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MITSUBISHI ELECTRIC

Connecting a QJ71MT91 Modbus/TCP Module to a Mitsubishi VFD

R72-127-SLSASG-012

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Contents

FURTHER READING REFERENCE LIST

QJ71MT91, GX Configurator-MB MODBUS(R)_TCP Interface Module User's Manual SH_NA_080446ENG-G

FR-A700 Instruction Manual (Applied), NA Version IB_NA_0600255ENG-E

FR-A7N-ETH User's Manual V2.320 (www.iccdesigns.com or http://www.iccdesigns.com/fr-a7n-eth.html)

ATTACHMENTS

QJ71MT91 Demo.gwx - GX Works2 File (Using the Module as a Master to a Slave Device(s))

QJ71MT91 Modbus Slave.gwx - GX Works2 File (Using the Module as a Slave from a Master Device)

QJ71MT91 as a Slave Addendum Manual.pdf – Addendum Manual for SLAVE Setup Only

Chapter 1 Introduction

This Quick Start Guide (QSG) provides instructions on how to set a QJ71MT91 (MT91) Modbus/TCP Communications Module to communicate to a Mitsubishi A700, F700 or E700 Series Variable Frequency Drive (VFD) using the Automatic Communication Parameters in the Intelligent Function Module Utility in GX Works2 Programmable Logic Controller (PLC) Software. **Installed in the VFD is a FR-A7N-ETH Option Module**.

The MT91 Master module supports up to 64 Remote Connections. A Slave Device can use One (1) or multiple Connections depending upon the setup.

The objective of this QSG is to assist the users to quickly setup the iQ or Q PLC CPU program to have the MT91 Module to send commands to the VFD and receive status information and data from the VFD. This QSG contains the necessary configuration information for the iQ or Q PLC and the 700 Series VFD.

If the MT91 Module is to be used as a SLAVE (Server) from a Modbus/TCP MASTER (Client) please reference the QJ71MT91 as a Slave Addendum Manual and GXW2 Modbus Slave program.

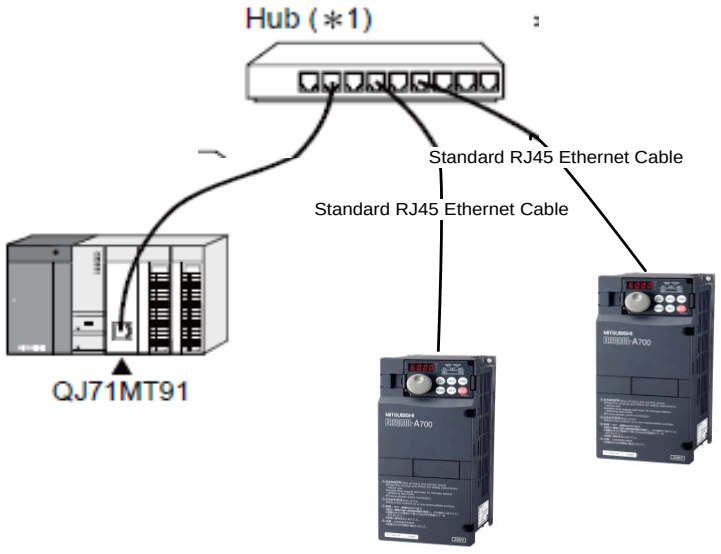


Figure 1 QJ71MT91 Module Ethernet Connection to a A700, F700 or E700 VFDs

Chapter 2 System Overview

This QSG was setup using the following test system. The PLC Programming software is GX Works2 V1.73B or Greater. Melsoft Navigator was NOT used or required.

The FR-A7N-ETH module is the Server and the PLC CPU is the Client.

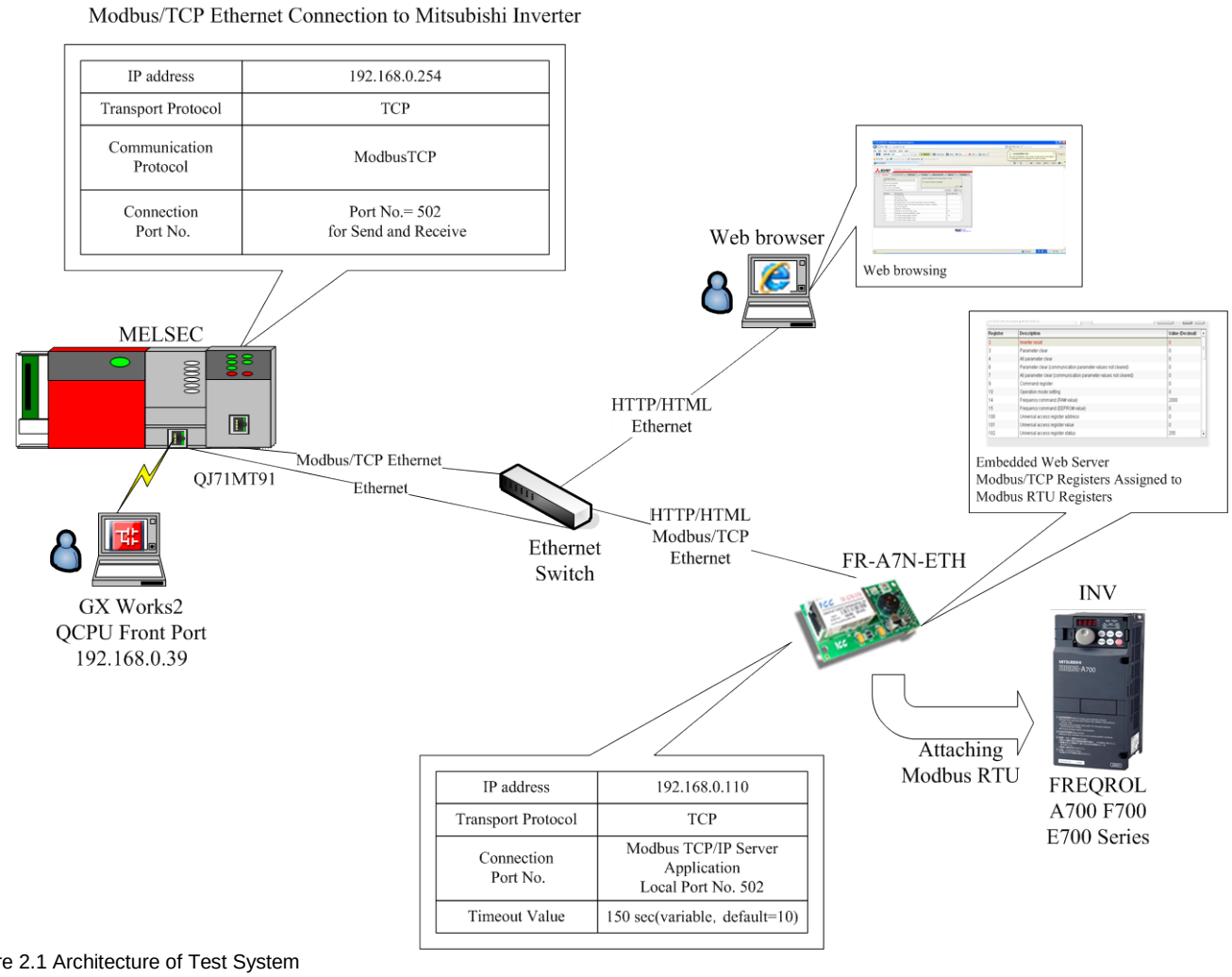


Figure 2.1 Architecture of Test System

Chapter 3 VFD Parameter Setup and Wiring

3.1 E700 Connecting the FR-A7N-ETH to the Standard RJ45 Parameter Unit (PU) Port

Parameter	Description	Setting
117	PU Station #	1
118	PU Comms Speed	384
120	PU Parity	2 (Default)
122	PU Comms Timeout	9999
340	Network Mode	10
549	Protocol Selection	1 (Modbus Protocol)
77	Parameter Write Mode	2

Use the OPTIONAL cable with the FR-A7N-ETH module to connect to the RJ45 Port built into the VFD as shown below and in the FR-A7N-ETH manual. Remember to cycle power to the VFD after setting any communication related parameter.

Figure 3.1 E700-NET-CBL Option Cable

3.2 A700/F700 Connecting the FR-A7N-ETH to the RS-485 Terminal Blocks

Parameter	Description	Setting
331	RS-485 Station #	1
332	RS-485 Speed	384 (38.4K)
334	RS-485 Parity	2 (Default)
340	Network Mode	10
549	Protocol Selection	1 (Modbus Protocol)
77	Parameter Write Mode	2

Use the supplied cable that comes with the FR-A7N-ETH module to connect to the RS-485 Terminals built into the VFD as shown below and in the FR-A7N-ETH manual. Remember to cycle power to the VFD after setting any communication related parameter.

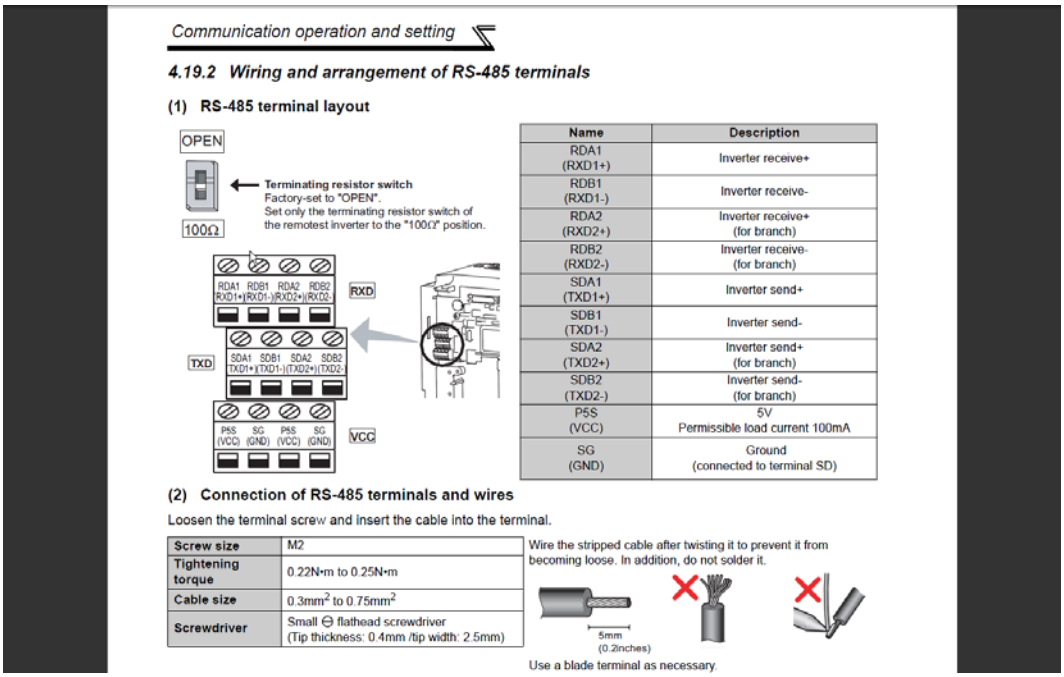


Figure 3.2.1 Terminal Block Layout

3.3 FR-A7N-ETH Module Setup

3.3.1. IP Address Settings

Use the ICC Finder software that came with the product or that can be downloaded at http://www.iccdesigns.com/downloads/software/icc-finder.html . It will automatically find the Module if connected to the network. If the IP address needs to be changed, select “Configure IP Settings”. Once the IP Address has been changed make sure your computer is on the same subnet as the module and select: “Open Web Interface”. Username is “root” and password is “icc”.

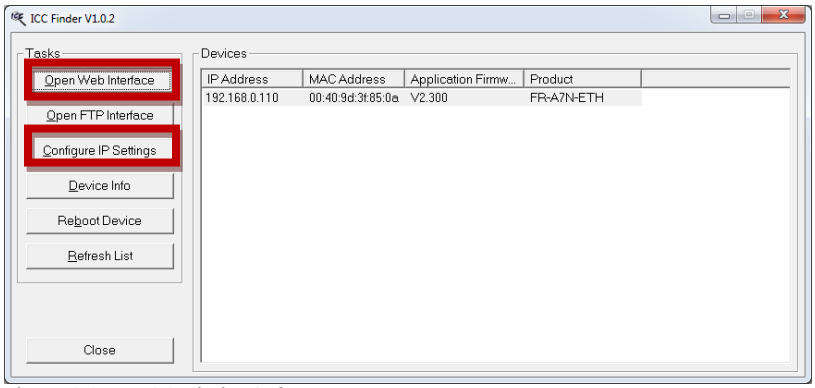


Figure 3.3.1.1 ICC Finder Software

Once the Web Interface is open, select the Config Tab and enter IP Address information if needed.

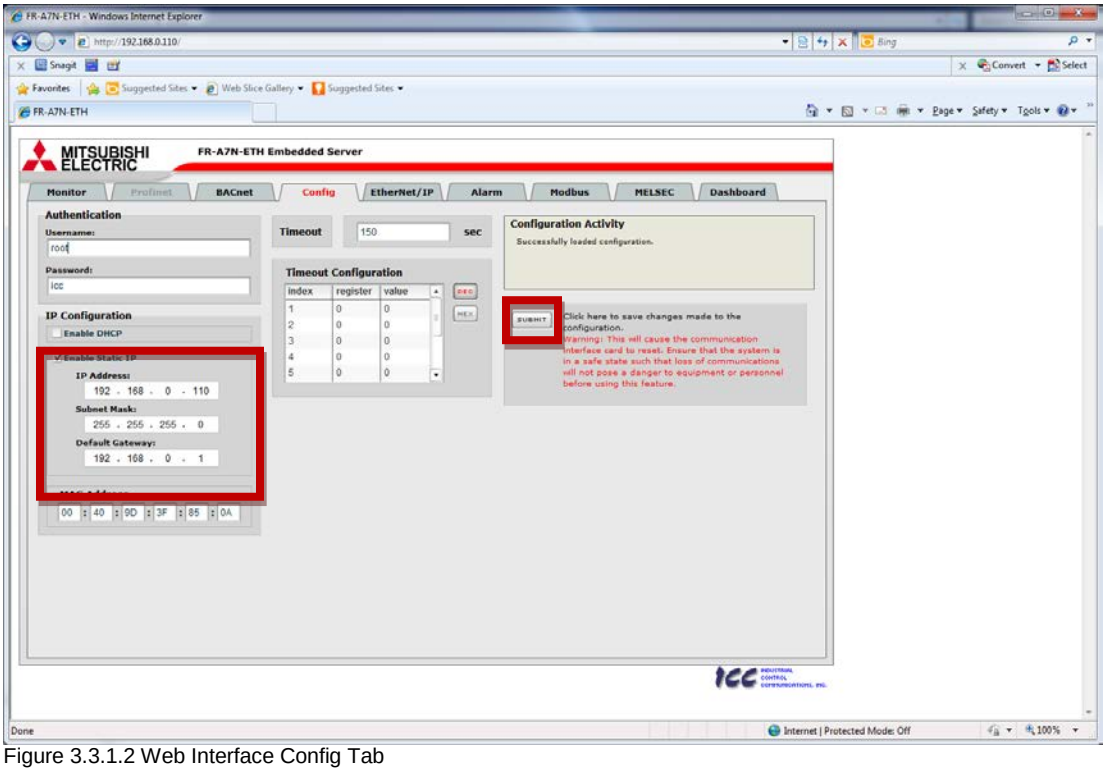


Figure 3.3.1.2 Web Interface Config Tab

Select **SUBMIT** to make changes in the module.

3.3.2. Modbus to Modbus/TCP Address Mapping

Select the Modbus Tab.

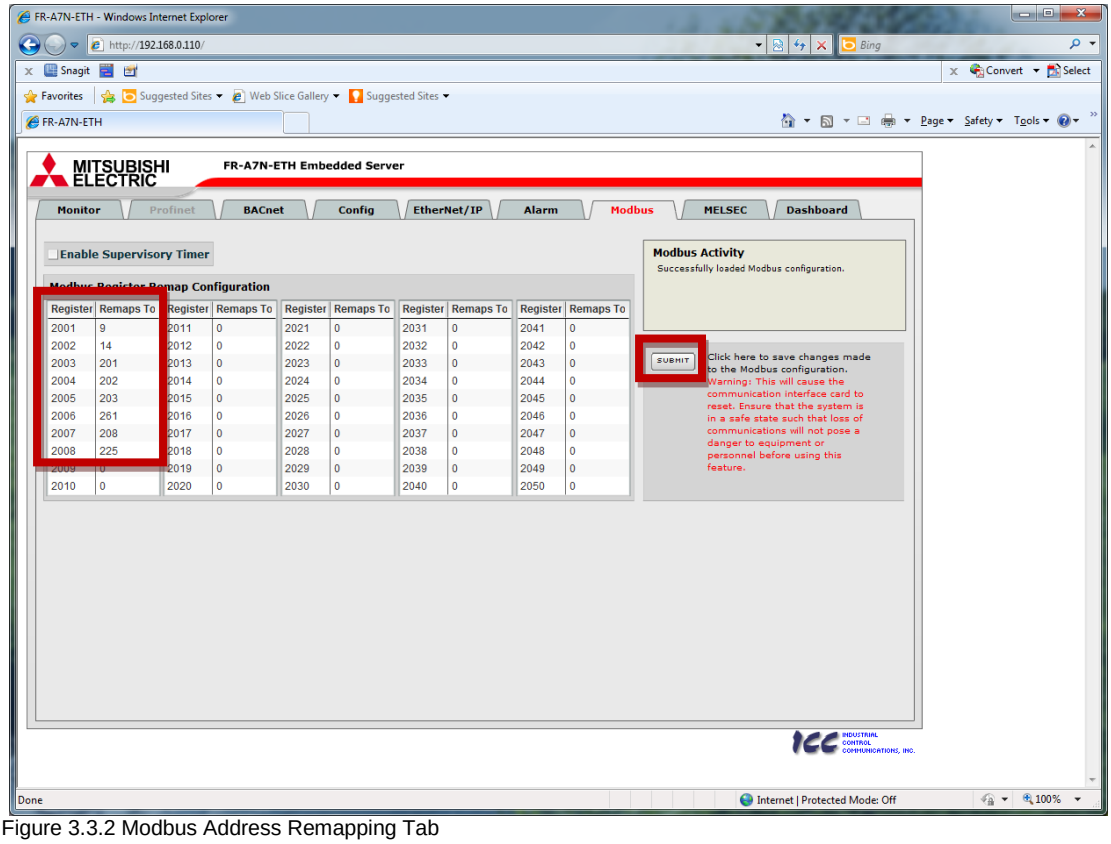


Figure 3.3.2 Modbus Address Remapping Tab

The Register Column is the Modbus/TCP register starting at 40xxxx.

The Remaps to Column is the Modbus register this is being used by the VFD.

Choose the following for the Remapping

	Modbus/TCP	Modbus
1.	2001 = 9	= 40009 = VFD Command Bits Write Word
2.	2002 = 14	= 40014 = VFD Frequency Write Word
3.	2003= 201	= 40201 = VFD Current Frequency
4.	2004 = 202	= 40202 = VFD Current Current
5.	2005 = 203	= 40203 = VFD Current Voltage
6.	2006 = 261	= 40261 = VFD Current Status Bits Word
7.	2007 = 208	= 40208 = VFD Current DC Bus Voltage
8.	2008 = 225	= 40225 = VFD Cumulative Power (1kWh)

Select **SUBMIT** to make changes in the module.

3.3.3. Monitoring

Select the Monitor Tab.

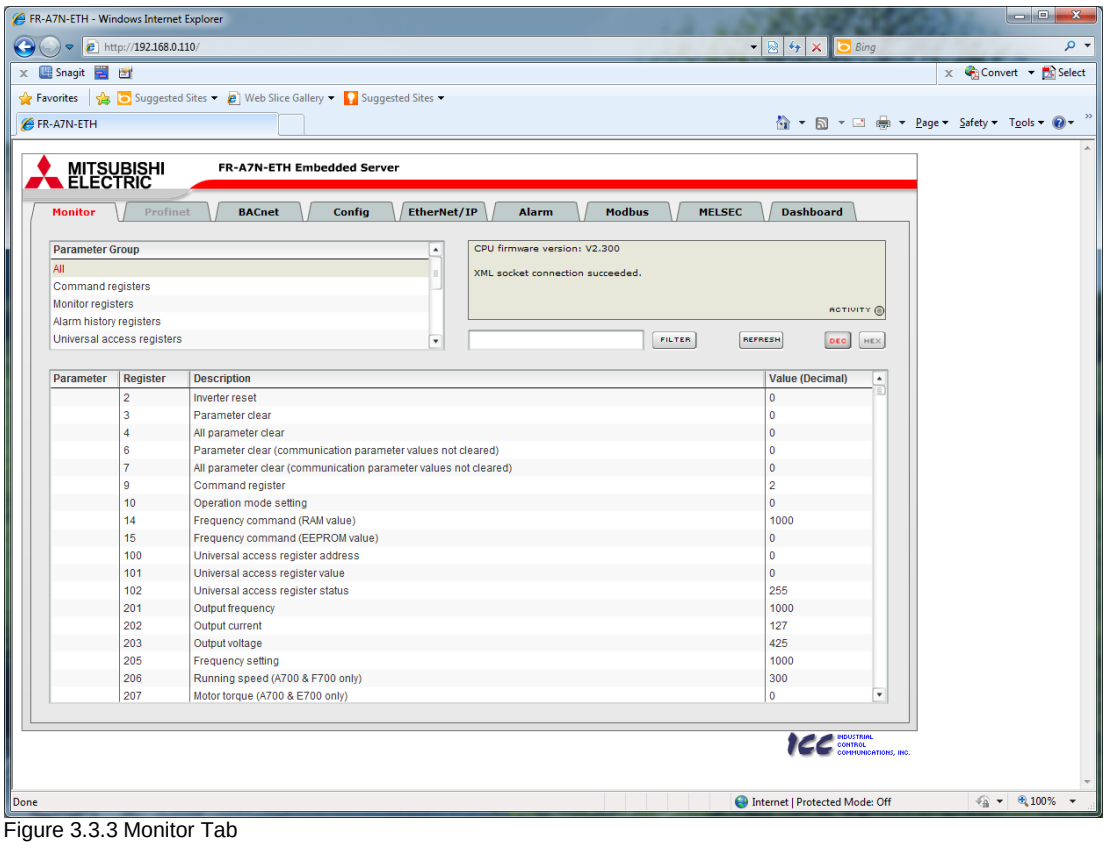


Figure 3.3.3 Monitor Tab

From the Monitor Tab you can see the values being written to or read from the Modbus addresses for the VFD. If the Modbus address is not mapped to a Modbus/TCP address it can be forced from this tab if needed. This is an excellent way to test communication from your MT91 Master and the Module/VFD.

Chapter 4 Modbus/TCP Protocol

4.1 Automatic Communication Function

This QSG uses the Automatic Communication Function of Modbus/TCP Communication

(1) Supporting master function of MODBUS® /TCP communication

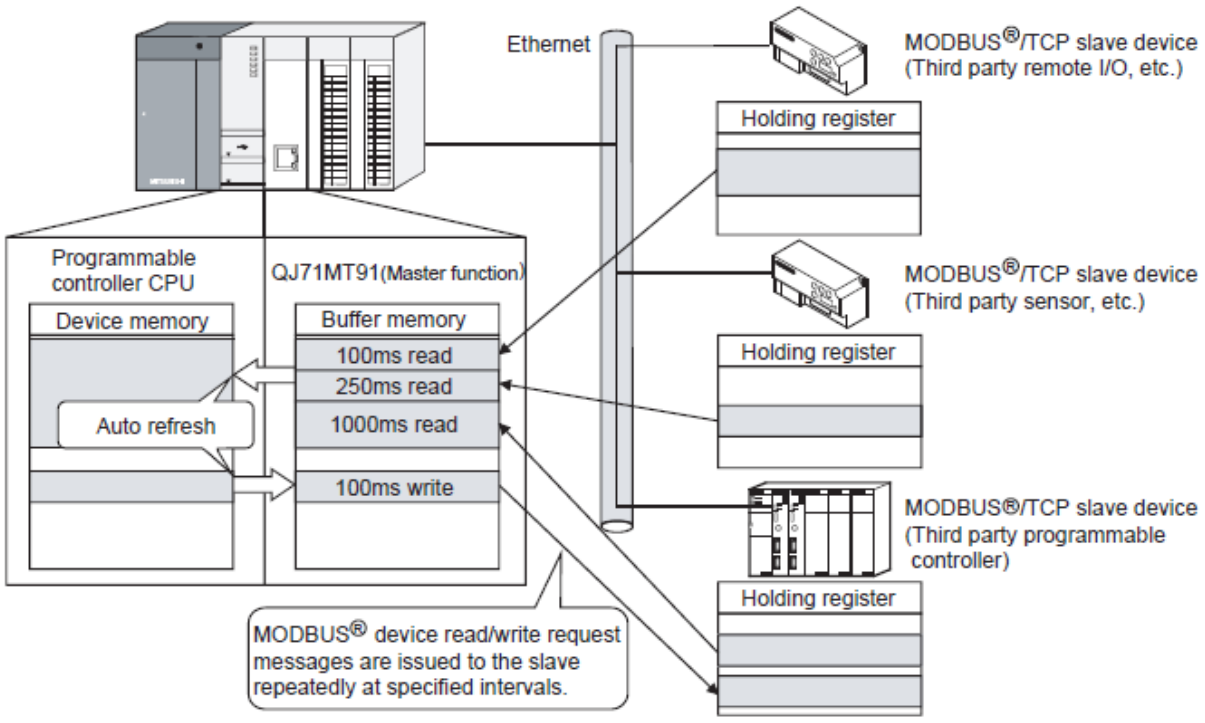
The QJ71MT91 supports the master function of MODBUS® /TCP communication, which is an open network system for factory automation, and it is compatible with various MODBUS® /TCP slave devices (hereafter abbreviated to the slaves) of other manufactures.

The master function supports the following two functions.

(a) Automatic communication function

By setting the automatic communication parameters, MODBUS® device data can be automatically read from or written to the slaves at the specified intervals using the QJ71MT91 buffer memory. (*1)

Data can be transferred between the QJ71MT91 buffer memory and programmable controller CPU device memory by making the auto refresh setting with the utility package (GX Configurator-MB) or accessing a intelligent function module device with a sequence program.



*1: The MODBUS® device indicates the device area of the slave where data can be read/written in response to a request from the master.

Figure 4.1 Modbus/TCP Protocol – Automatic Communication Function

The Buffer Memory Locations (BFMs) that the Automatic Communication Function uses are shown below. For data Read from the Slave a BFM of 1000h to 1FFFh and data Written to a Salve a BFM of 3000h to 3FFFh have to be defined in the Automatic Communication Parameters for each Read or Write. See Section 5.2 for **Head Buffer Memory Address** Parameter Setup.

(4) Automatic communication function buffer areas

(a) Automatic communication function buffer areas

The automatic communication function uses the following buffer memory areas.

Name	Application	Buffer Memory Address
Automatic communication function buffer input area	Stores data read from the slave	1000_H to $1FFF_H$
Automatic communication function buffer output area	Stores data to be written to the slave	3000_H to $3FFF_H$

Figure 4.1.2 Automatic Communication Function Buffer Memory Locations

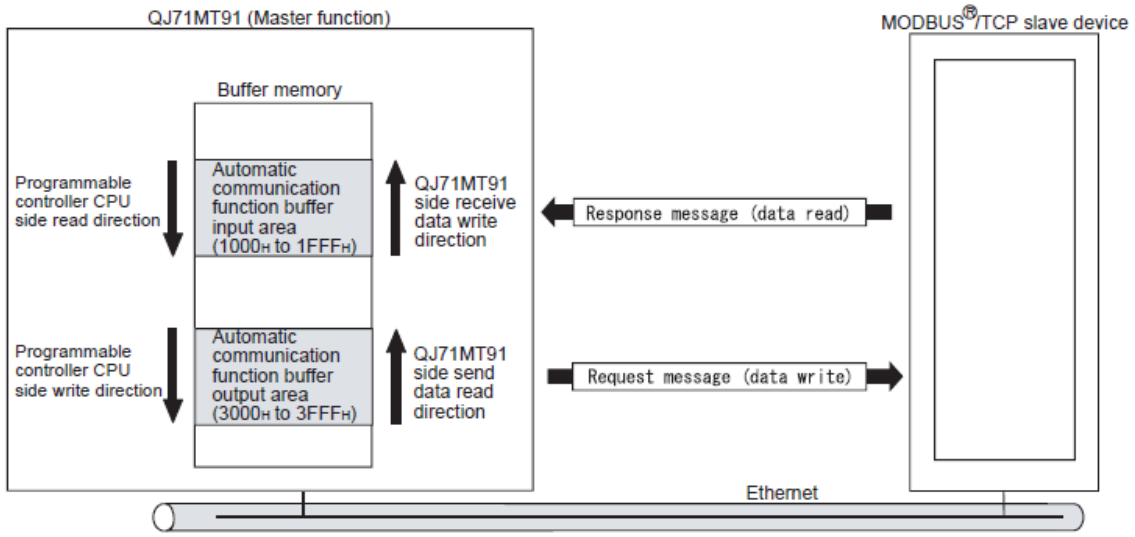


Figure 4.1.3 Automatic Communication Function Buffer Memory Transfer Directions

4.2 Modbus Performance Specifications

The following shows the Modbus performance specification.

This section provides the performance specifications of the QJ71MT91.

Item			Specifications		Reference Section
			10BASE-T	100BASE-TX	
Transmission specifications	Data transmission rate		10Mbps	100Mbps	—
	Transmission method		Base band		
	Maximum node-to-node distance		200m (656.16ft.)		
	Maximum segment length ＊1		100m (328.08ft.)		
	Number of cascade connection stages		Max. 4 stages	Max. 2 stages	
	Maximum number of connections ＊2		64 connections		
	Number of routers that can be set		1 default router + any 8 routers		
	Cable		Cable compliant with the IEEE802.3 10BASE-T Standard (unshielded twisted pair cable (UTP cable), Category 3 (4, 5))	Cable compliant with the IEEE802.3 100BASE-TX Standard (shielded twisted pair cable (STP cable), Category 5)	Section 2.2
	Connector applicable for external wiring		RJ45		—
Master function	Automatic communication function	Number of slaves ＊3	64 slaves		—
		Function (for send)	7 functions		Chapter 4
		Input area size	4k words		Section 3.3.1
		Output area size	4k words		
	Dedicated instruction	Number of instructions that can be executed concurrently ＊4	Up to 8 instructions		—
		Function (for send)	MBRW instruction: 9 functions MBREQ instruction: 19 functions		Chapter 4
		Input area size	Max. 253 bytes per instruction		Chapter 4
		Output area size	Max. 253 bytes per instruction		
Slave function	Automatic response function	Function (for receive)	12 functions		Chapter 4
	MODBUS® device size	Coil	64k points		Section 7.4.1
		Input	64k points		
		Input register	64k points		
		Holding register	64k points		
		Extended file register	Max. 4086k points		
	No. of simultaneously acceptable request messages		64		—
GX Developer connection function	Number of simultaneously connectable GX Developers		Max. 8 GX Developers		Section 7.2.3
Number of occupied I/O points			32 points		—
5VDC internal current consumption			0.52A		—
External dimensions			98 (3.86 in.) (H) × 27.4 (1.08 in.) (W) × 90 (3.54 in.) (D) [mm]		Appendix 1
Weight			0.11kg		—

＊1: Length between a hub and a node.
＊2: Indicates the number of TCP connections that can be established simultaneously.
＊3: Indicates the maximum number of slaves that can be communication targets.
＊4: Indicates the maximum number of dedicated instructions that can be started simultaneously from a sequence program.

Figure 4.2.1 Performance Specs

4.3 I/O Signal List

The follow I/O points are used for the MT91 module. These points are for a module in slot 0 of the rack. The module takes up 32 Digital Inputs and 32 Digital Outputs. I/O boxed in RED is used in the Demo Program for enabling Modbus/TCP Communications.

Signal Direction QJ71MT91 → Programmable controller CPU			Signal Direction Programmable controller CPU → QJ71MT91		
Device No.	Signal name	Reference section	Device No.	Signal name	Reference section
X0	Module READY＊1 ON : Accessible OFF: Inaccessible	Section 11.1	Y0	Use prohibited	—
X1	Basic parameter setting, normally completed ON : Normally completed OFF: —	Section 9.1.1	Y1	Basic parameter setting request ON : Being requested OFF: Not requested	Section 9.1.1
X2	Basic parameter setting, error completed ON : Error completed OFF: —		Y2	Use prohibited	—
X3	Basic parameter setting existence ON : Parameters set OFF: No parameters set		Y3		—
X4	Automatic communication parameter setting, normally completed ON : Normally completed OFF: —	Section 5.2.1, 9.1.2	Y4	Automatic communication parameter setting request/automatic communication start request ON : Parameter setting being requested/start being requested OFF: No parameter setting requested/no start requested	Section 5.2.1, 9.1.2
X5	Automatic communication parameter setting, error completed ON : Error completed OFF: —		Y5	Use prohibited	—
X6	Automatic communication operation status ON : Operating OFF: Stopped		Y6	Automatic communication stop request ON : Being requested OFF: Not requested	Section 5.2.1
X7	Automatic communication error status ON : Error occurred OFF: No error	Section 5.2.1	Y7	Use prohibited	—
X8	MODBUS® device assignment parameter setting, normally completed ON : Normally completed OFF: —	Section 9.1.3	Y8	MODBUS® device assignment parameter setting request ON : Being requested OFF: Not requested	Section 9.1.3
X9	MODBUS® device assignment parameter setting, error completed ON : Error completed OFF: —		Y9	Use prohibited	—

＊1: Turns ON when the QJ71MT91 is ready after the programmable controller is turned ON from OFF or after the programmable controller CPU is reset.

Figure 4.3.1 I/O Signal List 1

Signal Direction QJ71MT91 → Programmable controller CPU			Signal Direction Programmable controller CPU → QJ71MT91		
Device No.	Signal name	Reference section	Device No.	Signal name	Reference section
XA	MODBUS® device assignment parameter setting existence ON : Parameters set OFF: No parameters set	Section 9.1.3	YA	Use prohibited	—
XB	Use prohibited	—	YB		—
XC		—	YC		—
XD		—	YD		—
XE		—	YE		—
XF		—	YF		—
X10		—	Y10		—
X11		—	Y11		—
X12		—	Y12		—
X13		—	Y13		—
X14		—	Y14		—
X15		—	Y15		—
X16		—	Y16		—
X17		—	Y17		—
X18		—	Y18		—
X19		—	Y19		—
X1A		—	Y1A		—
X1B	COM.ERR.LED status ON : Lit OFF: Not lit	Section 11.4.2	Y1B	COM. ERR. LED OFF request ON : Being requested OFF: Not requested	Section 11.4.2
X1C	PING test completed ON : PING test completed OFF: —	Section 11.5.2	Y1C	PING test execution request ON : PING test execution being requested OFF: PING test execution not request	Section 11.5.2
X1D	Use prohibited	—	Y1D	Use prohibited	—
X1E		—	Y1E		—
X1F	Watch dog timer error ON : Module error occurred OFF: Module operating normally	Section 11.1	Y1F		—

Figure 4.3.2 I/O Signal List 2

Chapter 5 GX Works2 MT91 Parameter Overview

5.1 Intelligent Function Module Software Setup / Switch Settings

In your Project Tree Menu create a new Intelligent Function Module using the QJ71MT91 and assign in to address 0000, which is slot 0.

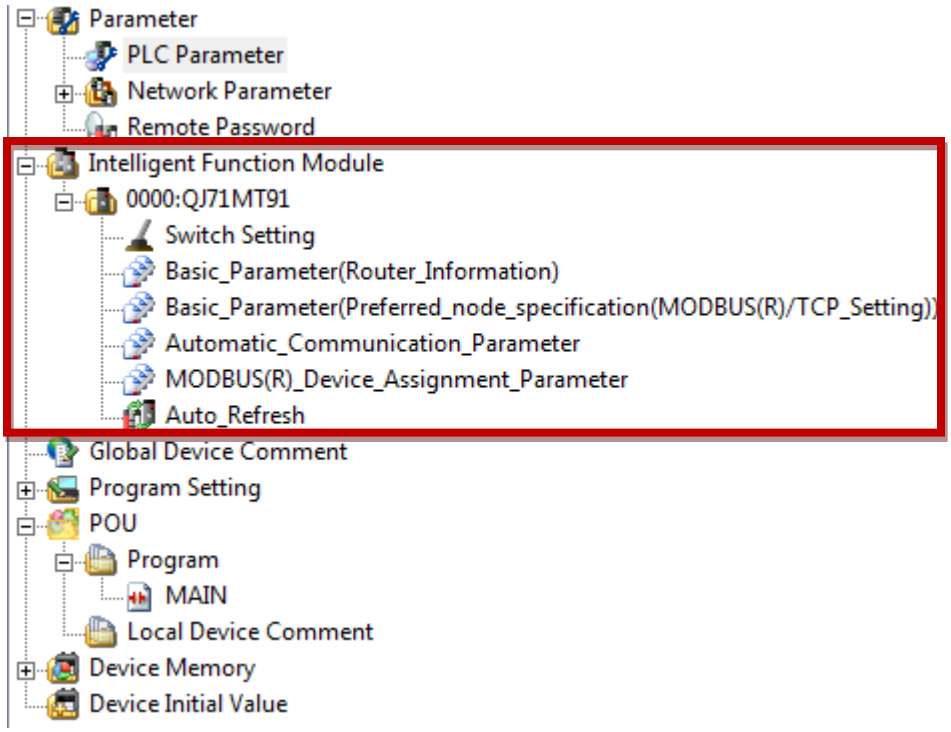


Figure 5.1.1 Project Menu Tree – Intelligent Function Module Creation

Select “Switch Setting” from Intelligent Function Module → 0000:QJ71MT91.

In this example the default IP Address of the MT91 Module is used. Change as needed. All other parameters are kept at DEFAULT.

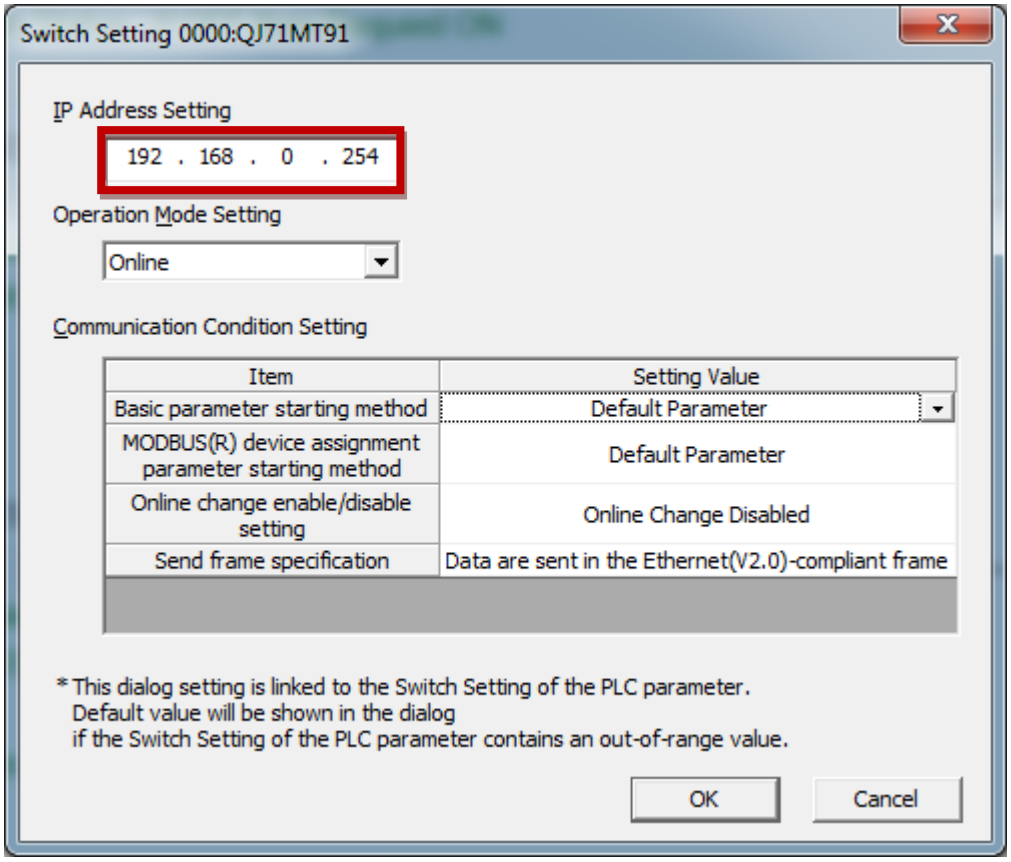


Figure 5.1.2 Switch Setting Detail

5.2 Intelligent Function Module Software Setup / Automatic Communication Parameter

Select “Automatic Communication Parameter” from Intelligent Function Module → 0000:QJ71MT91.

Automatic Communication Parameter	**Set the automatic communication parameters when using the autom**
Automatic Communication Parameter 1	**The parameter setting concerning the automatic communication.**
Target Station IP Address	192.168.0.110
Module ID	255
Repetition Interval Timer Value	0
Response Monitoring Timer Value	0
Type Specification of The Target MODBUS(R) Device	0005h:Write Holding Registers
Read Setting	**The parameter setting concerning reading data from slave.**
Head Buffer Memory Address	0000 h
Target MODBUS(R) Device Head Number	0
Access Points	0
Write Setting	**The parameter setting concerning writing data to slave.**
Head Buffer Memory Address	3000 h
Target MODBUS(R) Device Head Number	2000
Access Points	2

Figure 5.2.1 Automatic Communication Parameter 1 Settings

<u>Choose the following for #1 Settings to Write to Station 192.168.0.110 Modbus Address 402001 and 402002</u>

1. Target Station IP Address = 192.168.0.110
2. Module ID = 255 (Modbus/TCP) DEFAULT
3. Repetition Interval Timer Value = 0 = 0ms (How often the Command is SENT after a RECEIVE)
4. Response Monitoring Timer Value = 0 = 30s (How much time a SEND and RECEIVE is expected, when = to 0 a value of 60 is used (60 X 500ms = 30s))
5. Type Selection of the Target MODBUS Device = 0005h: Write Holding Register (4x type)
6. Head Buffer Memory Address = 3000h - This setting must NOT be duplicated in another Parameter.
7. Target Modbus Device Head Number = 2000 (Modbus Address -1)
8. Access Points = 2 (Consecutive Modbus Addresses)

Automatic Communication Parameter 2	**The parameter setting concerning the automatic communication.**
Target Station IP Address	192.168.0.110
Module ID	255
Repetition Interval Timer Value	0
Response Monitoring Timer Value	0
Type Specification of The Target MODBUS(R) Device	0500h:Read Holding Registers
Read Setting	**The parameter setting concerning reading data from slave.**
Head Buffer Memory Address	1000 h
Target MODBUS(R) Device Head Number	2000
Access Points	8
Write Setting	**The parameter setting concerning writing data to slave.**
Head Buffer Memory Address	0000 h
Target MODBUS(R) Device Head Number	0
Access Points	0

Figure 5.2.2 Automatic Communication Parameter 2 Settings

Choose the following for #2 Settings to Read from Station 192.168.0.110 Modbus Address 402001 - 402008

1. Target Station IP Address = 192.168.0.110
2. Module ID = 255 (Modbus/TCP) DEFAULT
3. Repetition Interval Timer Value = 0 = 0ms (How often the Command is SENT after a RECEIVE)
4. Response Monitoring Timer Value = 0 = 30s (How much time a SEND and RECEIVE is expected, when = to 0 a value of 60 is used (60 X 500ms = 30s))
5. Type Selection of the Target MODBUS Device = 0005h: READ Holding Register (4x type)
6. Head Buffer Memory Address = 1000h – This setting must NOT be duplicated in another Parameter.
7. Target Modbus Device Head Number = 2000 (Modbus Address -1)
8. Access Points = 8 (Consecutive Modbus Addresses)

5.3 Intelligent Function Module Software Setup / Auto Refresh Settings

Select “Auto Refresh” from Intelligent Function Module → 0000:QJ71MT91

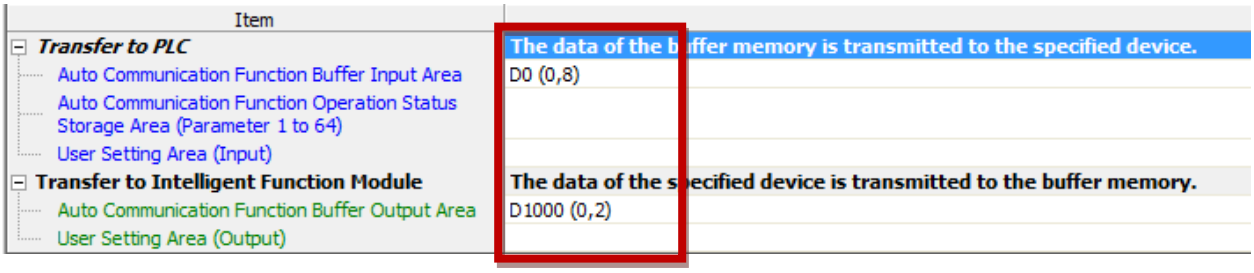


Figure 5.3.1 Automatic Refresh Detail

Define the PLC Data Register starting number (D0), the offset value (keep it at zero) and the number of consecutive Data Registers (8) that will be read from the Slave device(s), Inputs. As the Slave Devices increase the Transfer Word Counts will increase as needed per Slave Device.

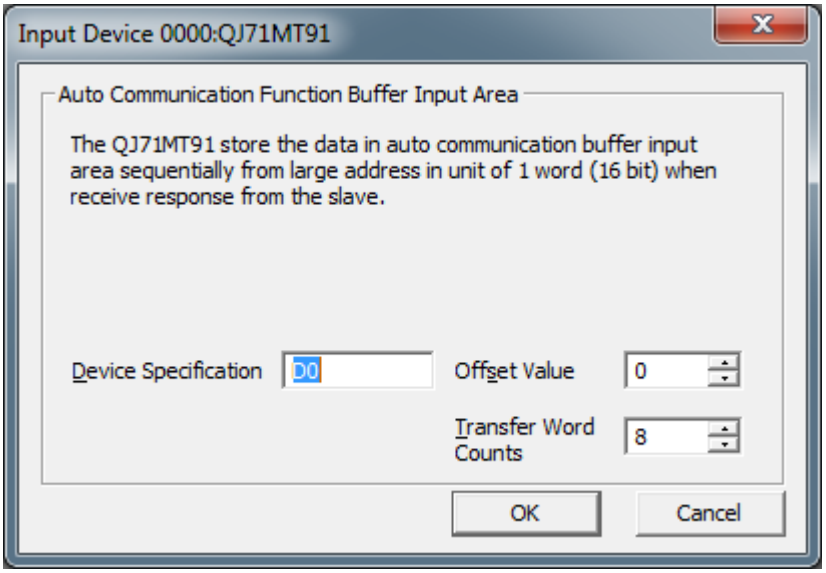


Figure 5.3.2 Data Register Input (Read from Slave) Parameters

Define the PLC Data Register starting number (D1000), the offset value (keep it at zero) and the number of consecutive Data Registers (2) that will be written to the Slave device(s), Outputs. As the Slave Devices increase the Transfer Word Counts will increase as needed per Slave Device.

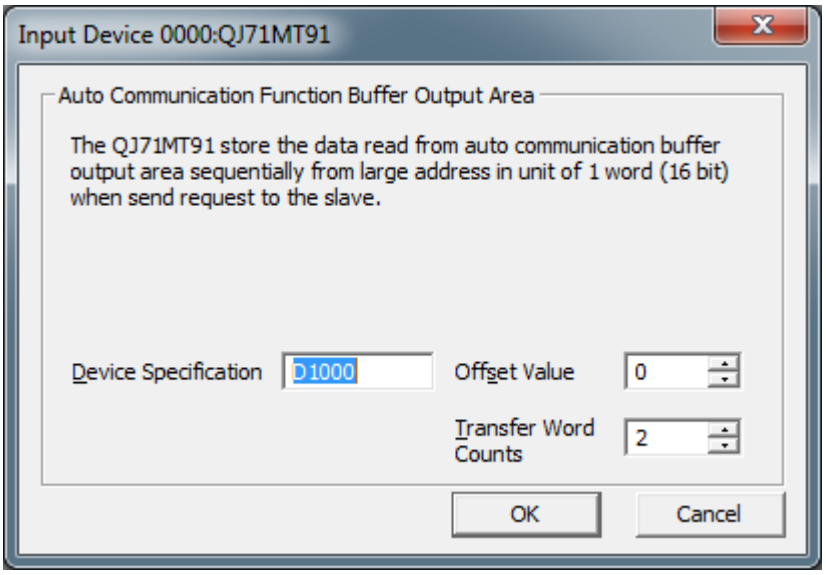


Figure 5.3.3 Data Register Output (Written to Slave) Parameters

These Settings in the Intelligent Function Module Setup are all kept at DEFAULT.

- **Basic Parameter (Router Information)**
- **Basic Parameter (Preferred Node Specification)**
- **Modbus Device Assignment Parameter**

5.4 MT91 Master Slave Register Setup

The following table shows the relationship between the Modbus Address (ETH Module), the MT91 BFM location, the PLC Data Register and the Modbus Address in the VFD. All these items, except Modbus Address (VFD), must be properly aligned in the Intelligent Function Module settings to work properly.

QJ71MT91 Quick Start Guide Master Slave Register Setup

Send to Slave (Write)

Modbus Address(ETH)	BFM		PLC Data Register	VFD	Modbus Address(VFD)
402001	3000h	←	D1000	Command Register	40009
402002	3001h	←	D1001	Command Frequency	40014

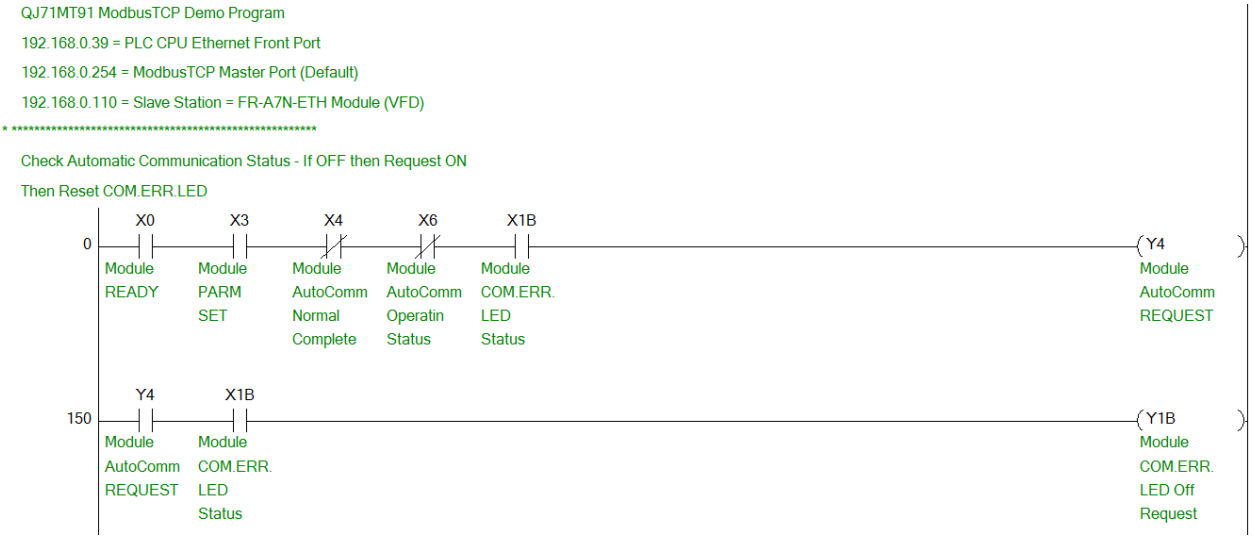
Receive from Slave (Read)

Modbus Address(ETH)	BFM		PLC Data Register	VFD	Modbus Address(VFD)
402001	1000h	→	D0	Commanded Bits	40009
402002	1001h	→	D1	Commanded Freq	40014
402003	1002h	→	D2	Output Frequency	40201
402004	1003h	→	D3	Output Current	40202
402005	1004h	→	D4	Output Voltage	40203
402006	1005h	→	D5	VFD Status Bits	40261
402007	1006h	→	D6	DC Bus Voltage	40208
402008	1007h	→	D7	Cumulative Power	40225

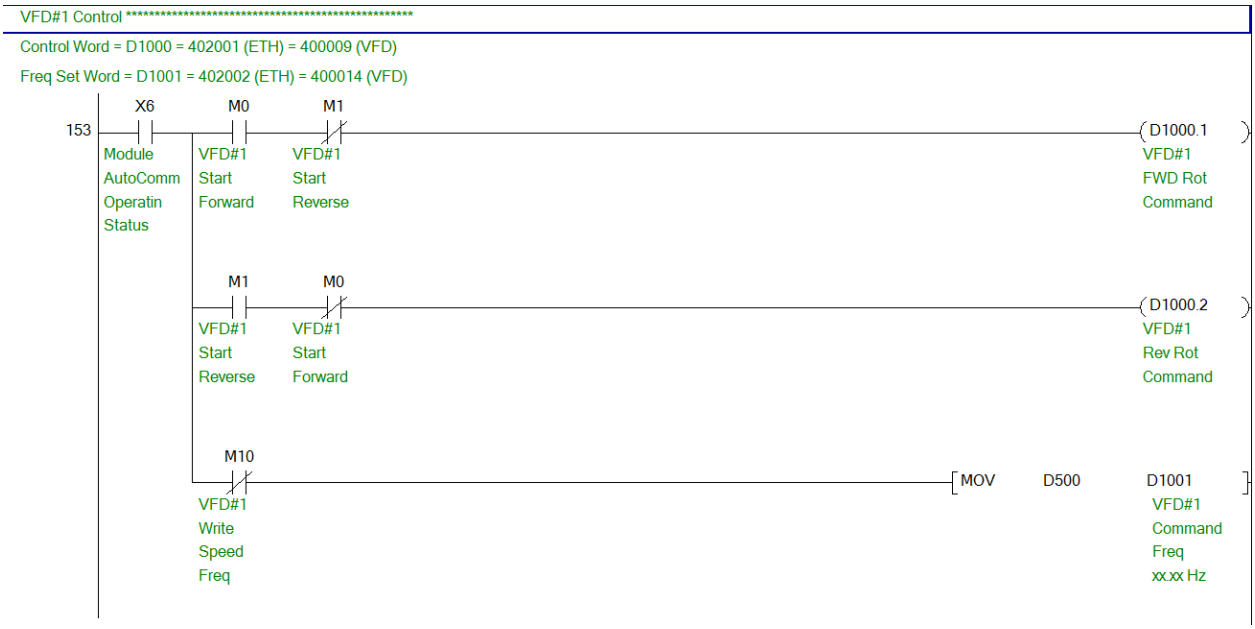
Chapter 6 GX Works2 PLC Program

If Automatic Communication Parameters are setup properly communication with the Slave device(s) will start when the PLC CPU is put into run. If not, the first two lines of code will be needed to turn on the Modbus/TCP Communication between the Master and the slaves.

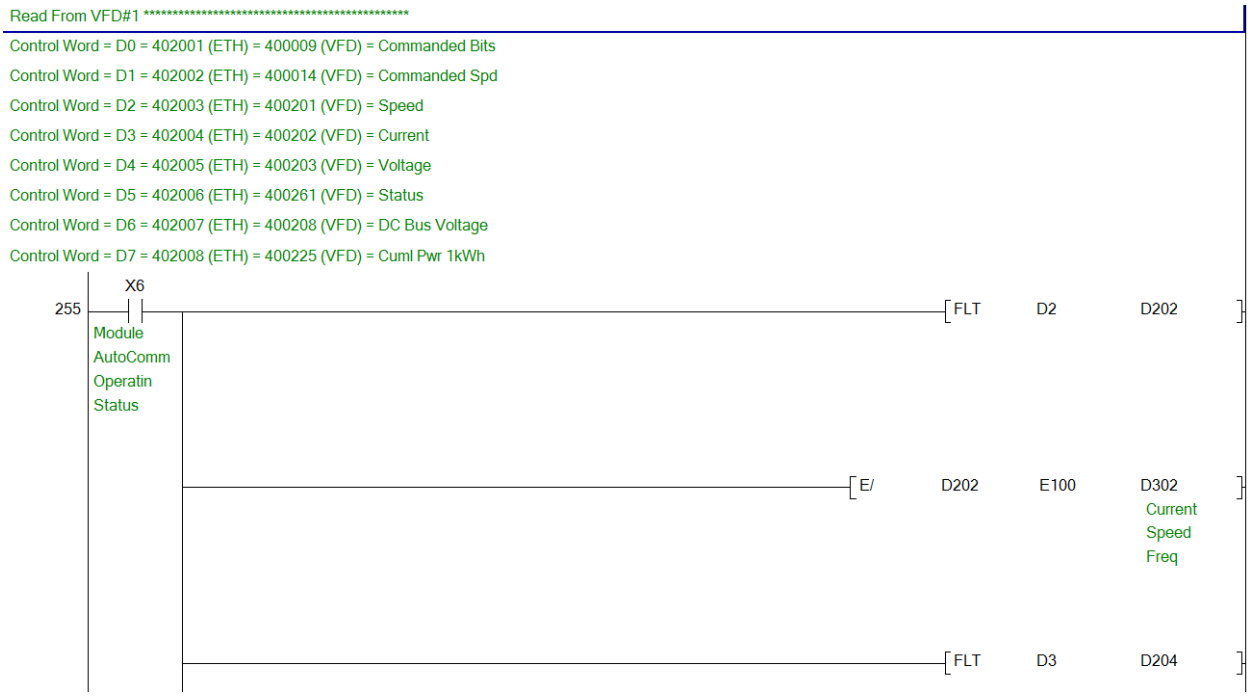
This code is used to Start Modbus/TCP Communications.



This code writes 2 Data Words to Start the VFD Forward or Reverse and Write Speed/Frequency.



This code reads all 8 Data Words from the VFD and converts them to real units (Freq, Current, Volts, etc.).



Revisions

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