

**Kawasaki Robot Controller  
E Series**

**Manual for  
Cubic-S-Network  
Safety Input/Output**

**Robot**

Kawasaki Heavy Industries, Ltd.

## **PREFACE**

This manual describes the function for Cubic-S-Network safety input/output, an option for the Kawasaki Robot Controller E series. Read and understand this manual thoroughly, and take appropriate safety measures in using this product.

Together with this manual, always refer to the separate manuals: Safety Manual, Operation Manual, External I/O Manual, Installation and Connection Manual and Cubic-S Instruction Manual.

### **Intended Reader**

This manual is intended to be read by the following readers:

- One who is in charge of introducing the robot system
- One who designs the robot control system
- One who supervises the robot system
- One who conducts the maintenance of the robot system

and has proper knowledge on electric and control system and the laws and regulations concerning safety.

- 
1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damage, and/or problems relating to industrial property rights as a result of using the system.
  2. It is recommended that all personnel assigned for activation of operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
  3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
  4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
  5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different side or sold off to a different use, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.

## SYMBOLS

The items that require special attention in this manual are designated with the following symbols.

Ensure proper and safe operation of the robot and prevent physical injury or property damage by complying with the safety matters given in the boxes with these symbols.

 **DANGER**

**Failure to comply with indicated matters can result in imminent injury or death.**

 **WARNING**

**Failure to comply with indicated matters may possibly lead to injury or death.**

 **CAUTION**

**Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.**

**[ NOTE ]**

Denotes precautions regarding robot specification, handling, teaching, operation and maintenance.

 **WARNING**

- 1. The accuracy and effectiveness of the diagrams, procedures, and explanations given in this manual cannot be confirmed with absolute certainty. Should any unexplained problems arise, please contact the nearest Kawasaki office or distributor in your country.**
- 2. In order to perform every work in safety, read and fully understand this manual, all pertinent laws, regulations and related materials as well as all the safety explanations described in each chapter, and prepare safety measures and procedures suitable for actual work.**

# CONTENTS

Preface.....	1
Symbols.....	2
1.0 Notes and Cautions.....	5
1.1 Notes and Cautions for System Designing.....	5
1.2 Cautions Concerning Wiring, Maintenance Operations and Disposal of This Product .....	5
1.3 Rules and Regulations.....	5
2.0 Overview.....	6
3.0 Specifications .....	7
4.0 EtherNet/IP Network.....	8
4.1 Supported Network .....	8
4.2 EtherNet/IP Safety Paramwrwe Setting .....	8
5.0 Safety Input/Output Signal from/to Network.....	9
5.1 Safety Input Signal from Network .....	9
5.2 Safety Output Signal to Network .....	9
5.3 Allocation of Safety Input/Output Signal from/to Network .....	10
6.0 Connection Methods .....	12
6.1 Ethernet Cable Connection.....	12
6.2 Connection of Safety Input/ Output Signal to Cubic-S.....	12
7.0 Monitoring Function .....	13
7.1 Monitor of Safety Input/Output Signal from/to Network .....	13
7.2 Network Status and Module Status .....	14
8.0 Response Time .....	16
9.0 Troubleshooting.....	19
Appendix 1.0 Connecting to CIP Safety System .....	21

Appendix 1.1	Adding modules to the I/O configuration tree .....	21
Appendix 1.2	Using Module Properties and General Dialogs.....	23
Appendix 1.3	Operating the Safety Dialog.....	25
Appendix 1.4	Saving and Downloading the Module Configuration .....	27

## 1.0 NOTES AND CAUTIONS

### 1.1 NOTES AND CAUTIONS FOR SYSTEM DESIGNING

In addition to the safety precautions in Cubic-S Instruction Manual and instruction manual(s) for the safety controller, comply with the following precautions.



#### CAUTION

1. Do not use Network Status indicator and Module Status indicator displayed on teach pendant for safety use.
2. Before connecting to safety network, clear previous configuration data (safety network number etc.) which is saved in Cubic-S using safety controller setting software (RSLogix etc.).
3. Before connecting to safety network, set IP addresses of robot controller with configuration data.
4. Assign a unique safety network number (SNN) using safety controller setting software (RSLogix etc.) for each safety network or safety sub-net within a system.

### 1.2 CAUTIONS CONCERNING WIRING, MAINTENANCE OPERATIONS AND DISPOSAL OF THIS PRODUCT

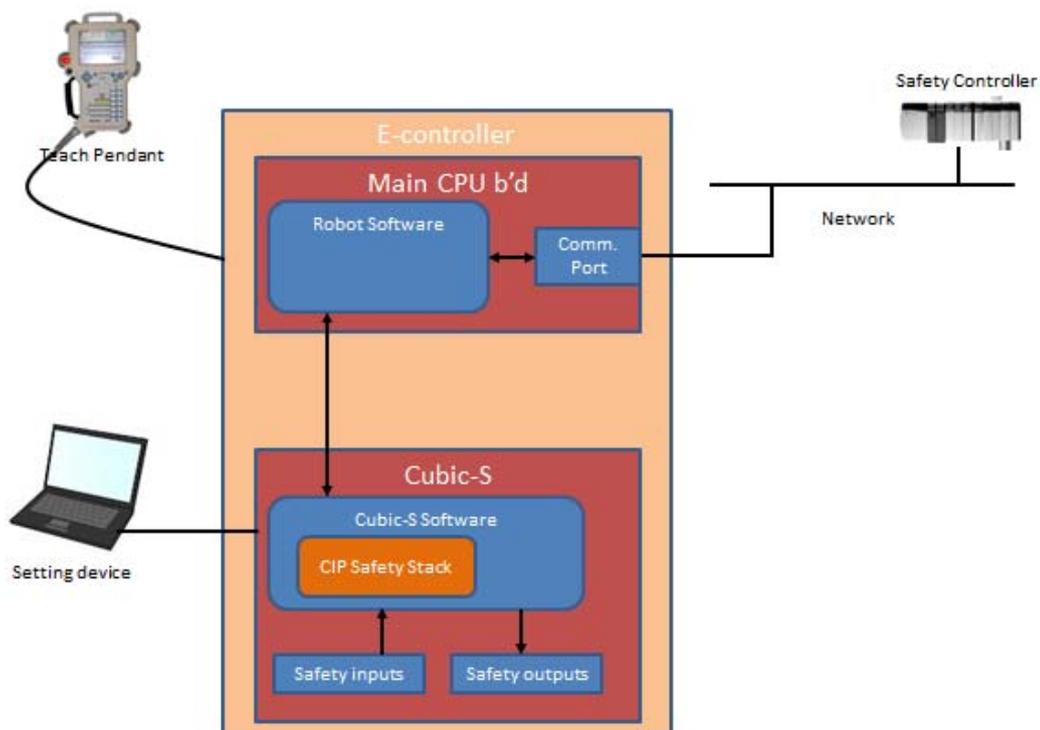
Comply with the safety precautions in Cubic-S Instruction Manual.

### 1.3 RULES AND REGULATIONS

Refer to Cubic-S Instruction Manual.

## 2.0 OVERVIEW

Function for Cubic-S-Network safety input/output uses CIP Safety stack embedded on Cubic-S and inputs/ outputs safety signals between the robot controller and the safety controller through the network.



### 3.0 SPECIFICATIONS

Item	Specification
Support Network	EtherNet/ IP Network
Safety Output to Network	Duplicated 16 channels. The duplicated logic is fixed to Equivalent.
Safety Input from Network	Duplicated 16 channels. The duplicated logic is fixed to Equivalent.
Minimum RPI	20msec

For specification and safety function of Cubic-S, refer to Cubic-S Instruction Manual.

## 4.0 ETHERNET/IP NETWORK

### 4.1 SUPPORTED NETWORK

This function supports EtherNet/IP network that is configured with Rockwell Automation, Inc.'s Guard Logix controller.

### 4.2 ETHERNET/IP SAFETY PARAMETER SETTING

Parameters setting for EtherNet/IP Safety are shown as follows.

Vender ID	601
Product Type	100
Product Code	1
Major Revision	1
Minor Revision	1
Input Assembly Instance	772
Output Assembly Instance	900
Configuration Assembly Instance	1024
Input Data Size	4 byte
Output Data Size	4 byte

## 5.0 SAFETY INPUT/OUTPUT SIGNAL FROM/TO NETWORK

### 5.1 SAFETY INPUT SIGNAL FROM NETWORK

Safety IO data (32 bits) are input to the robot controller from the safety controller which has established a safety connection. The number of safety input signals is 16 by treating a pair of bits from LSB as a signal (Duplicated).



The input from the network is treated as ON when both bits are ON and treated as OFF when both bits are OFF (Equivalent). If one bit of the input data turns OFF while the other is ON, Cubic-S detects a fault and turns OFF the input (Status indicator is turned to red). For an error reset, it is required to turn OFF the both bits once.

When a fault occurs in safety connection, “W4503 EtherNet/IP Safety) Connection is disconnected.” shows and all the network safety inputs are set to OFF.



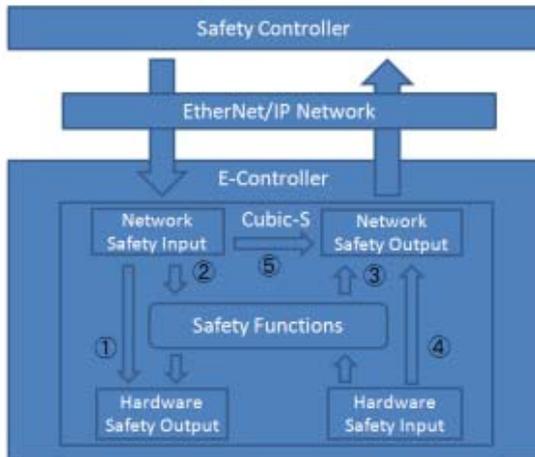
### 5.2 SAFETY OUTPUT SIGNAL TO NETWORK

The robot controller outputs safety IO data (32bits) to the safety controller which has established a safety connection. The number of safety output signals is 16 by treating a pair of bits as a signal (Duplicated). Sets both 2 bits to ON in the case of ON output, and sets both 2 bits to OFF in the case of OFF output.



### 5.3 ALLOCATION OF SAFETY INPUT/OUTPUT SIGNAL FROM/ TO NETWORK

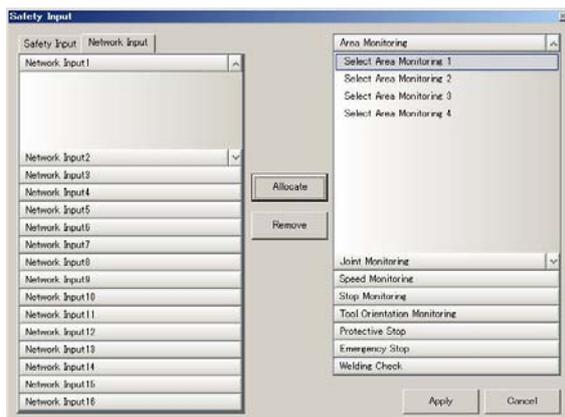
For safety input/output signals between the robot controller and the network, the following allocation is available.



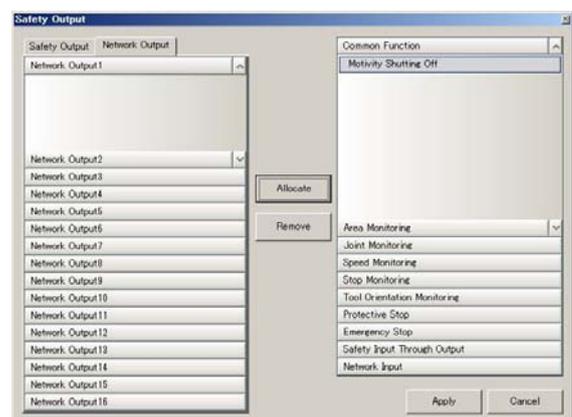
1. Allocates safety input signals from Network to hardware safety output signals (User safety output signals).
2. Allocates safety input signals from Network to safety input signals allocated to each Cubic-S Safety Function.
3. Allocates safety output signals allocated to each Cubic-S Safety Function to safety output signals to Network.
4. Allocates hardware safety input signals (Fixed safety input signals or user defined input signals) to safety output signals to Network.
5. Allocates safety input signals from Network to safety output signals to Network.

Use CS-Configurator for signal allocation. Refer to Cubic-S Instruction Manual for installation method of CS-Configurator.

Allocation of safety input signals from Network



Allocation of safety output signals to Network



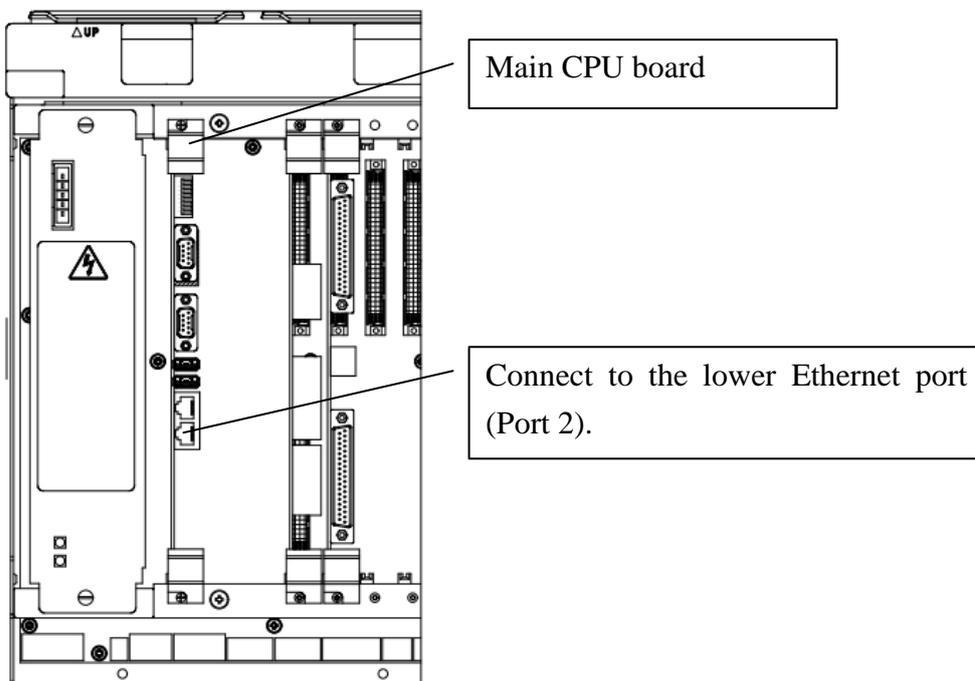
Select a port number from the left list, and select the signal name to allocate from the right list. By clicking <Allocate> button, the signal name to allocate is displayed in the left list. For removing an allocated signal, select the signal from the left list and click <Remove> button.

Before using any of the functions, confirm them using a safety controller. Regarding the method for confirming each function before use, refer to the chapter 11.2 of the Cubic-S Instruction Manual.

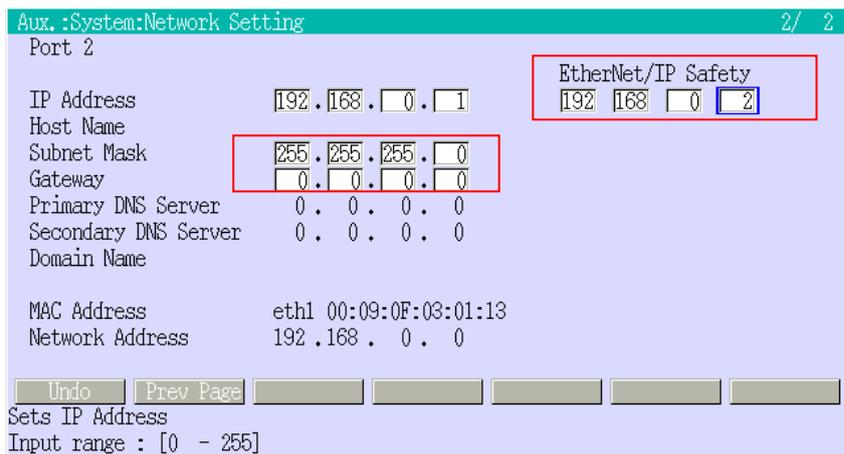
## 6.0 CONNECTION METHODS

### 6.1 ETHERNET CABLE CONNECTION

Connect to Ethernet port 2 on the main CPU board. For the Ethernet cable, use shielded cable of Category 5e or above.



Set the IP address for the Ethernet port in Aux. 0812.



After registering the IP address, turn OFF and restart the robot controller.

### 6.2 CONNECTION OF SAFETY INPUT/ OUTPUT SIGNAL TO CUBIC-S

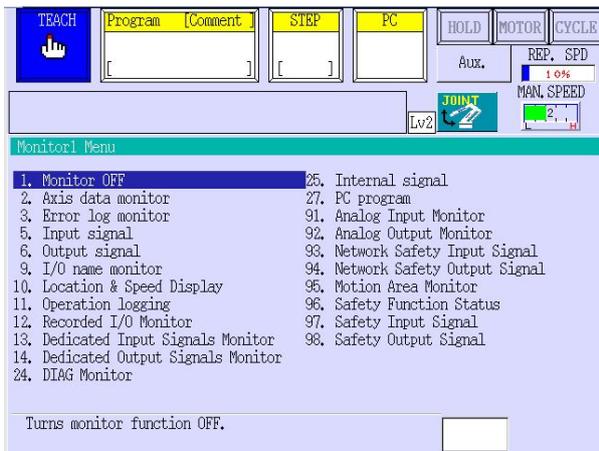
Refer to Cubic-S Instruction Manual for the connection method of safety input/output signals to Cubic-S.

## 7.0 MONITORING FUNCTION

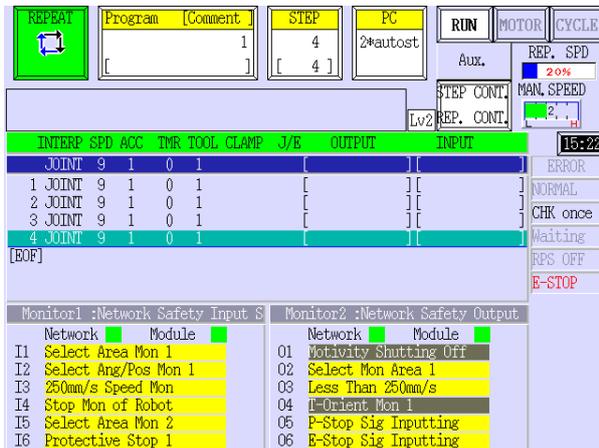
For troubleshooting, Network status, module status and input/output signal status from/ to network are able to be monitored on teach pendant screen.

### 7.1 MONITOR OF SAFETY INPUT/OUTPUT SIGNAL FROM/TO NETWORK

Display monitor menu screen from teaching screen, [93.Network Safety Input Signal] and [94.Network Safety Output Signal] is displayed.



Select [93.Network Safety Input Signal] and [94.Network Safety Output Signal], the following screen is shown.



If the safety input/ output signals are allocated to the safety input/output signals from/ to the network, the allocated signal names are displayed. The signal status is indicated by the display color.

Yellow	ON
Gray	OFF
Red	OFF ( Error status. Only for network safety input signal )

## 7.2 NETWORK STATUS AND MODULE STATUS

Network status and module status are displayed on network safety input signal monitor and network safety output signal monitor.

Monitor1 :Network Safety Input S		Monitor2 :Network Safety Output	
Network	Module	Network	Module
I1	Select Area Mon 1	01	Motivity Shutting Off
I2	Select Ang/Pos Mon 1	02	Select Mon Area 1
I3	250mm/s Speed Mon	03	Less Than 250mm/s
I4	Stop Mon of Robot	04	T-Orient Mon 1
I5	Select Area Mon 2	05	P-Stop Sig Inputting
I6	Protective Stop 1	06	E-Stop Sig Inputting

### Module status

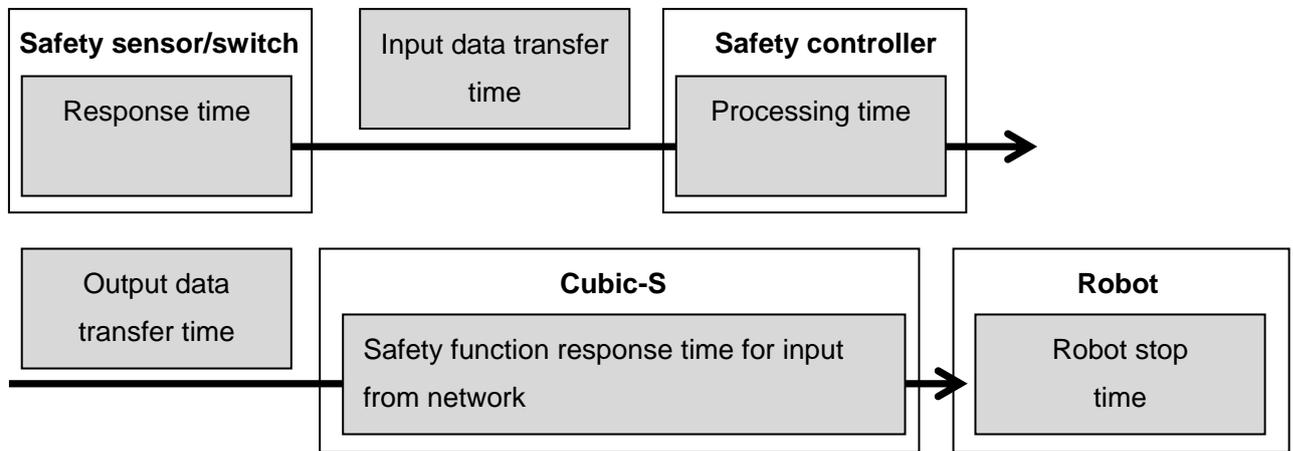
Indicator	Status	Description	Recommended Action
Solid green	Normal operation	The unit is operating normally.	None
Solid red	Unrecoverable fault	The unit detected an unrecoverable fault.	Turn controller power OFF/ON. Change the unit if fault occurs again.
Flashing red and green	Unit is unconfigured	Unit needs commissioning due to missing, incomplete, or incorrect configuration.	Reconfigure the unit.
Flashing green	Idle	Idle, waiting for connection from scanner.	Establish connection.
Flashing red	Recoverable fault	The unit has detected a recoverable fault.	Turn controller power OFF/ON

Network Status

Indicator	Status	Description	Recommended Action
Off	Unit not online	The unit does not have an IP address.	Verify your network is working properly.
Flashing green	Unit online with no connections in established state	The unit has acquired an IP address, but no connections are established.	Verify your network and unit configuration.
Solid green	Online with connections in established state	The unit is operating normally.	None.
Flashing red	One or more I/O connections in timed-out state	The unit detected a recoverable network fault.	Verify your network and unit configuration.
Solid red	Critical link failure	The unit detected an error that prevents it from communicating on the network, such as duplicate IP address has been detected.	Turn controller power OFF/ON Check network IP addressing.

## 8.0 RESPONSE TIME

1. When stopping the robot via safety sensor/ switch on network.



Response time for the whole system = Response time of safety sensor/ switch +  
Input data transfer time + Processing time of safety controller +  
Output data transfer time +  
Cubic-S safety function response time for input from network +  
Robot stop time

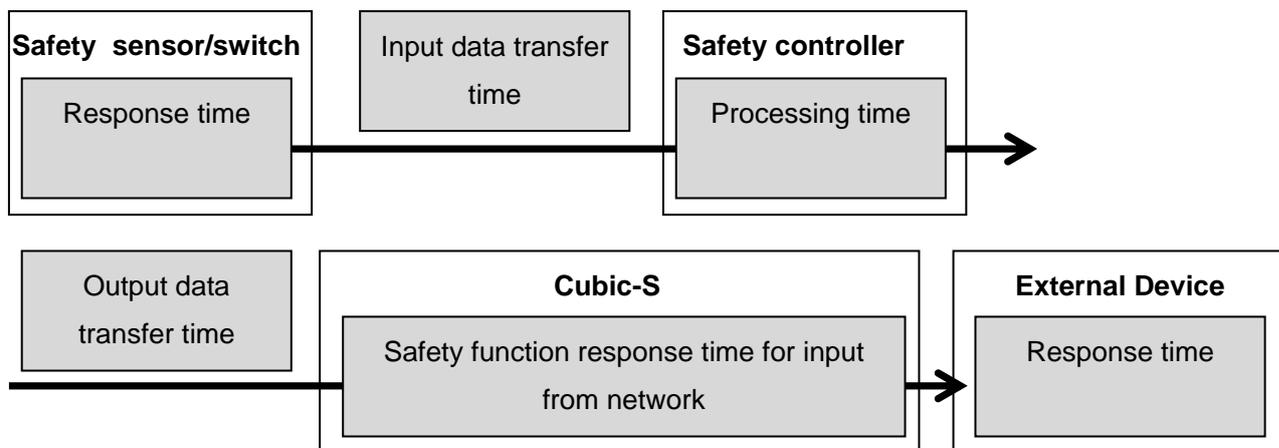
The Cubic-S safety function response time for input from network is:

Emergency stop/Protective stop, Stop category 0: 44 ms

Other safety functions (including Emergency stop/Protective stop, Stop category 1, 2): 60 ms

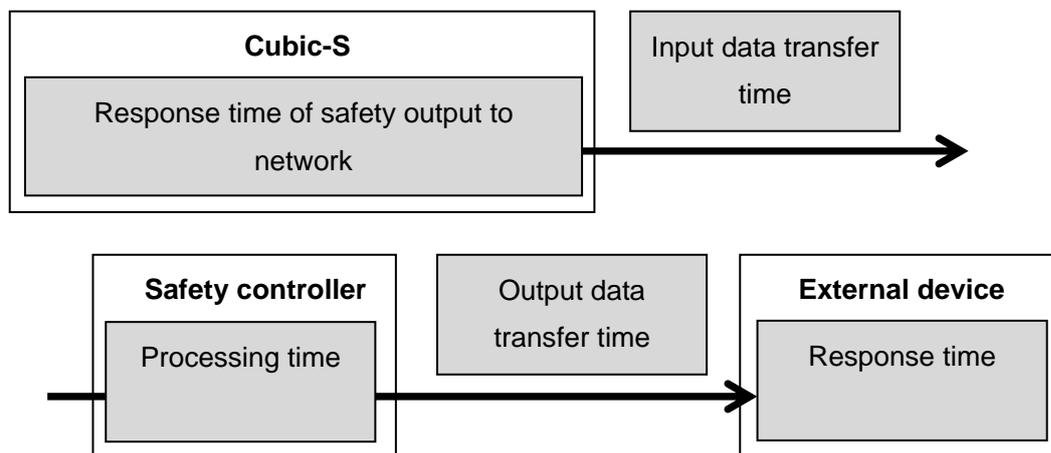
Robot stop time differs among the robot models.

2. When stopping external devices via safety sensor/ switch on network.



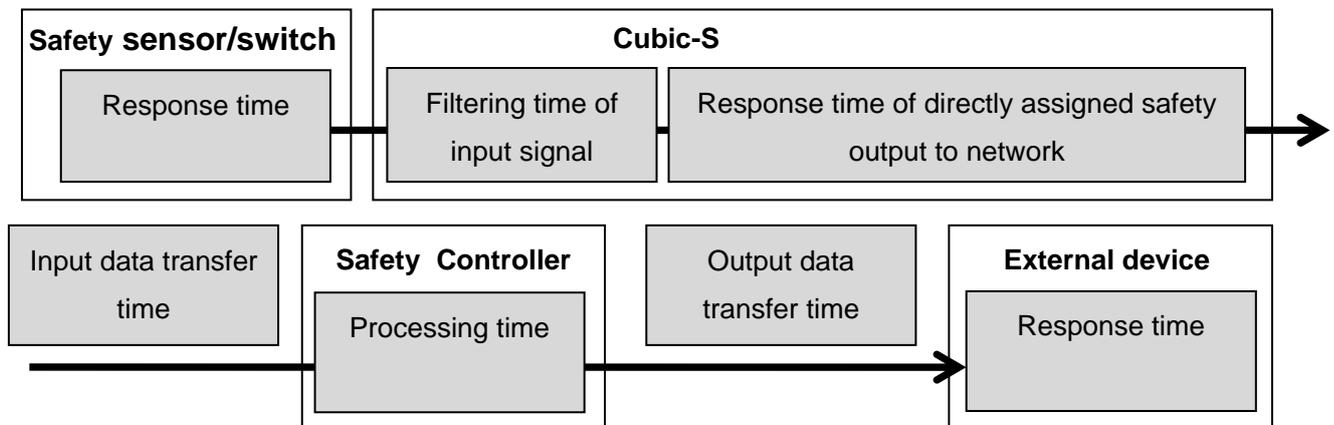
Response time for the whole system = Response time of safety sensor/ switch +  
 Input data transfer time + Processing time of safety controller +  
 Output data transfer time + Cubic-S safety function response time for input from  
 network (60 ms) +  
 Response time of external device

3. When stopping external device using the function of Cubic-S safety output to network



Response time for the whole system =  
 Cubic-S response time of safety output to network (90 ms) +  
 Input data transfer time + Processing time of safety controller +  
 Output data transfer time + Response time of external device

4. When stopping the safety external device on network with a safety sensor/ switch connected to Cubic-S.



Response time for the whole system =

= Safety sensor/ switch response time + Cubic-S filtering time of input signal+  
 Cubic-S response time of directly assigned safety output to network (72 ms) +  
 Input data transfer time + Safety controller processing time +  
 Output data transfer time + External device response time

[ NOTE ]

For the safety sensor/switch response time, safety controller processing time, external device response time, input data transfer time and output data transfer time, use values of each device.

## 9.0 TROUBLESHOOTING

Error code : D4507

Error message : EtherNet/IP Safety) Interface failed on start-up.

Error processing : Motor power OFF                      Error reset : Non-acceptable

7SEG LED display : -

### Content:

This error indicates that EtherNet/IP Safety interface failed to start up after turning motor power ON.

### Main cause:

1. The Servo software or Cubic-S version does not support EtherNet/IP Safety.
2. Defective AS software, Servo software or Cubic-S.

### Countermeasure:

When E4544 and E4545 are displayed, follow their measures.

When the errors described above are not displayed, report all details to KHI, including information of all messages, robot model, controller model, machine number, AS/servo software versions, operation at the time of error occurrence, equipped options, etc.

Error code : E4544

Error message : The Cubic-S unit doesn't support EtherNet/IP Safety.

Error processing : Motor power OFF                      Error reset : Non-acceptable

7SEG LED display : -

### Content:

This error indicates that the Cubic-S unit does not support EtherNet/IP Safety.

### Main cause:

The Cubic-S version being used does not support EtherNet/IP Safety.

### Countermeasure:

Change Cubic-S unit to one that supports EtherNet/IP Safety.

**Error code** : E4545

**Error message** : Servo software does not support EtherNet/IP Safety.

**Error processing** : Motor power OFF                      **Error reset** : Non-acceptable

**7SEG LED display** : -

**Content:**

This error indicates that the Servo software does not support EtherNet/IP Safety.

**Main cause:**

The Servo software version being used does not support EtherNet/IP Safety.

**Countermeasure:**

Change Servo software to one that supports EtherNet/IP Safety.

**Error code** : W4503

**Error message** : EtherNet/IP Safety) Connection is disconnected. (Code XX)

**Error processing** : Motor power OFF                      **Error reset** : Non-acceptable

**7SEG LED display** : -

**Content:**

This error indicates that the EtherNet/IP Safety connection is disconnected.

The code after the error message indicates the cause of the error.

01	Timeout
02	CRC Error
03	Packet Error
04	Data Error
05	Stack Error

**Main cause:**

1. Safety controller power is OFF.
2. Error occurred on EtherNet/IP network.

**Countermeasure:**

1. Check status of safety controller.
2. Check status of network.

## APPENDIX 1.0 CONNECTING TO CIP SAFETY SYSTEM

This section explains how to connect to Rockwell Automation, Inc.'s GuardLogix controller system.

Refer to the following manuals for details on GuardLogix controller system.

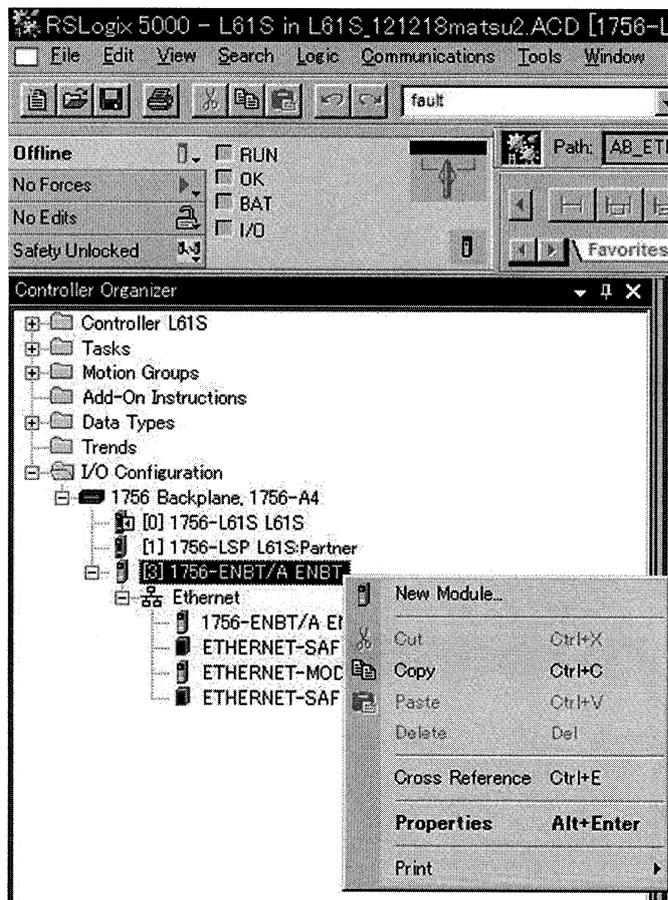
- GuardLogix controller user manual 1756-UM020\_-EN-P
- GuardLogix controller system safety reference manual 1756-RM093\_-EN-P

Configure modules with RSLogix 5000 software.

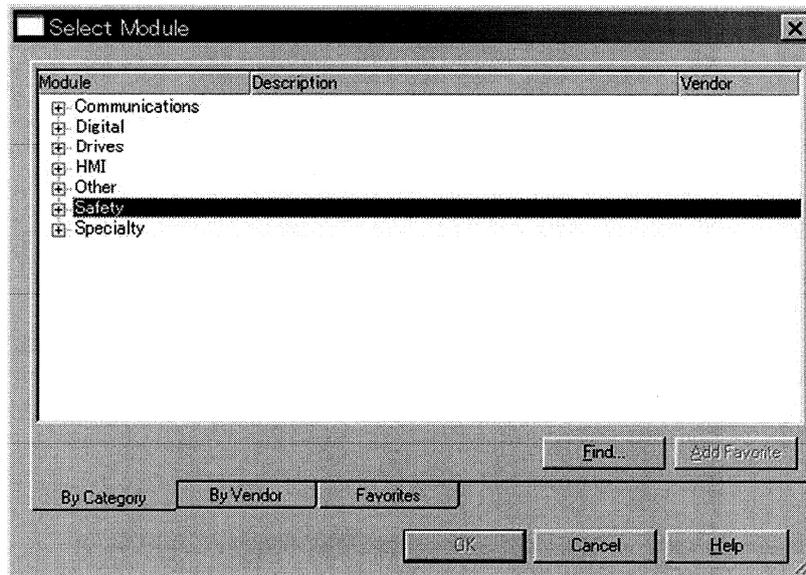
### APPENDIX 1.1 ADDING MODULES TO THE I/O CONFIGURATION TREE

To add a module to the I/O configuration tree, follow these guidelines.

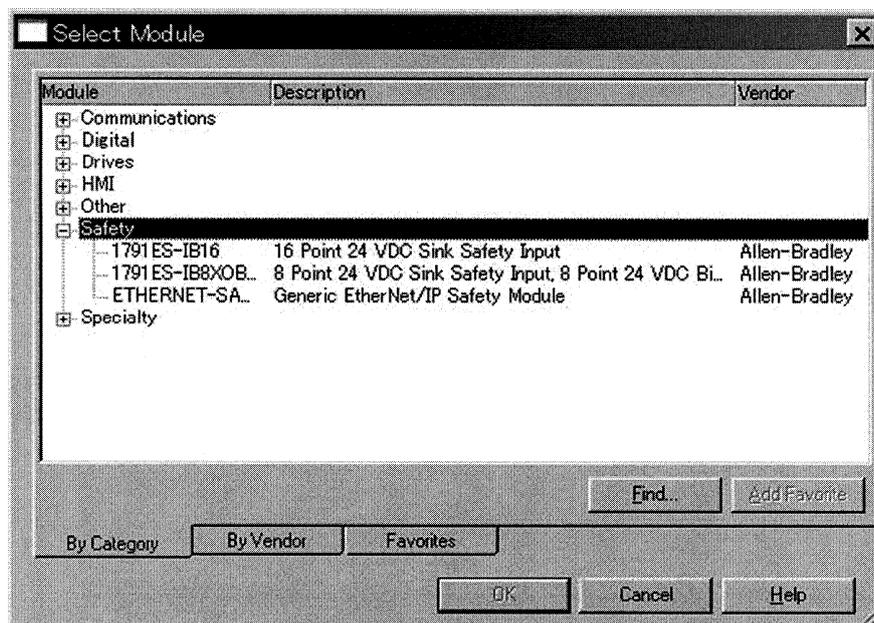
1. From the I/O Configuration tree, right-click the EtherNet Bridge module, as shown in the figure, and choose [New Module].



The Select Module dialog is displayed with a list that includes Safety.



2. From the Select Module dialog, click the <+> next to [Safety] to see a list of safety modules.

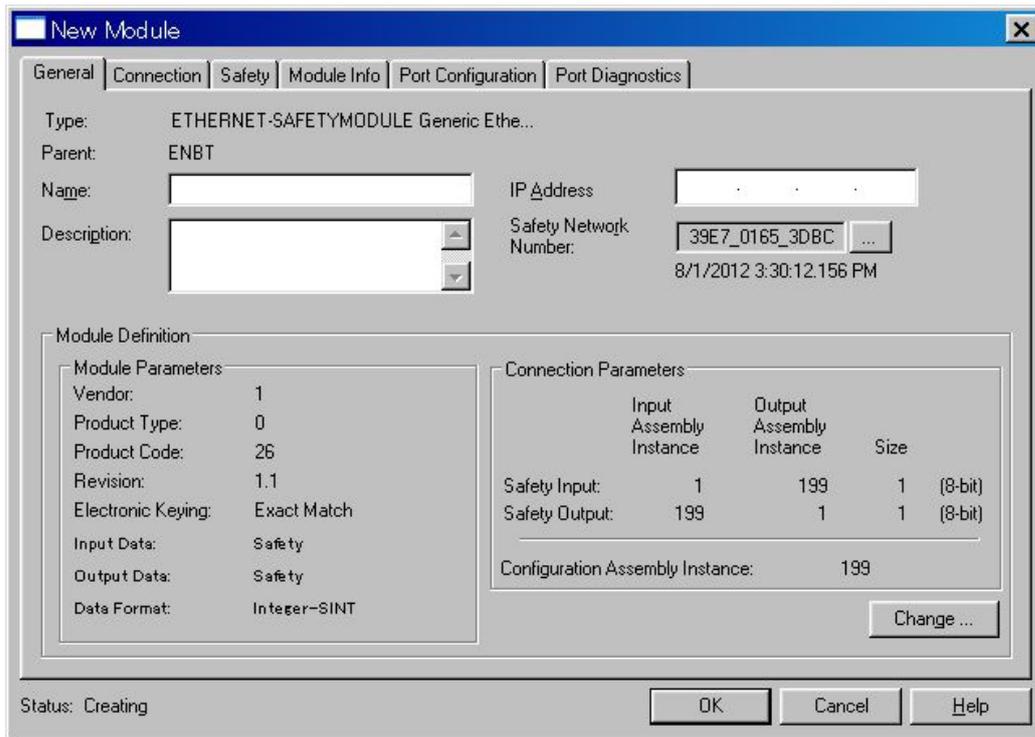


3. From the Select Module dialog, click [Generic EtherNet/IP Safety Module], and <OK> at the bottom of the dialog.

## APPENDIX 1.2 USING MODULE PROPERTIES AND GENERAL DIALOGS

Follow the procedure below to use the Module Properties and General dialogs to configure the module.

1. From the I/O configuration tree, double-click Generic EtherNet/IP Safety Module, to see the Module Properties dialog.



[Name]

For Name, type a unique name.

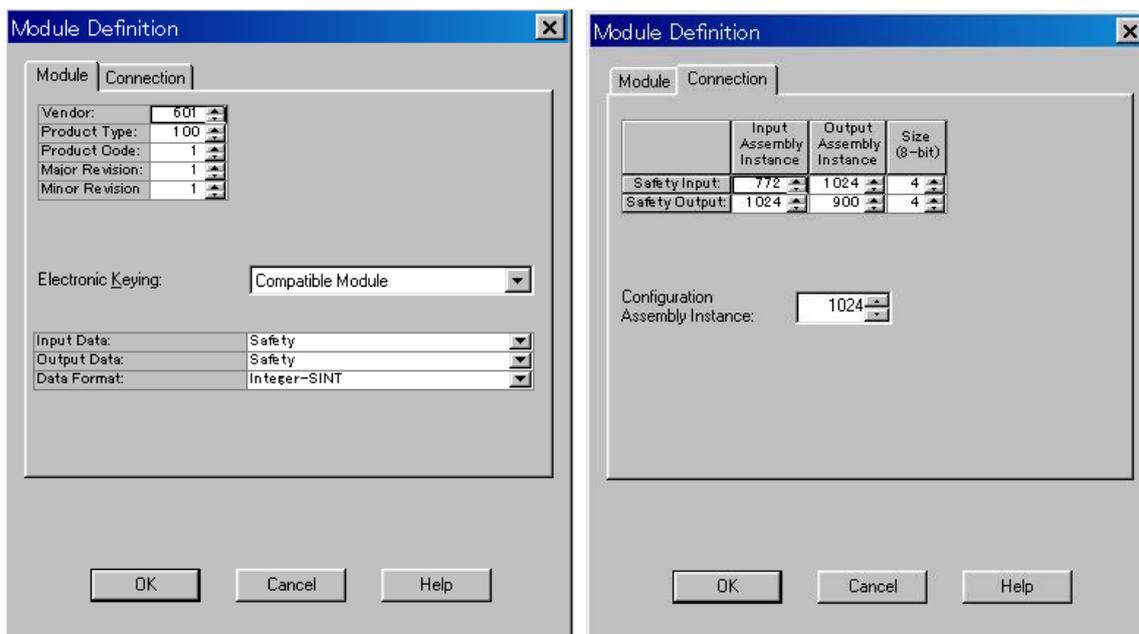
[IP Address]

For IP Address, enter the IP address of the secondary Ethernet port of main CPU board.

[Description]

For Description, if desired, type a description. For a detailed explanation of the safety network number (SNN), see the GuardLogix Controller Systems Safety Reference Manual, noting that in most cases, you use the default provided by the RSLogix 5000 software.

2. Click Change to see the Module Definition dialog.



Confirm that the settings of Module Definition dialog are as described previously in 4.2 Setting Parameters of EtherNet/IP.

- From the Module Definition dialog, select values to configure what data and status tags to generate implicitly for the safety module, noting that you can configure Input Data, Input Status, and Output Data

### Input Data Options

- Safety - Selecting Safety creates these tags for the target module.
- RunMode: Module mode
- ConnectionFaulted: Communication status
- Safety Data: Safety inputs from module

[-] SAFETY:I	{...}	{...}		AB:ETHERNET_SAFETYMODULE_8Bytes:I:0	Safety
SAFETY:I.RunMode	1		Decimal	BOOL	Safety
SAFETY:I.ConnectionFaulted	0		Decimal	BOOL	Safety
[-] SAFETY:I.Data	{...}	{...}	Decimal	SINT[4]	Safety
+ SAFETY:I.Data[0]	0		Decimal	SINT	Safety
+ SAFETY:I.Data[1]	0		Decimal	SINT	Safety
+ SAFETY:I.Data[2]	0		Decimal	SINT	Safety
+ SAFETY:I.Data[3]	0		Decimal	SINT	Safety

### Output Data Options

Choose from these options.

- None - Selecting None results in an input only connection to the module. Inputs and status are read, but no outputs are written.

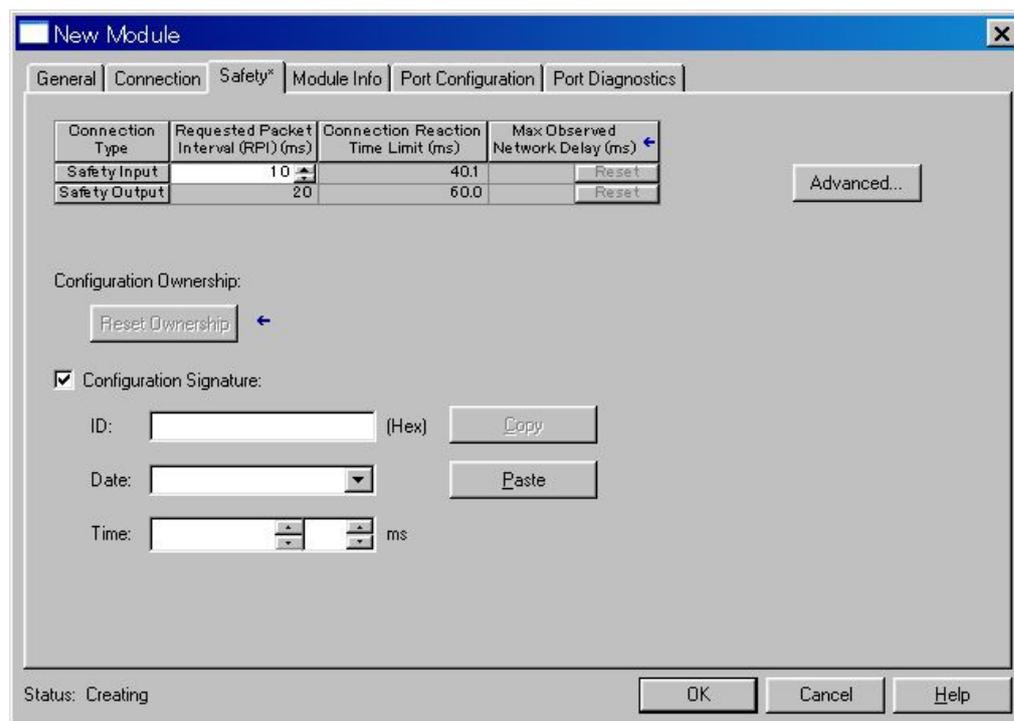
- Safety - Selecting Safety creates these safety tags and enables these outputs for use in the safety task.

[-] SAFETY:0	{...}	{...}		AB:ETHERNET_SAFETYMODULE_4Bytes:0:0	Safety
[-] SAFETY:0.Data	{...}	{...}	Decimal	SINT[4]	Safety
[+] SAFETY:0.Data[0]	0		Decimal	SINT	Safety
[+] SAFETY:0.Data[1]	0		Decimal	SINT	Safety
[+] SAFETY:0.Data[2]	0		Decimal	SINT	Safety
[+] SAFETY:0.Data[3]	0		Decimal	SINT	Safety

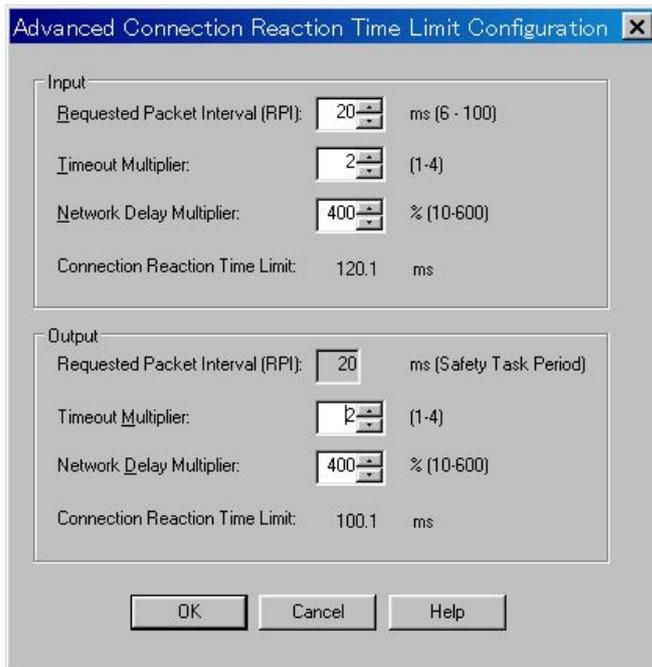
### APPENDIX 1.3 OPERATING THE SAFETY DIALOG

This section explains about how to complete entries when you click the Safety tab.

1. From the Module Properties dialog, click the Safety tab to see the Safety dialog.



2. Configure Requested Packet Interval (RPI) and Configure Connection Reaction Time Limit (CRTL) by following step 3 below.
3. From the Safety dialog, click <Advanced> to see the Advanced Connection Reaction Time Limit Configuration dialog.



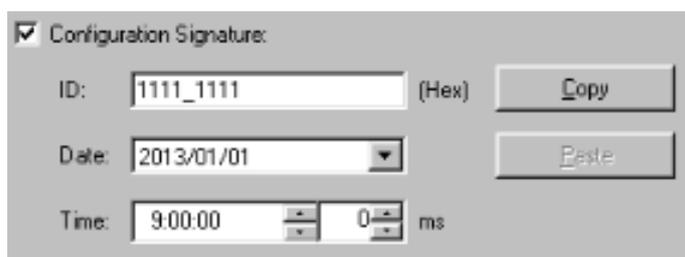
Make sure that input RPI is set to match the need. The smallest input RPI allowed is 20 ms. If the input RPI is set to under 20 ms, a timeout occurs and connection is disconnected.

4. Set Configuration Signature as below if necessary.

ID: 1111\_1111

Date/Time: 2013/01/01 0:00:00 0ms (GMT)

Date/Time needs to be adjusted to the local time. The figure below shows the example for Japan standard time.



**APPENDIX 1.4 SAVING AND DOWNLOADING THE MODULE CONFIGURATION**

We recommend you to save your work after a module is configured.

If after downloading the program the MS and NS LED indicators are not both solid green, this may be due to loss of ownership. The ownership is based on the following:

- EtherNet IP address
- Safety network number
- GuardLogix slot number
- GuardLogix safety network number
- Path from GuardLogix controller
- Configuration signature

If any of these is changed, the connection to the GuardLogix controller is lost, and the yellow yield in the RSLogix 5000 tree appears. Reset ownership to reestablish the connection using the procedure below.

1. From within RSLogix 5000 software, open the module properties.
2. Click the Safety tab.
3. From the dialog, click <Reset Ownership>.



---

Kawasaki Robot Controller E Series,  
MANUAL FOR CUBIC-S-NETWORK SAFETY INPUT/OUTPUT

---

January 2013 : 1st Edition  
July 2013 : 2nd Edition

Publication : KAWASAKI HEAVY INDUSTRIES, LTD.

90210-1284DEB

---

Copyright © 2013 KAWASAKI HEAVY INDUSTRIES, LTD. All rights reserved.