MAC address. • *U4-76*: First octet, Second octet • *U4-77*: Third octet, Fourth octet • *U4-78*: Fifth octet, Sixth octet	0000 - FFFF (Hex.)
U6-80 - U6-83	Ethernet IP Address 1 - 4	Shows the currently available local IP Address. • *U6-80*: First octet • *U6-81*: Second octet • *U6-82*: Third octet • *U6-83*: Fourth octet	0 - 255
U6-84 - U6-87	Ethernet Subnet 1 - 4	Shows the currently available subnet mask. • *U6-84*: First octet • *U6-85*: Second octet • *U6-86*: Third octet • *U6-87*: Fourth octet	0 - 255
U6-88 - U6-91	Ethernet Gateway 1 - 4	Shows the currently available gateway address. • *U6-88*: First octet • *U6-89*: Second octet • *U6-90*: Third octet • *U6-91*: Fourth octet	0 - 255
U6-92	Ethernet Speed	Shows CN1A Port 1 link speed currently available.	10: 10 Mbps 100: 100 Mbps
U6-93	Online Duplex	Shows CN1A Port 1 duplex setting currently available.	0: Half/Half 1: Full/Full
U6-94	Ethernet SPARE 1	Shows CN1B Port 2 link speed currently available.	10: 10 Mbps 100: 100 Mbps
U6-95	Ethernet SPARE 2	Shows CN1B Port 2 duplex setting currently available.	0: Half/Half 1: Full/Full
U6-96	Ethernet SPARE 3	RSTP Role and State. Refer to *Rapid Spanning Tree Protocol (RSTP) on page 33* for more information.	0000 - 9292
U6-97	Ethernet SPARE 4	Shows Modbus TCP/IP software version.	-
U6-98	Ethernet First Fault	Shows first Modbus TCP/IP fault.	-
U6-99	Ethernet Current Fault	Shows current Modbus TCP/IP fault.	-

6 Modbus TCP/IP Messaging

◆ Modbus TCP/IP Overview

The Modbus TCP/IP protocol is essentially the Modbus protocol over a Modbus TCP/IP network. A master controller (typically a PLC) sends commands to slave devices, which then perform the specified functions and send a response to the master. The drive using Modbus TCP/IP network has slave functionality.

■ Supported Modbus TCP/IP Commands

Table 6.1 Supported Modbus TCP/IP Commands

Function Code (Hex.)	Name
03	Read Multiple Registers
06	Write Single Register
10	Write Multiple Registers
17	Read/Write Multiple Registers

■ Drive Modbus TCP/IP Registers

All of the command registers, monitor registers, and parameters documented in the drive Technical Manual are accessible via the Modbus TCP/IP network.

■ High Speed Access Drive Modbus TCP/IP Registers

Many of the registers required for control have been specially mapped to provide higher speed access to increase network performance. Use these registers for the best response times.

Table 6.2 and Table 6.3 show all data that are refreshed in a fast cycle. Command registers can be read from and written into.

Note:

Set bits that you do not use to 0. Do not write to reserved registers.

Table 6.2 Command Register Data

Register Number (Hex.)	Description	
0000	Reserved	
0001	Operation Commands and Multi-function Inputs	
	bit0	1: Forward Run 0: Stop
	bit1	1: Reverse run 0: Stop
	bit2	External Fault (EF0 [Ethernet External Fault])
	bit3	Fault Reset
	bit4	Multi-Function Input 1
	bit5	Multi-Function Input 2
	bit6	Ethernet Multi-Function Input 3
	bit7	Ethernet Multi-Function Input 4
	bit8	Ethernet Multi-Function Input 5
	bit9	Ethernet Multi-Function Input 6
	bit A	Ethernet Multi-Function Input 7
	bit B- F	Reserved
0002	Frequency Reference	Units are determined by parameter *o1-03 [Frequency Display Unit Selection]*.
0003	Output voltage gain Unit: 0.1% Setting range: 20 (2.0%) - 2000 (200.0%) Default value at energize: 1000 (100.0%)	
0004	Torque limit (0.1% signed)	

Register Number (Hex.)	Description	
0005	Torque compensation (0.1% signed)	
0006	PID setpoint (0.01% signed)	
0007	Reserved	
0008	Reserved	
0009	MFDO setting	
	bit 0	Multi-Function Output 1 Terminal MA-MB-MC
	bit 1	Multi-Function Output 2 Ethernet DO1
	bit 2	Multi-Function Output 3 Ethernet DO2
	bit 3- F	Reserved
000A - 000E	Reserved	
000F	Command selection setting	
	bit 0	Reserved
	bit 1	Input for the PID setpoint
	bit 2	Torque limit input (enables the setting from MEMOBUS/Modbus)
	bit 3	Torque compensation input (enables the setting from MEMOBUS/Modbus)
	bit 4 - F	Reserved

Table 6.3 Drive Registers

No. (Modbus Register)	Drive Registers	Register Name	Bit	Description
2000	4B	Drive Status (U1-12)	0	1: During Run
			1	1: During zero speed
			2	1: During reverse
			3	1: During reset signal input
			4	1: During Speed Agree
			5	1: Drive operation ready
			6	1: Alarm
			7	1: Fault
			8	1: During Operation Error (oPExx)
			9	1: Momentary power loss recovery 0: Power loss recovery
			A	1: Motor 2 Selection
			B	Reserved
			C	Reserved
			D	Reserved
			E	ComRef status/ NetRef status
			F	ComCtrl status/ NetCtrl status
2001	44	Motor Speed Monitor (U1-05)		
2002	48	Torque Reference Monitor (U1-09)		
2003	F0	Reserved		
2004	40	Frequency Reference Monitor (U1-01)		
2005	41	Output Frequency Monitor (U1-02)		
2006	26	Output Current (U1-03) (units: 0.1 A)		
2007	4F	Reserved		
2008	46	DC Bus Voltage Monitor (U1-07)		
2009	C0	Error Signal 1	0	Reserved

No. (Modbus Register)	Drive Registers	Register Name	Bit	Description
			1	Undervoltage (Uv1)
			2	Control Power Supply Undervoltage (Uv2)
			3	Soft Charge Circuit Fault (Uv3)
			4	Short Circuit/IGBT Failure (SC)
			5	Ground Fault (GF)
			6	Overcurrent (oC)
			7	Overvoltage (ov)
			8	Heatsink Overheat (oH)
			9	Heatsink Overheat (oH1)
			A	Motor Overload (oL1)
			B	Drive Overload (oL2)
			C	Overtorque Detection 1 (oL3)
			D	Overtorque Detection 2 (oL4)
			E	Dynamic Braking Transistor Fault (rr)
			F	Braking Resister Overheat (rH)
200A	C1	Error Signal 2	0	External Fault (Ethernet DI3) (EF3)
			1	External Fault (Ethernet DI4) (EF4)
			2	External Fault (Ethernet DI5) (EF5)
			3	External Fault (Ethernet DI6) (EF6)
			4	External Fault (Ethernet DI7) (EF7)
			5	Reserved
			6	Reserved
			7	Overspeed (oS)
			8	Excessive Speed Deviation (dEv)
			9	PG Disconnected (PGo)
			A	Input Phase Loss (PF)
			B	Output Phase Loss (LF)
			C	Motor Overheat (PTC input) (oH3)
			D	Digital Operator Connection Fault (oPr)
			E	EEPROM Write Error (Err)
			F	Motor Overheat Fault (PTC input) (oH4)
200B	C2	Error Signal 3	0	MEMOBUS/Modbus Communication Error (CE)
			1	Ethernet Communication Error (bUS)
			2	Reserved
			3	Reserved
			4	Control Fault (CF)
			5	Zero Servo Fault (SvE)
			6	Ethernet External Fault (EF0)
			7	PID Feedback Loss (FbL)
			8	Undertorque Detection 1 (UL3)
			9	Undertorque Detection 2 (UL4)
			A	High Slip Braking Overload (oL7)
			B	Reserved
			C	Reserved
			D	Reserved
			E	Reserved

No. (Modbus Register)	Drive Registers	Register Name	Bit	Description
			F	Hardware Fault (includes oFx)
200C	4E	Terminal A1 Input Level Monitor (U1-13)		
200D	49	Digital Input Status (U1-10)		
200E	50	Reserved		
200F	F1	Reserved		
2010	4D	Drive Software Number (Flash) (U1-25)		

■ Types of Enter Commands

The drive supports the two Enter commands shown in Table 6.4.

An Enter command is enabled by writing 0 to register number 0900 (Hex.) or 0910 (Hex.).

These registers can be written to only.

An error will occur if the user attempts to read from these registers.

Table 6.4 Types of Enter Commands

Register Number (Hex.)	Description
0900	When you write parameter data to the EEPROM, you will enable the data on the RAM at the same time. Parameter changes remain even if the power supply is cycled.
0910	This updates the data on the RAM, but does not write data to the EEPROM. Parameter changes are lost when the drive is shut off.

Note:

- You can write the EEPROM to the drive a maximum of 100,000 times. Do not frequently execute the Enter command (0900 (Hex.)) that is written to EEPROM. When the command data or broadcast message is transmitted to the drive, the Enter command is not necessary.
- Parameter data cannot be written to EEPROM during undervoltage, even using 0900 (Hex.).
- If undervoltage occurs when a making several parameter changes issued with a single ENTER command, the writing process may be aborted before all of the new changes have been written. Because all of the data has not yet been written, the EEPROM data error *CPF06* will be displayed the next time power to the drive is cycled. To prevent *CPF06*, wait approximately 5 seconds after issuing the ENTER command before shutting off drive power.

■ Enter Command Function Differences Depending on the Setting of H5-11

Table 6.5 Enter Command Function Differences Depending on the Setting of H5-11

Function	H5-11 = 0	H5-11 = 1
Time when the parameter settings are enabled	When the drive receives the Enter command from the master	When you change the parameter settings
Upper and lower limit check	Checks the upper and lower limits and considers the related parameter settings.	Checks the upper and lower limit of the changed parameter only.
Default setting of related parameters	Not affected. The settings of related parameters remain unchanged. They must be changed manually, if needed.	Automatically changes the default settings for the related parameters.
Fault detection when you set more than one parameter	Accepts and responds as usual to correct setting data if the data contains parameter setting errors. The drive discards the disabled setting data, but will not return an error message.	Error occurs if only one setting is invalid. The drive discards the data that was sent.

■ Message Format

The data section of the Modbus packet contains the Modbus message. In this data section, the master sends commands to the slave, and the slave responds. The message format is configured for both sending and receiving as shown below, and the length of data packets depends on the command (function) content.

- Unit Identifier
- Function code
- Data

Unit Identifier

This field is used for intra-system routing purposes. It is typically used to communicate to a Modbus+ or a Modbus serial line slave through a gateway between a Modbus TCP/IP network and a Modbus serial line. This field is set by the Modbus master in the command and must be returned with the same value in the response by the

slave. This is sometimes referred to as the Unit ID. This field is not usually used because the drive does not have a gateway function. Refer to the manual of the master or gateway used when you set the value to the Unit identifier.

Function code

When sent by the master, this field identifies the command to be undertaken by the slave. It also identifies the format for the DATA section of the message. The slave normally echoes this command back to the master in its response message. When the most significant bit of this field is set in the response message, it signals an error condition has occurred.

Data

This field contains multiple bytes of varying length based upon the Function Code for commands and based upon the results of the command in the response. When sent by the master, this field contains details of the command that the slave will require to carry out the function. When sent by the slave, this field contains details of the response and sometimes error information.

■ Modbus TCP/IP Function Details

03 (03 (Hex.)) Read Multiple Registers

This function code is used to read the contents of a contiguous block of registers. The command specifies the starting register and the number of registers. The normal response packs two bytes per register. For each register in the response, the first byte contains the most significant bits and the second byte contains the least significant bits.

Table 6.6 Read Multiple Registers (Command)

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	03
Starting Register	2	0000 - FFFF
Quantity of Registers	2	N *1

*1 N = Quantity of Registers (1 to 16)

Table 6.7 Read Multiple Registers (Response)

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	03
Number of Data Bytes	1	2 × N *1
Register Values	N *1 × 2	Values contained in slave registers

*1 N = Quantity of Registers

Table 6.8 Read Multiple Registers (Error Response)

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Error Code	1	83
Exception Code	1	Refer to Modbus TCP/IP Exception Codes.

Examples of Fault Response, Read Response, and Read Multiple Registers Command

Table 6.9 lists command examples to 4 read register contents (register addresses 0020 (Hex.) to 0023 (Hex.)) from a drive with the slave address (unit identifier) 02 (Hex.).

Table 6.10 shows examples of responses indicating that multiple registers have been read successfully. The contents read from 0020 (Hex.) are 1770 (Hex.), 1770 (Hex.), 0109 (Hex.), and 0000 (Hex.).

Table 6.11 shows examples of an error response when reading multiple registers. The exception code is 02 (Hex.) (indicating a register number error).

Table 6.9 Example Read Multiple Registers Command

Description		Data (Hex.)
Slave Address (Unit Identifier)		02
Function Code		03
Starting Register *1	Upper	00

Description		Data (Hex.)
	Lower	20
Quantity of Registers	Upper	00
	Lower	04

*1 With Modbus TCP/IP, the drive is set up to use PLC based (holding) register addressing (base 1). The drive will automatically convert the register address to one more than the address sent over the network before it will respond.

When reading the starting register 0020 (Hex.) from the PLC:

1. The PLC sends out a command specifying the starting register 001F (Hex.) to the network.
2. The drive automatically converts the starting register 001F (Hex.) to 0020 (Hex.).
3. The drive responds the value of register address 0020 (Hex.) to the PLC.

Table 6.10 Example Read Multiple Registers Response

Description		Data (Hex.)
Slave Address (Unit Identifier)		02
Function Code		03
Number of Data Bytes		08
Starting Register	Upper	17
	Lower	70
Next Register	Upper	17
	Lower	70
Next Register	Upper	01
	Lower	09
Last Register	Upper	00
	Lower	00

Table 6.11 Example Read Multiple Registers Error Response

Description	Data (Hex.)
Slave Address (Unit Identifier)	02
Error Code	83
Exception Code	02

06 (06 (Hex.)) Write Single Register

This function code is used to write to a single register in the drive. The command specifies the address of the register to be written and the value to write. The normal response is an echo of the request, returned after the register contents have been written.

Table 6.12 Write Single Register Command

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	06
Register Address	2	0000 - FFFF
Register Values	2	0000 - FFFF

Table 6.13 Write Single Register Response

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	06
Register Address	2	0000 - FFFF
Register Values	2	0000 - FFFF

Table 6.14 Write Single Register Error Response

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Error Code	1	86
Exception Code	1	Refer to Modbus TCP/IP Exception Codes.

Examples of Register Write Command

Table 6.15 lists command examples when writing register value 0003 (Hex.) to register address 0001 (Hex.) in a drive with the slave address (unit identifier) 01 (Hex.).

Table 6.16 shows examples of responses indicating that the write command has been executed successfully. The command specifies the value and the register address to write to.

Table 6.17 shows examples of an error response when writing to a register. The exception code is 21 (Hex.) (indicating an invalid value).

Table 6.15 Examples of Register Write Command

Description		Data (Hex.)
Slave Address (Unit Identifier)		01
Function Code		06
Register Address *1	Upper	00
	Lower	01
Register Values	Upper	00
	Lower	03

*1 With Modbus TCP/IP, the drive is set up to use PLC based (holding) register addressing (base 1). The drive will automatically convert the register address to one more than the address sent over the network before it will respond.

When writing the register address 0001 (Hex.) from the PLC:

1. The PLC sends out a command specifying the register address 0000 (Hex.) to the network.
2. The drive automatically converts the register address 0000 (Hex.) to 0001 (Hex.).
3. The drive responds the value of register address 0001 (Hex.) to the PLC.

Table 6.16 Example Write Single Register Response

Description		Data (Hex.)
Slave Address (Unit Identifier)		01
Function Code		06
Register Address	Upper	00
	Lower	01
Register Values	Upper	00
	Lower	03

Table 6.17 Example Write Single Register Error Response

Description	Data (Hex.)
Slave Address (Unit Identifier)	01
Error Code	86
Exception Code	21

16 (10 (Hex.)) Write Multiple Registers

This function code is used to write to a contiguous block of registers in the drive. The command specifies the starting register address, the number of registers, and the values to be written. The command packs two bytes per register. For each register in the command, the first byte contains the most significant bits, and the second byte contains the least significant bits. The normal response returns the function code, starting address, and quantity of registers written.

Table 6.18 Write Multiple Registers Command

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	10

Description	Byte No.	Data (Hex.)
Starting Register *1	2	0000 - FFFF
Quantity of Registers	2	N *2
Number of Data Bytes	1	N *2 × 2
Register Values	N *2 × 2	0000 - FFFF

*1 With Modbus TCP/IP, the drive is set up to use PLC based (holding) register addressing (base 1). The drive will automatically convert the register address to one more than the address sent over the network before it will respond.

When writing the starting register 0258 (Hex.) from the PLC:

1. The PLC sends out a command specifying the starting register 0257 (Hex.) to the network.
2. The drive automatically converts the starting register 0257 (Hex.) to 0258 (Hex.).
3. The drive responds the value of register address 0258 (Hex.) to the PLC.

*2 N = Quantity of Registers (1 to 16)

Table 6.19 Write Multiple Registers Response

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	10
Starting Register	2	0000 - FFFF
Quantity of Registers	2	N *1

*1 N = Quantity of Registers

Table 6.20 Write Multiple Registers Error Response

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	01
Error Code	1	90
Exception Code	1	Refer to Modbus TCP/IP Exception Codes.

Examples of Multiple Registers Write Command

Table 6.21 lists command examples when writing register values 0001 (Hex.) and 0258 (Hex.) to register addresses 0001 (Hex.) and 0002 (Hex.) in a drive with the slave address (unit identifier) 01 (Hex.).

Table 6.22 shows examples of responses indicating that the write command has been executed successfully. The command specifies the beginning of the register address and the number of registers.

Table 6.23 shows examples of an error response when writing to a register. The exception code is 02 (Hex.) (indicating a register number error).

Table 6.21 Examples of Multiple Registers Write Command

Description		Data (Hex.)
Slave Address (Unit Identifier)		01
Function Code		10
Starting Register *1	Upper	00
	Lower	01
Quantity of Registers	Upper	00
	Lower	02
Number of Data Bytes		04
First Register Data	Upper	00
	Lower	01
Next Register Data	Upper	02
	Lower	58

*1 With Modbus TCP/IP, the drive is set up to use PLC based (holding) register addressing (base 1). The drive will automatically convert the register address to one more than the address sent over the network before it will respond.

When writing the starting register 0001 (Hex.) from the PLC:

1. The PLC sends out a command specifying the starting register 0000 (Hex.) to the network.
2. The drive automatically converts the starting register 0000 (Hex.) to 0001 (Hex.).
3. The drive responds the value of register address 0001 (Hex.) to the PLC.

Table 6.22 Example Write Multiple Registers Response

Description		Data (Hex.)
Slave Address (Unit Identifier)		01
Function Code		10
Starting Register	Upper	00
	Lower	01
Quantity of Registers	Upper	00
	Lower	02

Table 6.23 Example Write Multiple Registers Error Response

Description	Data (Hex.)
Slave Address (Unit Identifier)	01
Error Code	90
Exception Code	02

23 (17 (Hex.)) Read/Write Multiple Registers

This function code performs a combination of one read operation and one write operation in a single Modbus TCP/IP transaction. The write operation is performed before the read. The command specifies the starting read address, quantity of contiguous registers to read, starting write address, quantity of contiguous registers to write and the values to be written. The normal response contains the values of the registers that were read.

For both the address and the values, the first byte contains the most significant bits and the second byte contains the least significant bits.

Table 6.24 Read/Write Multiple Registers Command

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	17
Read Starting Register	2	0000 - FFFF
Quantity of Registers to Read	2	M *1
Write Starting Register	2	0000 - FFFF
Quantity of Registers to Write	2	N *2
Write Byte Count	1	N *2 × 2
Write Register Values	N *2 × 2	0000 - FFFF

*1 M = Quantity of Registers to Read (range is 1 - 16)
*2 N = Quantity of Registers to Write (range is 1 - 16)

Table 6.25 Read/Write Multiple Registers Response

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Function Code	1	17
Number of Data Bytes	1	M *1 × 2
Read Register Values	M *1 × 2	Values contained in slave registers

*1 M = Quantity of Registers

Table 6.26 Read/Write Multiple Registers Error Response

Description	Byte No.	Data (Hex.)
Slave Address (Unit Identifier)	1	00 - FF
Error Code	1	97
Exception Code	1	Refer to Modbus TCP/IP Exception Codes.

Read/Write Multiple Registers

Table 6.27 lists command examples when reading registers 0001 (Hex.) and 0002 (Hex.) and then writing register values 0103 (Hex.) and 0258 (Hex.) to register addresses 0102 (Hex.) and 0103 (Hex.) in a drive with the slave address (unit identifier) 01 (Hex.).

Table 6.28 shows examples of responses indicating that the read/write multiple registers command has been executed successfully. Read data 1 contains the value of register address 0001 (Hex.) (0001 (Hex.)). Read data 2 contains the value of the register address 0002 (Hex.) (0002 (Hex.)).

Table 6.29 shows examples of an error response when the command to read and write to multiple registers has failed. The exception code is 02 (Hex.) (indicating a register number error).

Table 6.27 Example Read/Write Multiple Registers Command

Description		Data (Hex.)
Slave Address (Unit Identifier)		01
Function Code		17
Read Starting Register	Upper	00
	Lower	01
Quantity of Registers to Read	Upper	00
	Lower	02
Write Starting Register	Upper	01
	Lower	02
Quantity of Registers to Write	Upper	00
	Lower	02
Write Byte Count		04
First Write Register Data	Upper	01
	Lower	03
Next Write Register Data	Upper	02
	Lower	58

Table 6.28 Example Read/Write Multiple Registers Response

Description		Data (Hex.)
Slave Address (Unit Identifier)		01
Function Code		17
Number of Data Bytes		04
Read Data 1	Upper	00
	Lower	01
Read Data 2	Upper	00
	Lower	02

Table 6.29 Example Read/Write Multiple Registers Error Response

Description	Data (Hex.)
Slave Address (Unit Identifier)	01
Error Code	97
Exception Code	02

■ Modbus TCP/IP Exception Codes

When an error occurs, remove the cause and restart communications. The response message will contain one of the Error Codes defined in Table 6.30.

Table 6.30 Modbus TCP/IP Exception Codes

Error Code (Hex.)	Error Name and Cause
01	Function Code Error Attempted to set a function code from a PLC other than 03 (Hex.), 06 (Hex.), 10 (Hex.), and 17 (Hex.).
02	Register Number Error A register number specified in the command message does not exist.
03	Data Length Error • Invalid command message quantity • In a write message, the value for write byte count does not match twice the value of the stated quantity of registers to write.

Error Code (Hex.)	Error Name and Cause
21	Data Setting Error • Control data or parameter write data is outside the allowable setting range. • Attempted to write a contradictory parameter setting.
22	Write Mode Error • Attempted to write while the drive was operating to a parameter that cannot be written to during run. • During an EEPROM data error (*CPF06 [EEPROM Memory Data Error]*), the master attempted to write to a parameter other than *A1-00 [Language Selection]*, *A1-01 [Access Level Selection]*, *A1-02 [Control Method Selection]*, *A1-03 [Initialize Parameters]*, *A1-04 [Password]*, *A1-05 [Password Setting]*, *E1-03 [V/f Pattern Selection]*, or *o2-04 [Drive Model (KVA) Selection]*. • Attempted to write to read-only data.
23	DC Bus Undervoltage Write Error • Attempted to write from the master during a *Uv1 [DC Bus Undervoltage]*. • Attempted to execute and Enter command during a *Uv1 [DC Bus Undervoltage]*.
24	Writing Error during Parameter Processing Master attempted writing to the drive while the drive was processing parameter data.
25	Writing into EEPROM Disabled Writing into EEPROM write is disabled, but EEPROM write was executed from the MEMOBUS/Modbus network. When this error occurs, the keypad shows a message and the drive continues operation.

■ Control Connection Timeout

Modbus TCP/IP communications has a safety feature that declares a fault if communications between the master and drive is lost after the master commanded the drive to run.

A controlled connection is defined as one in which a master commands the drive by writing to register 01 (Hex.). After this write, the timer will begin. The timer will be reset upon subsequent writes to register 01 (Hex.). If the timer exceeds the value programmed in drive parameter *F7-16 [Timeout Value]*, a *bUS [Ethernet Communication Error]* will occur. A value of 0 in *F7-16* means that the timeout is disabled.

The drive reaction to a *bUS* is programmable through drive parameter *F6-01 [Communication Error Selection]*.

7 Web Interface

The drive contains a series of web pages that let you use a standard web browser to view status and diagnostic information.

You can access the web page through a self-contained web server at port 80. Type the IP address of the drive into a web browser to access the Home page.

Example: http://192.168.1.20

If you do not know the IP address, use monitors *U6-80 to U6-83 [Ethernet IP Address 1 to Ethernet IP Address 4]* on the keypad to read the IP address of the drive. Refer to Table 5.1 for more information.

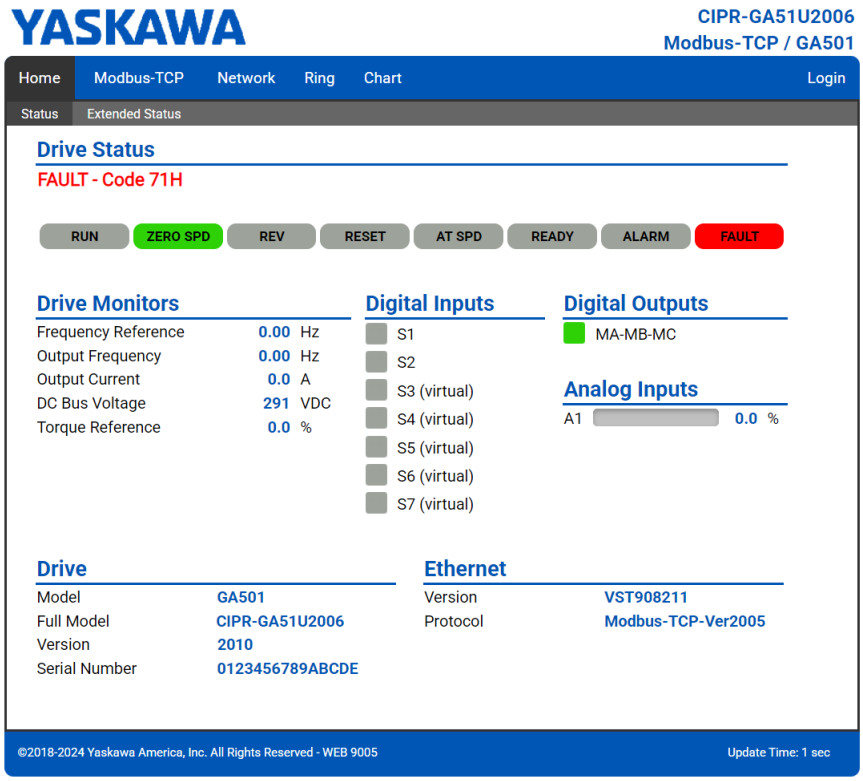
◆ Home Page

The Home page shows the status of the drive and the I/O. It also shows identifying information about the drive.

Figure 7.1 Home Page View

When a fault or minor fault occurs in the drive, the details of the fault or minor fault are displayed on the Home page.

If a fault or minor fault occurs in the drive and only the fault or minor fault code is displayed on the Home page, refer to the drive manuals for details on the fault or minor fault.



◆ Modbus-TCP Page

The Modbus-TCP page shows basic information about the protocol.

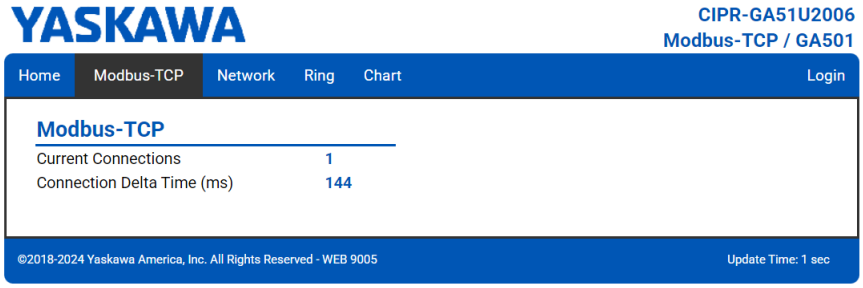


Figure 7.2 Modbus-TCP Page View

Table 7.1 Modbus-TCP Page Description

Network Monitor	Description
Current Connections	Current number of open connections.
Control Connection Delta Time	The time between the last two writes to the Control register, MEMOBUS/Modbus address 0001 (Hex.).

◆ Network Page

The Network page shows the status of the drive network traffic and the status of open I/O connections.

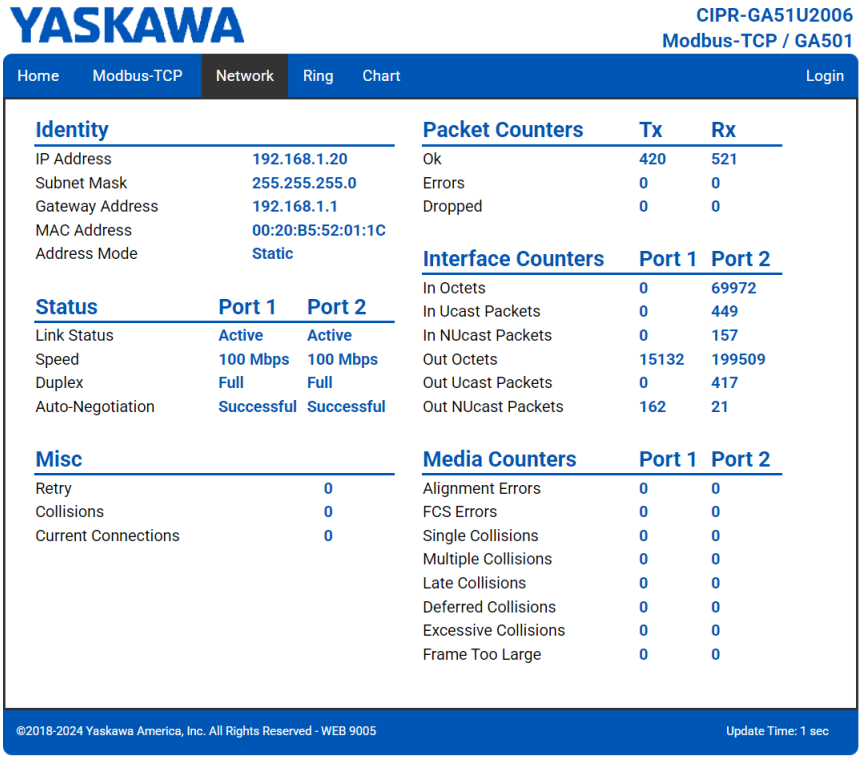


Figure 7.3 Network Page View

Table 7.2 Network Monitor Descriptions

Name	Description
Address Mode	Either static IP address or DHCP.
Alignment Errors	Cumulative number of errors for uneven packets lengths.
Auto-Negotiation	If auto-negotiation is enabled, this will show the status of the negotiation.
Collisions	Cumulative number of collisions (half duplex only) reported by the MAC/PHY (Media Access Control/Physical Layer).
Current Connections	Current number of open connections.
Deferred Collisions	Cumulative number of deferred collisions.
Duplex	Display either Full or Half.
Excessive Collisions	Cumulative number of excessive collisions.
FCS Errors	Cumulative number of frame check sequence errors.
Frame Too Large	Cumulative number of frames that exceed the maximum frame size.
Gateway Address	The Gateway IP Address.
In NUcast Packets	Cumulative number of non-unicast packets received.
In Octets	Cumulative number of incoming octets.
In Ucast Packets	Cumulative number of unicast packets received.
IP Address	IP Address.
Late Collisions	Cumulative number of late collisions.
Link Status	Active if the cable is plugged in, or inactive if no cable.
MAC Address	MAC Address.
Msg Rx Dropped	Cumulative number of messages dropped due to input network buffer being full and unable to hold the new message.
Msg Rx Errors	Cumulative number of receive errors reported by the MAC/PHY (Media Access Control/Physical Layer).
Msg Rx OK	Cumulative number of messages received successfully.
Msg Tx Dropped	Cumulative number of messages dropped due to output network buffer being full and unable to hold the new message.
Msg Tx Errors	Cumulative number of transmit errors reported by the MAC/PHY (Media Access Control/Physical Layer).
Msg Tx OK	Cumulative number of messages transmit successfully.
Multiple Collisions	Cumulative number of multiple collisions.

Name	Description
Out NUcast Packets	Cumulative number of non-unicast packets sent.
Out Octets	Cumulative number of outgoing octets.
Out Ucast Packets	Cumulative number of unicast packets sent.
Single Collisions	Cumulative number of single collisions.
Speed	Connection speed, either 10 Mbps or 100 Mbps.
Subnet Mask	Subnet Mask.
Tx Retry	Cumulative number of retransmits due to busy medium reported by the MAC/PHY (Media Access Control/Physical Layer).

Note:
Cumulative counters are reset when the power supply is cycled.

◆ Ring Page

The Ring page shows the status of the RSTP network. RSTP can be enabled and disabled from this page, and the priority can be modified. To change either of these values, you must be logged into the page first.

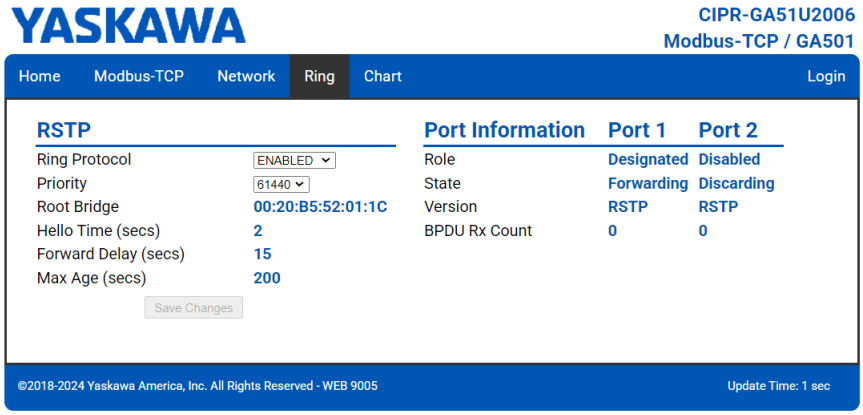


Figure 7.4 Ring Page View

■ RSTP

Ring Protocol

After setting the setting value to [ENABLED], click [Save Changes] to enable RSTP.

Priority

The RSTP Priority controls which bridge in the network becomes the root bridge. A lower value in the [Priority] field indicates a higher priority. The [Priority] field ranges from 0 to 61440 in increments of 4096. The drive defaults to the lowest priority, 61440. Refer to Table 7.3 for information on [Priority] field setting.

Table 7.3 Priority Values

0	16384	32678	49152
4096	20480	36864	53248
8192	24576	40960	57344
12288	28672	45056	61440

To change the priority in [Priority] field, select the desired priority from the list Table 7.3 and click [Save Changes].

Root Bridge

This field displays the MAC address of the root bridge on the network.

Hello Time (secs)

This field displays and indicates how often the bridge packets will be sent out. This value is set by the root bridge.

Forward Delay (secs)

The Forward Delay is displayed in seconds. This value is set by the root bridge.

Max Age (secs)

The Max Age is displayed in seconds. This value is set by the root bridge and indicates how long a message can be passed along before being discarded.

■ Port Information

Role

The [Role] field shows how the port is being used. Refer to Table 7.4 for the seven settings in the [Role] field.

Table 7.4 Port Role Values

Port Role	Description
Unknown	An unknown error has occurred within RSTP.
Root	This port leads to the root bridge.
Designated	This port leads away from the root bridge.
Alternate	This port is an alternate path to the root bridge.
Backup	This port is an alternate path away from the root bridge.
Disabled	This port does not have an active link.
RSTP is disabled.	RSTP is disabled.

State

The [State] field indicates if the port is accepting and sending messages. The four possible values for [State] field and the features of each state are shown in Table 7.5.

Table 7.5 State Values

State	Accept Packets	Forward Packets	Learn MAC Addresses
Discarding	NO	NO	NO
Learning	NO	NO	YES
Forwarding	YES	YES	YES
Disabled	RSTP is disabled.		

Version

In the [Version] field, when an STP-only node is detected on the network, this port operates in STP mode and displays [STP]. [RSTP] will be displayed in all other cases. RSTP supports normal RSTP mode or STP mode.

Port BPDU Rx Count

The [Port BPDU Rx Count] field shows the number of BPDU packets received on that port. In general, root ports receive far more BPDU packets than designated ports.

◆ Chart Page

The Chart page can be used to monitor one signal from a predefined list.

- Frequency Reference
- Output Frequency
- Output Current
- Motor Speed
- Torque Reference
- DC Bus Voltage
- Terminal Analog Input 1

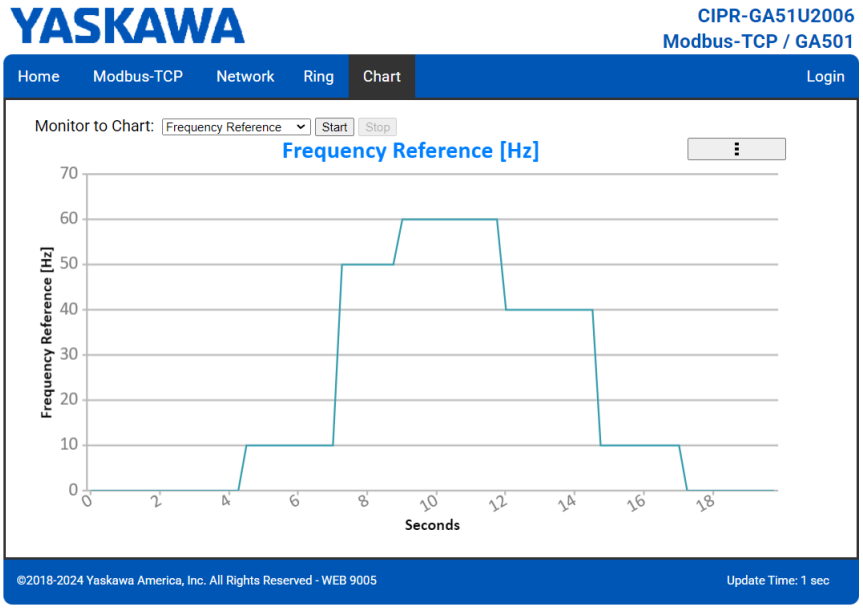


Figure 7.5 Chart Page View

◆ Email Alerts Page

The Email Alerts page allows the user to configure four Email Fault/Alarm conditions. When the condition is true, one email will be sent to the provided email address. Another email will not be sent until the condition becomes false and then true again. A 30-second timer prevents emails from being sent when conditions reoccur immediately after being removed. The timer helps limit the amount of emails sent regarding the same intermittent condition and helps to reduce network traffic by reducing emails about reoccurring errors.

Click [Save Email Settings] when you save the entered information.

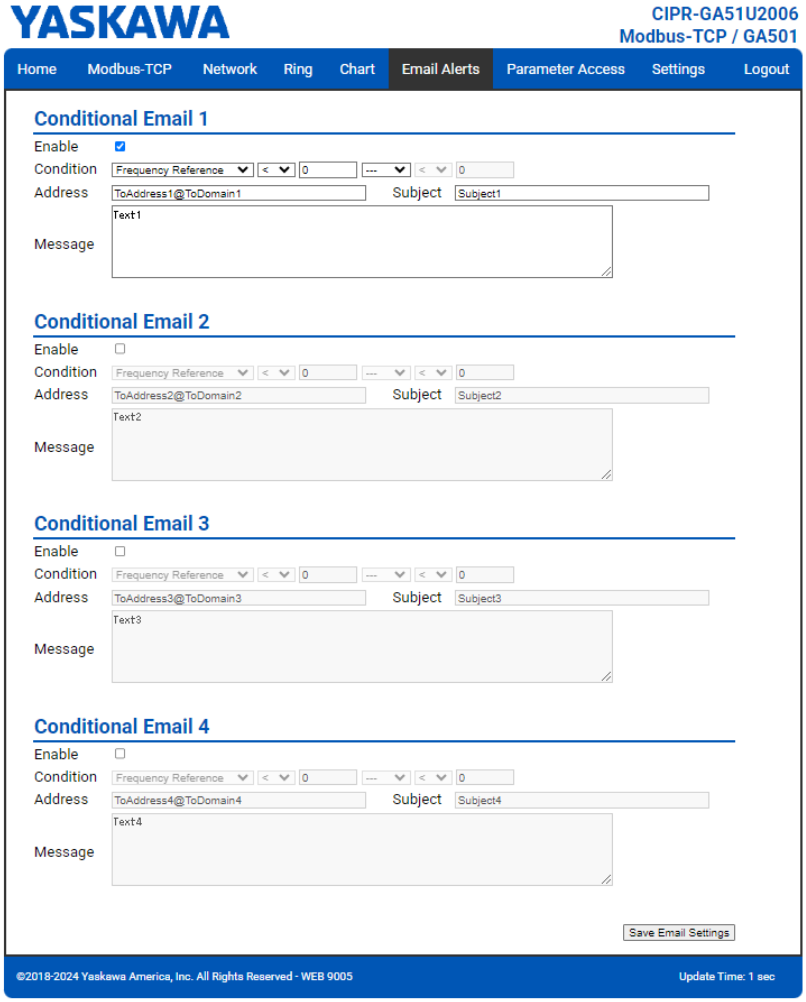


Figure 7.6 Email Alerts Page View

■ Procedure: Conditional Email Set-up

1. Click the “Enable” check box to enable the alert.
2. Define the condition that will trigger the email by selecting a monitor parameter, a comparator, and a value.
   Set the conditions to send alerts from the “Condition” drop-down selection. If choosing only one condition and no OR or AND are needed, set the “OR/AND” drop-down selection to “—”.
3. Enter the email address where the alert will be sent.
4. Enter the message that will appear in the email contents.
5. Enter the email subject.

◆ Parameter Access Page

The Parameter Access page lets you read and write parameters, monitors and other MEMOBUS/Modbus registers from the drive.

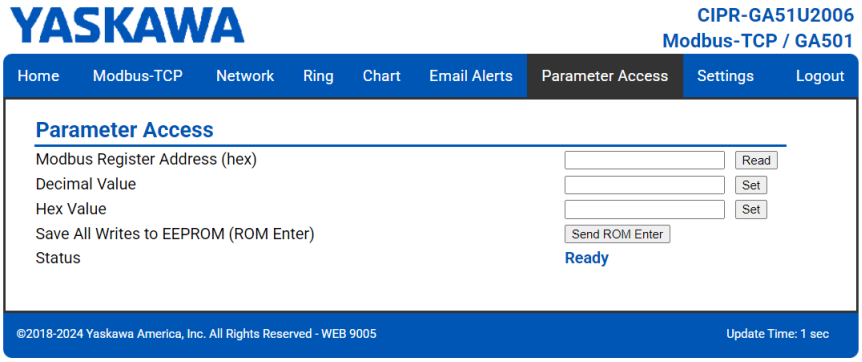


Figure 7.7 Parameter Access Page View

The MEMOBUS/Modbus address for the drive parameter being accessed must be entered in hexadecimal.

Clicking [Read] will load and display the current value of the given MEMOBUS/Modbus Address.

Clicking [Set] will save the given value to the given MEMOBUS/Modbus address.

After a [Read] or [Set] command is given, Status will display [Waiting] while the action is being carried out, then [Read Successful] or [Write Successful] is displayed when finished.

◆ Settings Page

The Settings page sets web page behavior parameters. Access is restricted unless a valid password is entered. The default password is yaskawa.

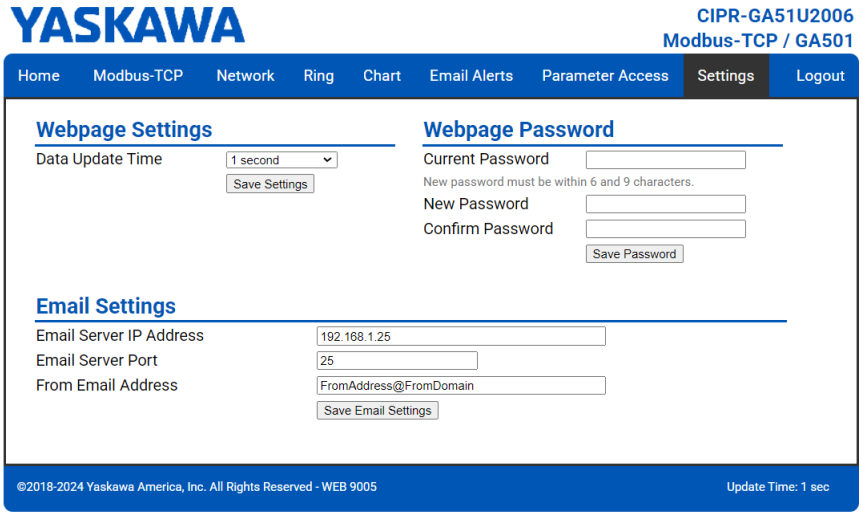


Figure 7.8 Settings Page View

■ Security Login

Click “Login” and enter a valid password. The button text will change to “Log out” and the status will change to “Logged in”.

Note:
The default security password is “yaskawa”.

This password can be changed in the “Change Password” section of the Settings page.

Entering a valid password allows access to the settings in the Settings page, Email Alerts page, and the Parameter Access page.

■ Webpage Password

To change the password, enter the new password in the “New Password:” and “Confirm Password:” text boxes. Click “Save password”.

■ Webpage Settings

The values displayed in the various tabs are refreshed at the rate defined in the “Data Update Time” select box.

The Data Update Time can be set to 250 ms, 500 ms, 1 second, 2 seconds, or 5 seconds.

■ Email Settings

The “Email Server IP Address” text box must contain the IP address of the email server. The subnet address is configured in drive parameters *F7-05* through *F7-08*. The configured email alerts will use the server at this address when sending emails.

Enter the email server port in the “Email Server Port” text box.

The value in the “From Email Address” text box identifies the origin of the email alerts to the recipient.

To save the entered information, click “Save Email Settings”.

8 Rapid Spanning Tree Protocol (RSTP)

Rapid Spanning Tree Protocol (RSTP) is a mechanism that allows an Ethernet network to be configured as a ring or other topology that may have more than one pathway to each node. The RSTP protocol automatically determines the most efficient pathway to each node and disables any redundant pathways.

If one path fails, RSTP activates another pathway to keep the network traffic flowing. After restoring the failed path, RSTP disables any redundant paths without disrupting network traffic.

◆ Convergence Time

Convergence is the process that RSTP performs to identify the root node and which pathways to disable. Convergence occurs on power up and when the network changes (for example path failures and restorations).

Take special care when using parameter *F7-16 [Timeout Value]*, Communication Timeout Loss, and be sure to give RSTP enough time for convergence. When *F7-16* is set too short, convergence will not be able to complete before it expires. The complexity of the network and the number of drives on the network will both factor into the value of the timeout.

◆ Topology

Modbus TCP/IP is ideal for use in ring topologies. With RSTP enabled, a ring topology provides redundancy to the network. RSTP determines the fastest paths to each node on the network and virtually splits the ring by disabling one port on one node to prevent data from being transmitted endlessly around the ring. If a path on the ring fails, RSTP re-enables the disabled port and reconnects the split. All nodes on the network remain accessible without any interruptions.

◆ Enabling RSTP

RSTP is enabled from the webpage on the drive.

1. Use the keypad to read the IP address values from monitors *U6-80*, *U6-81*, *U6-82*, and *U6-83*.
   The IP address is necessary to access the webpage.
   Refer to Table 8.1 for example values of the monitors for an IP address of 192.168.1.20.

Table 8.1 Example IP Address Monitor Values

Monitor	Value
U6-80	192
U6-81	168
U6-82	1
U6-83	20

2. Enter the IP address to address bar of your web browser (Ex. http://192.168.1.20) and press the Enter key.
   The Home page will be loaded. Refer to *Home Page on page 24* for more information about the Home page.
3. Click [Ring] tab on top of the webpage.
   The Ring page is displayed with the [Ring Protocol] label in the [RSTP] field set to [DISABLED].
4. After changing the setting value of the [Ring Protocol] label to [ENABLED], click [Save Changes].
   The Ring page is automatically updated and RSTP is enabled.

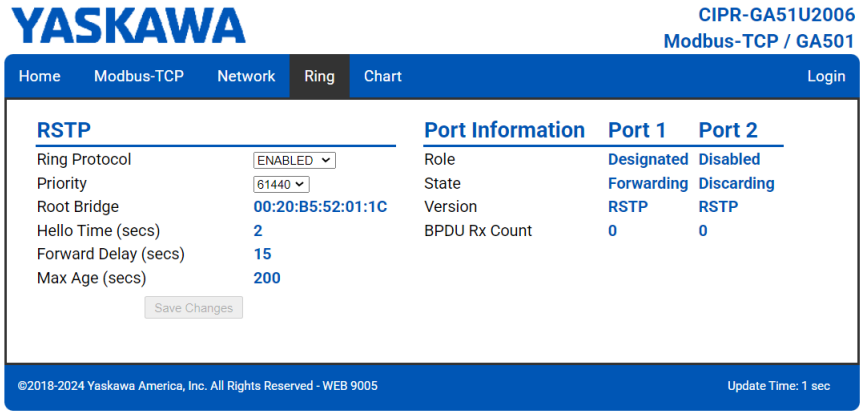


Figure 8.1 Ring Page View

◆ RSTP Monitor U6-96

Monitor *U6-96* is dedicated to RSTP. Shows the role and state for each port.

The displayed value has four digits. The first two digits belong to port 1 and the last two digits belong to port 2. The first and third digits represent port role while the second and fourth digits represent port state.

The possible port role and state values are shown in Figure 8.2.

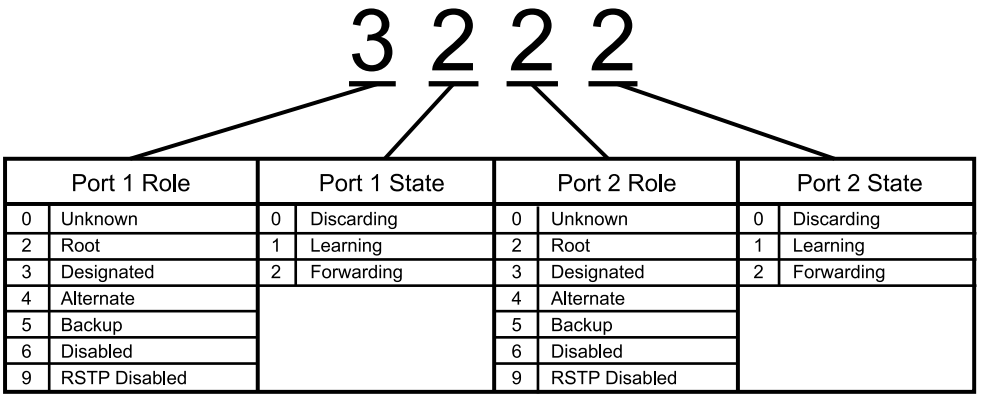


Figure 8.2 U6-96 Monitor Values

Refer to Table 7.4 for descriptions of the port role values.

Refer to Table 7.5 for descriptions of the port state values.

Below are a few examples:

- 9292 = RSTP is disabled and both ports are forwarding.
- 3222 = Port 1 is forwarding and is the designated port. Port 2 is forwarding and is the root port.
- 2232 = Port 1 is forwarding and is the root port. Port 2 is forwarding and is the designated port.
- 3232 = Both ports are forwarding and are designated ports. This only occurs when the drive is the root bridge.
- 4022 = Port 1 is discarding and is the alternate port. Port 2 is forwarding and is the root port.
- 2260 = Port 1 is forwarding and is the root port. Port 2 is discarding and is the disabled port.

9 Troubleshooting

◆ Drive-Side Error Codes

Drive-side error codes appear on the drive keypad.*Fault on page 34* lists causes of the errors and possible corrective actions. Refer to the drive manuals for additional error codes that may appear on the drive keypad.

■ Fault

A *bUS [Ethernet Communication Error]* and *EF0 [Ethernet External Fault]* can appear as a fault. When a fault occurs, the keypad ALM LED stays lit. When an alarm occurs, the ALM LED flashes.

If communication stops while the drive is running, use these questions as a guide to help remove the fault:

- Is the communication line connected correctly to the drive?
- Is the PLC program working? Is the controller/PLC CPU stopped?
- Did a momentary power loss interrupt communications?

Code	Name	Causes	Possible Solutions
bUS	Ethernet Communication Error	The drive did not receive a signal from the controller.	• Check for wiring errors. • Correct the wiring.
		The communications cable wiring is incorrect.	
		An existing short circuit or communications disconnection	Check disconnected cables and short circuits and repair as needed
		A data error occurred due to electric interference	• Prevent noise in the control circuit, main circuit, and ground wiring. • If you identify a magnetic contactor as a source of noise, install a surge absorber to the contactor coil. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Separate all communication wiring from drive power lines. Install an EMC noise filter to the drive power supply input. • Decrease the effects of electrical interference from the controller.
		Connection Time-out	Check if the CPU of the controller stopped.
		Duplicate IP Address found on network	Change to a different IP address. If *F7-13 = 0 [Address Mode at Startup = Static]*, change parameters *F7-01 to F7-04 [IP Address 1 to 4]*.
		IP Configuration Error	IP Address Setting/Gateway Setting If *F7-13 = 0 [Address Mode at Startup = Static]*, change the settings of *F7-01 to F7-12 [IP Address 1 to 4, Subnet Mask 1 to 4, Gateway Address 1 to 4]* to align with the network part of IP address and the gateway address, then cycle power. If *F7-13 = 1 or 2 [Address Startup Mode = BOOTP (Use network address.) or DHCP (Use network address.)]*, check the configuration of your BOOTP or DHCP server.
EF0	Ethernet External Fault	The drive received an external fault from the controller.	1. Find the device that caused the external fault and remove the caus. 2. Clear the external fault input from the controller.
		A programming error occurred on the controller side.	Examine the operation of the controller program.
oFA00	Ethernet HW Error	Invalid DIP switch S1 setting	Check if the DIP switch S1 setting is correct for the communication protocol you are using.
PSE	Protocol Set Error	Invalid DIP switch S1 setting	Check if the DIP switch S1 setting is correct for the communication protocol you are using.

◆ bUS Fault Tolerance

■ bUS Fault Auto-Restart

Setting *F6-14 = 0 [Disabled]* or *F6-01 = 3, 4, 5 [Alarm Only, Alarm (Run at d1-04), Alarm - Ramp Stop]* will not affect default drive behavior.

Setting *F6-14 = 1 [Enabled]* AND *F6-01 = 0, 1, 2 [Ramp to Stop, Coast to Stop, Fast Stop (Use C1-09)]* will cause the following operation:

1. The *bUS* fault occurs after *F7-16 [Timeout Value]* delay and the Run command is removed from the drive.
2. The drive detects that the *bUS* fault occurred in the Modbus TCP/IP network.
3. When the condition is removed, a fault reset is commanded and the control of the drive is returned to the Modbus TCP/IP network.

■ bUS Fault Delay

The setting value of *F7-16* is the length of time from when the network detects a fault until the *bUS* fault is detected on the drive. The status LEDs on the drive are not affected by the *bUS* delay time set in *F7-16*; the LEDs will indicate the *bUS* condition immediately.

◆ Modbus TCP/IP Error Codes

■ Fault Monitors *U6-98* and *U6-99*

If any faults occur with Modbus TCP/IP, you can check error/warning conditions via drive monitor parameters on the drive keypad as shown in Table 9.1.

Table 9.1 Fault Monitor Descriptions

Status	Fault Declared	Status Value (*U6-98*/*U6-99*)	Description
No faults	-	0	No faults
Fatal error occurred	EF0	3	Network sent a message to force this node to the fault state.
Connection Time-out	bUS	1101	The control connection timer is more than the setting value of *F7-16 [Timeout Value]*.
Duplicate IP Address	bUS	1102	This node and at least one other node have the same IP Address.
Default MAC Address	-	1103	Programmed MAC Address is not at factory default setting. **Note:** Contact Yaskawa or your nearest sales representative for more information.
Network Link Down	bUS	1104	Neither of the two network Ethernet ports has a link. This will only happen when a link is established, then lost.
IP Configuration Error	bUS	1106	*F7-13 = 0 [Address Mode at Startup = Static]* is set and *F7-01 to F7-12 [IP Address 1 to 4, Subnet Mask 1 to 4, Gateway Address 1 to 4]* are set to an invalid configuration. If *F7-13 = 1 or 2 [Address Startup Mode = BOOTP (Use network address.) or DHCP (Use network address.)]*, your BOOTP or DHCP server is not configured correctly. Set the parameters to the correct values and cycle power on the drive.
Web Interface Setting Error	-	1110	Failure to read the web interface setting.

Two drive monitors, *U6-98 [Ethernet First Fault]* and *U6-99 [Ethernet Current Fault]* assist the user in network troubleshooting.

- *U6-98* displays the first declared fault since the last power cycle. *U6-98* is only cleared upon drive power-up.
- *U6-99* displays the present network status. *U6-99* is cleared upon a network-issued fault reset and upon power-up.

If another fault occurs while the original fault is still active, *U6-98* retains the original fault value and *U6-99* stores the new fault status value.

◆ Communication Error

If there are no problems with the drive, but you cannot communicate with other devices, try the possible solution below.

Status	Possible Solutions
The LINK/ACT LED will not illuminate.	Set *F7-14 = 1 [Duplex Mode Selection = Auto/Auto (Auto Negotiation/Auto Negotiation)]*.

◆ Self RAM Check

Use these procedures to do a self RAM check for all areas including unused areas.

Note:
- The self RAM check completes in approximately 1.5 minutes.
- When you start the self RAM check, the drive will detect *oFA00 [Ethernet HW Error]*.

1. Set DIP switch S1 as shown in Figure 9.1.

Note:
Use non-conductive tweezers or a tool with a tip width of approximately 0.5 mm (0.02 in) to set DIP switch S1.

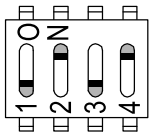


Figure 9.1 DIP Switch S1 Settings for the Self RAM Check

2. Apply power to the drive.
   This will start the self RAM check.
3. Look at the LEDs to see the status of the self RAM check.
   Refer to Table 9.2 for more information.

Table 9.2 LED States during Self RAM Check

Self RAM Check Status	LED States	
	MS	NS
Checking	Lit in green	OFF
Successful termination	Lit in green	Lit in green
Abnormal termination	Lit in red	Lit in red

10 Specifications

◆ Specifications

Table 10.1 Modbus TCP/IP Specifications

Items	Specifications
Supported Messages	• Read Multiple Registers (03 (Hex.)) • Write Single Register (06 (Hex.)) • Write Multiple Registers (10 (Hex.)) • Read and Write Registers (17 (Hex.)) Commands that support multiple registers have a maximum Read and Write size of 16 registers.
Modbus TCP/IP Specifications	Modbus-IDA
IP Address Setting	Programmable from drive keypad or network
Communication Speed	Programmable from drive keypad or network: 10/100 Mbps, auto-negotiate.
Number of Connections	• Modbus TCP/IP: 10 • Web page connections: 2
Duplex Mode	• Half/Half • Auto-negotiate • Full/Full
Address Startup Mode	• Static • BOOTP • DHCP

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YASKAWA AC Drive GA501

Modbus TCP/IP

Technical Manual

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