

# Operating CFW900 in an EtherNet/IP<sup>®</sup> network using Rockwell ControlLogix<sup>™</sup> PLC

## CFW900

### Application Note



# EtherNet/IP Application Note

**CFW900**

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## SUMMARY OF REVISIONS

The information below describes the reviews made in this manual.

Version	Revision	Description
-	R00	First Edition.
-	R01	Changed document template.

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## 1 DESCRIPTION

This application note is intended to provide a description of how to program a CFW900 frequency converter to communicate in EtherNet/IP network using Rockwell ControlLogix PLC.

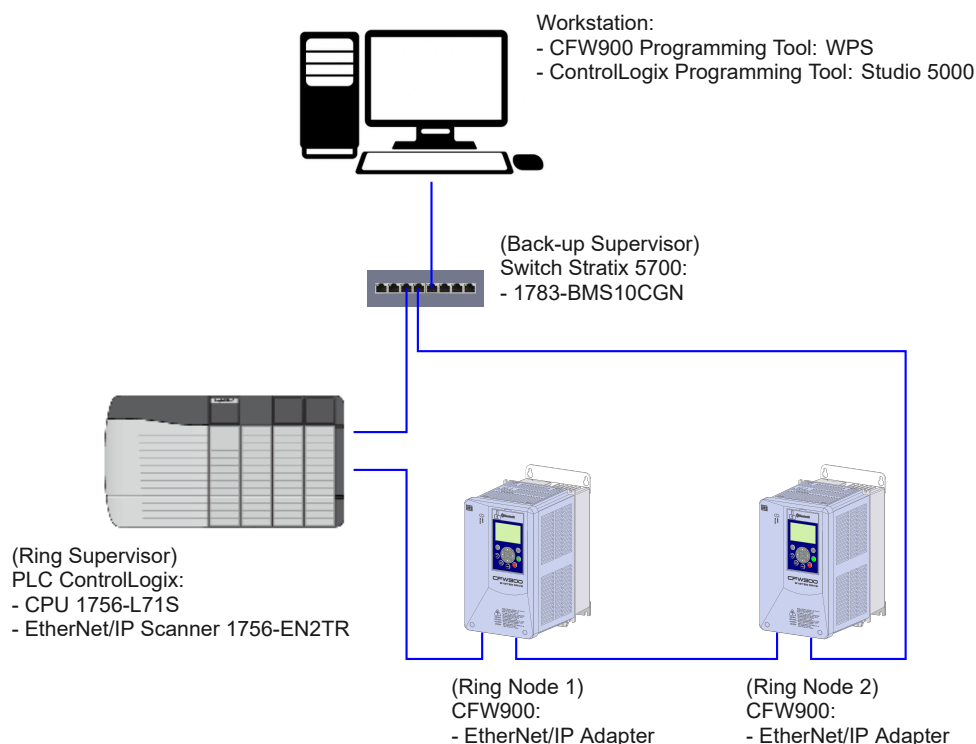
This document is meant for trained personnel working with the described equipment and EtherNet/IP network installation, besides a good knowledge of automation and programmable logic controllers, in particular about Rockwell Automation software.

### 1.1 REFERENCE DOCUMENTS

This application note was developed based on the following documents and tools:

Document / Tool	Version	Source
CFW900 User's Manual	10008985516 / 02	WEG
CFW900 Frequency Inverter Programming Manual	10008985492 / 03 (1.07.xx)	WEG
CFW900 EtherNet/IP User's Guide	10010168000 / 00	WEG
Media Planning and Installation Manual - EtherNet/IP	PUB00148R0	ODVA
Using Device Level Ring (DLR) with EtherNet/IP	PUB00316R2	ODVA
RSNetWorx™ for EtherNet/IP	28.01	Rockwell Automation
Studio 5000® PLC Programming Software	34.00	Rockwell Automation
WPS	3.00	WEG

### 1.2 ARCHITECTURE



**Figure 1.1:** Network components

### 1.3 CFW900

- Equipment: CFW900 version 1.07.0X.
- Programming tool: WPS version 3.00.

## DESCRIPTION

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### 1.4 CONTROLLOGIX

- CPU: 1756-L71S version 34.011
- EtherNet/IP Scanner: 1756-EN2TR version 11.003
- Programming tools:
  - RSNetWorx For EtherNet/IP version 28.01
  - Studio 5000 Logix Designer version 34.00

### 1.5 STRATIX 5700

- Managed Switch: 1783-BMS10CGN

### 1.6 PASSIVE NETWORK COMPONENTS

For passive network components - cables, ethernet switch - we recommend using certified components for industrial applications. Please refer to the product documentation for information about the proper network installation.

## 2 IP ADDRESS AND NETWORK CONFIGURATION

To allow communication among the devices, they need to have a compatible IP address configuration. It means the IP address must be in the same range, according to network mask. For this example, we will use the following IP addresses:

- Subnet mask: 255.255.255.0
- IP addresses: each device must have a different IP address.
  - Workstation: 192.168.0.20
  - ControlLogix: 192.168.0.71
  - Stratix® 5700: 192.168.0.66
  - CFW900 (1): 192.168.0.10 (as described at item 3).
  - CFW900 (2): 192.168.0.11

### 2.1 PC IP ADDRESS CONFIGURATION

To configure this option on Windows platform, go to “Network Connections” and select “Properties” of the applicable Ethernet interface:

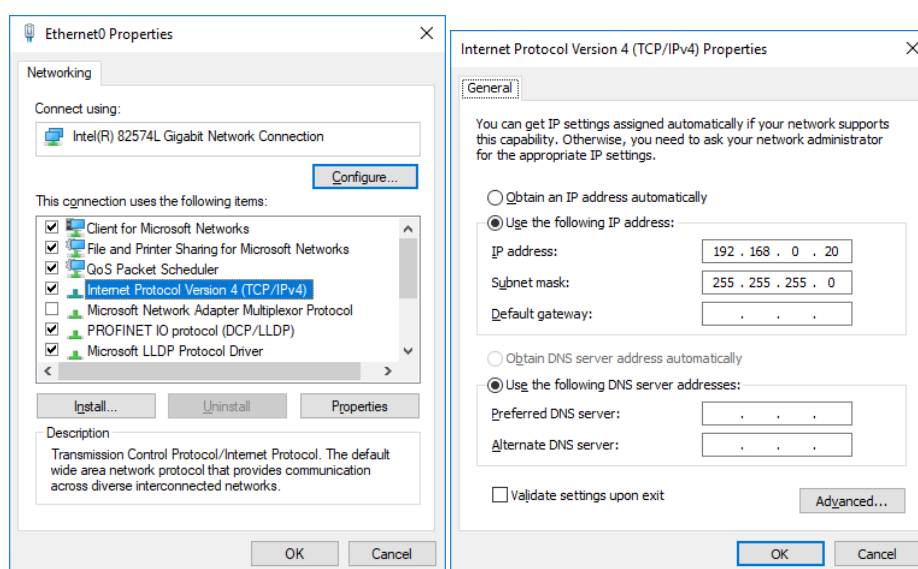
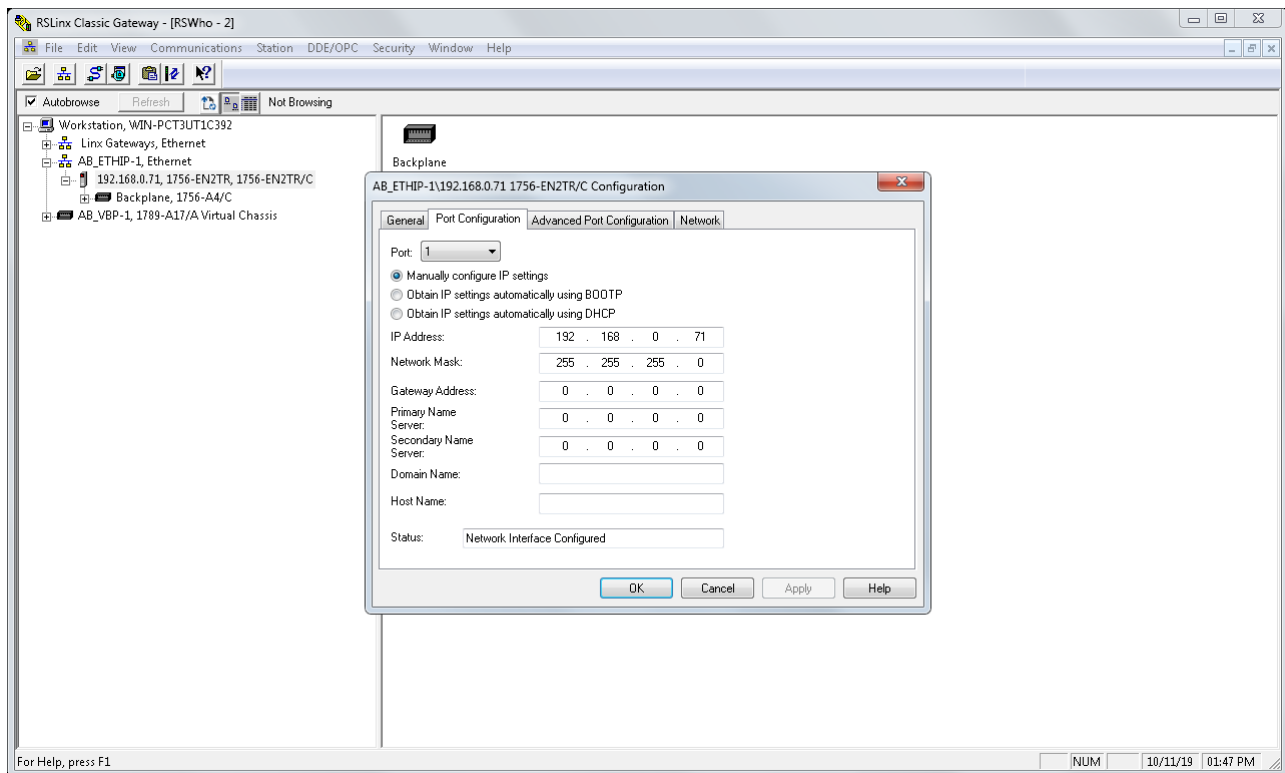


Figure 2.1: PC IP Address Configuration

### 2.2 CONTROLLOGIX IP ADDRESS CONFIGURATION

User can set IP address for ControlLogix using Rockwell configuration tools. Check ControlLogix documentation to obtain information about how to perform this configuration.

## IP ADDRESS AND NETWORK CONFIGURATION



**Figure 2.2:** ControlLogix IP Address Configuration



### 3 SERVER CONFIGURATION - CFW900

This section describes the main configurations for operating the CFW900 frequency converter in an EtherNet/IP network for Ring Node 1 and 2.

Refer to the CFW900 programming manual for the necessary configurations related to other device functions, like motor configuration, protections, etc.

#### 3.1 ETHERNET INTERFACE

For this application, the following configurations have been done via keypad to allow Ethernet communication to WPS:

- C9.4.1 Ethernet - IP Address Config: **0** (Parameters).
- C9.4.2 Ethernet - IP Address: 192.168.0.**10** and 192.168.0.**11**.
- C9.4.3 Ethernet - CIDR: 255.255.255.0.
- C9.5.4 Ethernet - Gateway: 0.0.0.0.

When communication configuration is done, it is also possible to create a WPS configuration and connect to it via Ethernet, to access the parameter list and configuration wizards:

P...	Description	Offline	Online	Minimum	Maximum	Factory settings	Unit	T...
A1	Oriented Startup	0: No		0: No	1: Yes	0: No		UINT
A2	Run Self-tuning	0: No		0: No	2: Running	0: No		UINT
C1...	Type	0: CA Three-Phase		0: CA Three-Phase	2: DC	0: CA Three-Phase		UINT
C1...	Rated Voltage	440		1	1200	440	V	UINT
C1...	Overload Type	0: Normal Duty		0: Normal Duty	1: Heavy Duty	0: Normal Duty		UINT
C1...	User	4.0		1.0	16.0	4.0	kHz	UINT
C1...	Minimum	1.40		1.00	16.00	1.40	kHz	UINT
C1...	Modulation	0: Standard		0: Standard	2: Long Cable Mod...	0: Standard		UINT
C1...	Pul.Wid.Adj.PWM Long Cab.	0.15		0.00	1.00	0.15		UINT
C1...	Dead Time Compens.	1: Enabled		0: Disabled	1: Enabled	1: Enabled		UINT
C1...	Power	2: Temp.Control w...		0: Off	3: Temperature C...	2: Temp.Control w...		UINT
C1...	Internal	2: Temp.Control w...		0: Off	3: Temperature C...	2: Temp.Control w...		UINT
C1...	Invert Output Phase Seq.	0: U(T1)/V(T2)/W(...)		0: U(T1)/V(T2)/W(...)	1: W(T3)/V(T2)/U(...)	0: U(T1)/V(T2)/W(...)		UINT
C1...	Reset Counters	0: Disabled		0: Disabled	3: Enabled Inverter	0: Disabled		UINT
C1...	Inom Manual Reduction	0.0		0.0	100.0	0.0	%	UINT
C2...	Type	0: Induction		0: Induction	1: Permanent Mag...	0: Induction		UINT
C2...	Motor Power Unit	0: HP/cv		0: HP/cv	1: kW	0: HP/cv		UINT
C2...	Rated Power	2.0		0.0	2000.0	2.0		UINT
C2...	Rated Voltage	440		1	690	440	V	UINT
C2...	Rated Current	3.6		0.0	2223.0	3.6	A	UINT
C2...	Rated Frequency	60		1	500	60	Hz	UINT
C2...	Pole Pair Numbers	3		1	12	3		UINT
C2...	Rated Speed	1750		0	18000	1750	rpm	UINT
C2...	Nominal Efficiency	90.0		50.0	99.9	90.0	%	UINT
C2...	Nominal cos phi	0.82		0.50	0.99	0.82		UINT
C2...	Service Factor	1.15		1.00	1.50	1.15		UINT
C2...	Ventilation	0: Self-Vent.		0: Self-Vent.	1: Separate Vent.	0: Self-Vent.		UINT
C2...	Stator Resistance	1.000		0.000	10.000	1.000	Ω	UINT
C2...	Magnetization Reactance	1.0		0.0	500.0	1.0	Ω	UINT
C2...	Leakage Reactance	1.00		0.00	50.00	1.00	Ω	UINT
C2...	Rotor Resistance	1.000		0.000	10.000	1.000	Ω	UINT
C2...	Rotor Reactance	1.00		0.00	50.00	1.00	Ω	UINT
C2...	Ld Inductance	0.00		0.00	200.00	0.00	mH	UINT
C2...	Lq Inductance	0.00		0.00	200.00	0.00	mH	UINT
C2...	Ke Constant	0.0		0.0	2000.0	0.0		UINT

Figure 3.1: WPS - Parameter list

#### 3.2 LOCAL/REMOTE

CFW900 has three operation modes: local (via HMI), remote 1 (R1) and remote 2 (R2). For each operation mode, it is necessary to define the source that it will use to receive commands, like start/stop, fault reset. For this application, the following control sources have been defined:

- Local: Keypad disable.
- R1: Ethernet.

- R2: Not Used.
- R1/R2 selection: Not used. Commands not coming from R1 will be ignored by the drive.

Based on this, the following configurations have been programmed:

- C4.1.1 Config. LOC/REM Mode - LOC/REM Command Mode: Remote 1.
- C4.1.3 Config. LOC/REM Mode - LOC/REM HMI Key: Disable.
- C4.2.1.1 R1 Config. Commands - General Enable: Ethernet.
- C4.2.1.2 R1 Config. Commands - Run/Stop: Ethernet.
- C4.2.1.3 R1 Config. Commands - Speed Direction: Ethernet.
- C4.3.1.2.1 Speed Ref. Source - Remote 1 Mode: Ethernet.

### 3.3 COMMUNICATION ERROR

For CFW900, the following events lead to error indication:

- When cyclic communication is active and it is interrupted.
- When cyclic communication is active and master is in "Run" mode, and then it goes to "Idle" mode.

For both situations, CFW900 will indicate A147 ou F247 (EtherNet/IP Communication Offline). It is important to define the action CFW900 will take in case of communication error. If CFW900 was running the motor via network command, CFW900 should also perform a general disable. Based on this, the following configurations have been programmed:

- C9.1.1.2 Master Offline Alarm Action: 2 (General Disable).

### 3.4 I/O DATA CONFIGURATION

CFW900 has a set of configurations where it is possible to define any device data to exchange with network master. There is an appendix in Ethernet User's Guide describing the entire list of device data that can be programmed to I/O Data.

Parameter	Description	Range of values	Decimal places	Class	Instance	Attribute	CIP data type	Net Id	Size	Qty mapped words
S5 Status/Communications										
S5.1	Status and Commands			64h	07h	B4h	WORD	680	16bit	1
S5.1.1	Status Word 1	Bit 0 = STO Bit 1 = Run Command Bit 2 = Local Bit 3 = Not used Bit 4 = No Quick Stop Bit 5 = 2nd Ramp Bit 6 = Config. Mode Bit 7 = Alarm Bit 8 = Running Bit 9 = Enabled Bit 10 = Reverse Bit 11 = JOG Bit 12 = Remote 2 Bit 13 = Undervoltage Bit 14 = Not used Bit 15 = Fault								

Figure 3.2: List of available data described in Ethernet User's Guide

For each application, it is necessary to look at this appendix and define the data to communicate between CFW900 and ControlLogix. For this application, CFW900 will transfer the following I/O data with network master:

Mapped Inputs	Net Id	Size	Qty Mapped Words
S5.1.1 Status and Commands Status Word 1	680	16bit	1
S5.1.3 Status and Commands Status Word 2	690	16bit	1
S5.1.2 Status and Commands Speed	681	16bit	1
S2.3.1 Inverter Output Current	3	16bit	1
TOTAL			4 Words (8 Bytes)

Mapped Outputs	Net Id	Size	Qty Mapped Words
S5.3.2 Ethernet Control Word	664	16bit	1
S5.3.3 Ethernet Speed Reference	665	16bit	1
TOTAL			2 Words (4 Bytes)

Based on this sequence of data for communication, the following configurations have been programmed:

Device profile configuration (Input and Output Words):

- C9.5.1 EtherNet/IP I/O Instances: 102/152 Config I/O data.

Data read configuration (Input Words):

- C9.5.2 EtherNet/IP Reading 1st Word: 1.
- C9.5.3 EtherNet/IP Reading Quantity: 4.
- C9.2.1.1 Reading Data Word #1: 680 (Status and Commands Status Word 1).
- C9.2.1.2 Reading Data Word #2: 690 (Status and Commands Status Word 2).
- C9.2.1.3 Reading Data Word #3: 681 (Status and Commands Speed).
- C9.2.1.4 Reading Data Word #4: 3 (Inverter Output Current).

Data write configuration (Output Words):

- C9.5.4 EtherNet/IP Writing 1st Word: 1.
- C9.5.5 EtherNet/IP Writing Quantity: 2.
- C9.2.2.2 Writing Data Word #1: 664 (Ethernet Control Word).
- C9.2.2.3 Writing Data Word #2: 665 (Ethernet Speed Reference).

## 4 MASTER CONFIGURATION - CONTROLLOGIX

Use Rockwell software to configure and program ControlLogix to communicate with CFW900. The main steps are described below.

### 4.1 RSNETWORX FOR ETHERNET/IP

#### 4.1.1 Register EDS File

Use EDS Wizard to register EDS file for CFW900.

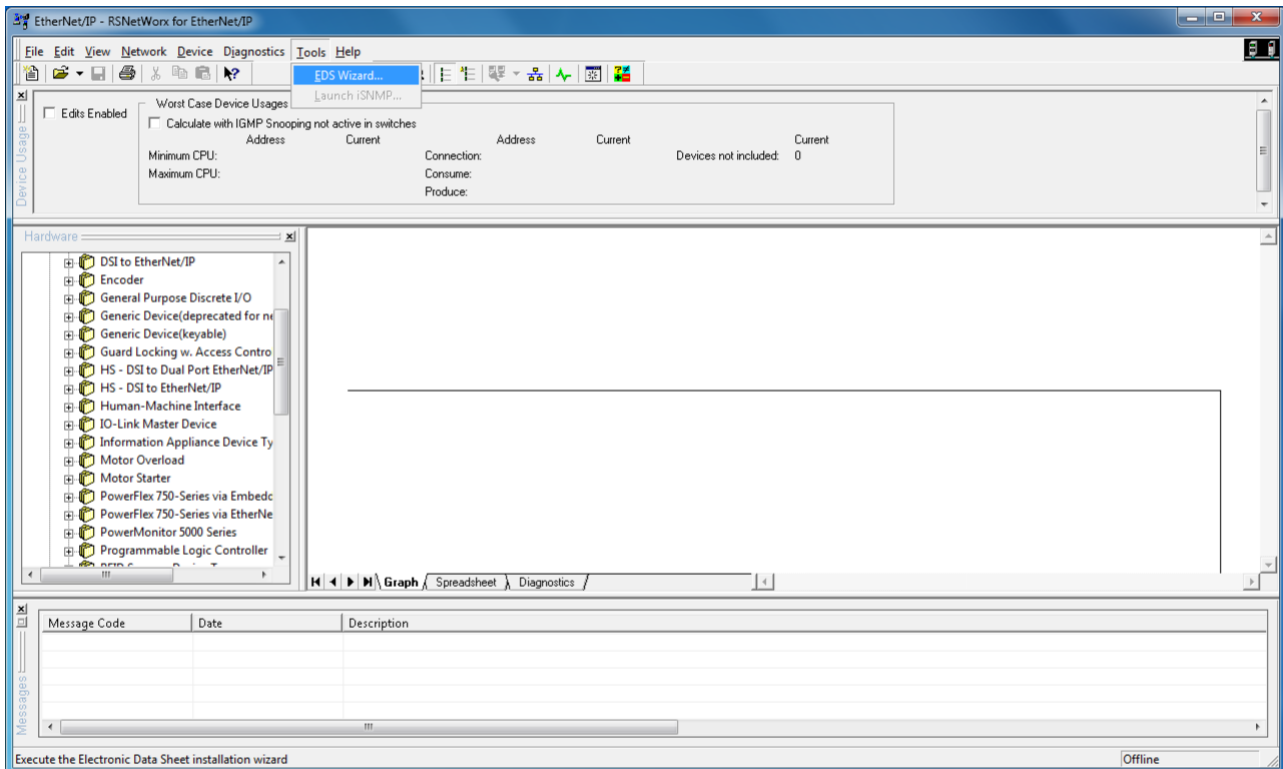
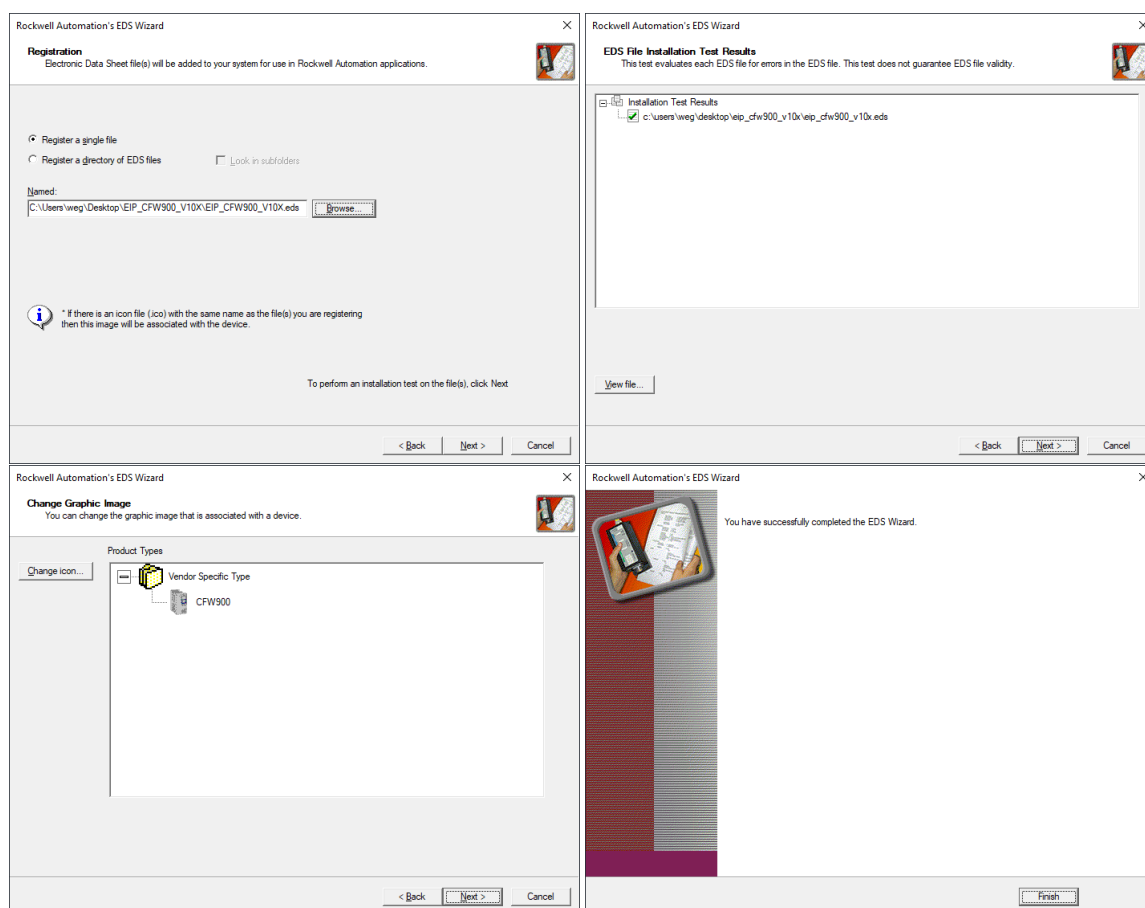


Figure 4.1: RSNetWorx For EtherNet/IP



**Figure 4.2:** RSNetWorx - Register EDS File

### 4.1.2 Scan Devices

With devices connected, it is possible to scan the network to find active nodes for communication. For this example, EtherNet/IP scanner (1756-EN2TR) is present in address 192.168.0.71. It is possible to save this configuration and link it during ControlLogix configuration.

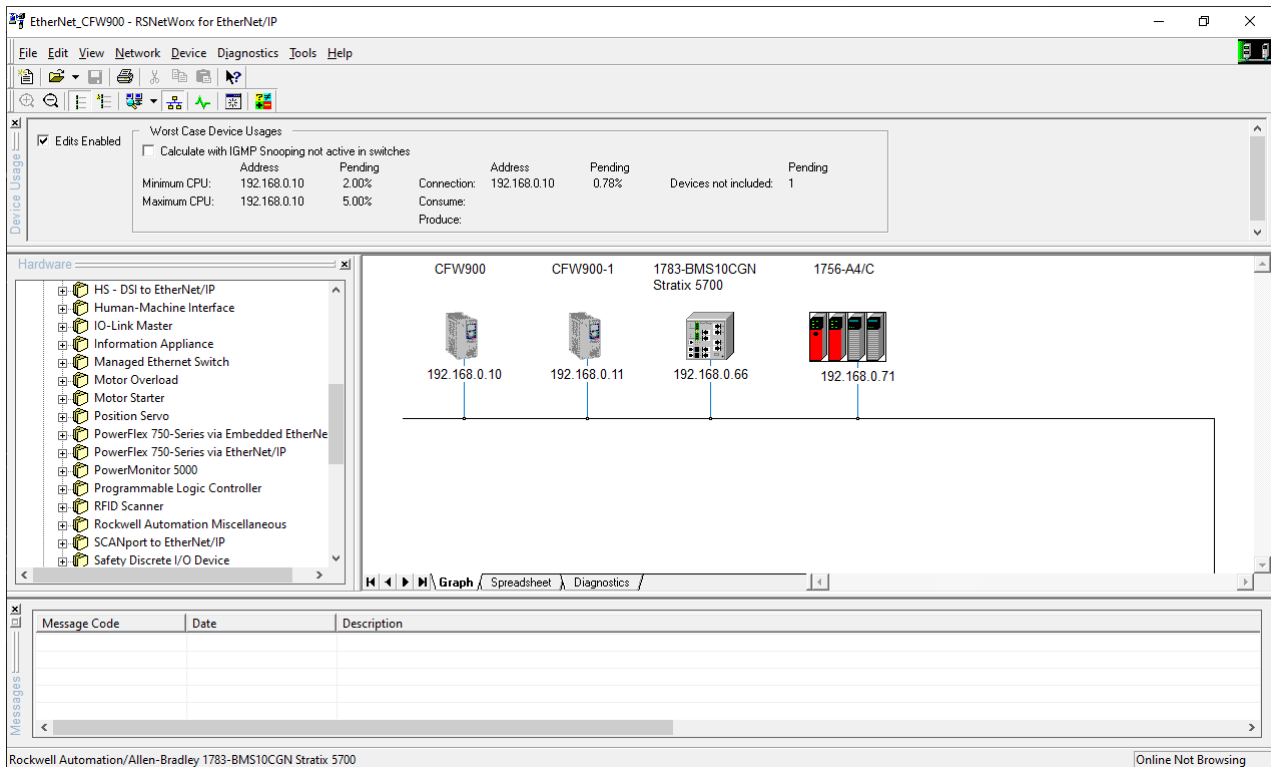


Figure 4.3: RSNetWorx for EtherNet/IP - Online Identification

## 4.2 STUDIO 5000 LOGIX DESIGNER

Open Studio Rockwell 5000 software and create a new project. Select ControlLogix CPU, chassis and EtherNet/IP scanner, according to available hardware and firmware version.

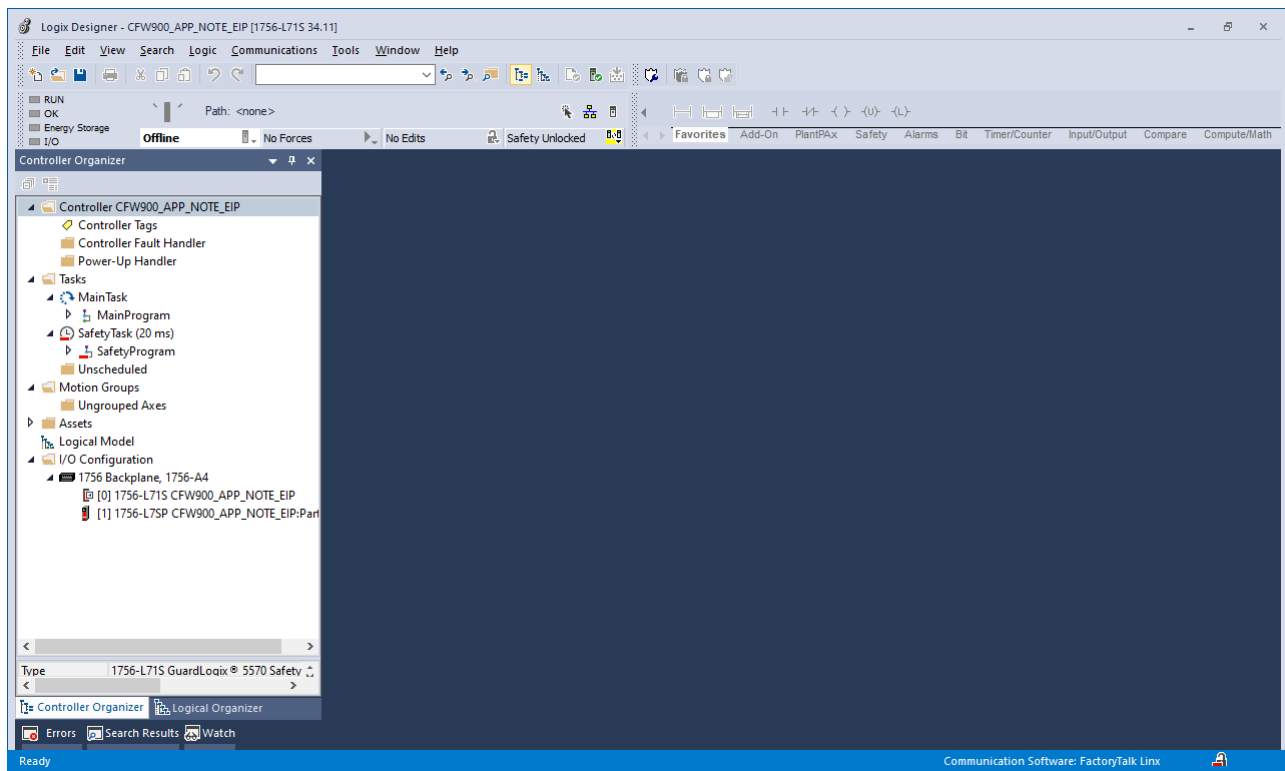


Figure 4.4: Studio 5000 Logix Designer - Create New Project

### 4.2.1 Add New Module for Control Logix

Create a new scanner module for Ethernet interface and configure, as programmed in item 2.2.

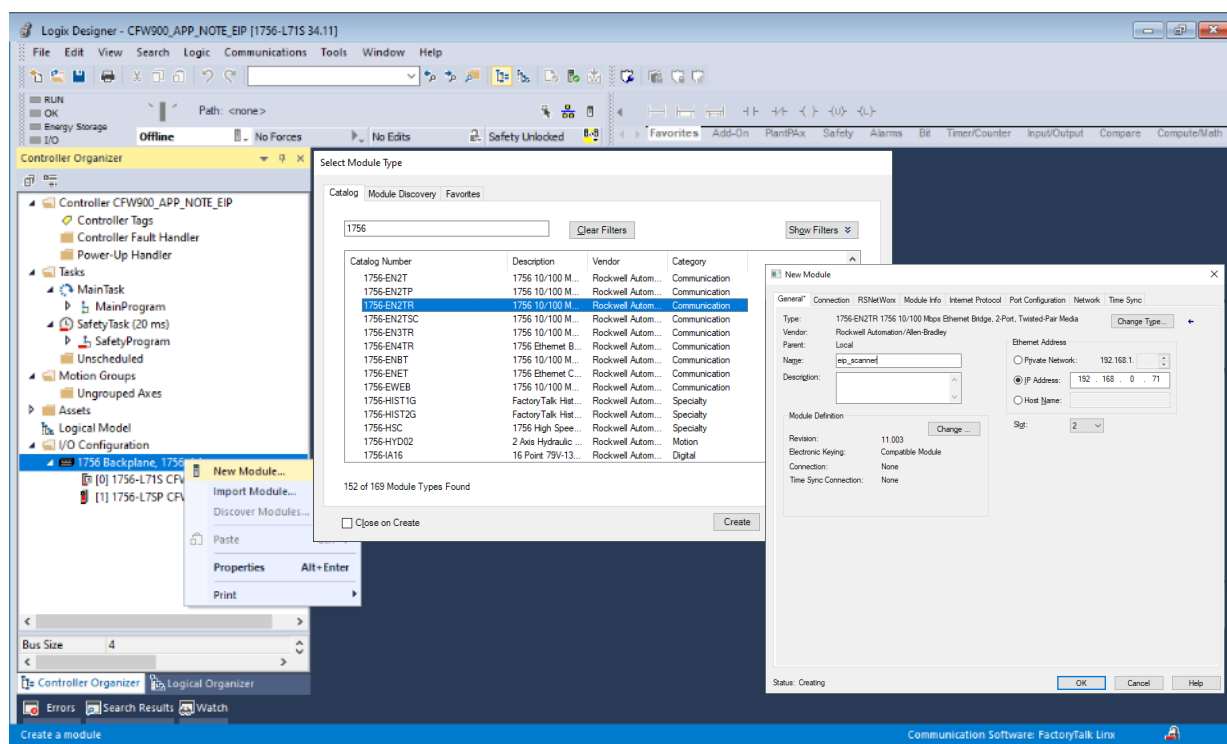
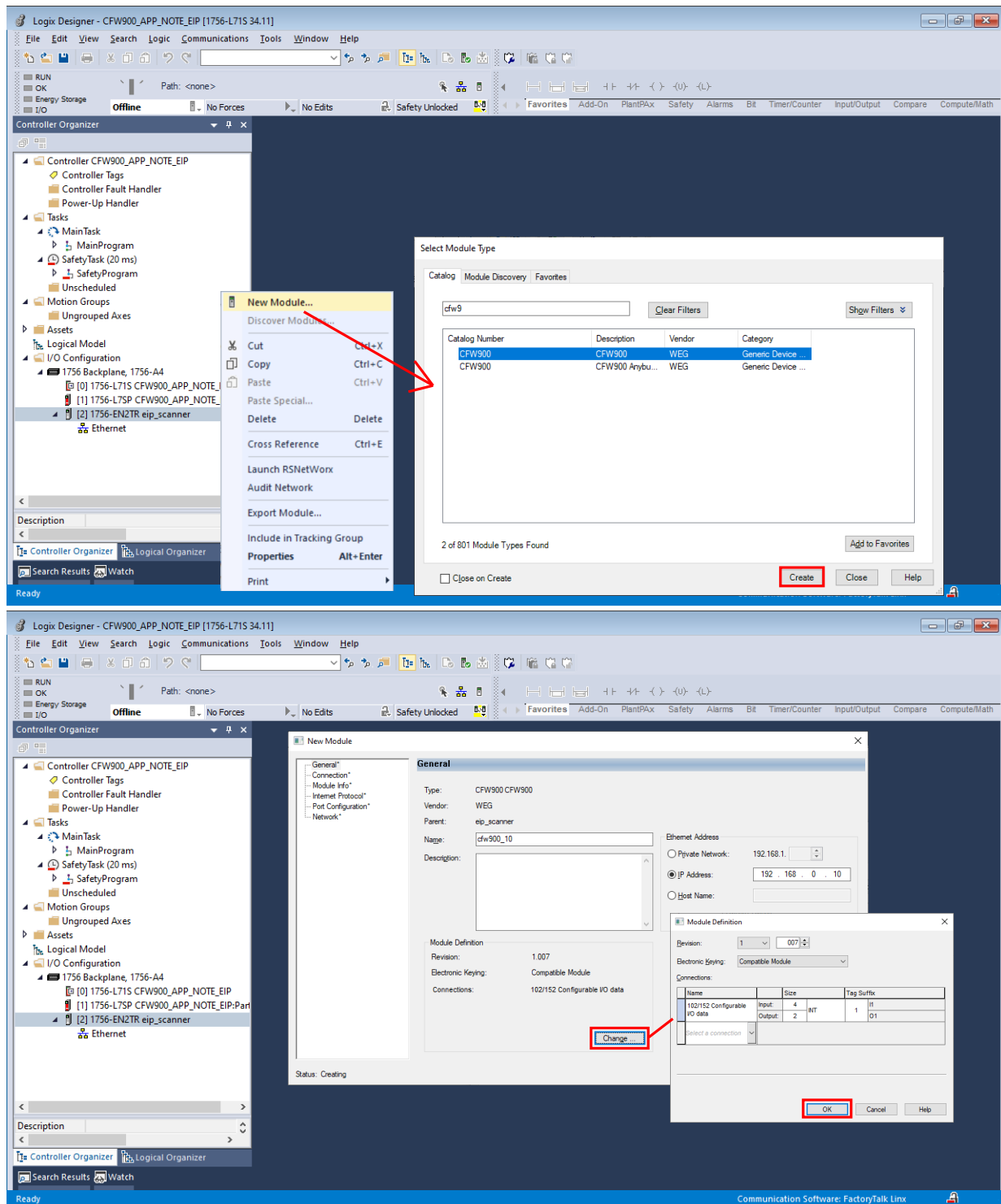


Figure 4.5: Studio 5000 Logix Designer - Add New EtherNet/IP Module

### 4.2.2 Add New Module for CFW900

Create a new CFW900 module for Ethernet interface, and configure the instance and I/O size, as programmed in item 3.4.



**Figure 4.6:** Studio 5000 Logix Designer - Add New CFW900 Module

For this example, CFW900 will communicate 4 input words and 2 output words. Status and control data will follow the manufacturer specific profile. This must match the same configuration programmed in drive parameters.

## 4.2.3 Download and Monitor Configuration

With module created, device data should be available at Controller Tags. Using these tags, it is possible to view and edit online device I/O data, as well as creating a ladder logic to control and monitor the device.

Once the configuration is finished, download it to PLC in order to monitor CFW900 I/O data.



# MASTER CONFIGURATION - CONTROLLOGIX

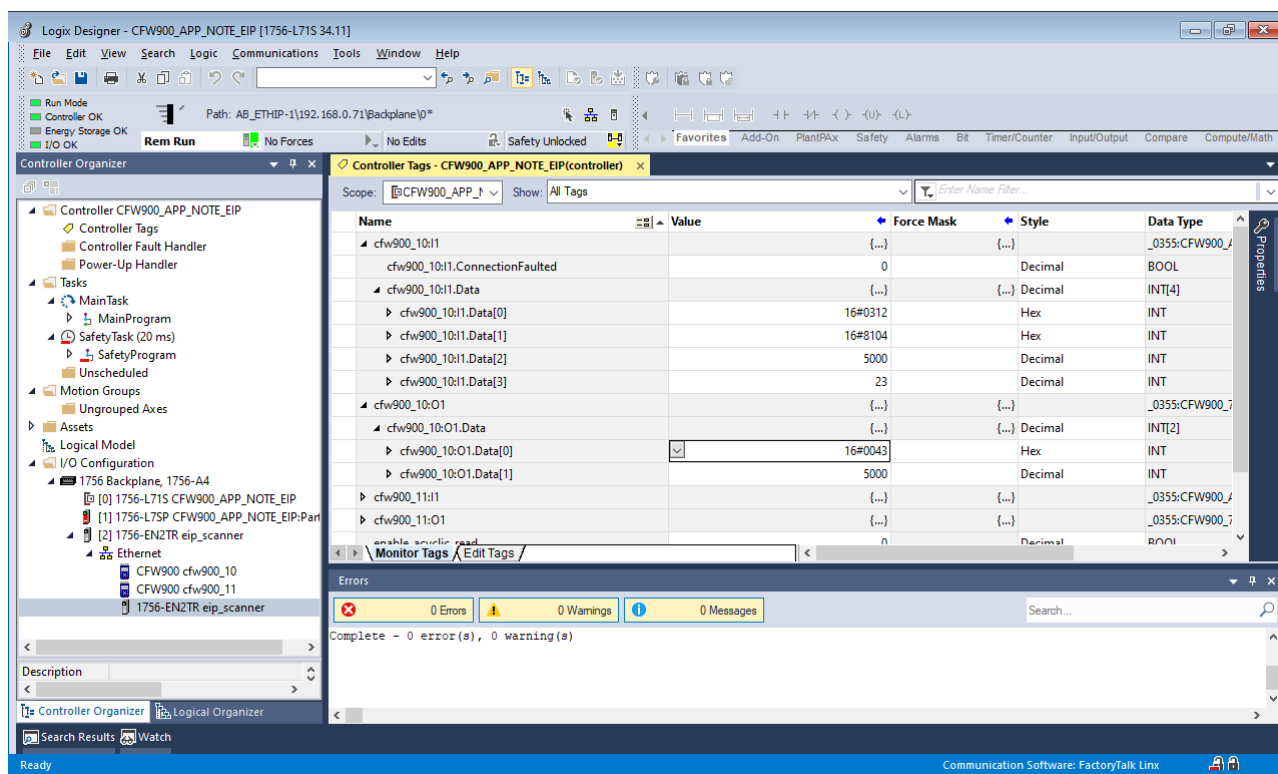


Figure 4.7: Studio 5000 Logix Designer - Download

## 5 CONTROL AND MONITORING

Once network configuration is done, it is possible to control and monitor the device. The main steps are described below.

### 5.1 VIEW AND EDIT READ AND WRITE DATA

In online mode, at controller tags, it is possible to check input and write output data directly in controller memory.

Bit	Value/Description
Bit 0 STO	0 = No: STO function is inactive (inverter operational) 1 = Yes: STO function is active (inverter locked)
Bit 1 Run Command	0 = No: no run command active 1 = Yes: run command active
Bit 2 Local	0 = No: inverter in the Remote command mode 1 = Yes: inverter in the Local command mode
Bit 3 Not used	Not used.
Bit 4 No Quick Stop	0 = No: no quick stop command active 1 = Yes: quick stop command active
Bit 5 2nd Ramp	0 = No: 1 <sup>st</sup> acceleration and deceleration ramp by C6.1.1 and C6.1.2 1 = Yes: 2 <sup>nd</sup> acceleration and deceleration ramp by C6.1.4 and C6.1.5
Bit 6 Config. Mode	0 = No: inverter in normal operation 1 = Yes: inverter in configuration state. Indicates a special condition in which the inverter cannot be enabled
Bit 7 Alarm	0 = No: without alarm 1 = Yes: with alarm active
Bit 8 Running	0 = No: motor is stopped 1 = Yes: motor is running according to reference and command
Bit 9 Enabled	0 = No: inverter is general disabled 1 = Yes: inverter is general enabled
Bit 10 Reverse	0 = No: motor running in the forward direction 1 = Yes: motor running in the reverse direction
Bit 11 JOG	0 = No: no JOG command active 1 = Yes: JOG command is active
Bit 12 Remote 2	0 = No: inverter in Remote 1 command mode 1 = Yes: inverter in Remote 2 command mode
Bit 13 Undervoltage	0 = No: without undervoltage 1 = Yes: with undervoltage
Bit 14 Not used	Not used.
Bit 15 Fault	0 = No: without fault 1 = Yes: with active fault

Figure 5.1: Read data, with highlight to the status word 1 as described in CFW900 EtherNet/IP documentation

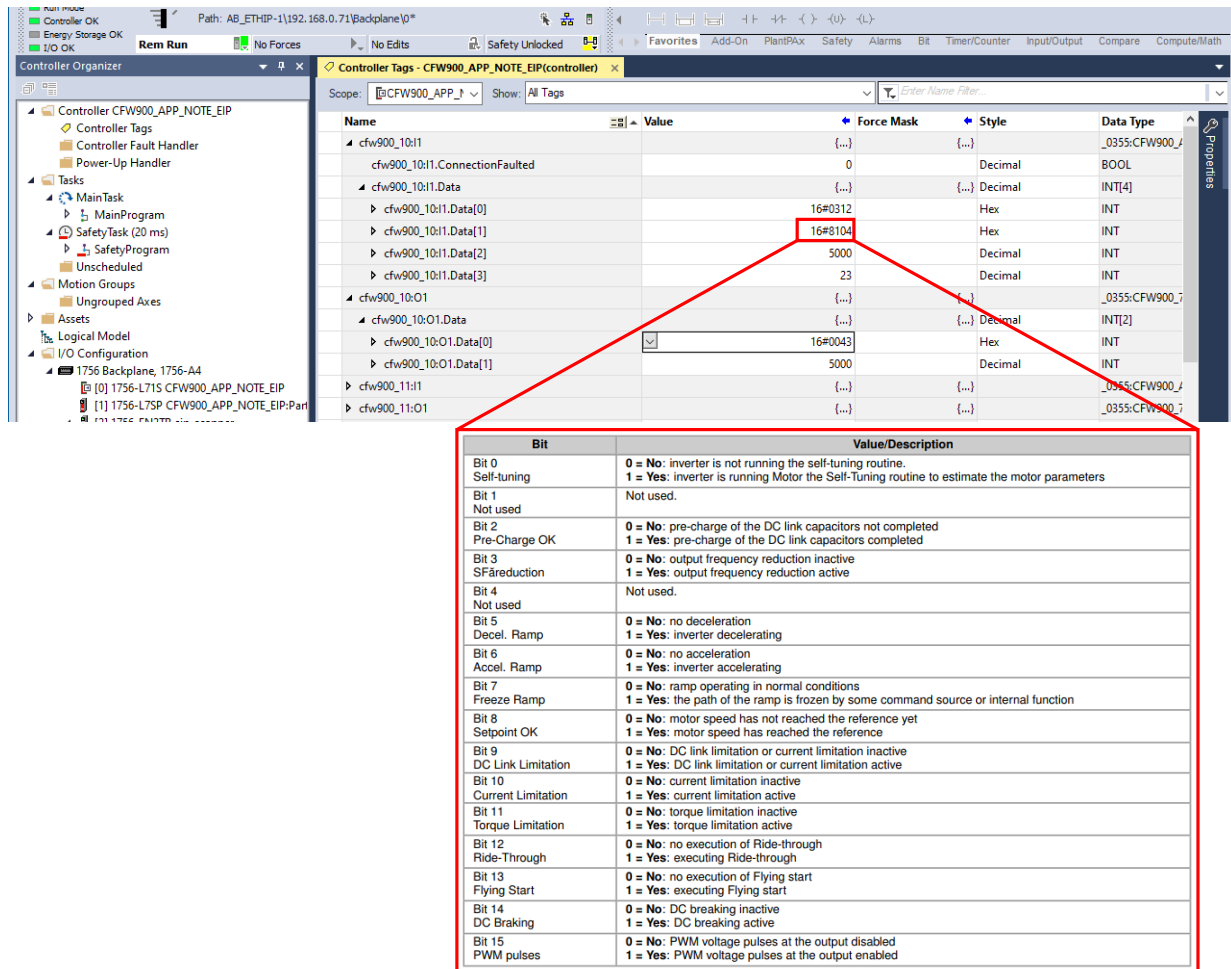
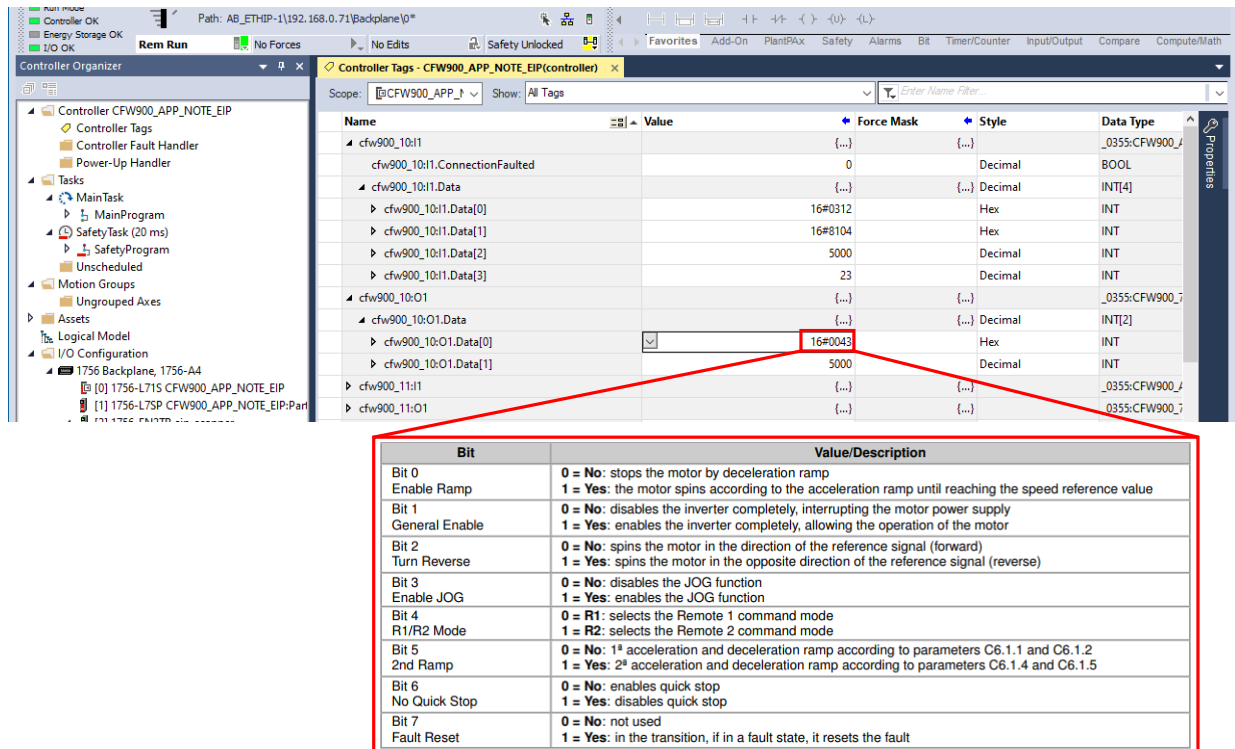


Figure 5.2: Read data, with highlight to the status word 2 as described in CF900 EtherNet/IP documentation

For inputs, as described at item 3.4, it is programmed to read the following information:

- CF900\_10:11.Data[0]: 680, value 0x0312 hexadecimal (binary 0000 0011 0001 0010).
  - Bit 1 = 1 (run command).
  - Bit 4 = 1 (no quick stop).
  - Bit 8 = 1 (running).
  - Bit 9 = 1 (enabled).
  - Bit 12 = 0 (R1 command mode).
- CF900\_10:11.Data[1]: 690, value 0x8104 hexadecimal (binary 1000 0001 0000 0100).
  - Bit 2 = 1 (pre-charge OK).
  - Bit 8 = 1 (setpoint OK).
  - Bit 15 = 1 (PWM pulses).
- CF900\_10:11.Data[2]: 681, value 5000 (motor speed actual value = 50.00%).
- CF900\_10:11.Data[3]: 3, value 23 (motor current actual value = 2.3A).



**Figure 5.3:** Write data, with highlight to the command word as described in CFW900 EtherNet/IP documentation

For output, as described at item 3.4, it is programmed to write the following information:

- CFW900\_10:O1.Data[0]: 664, value 0x0043 hexadecimal (binary 0000 0000 0001 0011).
  - Bit 0 = 1 (enable ramp).
  - Bit 1 = 1 (general enable).
  - Bit 4 = 0 (R1 command mode).
  - Bit 6 = 1 (no quick stop).
- CFW900\_10:O1.Data[1]: 665, value 5000 (motor speed reference = 50.00%).

These tags can be used during PLC program to create a logic in order to monitor and control devices.

## 5.2 ACYCLIC REQUESTS

Besides monitoring status data and writing control data, it is possible to create acyclic requests to access other device parameters. For this example, we will read the value of C6.1.1 - Acceleration Time.

Parameter	Description	Range of values	Decimal places	Class	Instance	Attribute	CIP data type	Net Id	Size	Qty mapped words
C6 Configuration/Ramps										
C6.1	Speed Control Ramps									
C6.1.1	Acceleration Time	0.1 to 999.9 s	1	64h	02h	64h	UINT	100	16bit	1
C6.1.2	Deceleration Time	0.1 to 999.9 s	1	64h	02h	65h	UINT	101	16bit	1

**Figure 5.4:** CFW900 Ethernet documentation describing CIP path for acyclic access

Configure Service, Class, Instance and Attribute to address the parameter, as shown below:

- Service “Get Attribute Single” to read parameter.
- Class 100 (64 hex)
- Instance 2
- Attribute 100 (64 hex)

## CONTROL AND MONITORING

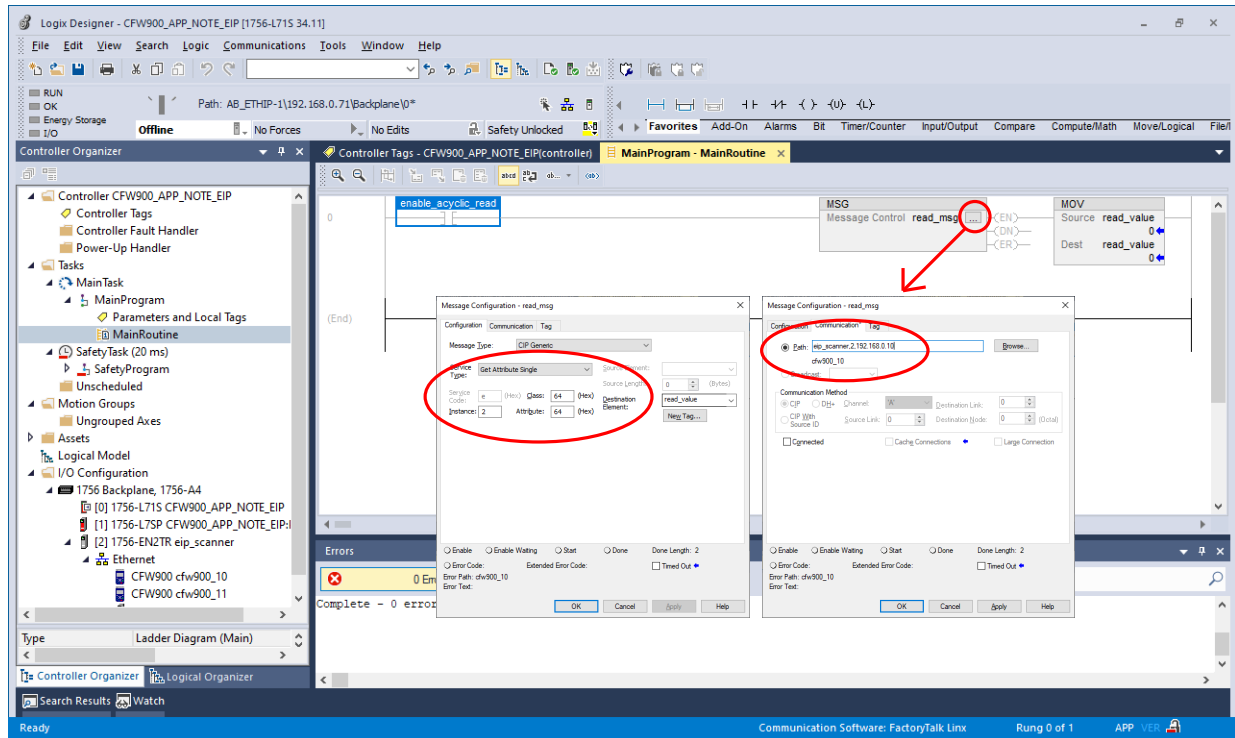


Figure 5.5: Program MSG instruction

Once defined the information for acyclic access, design a program using PLC's ladder language. A "MSG" instruction will be used to send such request. In online mode, it is possible to enable the block to send an acyclic request to read the parameter value.

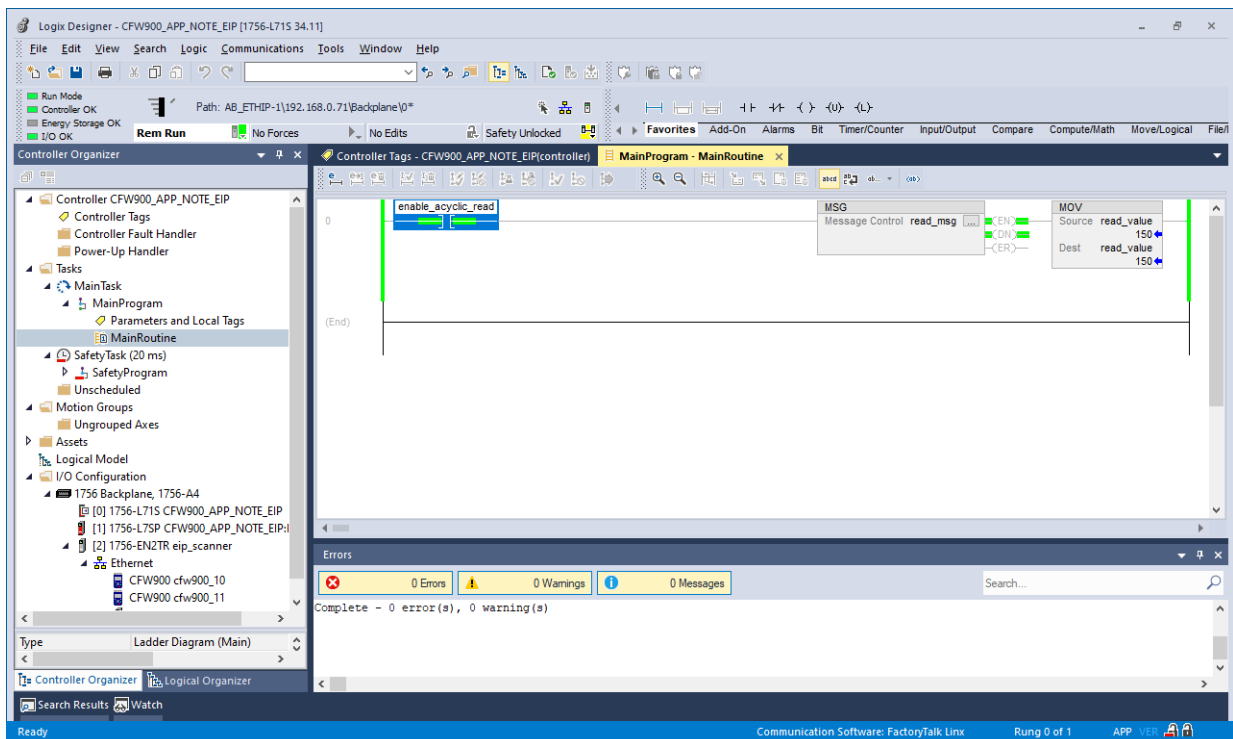


Figure 5.6: Enable MSG Instruction

## 6 NETWORK REDUNDANCY

Each ring node supports two EtherNet/IP ports. Therefore, each ring or supervisor node has a embedded Ethernet switch. Note, the CFW900 is an announced-based ring node.

Figure 1.1 shows a topology of a DLR ring. The application includes CFW900 frequency converter, PLC, managed switch and a workstation for network configuration. The following configurations have been done via CIP for ring supervisor and back-up supervisor:

Ring Supervisor:

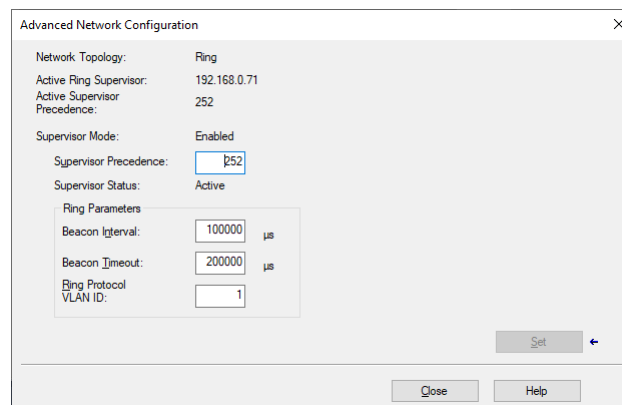
- Precedence: **252**.
- Beacon Interval: **100000**  $\mu$ s.
- Beacon Timeout: **200000**  $\mu$ s.
- VLAN ID: **1**.

Back-up Supervisor:

- Precedence: **250**.
- Beacon Interval: **100000**  $\mu$ s.
- Beacon Timeout: **200000**  $\mu$ s.
- VLAN ID: **1**.

### 6.1 RING SUPERVISOR SETTINGS

Ring Supervisor configuration in Studio 5000.



**Figure 6.1:** Studio 5000 Logix Designer - Ring Supervisor Configuration

With the devices online and arranged according to the diagram in Figure 1.1, the ring will go into Normal state.

## NETWORK REDUNDANCY

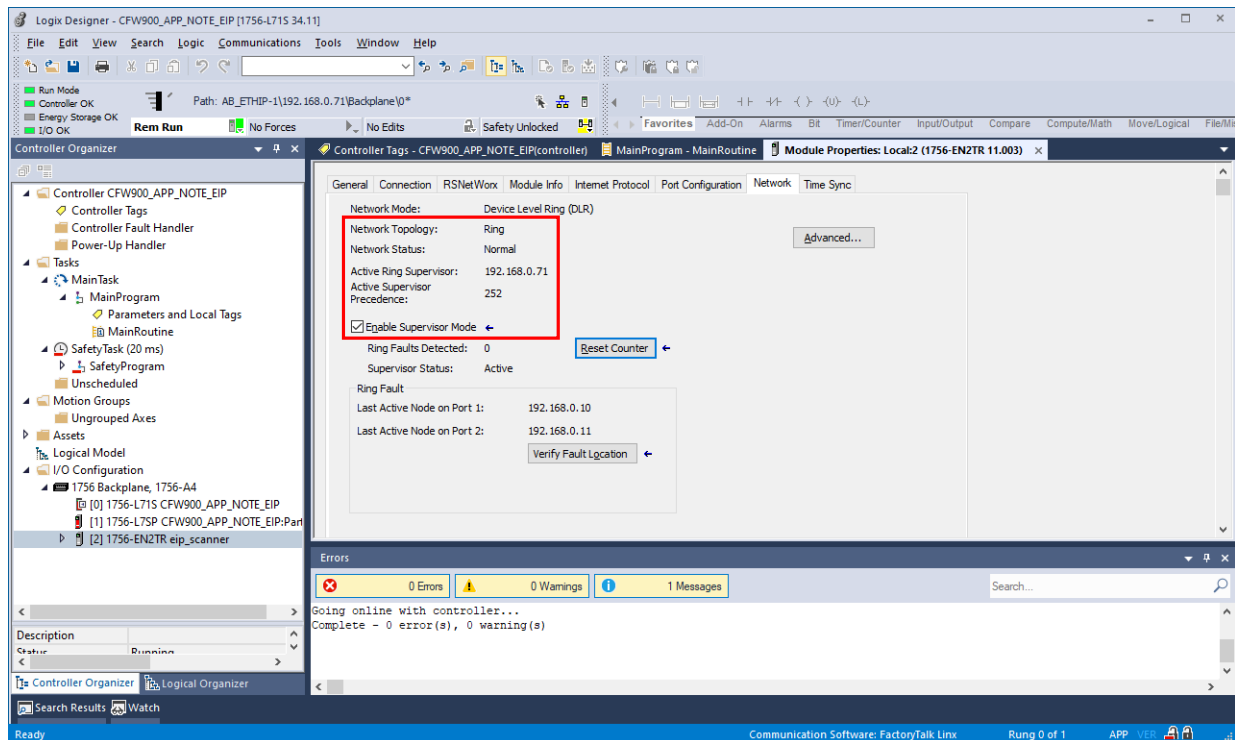


Figure 6.2: Studio 5000 Logix Designer - Ring Supervisor in Normal State

When pulling out one of the network cables, the ring will go into Fault state.

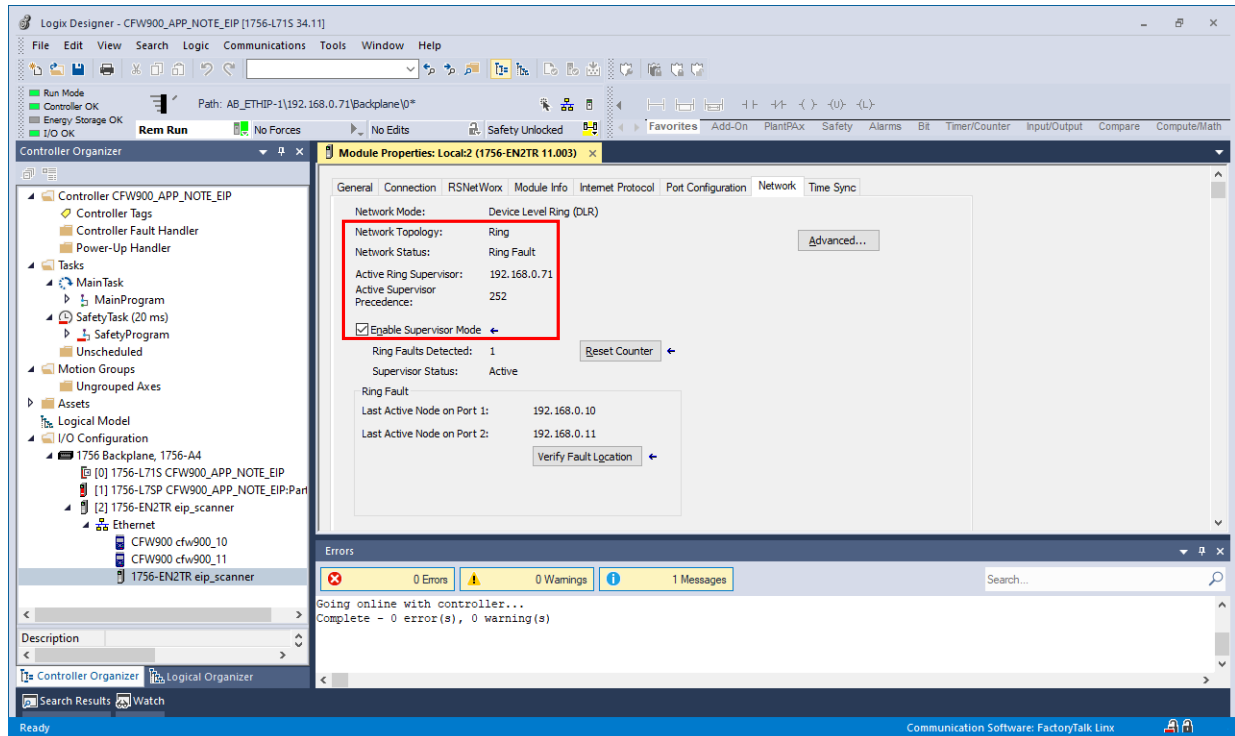


Figure 6.3: Studio 5000 Logix Designer - Ring Supervisor in Fault State

By disabling the Supervisor Mode of the Ring Supervisor, the Back-up supervisor will take over.

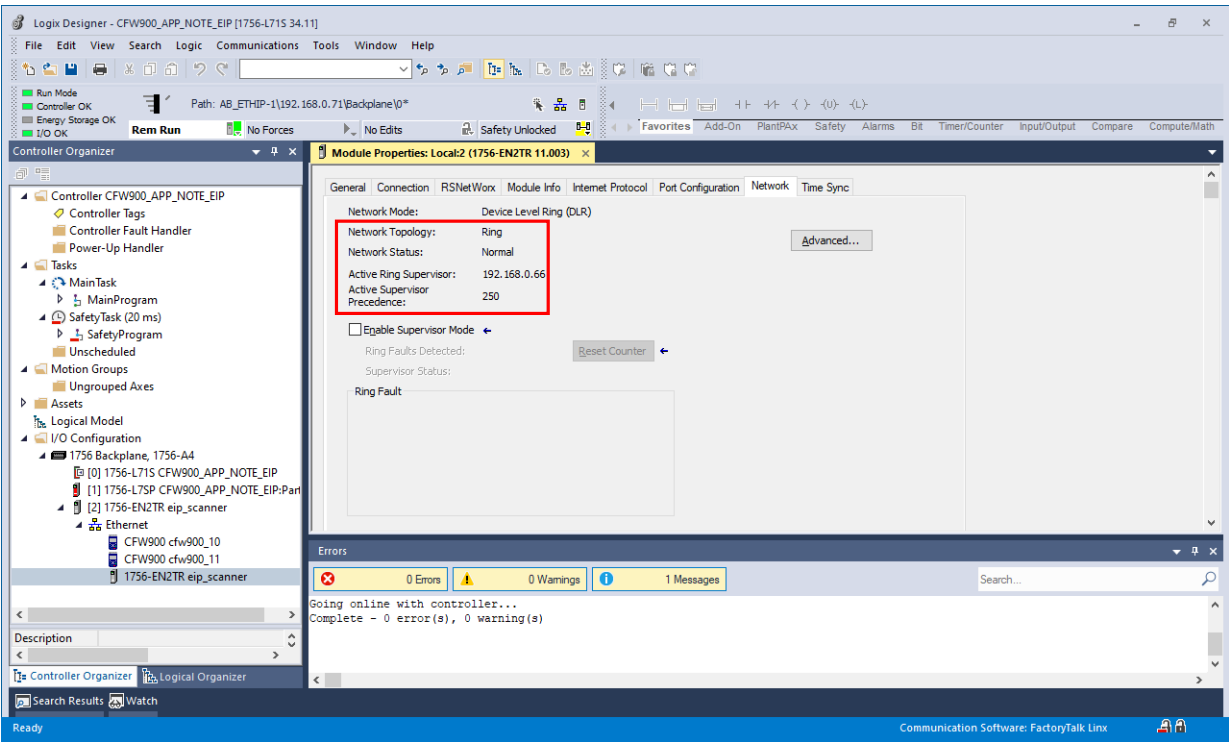


Figure 6.4: Studio 5000 Logix Designer - Back-up Supervisor





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