YRC1000 OPTIONS INSTRUCTIONS
FOR PROFIsafe FUNCTION
(FOR CP1616 MADE BY Siemens)

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

MOTOMAN INSTRUCTIONS
MOTOMAN-□□□ INSTRUCTIONS
YRC1000 INSTRUCTIONS
YRC1000 OPERATOR’S MANUAL (GENERAL) (SUBJECT SPECIFIC)
YRC1000 MAINTENANCE MANUAL
YRC1000 ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)

Please have the following information available when contacting Yaskawa Customer Support:
- System
- Primary Application
- Software Version (Located on Programming Pendant by selecting: {Main Menu} - {System Info} - {Version})
- Robot Serial Number (Located on robot data plate)
- Robot Sales Order Number (Located on controller data plate)

Part Number: 179326-1CD
Revision: 0

MANUAL NO. HW1483862
DANGER

• This manual explains the PROFIsafe function of the YRC1000 system (CP1616 made by Siemens). Read this manual carefully and be sure to understand its contents before handling the YRC1000. Any matter, including operation, usage, measures, and an item to use, not described in this manual must be regarded as “prohibited” or “improper”.

• General information related to safety are described in “Chapter 1. Safety” of the YRC1000 INSTRUCTIONS. To ensure correct and safe operation, carefully read “Chapter 1. Safety” of the YRC1000 INSTRUCTIONS.

CAUTION

• In some drawings in this manual, protective covers or shields are removed to show details. Make sure that all the covers or shields are installed in place before operating this product.

• YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.

NOTICE

• The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.

• YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.

• If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the YRC1000.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

DANGER
Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

WARNING
Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

CAUTION
Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

NOTICE
NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

Even items described as “CAUTION” may result in a serious accident in some situations.

At any rate, be sure to follow these important items.

NOTE
To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, “WARNING” and “CAUTION”.
### NOTICE

- To prevent a board failure, use and store the board in the proper installation environment. ¹)

1) The allowable range for the ambient temperature when using the board in the YRC1000 is shown below.
   - +5°C to +45°C (during operation)
   - -10°C to +60°C (during transportation and storage)

For specific installation environment requirements other than those listed above, refer to the YRC1000 INSTRUCTIONS (RE-CTO-A221).
Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

- Press the emergency stop buttons on the front door of the YRC1000, on the programming pendant, on the external control device, etc.
- Disconnect the safety plug of the safety fence. (when in the play mode or in the remote mode)

If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

Failure to observe this instruction may result in personal injury caused by unintended manipulator movement.

Observe the following precautions when performing a teaching operation within the P-point maximum envelope of the manipulator:

- Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
- View the manipulator from the front whenever possible.
- Always follow the predetermined operating procedure.
- Always keep in mind emergency response measures against the manipulator’s unexpected movement toward a person.
- Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may result in personal injury caused by improper or unintended manipulator movement.

Confirm that no person is present in the P-point maximum envelope of the manipulator and that the operator is in a safe location before:

- Turning ON the YRC1000 power
- Moving the manipulator by using the programming pendant
- Running the system in the check mode
- Performing automatic operations

Injury may result if any person should enter the P-point maximum envelope of the manipulator during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop buttons are located on the front panel of the YRC1000 and on the right of the programming pendant.

Read and understand the Explanation of the Warning Labels before operating the manipulator.

1 Every time after the YRC1000 power is turned ON
<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Do not touch the inside of the panel for 5 minutes after the power is turned OFF. The remaining charged voltage in the capacitor may cause an electric shock or an injury.</td>
</tr>
<tr>
<td>• Be sure to close the door and install the protection cover while the power is turned ON. Failure to observe this warning may result in a fire or an electric shock.</td>
</tr>
<tr>
<td>• Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.</td>
</tr>
<tr>
<td>– Check for problems in manipulator movement.</td>
</tr>
<tr>
<td>– Check for damage to insulation and sheathing of external wires.</td>
</tr>
<tr>
<td>• Always return the programming pendant to the hook on the cabinet of the YRC1000 after use.</td>
</tr>
<tr>
<td>If the programming pendant is left unattended on the manipulator, on a fixture, or on the floor, the Enable Switch may be activated due to surface irregularities of where it is left, and the servo power may be turned ON. In addition, in case the operation of the manipulator starts, the manipulator or the tool may hit the programming pendant left unattended, which may result in personal injury and/or equipment damage.</td>
</tr>
<tr>
<td>• The wiring and mounting must be performed by authorized and qualified personnel. Failure to observe this caution may result in fire or electric shock.</td>
</tr>
</tbody>
</table>
**CAUTION**

- Make sure that there is no foreign matter such as metal chips on the board.
  In case of malfunction, etc. it may result in an injury or damage the board.
- Make sure that there is no damage or deflection of parts on the board.
  In case of malfunction, etc. it may result in an injury or damage the board.
- Correctly connect each cable and connector.
  Failure to observe this caution may result in a fire or damage the board.
- Set the switches, etc. correctly.
  Malfunction, caused by an incorrect setting, may result in an injury or damage the board.
- Never touch the soldered surfaces of the board directly with fingers.
  Protrusions on the soldered surface may result in an injury.

**NOTICE**

- Never touch the mounting surfaces of the board parts directly with fingers.
  The generated static electricity may damage the IC.
- No shock to the board.
  The shock may damage the board.
Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the controller, the programming pendant, and supply cables.

In this manual, the equipment is designated as follows.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>YRC1000 controller</td>
<td>YRC1000</td>
</tr>
<tr>
<td>YRC1000 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>
Descriptions of the programming pendant keys, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Pendant</td>
<td></td>
</tr>
<tr>
<td>Character Keys /Symbol Keys</td>
<td>The keys which have characters or symbols printed on them are denoted with []. e.g. [ENTER]</td>
</tr>
<tr>
<td>Axis Keys /Numeric Keys</td>
<td>[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td>Keys pressed simultaneously</td>
<td>When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, e.g. [SHIFT]+[COORD].</td>
</tr>
<tr>
<td>Mode Switch</td>
<td>Mode Switch can select three kinds of modes that are denoted as follows: REMOTE, PLAY or TEACH. (The switch names are denoted as symbols)</td>
</tr>
<tr>
<td>Button</td>
<td>The three buttons on the upper side of the programming pendant are denoted as follows: START, HOLD, or EMERGENCY STOP. (The button names are denoted as symbols)</td>
</tr>
<tr>
<td>Displays</td>
<td>The menu displayed in the programming pendant is denoted with {}. e.g. {JOB}</td>
</tr>
</tbody>
</table>

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![Programming Pendant Diagram](image.png)

- Start button
- Hold button
- Mode switch
- Emergency stop button
- Page key
- Coordinate key
- Axis keys
- Shift key
- Enter key

*The button/switch names are denoted as symbols.*
Description of the Operation Procedure

In the explanation of the operation procedure, the expression “Select • • •” means that the cursor is moved to the object item and [SELECT] is pressed, or that the item is directly selected by touching the screen.

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or brand names for each company or corporation. The indications of (R) and TM are omitted.
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  1.2 Virtual Communication Function ....................................................................... 1-3

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1 Outline

This instruction manual describes settings and other information required for the PROFIsafe communication using the PROFINET board CP1616 (made by Siemens, hereinafter referred to as CP1616).

The use of the CP1616 enables safety signals to be transferred to and from the safety PLC, and the safety signals can be used for the I/O signals of the safety logic circuit and for switching the condition files of functional safety.

**NOTE**

The PROFIsafe function is available with software version YAS3.00.00A-00 and later.

**NOTE**

The CP1616 has multiple firmware versions.

For the PROFIsafe function, use a CP1616 with firmware version V.2.8.1.0.

**NOTE**

First read the safety manuals and instruction manuals provided by the safety PLC manufacturer and carefully follow all instructions in those manuals. This manual describes communication settings of the CP1616 board using Siemens "TIA Portal" application software and the optional software "STEP 7 Safety". When using other software, refer to the manuals provided by the manufacturers.

1.1 System Configuration

The safety PLC will be the F-Host that is the master station for PROFIsafe communication. The YRC1000 safety circuit board will be the F-Device that is a slave station.

The CP1616 relays data between the F-Host and the F-Device as the IO device for PROFINET communication. In addition, the IO controller, which is the master station for PROFINET communication, usually functions within the safety PLC that is the F-Host.

![Diagram of System Configuration](image)
1 Outline
1.1 System Configuration

NOTICE
Check the function and wiring of safety signals when the robot system is commissioned.

NOTE
When changes are made that affect the ON/OFF state of safety signals in the YRC1000 or safety PLC (e.g., changes to safety logic circuits, changes to the safety ladder program, or changes to the definitions of the ON/OFF state of safety signals), always check that the robot system operates correctly before using it.
1.2 Virtual Communication Function

Use the virtual communication function when communication cannot be established with the safety PLC, such as during commissioning of the safety system. When the system is set to virtual communication, the robot can be operated without generating errors in communication with the safety PLC.

The setting status of virtual communication can be checked using concurrent I/O and outputting that status to an external indicator (e.g., LED or signal tower).

- Virtual communication can be set only when the security mode is safety mode. For how to set virtual communication, refer to step 6 of chapter 4.2.1 "I/O Device Settings".

- Communication error alarms will not occur after virtual communication is set and the system is started in online mode (normal mode) if the safety PLC and YRC1000 are not connected. However, if the safety PLC and YRC1000 are connected and communication is established, virtual communication will end automatically and safety communication (the exchange of safety signals between the safety PLC and YRC1000) will be started.

- During operation in safety communication, the communication mode cannot be switched to virtual communication.

- During operation in virtual communication, the values of the safety input signals received by the YRC1000 from the safety PLC and the values of safety output signals sent by the YRC1000 to the safety PLC are all 0. When virtual communication is set, create the conditions files that will be used in safety logic circuits and function safety (e.g., robot movement range limit function) by taking into consideration that all safety input signals and safety output signals are 0.

- During operation in virtual communication, the "Safety Fieldbus: It is operating in Virtual Communication mode." message is displayed on the screen of the programming pendant and control status signal #80515 is 0 (0: in virtual communication mode, 1: in safety communication mode). Control status signal #80515 can also be output with concurrent I/O to an external indicator so that the setting status of virtual communication can be checked.
DANGER

During operation in virtual communication, safety input and output signals are not exchanged between the safety PLC and YRC1000. Therefore, if playback operation is performed when virtual communication is set, there is a risk of serious accident because the safety functions will be impaired.

When using the virtual communication function, conduct a full risk assessment for the entire robot system and consider measures to ensure safety.
2 Hardware Specifications

Refer to "YRC1000 OPTIONS INSTRUCTIONS FOR PROFINET COMMUNICATIONS FUNCTION (FOR CP1616 MADE BY Siemens) (Manual No.:HW1483860)" for the information on the CP1616 hardware specifications.
3 Attaching of the Board

Refer to “YRC1000 OPTIONS INSTRUCTIONS FOR PROFINET COMMUNICATIONS FUNCTION (FOR CP1616 MADE BY Siemens) (Manual No.:HW1483860)” for how to attach the CP1616.

NOTE

When the CP1616 is used for the PROFIsafe communication, make sure to insert the CP1616 into option slot 1 of the riser card (JANCD-ABB03-E or JANCD-ABB04-E).

The CP1616 cannot operate correctly if inserted into option slot 2.
4 Setting of the Board

4.1 CP1616 Communication Settings

To perform the CP1616 communication settings, it requires the setting tool made by Siemens.

This section explains the setting method using the setting tool "TIA Portal" on which the STEP 7 Safety software is installed. The version of the software to use is shown next.

- TIA Portal: V15.1 Update 2
- STEP 7 Professional: V15.1 Update 2
- STEP 7 Safety: V15.1

Refer to the instruction manual of TIA Portal for more information on the setting method.

**NOTICE**

The procedures described in this manual contain only the setting methods, and safety countermeasures are not covered at all. The operator should carefully read the instruction manuals and other materials provided from the manufacturer of the safety PLC and setting tool, fully understand the contents of those instruction manuals and other materials before performing this procedure, and implement safety countermeasures as necessary.

4.1.1 Network Interface Settings

In order to access to the devices, such as the CP1616 and the PLC, from the PC on which TIA Portal is installed, it requires the PC network interface settings.

1. Start TIA Portal.
2. Select {Project view} - {Options} - {Settings} - {Online & diagnostics} - {Default connection path for online access} to display the following dialogue.
3. Select the network interface of the PC to be used from the {PG/PC interface:}.

For the network interface selected at this step, an optional fixed IP address must be set. When the IP address of the selected network interface is allocated automatically by DHCP, the PC cannot access to the devices such as the CP1616 and the PLC.

### 4.1.2 IO Device Settings

1. Connect the PC with TIA Portal installed to the CP1616 with the PROFINET cable, and then turn ON the YRC1000 pressing {MAIN MENU}.

2. Start TIA Portal, and then select {Create new project}.

3. On the Create new project window, enter the project name and the path to the project, and then select {Create}.
4. When the project is created, select {Project view}.

5. When the project opens, select {Add new device} on the menu.
4 Setting of the Board
4.1 CP1616 Communication Settings

6. Select {PC systems} - {PC general} - {PC station} from the device list.

7. Select {Device view} from the menu on the PC station window.
4 Setting of the Board
4.1 CP1616 Communication Settings

8. Select {Communications modules} - {PROFINET/Ethernet} - {CP1616} - {6GK1 161-6AA02} - {Version V2.8} from the catalog list, and then drag and drop it on the first slot of the added station.

9. Select {Network view} from the menu on the PC station window.
4 Setting of the Board
4.1 CP1616 Communication Settings

10. Open the CP1616 properties. Select the {IO device} check box for {PROFINET interface(X1)} - {Operating mode}.

11. Select the {Parameter assignment of PN interface…} check box. Set the {PROFIsafe norm} item to "V2.6.1".
4. Setting of the Board
4.1 CP1616 Communication Settings

12. Select {PROFINET interface(X1)} - {Operating mode} - {I-device communication}, and then set the communication data and safety IO signal sizes (safety IO size).

13. Select {PROFINET interface(X1)} - {Ethernet addresses}, select {IP address is set directly at the device} for {IP protocol}, so that the IP address and device name can be set for the CP1616 in chapter 4.1.3 “Device name and IP address Settings”, and then select the {PROFINET device name is set directly at the device} check box for {PROFINET}.

**NOTE**

Set the {Type} item to "F-PS".
Set the {Length} item to "1 Byte" to "8 Byte". Set input and output to the same values.
14. Set the vendor information. Select the {Enable customization} check box for {General} - {Catalog information} - {Customization}, and then configure the following settings.

PROFINET vendor ID: 213
PROFINET Device ID: 503
Article number: YRC PROFI CP1616
Product family: SIMATIC PC-CP
Vendor name: YASKAWA Electric Corporation
Product name: PROFIsafe-CP1616
Clear the {Export software version} check box.
15. Save and compile the settings. Right-click {PC station} on the project tree, and then execute {Compile} - {Hardware (rebuild all)} and {Compile} - {Software (rebuild all)}.

16. Download the compiled project to the CP1616. Right-click {PC station} on the project tree, and then execute {Download to device} - {Hardware configuration}.
4 Setting of the Board
4.1 CP1616 Communication Settings

17. Open {Network view}. Open the CP1616 properties, and then click {PROFINET interface(X1)} - {Operating mode} - {I-device communication} - {Export generic station...} - {Export} to create the GSD file.

4.1.3 Device name and IP address Settings

In order to use the CP1616 as an IO device, a device name and IP address must be set for the CP1616.

1. Connect the PC with TIA Portal installed to the CP1616 with the PROFINET cable, and then turn ON the YRC1000 while pressing {MAIN MENU}.

2. Start TIA Portal, and then select {Online & Diagnostics} - {Accessible devices}. Click {Start search} to detect the CP1616, and then click {Show} to display the CP1616 settings window.
4. Setting of the Board

4.1 CP1616 Communication Settings

3. Select {Functions} - {Assign IP address}, set the IP address, and then click {Assign IP address}.

4. Select {Functions} - {Assign PROFINET device name}, set the device name, and then click {Assign name}.
4. Setting of the Board
4.1 CP1616 Communication Settings

4.1.4 F-Host (IO Controller) Settings

When setting the F-Host, the CP1616 GSD file is necessary.

Configure the CP1616 settings and create the CP1616 GSD file according to chapter 4.1.2 "IO Device Settings".

This section explains how to set the F-Host when using the safety PLC "CPU1516F-3 PN/DP" made by Siemens as the F-Host, as an example.

When using an equipment not made by Siemens as the F-Host, refer to the instruction manual for each equipment.

1. Start TIA Portal.
2. Perform the step 1 to step 4 in chapter 4.1.2, create a new project, and open Project View.
3. Select {Options} - {Manage general station description files (GSD)}.
   Enter the path that holds the CP1616 GSD file in "Source path", and then select the check box of the GSD file to install. Click "Install" to add the GSD file to the hardware catalog.
4. Setting of the Board

4.1 CP1616 Communication Settings

4. Select {Devices & networks} on the project tree.

5. Select the F-Host (CPU 1516F-3 PN/DP) to use from the catalog list, and then drag and drop it on the network.
6. Add the CP1616 (IO device) as follows.
Select the version (GSD file name) that was installed in step 3 from {PROFIsafe-CP1616} under {Other field devices} - {PROFINET IO} - {PLCs & CPs} - {YASKAWA Electric Corporation} - {SIMATIC PC-CP} catalog list, and then drag and drop it on the network.
If there are multiple GSD files, select the GSD file to use from the "Version" list.

7. Set the F-Host network.
Open Device view for the CPU 1516F-3 PN/DP, and then open the PLC properties.
Click (PROFINET interface[X1]) - (Ethernet addresses) - (Interface networked with) - (Add new subnet) to add a network.
8. Enter the IP address and device name to assign to the CPU 1516F-3 PN/DP.
To change the device name, clear the {Generate PROFINET device name automatically} check box, and then enter the device name in {PROFINET device name:}.

9. Set the IO device network.
Open Device view for the CP1616, and then open the CP1616 properties.
Set {subnet:} for {PROFINET interface[X1]} - {Ethernet addresses} - {Interface networked with} to the subnet that was added in step 7.
Enter the IP address and device name as well.
To change the device name, clear the {Generate PROFINET device name automatically} check box, and then enter the device name in {PROFINET device name:}. 
10. Set the parameters (F-Parameter) for IO device safety communication. Select the name of the transfer area that was set in step 12 of chapter 4.1.2 “IO Device Settings” (ps_8) here, and then open the safety IO signal properties. Set the parameters for safety communication with the (PROFIsafe) items.

The details of the parameters to edit are shown below. Make settings according to the environment.

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
<th>Initial Value</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>F_SIL</td>
<td>Safety level guaranteed by the YRC1000</td>
<td>SIL3</td>
<td>SIL3</td>
</tr>
<tr>
<td>F_CRC_Length</td>
<td>Length of CRC to be added to the safety data</td>
<td>4-Byte-CRC</td>
<td>4-Byte-CRC</td>
</tr>
<tr>
<td>F_Block_ID</td>
<td>Whether to set iParameter or not.</td>
<td>1: Can be set</td>
<td>1: Can be set</td>
</tr>
<tr>
<td>F_Par_Version</td>
<td>Version of the F-Parameter</td>
<td>1: V2-mode</td>
<td>1: V2-mode</td>
</tr>
<tr>
<td>F_Source_Add</td>
<td>Address set for the F-Host (safety PLC)</td>
<td>1</td>
<td>1 to 65534</td>
</tr>
<tr>
<td>F_Dest_Add</td>
<td>Address set for the F-Device (YRC1000)</td>
<td>1</td>
<td>1 to 65534</td>
</tr>
<tr>
<td>F_Passivation</td>
<td>Availability of support for Channel-granular Passivation (CGP)</td>
<td>Device/ Module: No support</td>
<td>Device/ Module: No support</td>
</tr>
<tr>
<td>F_CRC_Seed</td>
<td>Creation method of CRC to be added to the safety data</td>
<td>CRC-SeedException24/32: CRC-FP+/MNR</td>
<td>CRC-SeedException24/32: CRC-FP+/MNR</td>
</tr>
<tr>
<td>F_WD_Time</td>
<td>Allowable value for the communication response time between the safety PLC and the YRC1000 (Unit: millisecond)</td>
<td>150</td>
<td>1 to 10000</td>
</tr>
<tr>
<td>F_iPar_CRC</td>
<td>CRC value to be added to iParameter</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>F_Par_CRC</td>
<td>CRC value to be calculated from F-Parameter</td>
<td>-</td>
<td>0 to 65535</td>
</tr>
</tbody>
</table>
11. Set the parameters (F-Parameter) for F-Host safety communication.
   Open Device view for the CPU 1516F-3 PN/DP, and then open the PLC properties.
   Set the following parameters for {Fail-safe} - {F-parameters}.
   High limit for F-destination addresses: 65534
   Central F-source address: Value set for F_Source_Add in step 10

   ![Device Properties](image)

   • If {PROFIsafe norm} was set to "V2.6.1" in step 11 of chapter 4.1.2 "IO Device Settings", F_CRC_Length is fixed to "4-Byte-CRC".
   • The value of F_CRC_Length must be the same as the size of F_CRC_Length set in step 6 of chapter 4.2.1 "IO Device Settings".
   • The value of F_Src_Add must be the same value as Central F-source address set in step 11 of this section.
   • The value of F_Dest_Add must be the same value as F_Dest_Address set in step 6 of chapter 4.2.1.
   • Always set F_iPar_CRC to "1".

12. Connect the CP1616 and F-Host.
   Open {Network view}, right-click {Not assigned} for the IO device, select {Assign to new...}, and then set the connection destination.

   ![Network Configuration](image)
4. Setting of the Board
4.1 CP1616 Communication Settings

13. Download the error program (OB: Organization Block), which is executed when an error occurs, to the IO controller. For example, in order to enable the ability to restore from a communication error such as a disconnection, create and download OB86 to the IO controller. For the details of the organization block, refer to the instructions of TIA Portal.

Select {PLC} - {Program blocks} - {Add new block} - {Organization block} - {Rack or station failure} from the project tree in TIA Portal to create OB86.

**NOTE**
When establishing communication between the F-Host and F-Device, a reintegration operation may be required to recover the passivation state of the F-Device.

For how to create and use a ladder program for reintegration, refer to chapter 7.2 “Reintegration”.
14. Save and compile the settings. Right-click the station name on the project tree, and then execute {Compile} - {Hardware (rebuild all)} and {Compile} - {Software (rebuild all)}.

15. Download the compiled project to the CP1616. Right-click {PC station} on the project tree, and then execute {Download to device} - {Hardware configuration} and {Download to device} - {Software (all)}.
4 Setting of the Board
4.2 Maintenance Mode Settings

4.2 Maintenance Mode Settings

4.2.1 IO Device Settings

To perform these settings, first install the CP1616 to use with PROFIsafe communication in option slot 1 of the riser card (JANCD-ABB03-E or JANCD-ABB04-E), and then change the security mode to the safe mode.

If the CP1616 is not installed or the YRC1000 is in the operation mode or in the editing mode, the settings cannot be performed.

To use the CP1616 for the YRC1000 PROFIsafe communication, the option board and I/O module settings must be performed using the following steps.

1. Turn the power supply ON again while pressing {Main Menu} simultaneously.
   - The maintenance mode is displayed.

2. Change the security mode to the safety mode.

3. Select {SYSTEM} under the main menu.
   - The sub menu is displayed.
4 Setting of the Board

4.2 Maintenance Mode Settings

4. Select {SETUP}.
   – The SETUP window is displayed.

5. Select “OPTION BOARD”.
   – The option board window is displayed.

6. Select “CP1616”.
   – The CP1616 setting window is displayed.
4 Setting of the Board
4.2 Maintenance Mode Settings

– (Description of each setting item)

(1) CP1616
Set whether the CP1616 will be used.
Switch between "USED" and "NOT USED" with each selection.

(2) IO SIZE
The IO size is automatically calculated if the IO size (IN/OUT) is set on
the IO controller or the IO device window.

(3) IO Controller
Perform the IO Controller settings.

(4) IO Device
Perform the IO Device settings.

(5) ALARM AT INITIALIZE ERROR
If this communication settings are not performed using the procedures
in chapter 4.1 “CP1616 Communication Settings”, the initializing pro-
cess of the CP1616 at the start of the YRC1000 will be terminated
abnormally.
In this setting item, set whether the alarm which indicates that the
abnormal termination of initializing process occurs will be displayed on
the window.

(6) PROFIsafe
Set whether to use the safety communication using PROFIsafe.
The setting of this item cannot be changed. (Fixed to "USED".)

(7) SAFETY IO SIZE
Set the safety IO signal size used for the PROFIsafe communication in
the range of 1 to 8 bytes.
Set the same value as the IO size in step 12 of chapter 4.1.2 “IO
Device Settings”.
To change the setting of this item, change the security mode to the safe
mode.

(8) F_CRC_Length
Set the length of the CRC to be added to the safety data.
Select either "3Byte" or "4Byte".
However, set "4Byte" so that F_CRC_Length has the same value as
F_CRC_Length in step 10 of chapter 4.1.4 “F-Host (IO Controller) Set-
tings”.
To change the setting of this item, change the security mode to the safe
mode.

(9) F_Dest_Address
Set the address of the YRC1000 (F-Device) used for the PROFIsafe
communication in the range of 1 to 65534.
To change the setting of this item, change the security mode to the safe
mode.
Set this item to an address that is not already used for another F-Device
on the same network.

(10) PROFIsafe VIRTUAL COMM.
This item is a mode which is used when the robot performs the trial
operation. When starting the YRC1000 without connecting the CP1616
to the safety PLC, set this item as "VIRTUAL".
This function is for PROFIsafe communication only. This setting does
not affect PROFINET communication.
To change the setting of this item, change the security mode to the safe
mode.
For virtual communication, refer to chapter 1.2 “Virtual Communication
Function”.

For virtual communication, refer to chapter 1.2 “Virtual Communication
Function”.

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4 Setting of the Board
4.2 Maintenance Mode Settings

- The value of the safety IO size must be the same as Length set in step 12 of chapter 4.1.2 “IO Device Settings”.
- The value of F_CRC_Length must be the same as the size of F_CRC_Length set in step 10 of chapter 4.1.4 “F-Host (IO Controller) Settings”.
- The value of F_Dest_Address must be the same value as F_Dest_Add set in step 10 of chapter 4.1.4.

**NOTE**

PROFIsafe Virtual Communication

- When performing normal operation (exchanging safety IO signals with the safety PLC), make sure to set this item to “SAFETY”.
- If the connection with the safety PLC establishes with the setting remaining as "VIRTUAL", the setting will automatically be changed to "SAFETY" and then, the safety communication using PROFIsafe starts.
- In order to use virtual communication with the YRC1000, the following settings need to be set.
  - CP1616 is set as "USED". (CP1616 window)
  - IO device is set as "ENABLE". (IO device window)

7. Change CP1616 to "USED".
4 Setting of the Board
4.2 Maintenance Mode Settings

8. Select "DETAIL" of the IO device.
   – The IO device setting window is displayed.
   – (Description of each setting item)

(1) **IO Device**
   Switch between "ENABLE" and "DISABLE" with each selection. Set this to "ENABLE" to use the CP1616 as an IO device.

(2) **IO Size (IN/OUT)**
   Set this to use normal IO signals (not safety IO signals).
   When normal IO signals are set in step 12 of chapter 4.1.2 "IO Device Settings", set the same value as that IO size.
   - The display returns to the CP1616 settings window.
     * The data size for the safety signals is not included in the displayed IO size.

10. Press [ENTER].
    - The confirmation dialog box is displayed.

11. Select {YES}.
    - The IO module window is displayed.

The CP1616 settings are complete here. Next, the IO module needs to be set based on the board settings. Continue the settings for the following items.

If there is a mismatch between the option board and IO module settings, the YRC1000 cannot operate properly. To avoid mismatched settings, proceed to chapter 4.2.2 “IO Module Settings” after the option board settings are configured.
4.2.2 IO Module Settings

If the CP1616 settings are changed, the IO module needs to be set as well. Set the IO module settings using the following steps.

The message "Select 'Safety Board FLASH Reset'" is displayed, but do not perform the safety circuit board FLASH data reset and continue configuring the settings.

1. (the continuation of the CP1616 settings)
   – The IO module window (the first half) is displayed.

2. Press [ENTER].
   – The IO module window (the latter half) is displayed.

   – Ensure that the following value is allocated to DI and DO for the number of the slot (ST#16) to which the CP1616 is installed: the set IO size (unit: bit) + 8. However, the data size for the safety signals is not included.
3. Press [ENTER].

   – The confirmation dialog box is displayed.

4. Select {YES}.

   – If the IO module is properly installed, select {YES}. The IO module
     settings will be updated, and the external IO setup window is
     displayed.
4.2.3 External IO Settings

1. The EXTERNAL IO SETUP window is displayed.

2. Select "AUTO" or "MANUAL" for the allocation mode.

   - After "AUTO"/"MANUAL" is selected, the selection menu is displayed.

   - Allocation mode is the setting that controls whether the system automatically configures external IO allocation settings (which are found after step 4 in this section) or the operator manually configures those settings. When the allocation mode is set to "AUTO", the external IO signals are completely allocated from the start of the external IO signal area in order of IO module station numbers (ST#). This leaves no unallocated areas between station numbers. The unallocated area is located after the allocated external IO signals. To change the order of external IO signals or to leave unallocated areas in arbitrary locations, set the allocation mode to "MANUAL" and perform steps 5-7.

   If the allocation mode is changed from "MANUAL" to "AUTO", the allocation data that has been set will be lost, and re-allocating will be executed in the auto mode. If the set allocation data need to be kept, save the data in the external memory menu in advance.
3. Select the allocation mode to be set.
   - When allocating the I/O signal automatically, select "AUTO". When allocating the I/O signal manually, select "MANUAL".
   - The selected allocation mode will be set.

4. Select "DETAIL" of {EXTERNAL IO ALLOCATION}.
   - When selecting "AUTO" for the allocation mode, the following steps 5-7 are not necessary. Perform the operation from step 8.
   - When selecting "MANUAL" for the allocation mode, perform the following steps 5-7 for the items necessary for manual settings.

5. Select the external I/O signal number to be changed from the original. ("#20060" is selected in the setting example.)
   - The select menu is displayed.
4 Setting of the Board
4.2 Maintenance Mode Settings

6. Select "MODIFY" and enter the desired external input signal number to replace the original. ("20200" is entered in the setting example.)
   - The external input signal number will be changed.

7. Select and change the external input signal number with the same steps.
   - Repeat the selecting and changing operation for the desired allocation.

8. Press [ENTER].
   - The external output signal allocation window is displayed.

9. Select and change the external output signal number with the same procedure as the external input signal number.
   - Repeat the selecting and changing operation for the desired allocation.
10. Press [ENTER].

- The confirmation dialog box is displayed.

11. Select {YES}.

- The setting contents are confirmed, and the display returns to the settings window.
4.3 Reset Safety Circuit Board FLASH Data

After the PROFIsafe communication setting, the safety circuit board FLASH data reset must be performed in accordance with the following procedures.

1. Set the security mode to the safety mode.
2. Select {FILE} from the Main Menu. Select {INITIALIZE} to open the INITIALIZE window.
3. Select “Safety Board FLASH Reset”.
   - The confirmation dialog box is displayed.
4. Press [YES].
   - The settings are completed when the beep sounds.

4.4 GSD File Creation

When performing the communication settings of the PROFIsafe communication, a GSD (Generic Station Description) file is required for setting of the communication master (F-Host).

TIA Portal can be used to create a GSD file. Refer to chapter 4.1.2 “IO Device Settings”.
4.5 PROFIsafe Communication Sample

A sample that uses PROFIsafe communication is shown below.

**1 Sample that instantly stops the manipulator when teaching mode is active and the first bit of the input signals from the safety PLC is ON**

1. Create the following safety logic circuit.

   Signal 1: Teach mode (TEACH)
   Signal 2: Input signal from safety PLC (SFBIN01)
   Logic: AND
   Output signal: Stop (SVOFF CAT0)

   ![Safety Logic Circuit Diagram](image-url)

2. The timing chart is shown below.

   ![Timing Chart](image-url)

   **Servo OFF instantly because SFBIN01 is ON with teach mode**
3. Check operation of the safety logic circuit.
Set teach mode and turn ON the servo. Turn ON input signal (SFBIN01). The stop signal (SVOFF CAT0) changes from “○” to “●” and the manipulator stops instantly.
When the manipulator is stopped by the safety logic circuit, “Robot is stopped by safety logic circuit” is shown on the message area of the programming pendant.

When the manipulator is stopped by the safety logic circuit signal, “Robot is stopped by safety logic circuit” is shown on the message area of the programming pendant. The control status signal #80343 (Robot stopped by safety logic circuit) is turned ON.
(2) Sample that stops manipulator operation

1. Create the following safety logic circuit.

Signal 1: Input signal from safety PLC (SFBIN01)
Signal 2: None
Logic: None
Output signal: Manipulator decelerate to stop (SVOFF CAT1)

![Safety Logic Circuit Diagram]

2. The timing chart is shown below.

   • In teach mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>TEACH</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLAY</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SFBIN01</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Servo ON</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td></td>
</tr>
</tbody>
</table>

   Servo OFF because SFBIN01 is ON

For the safety logic circuit of the YRC1000, even if the manipulator deceleration to a stop (SVOFF CAT1) is turned ON, the manipulator stops its operation instantly without decelerating.

Under the play mode, if the manipulator deceleration to a stop (SVOFF CAT1) is turned ON, the manipulator decelerates and stops its operation.
4 Setting of the Board

4.5 PROFIsafe Communication Sample

3. Check operation of the safety logic circuit.
Set teach mode and turn ON the servo. Turn ON input signal (SFBIN01). The manipulator decelerate to stop signal (SVOFF CAT1) changes from “○” to “●” and the manipulator stops instantly.
Set play mode and turn ON the servo in the same manner. Turn ON input signal (SFBIN01). The manipulator decelerate to stop signal (SVOFF CAT1) changes from “○” to “●” and the manipulator decelerates to a stop.
When the manipulator is stopped by the safety logic circuit, “Robot is stopped by safety logic circuit” is shown on the message area of the programming pendant.
(3) **Robot movement range limit function sample**

In the robot range limit function, the individual conditions file can be enabled and disabled using input signals from the safety PLC.

The functional safety function must be enabled to use the robot range limit function.

For details on this function, refer to chapter 4.3 "Robot Range Limit Function" in YRC1000 Functional Safety Function Manual (Manual No.: HW1483576).

This example shows the settings for the following: When input signal 1 from the safety PLC is ON and input signal 2 from the safety PLC is ON, individual conditions file 1 for the robot range limit function is enabled and the monitored result is output to output signal 1 on the safety PLC.

1. Make the settings to use output signal 1 to the safety PLC in functional safety.
2. Allocate the following signal in the SAFETY SIG.BOARD ALLOC window.

   **SFOUT01: F-SAFE #1**
2. Set individual conditions file 1 for the robot range limit function as shown below.

File valid condition: Signal
Input signal bit 0: Input signal 1 from safety PLC (SFBIN01)
Input signal bit 1: Input signal 2 from safety PLC (SFBIN02)
Output signal: Output signal 1 to safety PLC (SFBOUT01)

For robot range limit file settings, refer to chapter 4.3 "Robot Range Limit Function" in YRC1000 Functional Safety Function Manual (Manual No.: HW1483576).

3. The timing chart is shown below.

Robot range limit function is enabled because SFBIN01 and SFBIN02 are ON.
4. Check operation of the robot range limit function.
   Turn ON input signal 2 from safety PLC (SFBIN02), and then turn ON input signal 1 from the safety PLC (SFBIN01). The status of file 1 changes from "Disabled (signal)" to "Enabled (signal)" and the robot range limit is enabled with the conditions in individual file 1.

(4) Speed limit function sample
In the speed limit function, the individual conditions file can be enabled and disabled using input signals from the safety PLC.

The functional safety function must be enabled to use the speed limit function.

For details on this function, refer to chapter 4.4 "Speed Limit Function" in YRC1000 Functional Safety Function Manual (Manual No.: HW1483576).

This example shows the settings for the following: When input signal 1 and input signal 2 from the safety PLC are ON, individual conditions file 1 for the speed limit function is enabled and the monitored result is output to output signal 1 on the safety PLC.

1. Make the settings to use output signal 1 to the safety PLC in functional safety.
   Allocate the following signal in the SAFETY SIG.BOARD ALLOC window.

SFBOUT01: F-SAFE #1
2. Set individual speed limit file 1 as shown below.

File valid condition: Signal
Input signal bit 0: Input signal 1 from safety PLC (SFBIN01)
Input signal bit 1: Input signal 2 from safety PLC (SFBIN02)
Output signal: Output signal 1 to safety PLC (SFBOUT01)

For speed limit file settings, refer to chapter 4.4 "Speed Limit Function" in YRC1000 Functional Safety Function Manual (Manual No.: HW1483576).

3. The timing chart is shown below.

Robot range limit function is enabled because SFBIN01 and SFBIN02 are ON.
4. Check operation of the speed limit function. Turn ON input signal 2 from safety PLC (SFBIN02), and then turn ON input signal 1 from the safety PLC (SFBIN01). The speed limit function is enabled.
5 Concurrent I/O

5.1 I/O Signal Allocation

For the information about how to allocate the I/O signals, refer to "YRC1000 OPTIONS INSTRUCTIONS FOR PROFINET COMMUNICATIONS FUNCTION (FOR CP1616 MADE BY Siemens) (Manual No.:HW1483860)".

5.2 Safety Signal Allocation

The data for safety signals are not allocated to the external I/O signal, but to the control input. The allocations for the control input are as follows.

The concurrent I/O is not the function for the safety product. For this reason, the signals allocated to the control input cannot be used as the safety-related signals.

<table>
<thead>
<tr>
<th>PROFIsafe Status Byte</th>
<th>cons_nr_R</th>
<th>Toggle_d</th>
<th>FV_activated</th>
<th>WD_timeout</th>
<th>CE_CRC</th>
<th>Device_Fault</th>
<th>iPar_OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPar_OK</td>
<td>Completion for allocating the iParameter value from the F-Host</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device_Fault</td>
<td>F-Device failure notice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE_CRC</td>
<td>CRC error for safety signals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WD_timeout</td>
<td>Timeout of the communication response time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FV_activated</td>
<td>Completion for switching to the fail safe value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toggle_d</td>
<td>Trigger for incrementing the sequence number for the safety signals sent from the F-Host</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cons_nr_R</td>
<td>Completion for resetting the sequence number for the safety signals sent from the F-Device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROFIsafe Control Byte</th>
<th>LoopCheck</th>
<th>ChF_Ack</th>
<th>Toggle_h</th>
<th>activate_FV</th>
<th>Use_TO2</th>
<th>R_cons_nr</th>
<th>OA_Req</th>
<th>iPar_EN</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPar_EN</td>
<td>Request for allocating the iParameter value to the F-Device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OA_Req</td>
<td>Request for switching from the fail safe value to the process value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_cons_nr</td>
<td>Request for resetting the sequence number for the safety signals sent from the F-Device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use_TO2</td>
<td>Request for resetting communication response time to F-Device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>activate_FV</td>
<td>Request for switching to the fail safe value due to communication error, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toggle_h</td>
<td>Trigger for incrementing the sequence number for the safety signals sent from the F-Device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5 Concurrent I/O
5.2 Safety Signal Allocation

ChF_Ack Request for acknowledgment for channel fault restoration request from F-Device (for remote I/O)
LoopCheck Loopback check (reserved for future use)

Followings are Status Byte and Control Byte signals under each communication situation of PROFIsafe.

While in safety communication status:
“Toggle_d” of Status Byte and “Toggle_h” of Control Byte alternate 0 → 1 → 0 → 1 → • • • consecutively.

When communication error occurred:
The value of Status Byte’s “WD_timeout” and “FV_activated” becomes 1.

In case the operation for restoration from communication errors is necessary
(Refer to chapter 7.2 “Reintegration”):
The value of Control Byte’s “OA_Req” and “activate_FV” becomes 1.

<table>
<thead>
<tr>
<th>80517</th>
<th>80516</th>
<th>80515</th>
<th>80514</th>
<th>80513</th>
<th>80512</th>
<th>80511</th>
<th>80510</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual communication execution status</td>
<td>Virtual communication set value</td>
<td>PROFIsafe communication status</td>
<td>PROFIsafe communication establishment</td>
<td>PROFINET communication status</td>
<td>PROFINET communication establishment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| PROFINET communication establishment status | Communication establishment status between the IO controller (safety PLC) and the IO device (CP1616) (0: establishment failure 1: establishment completion) |
| PROFINET communication status | Communication status after establishing the communication between the IO controller (safety PLC) and the IO device (CP1616) (0: not during communication 1: during communication) |
| PROFIsafe communication establishment status | Safety communication establishment status between the F-Host (safety PLC) and the F-Device (safety circuit board) (0: establishment failure 1: establishment completion) |
| PROFIsafe communication status | Safety communication status after establishing the communication between the F-Host (safety PLC) and the F-Device (safety circuit board) (0: not during communication 1: during communication) |
| Virtual communication set value | Set value of PROFIsafe virtual communication which is set in the maintenance mode (0: safety communication 1: virtual communication) |
| Virtual communication execution status | Actual communication status (0: during virtual communication 1: during safety communication) |

<table>
<thead>
<tr>
<th>80527</th>
<th>80526</th>
<th>80525</th>
<th>80524</th>
<th>80523</th>
<th>80522</th>
<th>80521</th>
<th>80520</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety input signal (Byte 0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit 7</td>
<td>Bit 6</td>
<td>Bit 5</td>
<td>Bit 4</td>
<td>Bit 3</td>
<td>Bit 2</td>
<td>Bit 1</td>
<td>Bit 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>80537</th>
<th>80536</th>
<th>80535</th>
<th>80534</th>
<th>80533</th>
<th>80532</th>
<th>80531</th>
<th>80530</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety input signal (Byte 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit 7</td>
<td>Bit 6</td>
<td>Bit 5</td>
<td>Bit 4</td>
<td>Bit 3</td>
<td>Bit 2</td>
<td>Bit 1</td>
<td>Bit 0</td>
</tr>
</tbody>
</table>
5 Concurrent I/O
5.2 Safety Signal Allocation

<table>
<thead>
<tr>
<th>Safety input signal (Byte 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety input signal (Byte 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety input signal (Byte 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety input signal (Byte 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety input signal (Byte 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety output signal (Byte 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety output signal (Byte 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety output signal (Byte 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety output signal (Byte 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety output signal (Byte 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety output signal (Byte 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 7</td>
</tr>
</tbody>
</table>
### Concurrent I/O

#### 5.2 Safety Signal Allocation

<table>
<thead>
<tr>
<th>80667</th>
<th>80666</th>
<th>80665</th>
<th>80664</th>
<th>80663</th>
<th>80662</th>
<th>80661</th>
<th>80660</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety output signal (Byte 6)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit 7</td>
<td>Bit 6</td>
<td>Bit 5</td>
<td>Bit 4</td>
<td>Bit 3</td>
<td>Bit 2</td>
<td>Bit 1</td>
<td>Bit 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>80677</th>
<th>80676</th>
<th>80675</th>
<th>80674</th>
<th>80673</th>
<th>80672</th>
<th>80671</th>
<th>80670</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety output signal (Byte 7)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit 7</td>
<td>Bit 6</td>
<td>Bit 5</td>
<td>Bit 4</td>
<td>Bit 3</td>
<td>Bit 2</td>
<td>Bit 1</td>
<td>Bit 0</td>
</tr>
</tbody>
</table>
Management of Setting Data

Setting information of PROFIsafe (CP1616 board) can be saved/loaded using the external memory devices. The procedures are as follows. For the operation of external memory devices, refer to chapter 7 “External Memory Devices” of “YRC1000 OPERATOR’S MANUAL (Manual No.: RE-CSO-A051)”.

6.1 Procedures for Saving

1. Turn ON the YRC1000.
2. Select {EX. MEMORY} under the main menu. The sub menu is displayed.
3. Select {SAVE}. The SAVE window is displayed.
4. Select "SYSTEM DATA". The SYSTEM DATA selection window is displayed.

5. Select "CP1616 INFO". "★" is displayed before the name of the selected system data.

6. Press [ENTER]. The confirmation dialog box is displayed.
6.2 Procedures for Loading

1. Turn ON the YRC1000.
2. Change the security mode to the management mode.
3. Select (EX. MEMORY) under the main menu. The sub menu is displayed.
4. Select {LOAD}.
The LOAD window is displayed.

5. Select "SYSTEM DATA".
The SYSTEM DATA selection window is displayed.

6. Select "CP1616 INFO".
"★" is displayed before the name of the selected data.
6. Management of Setting Data
6.2 Procedures for Loading

7. Press [ENTER].
   The confirmation dialog box is displayed.

   File loading is started, and the transmission window is displayed.
   When loading is completed, the display returns to the file selection window.
6 Management of Setting Data

6.2 Procedures for Loading

9. After loading is completed, turn the power supply ON again.

**NOTE**

- For the content stored in the CP1616 setting information file and the content set on the YRC1000 to which the file will be loaded, the CP1616 setting information file can be loaded only if all of the following items are the same.
  - Slot number in which the CP1616 board is inserted
  - IO size set for the CP1616 board (Total IO size used for the IO controller and IO devices)

If the above items are not the same, "Error 1520 'Cannot be used on this system configuration’" will be displayed when attempting to load the CP1616 setting information file to the YRC1000 and the file will not be loaded.

- Configure the following settings on the CP1616 setting window, even when the CP1616 setting information file is loaded. (These settings are not changed when the CP1616 setting information file is loaded.) For these settings, change the security mode to safety mode and refer to step 6 of chapter 4.2.1 “IO Device Settings”.
  - SAFETY IO SIZE
  - F_CRC_Length
  - F_Dest_Address
  - PROFIsafe VIRTUAL COMM.
7 Error Indication

7.1 LED Display

For the information about the LED display of the CP1616, refer to "YRC1000 OPTIONS INSTRUCTIONS FOR PROFINET COMMUNICATIONS FUNCTION (FOR CP1616 MADE BY Siemens) (Manual No.: HW1483860)".

7.2 Reintegration

If a communication alarm occurs due to the cable disconnection, etc., the safety input signal to the YRC1000 is forcefully cleared to 0 in order to maintain the safety. This action is called passivation.

In order to return the safety input signal cleared to 0 due to the passivation to the original value, operating the safety program (the ladder program for safety that operates on the safety PLC) created in TIA Portal is necessary after the communication is established. This operation is called reintegration.

This section describes the creating and operating methods of the following safety program. For the details, refer to the Siemens manual.

Creating Method of Safety Program

1. After completing the procedure described in chapter 4.1.4 “F-Host (IO Controller) Settings”, check that the following programs exist in the {Program blocks} list of the project tree.
2. Select {PLC tag} - {Default tag table} from the project tree and create the tag required for the reintegration operation.

<table>
<thead>
<tr>
<th>Default tag table</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Tag_1</td>
<td>Bool</td>
<td>HW1483862</td>
<td>HW1483862</td>
</tr>
<tr>
<td>Data type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td>HW1483862</td>
<td>HW1483862</td>
<td>HW1483862</td>
<td>HW1483862</td>
</tr>
<tr>
<td>Read access</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write access</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visible</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Select {Program blocks} - {Main_Safety_RTG1} - {Switch...} - {LAD}.

4. Right-click the Main_Safety_RTG1 window and select {Insert network}.
7 Error Indication
7.2 Reintegration

5. Add the following instruction (M0.0 / “F00000_ps_8”.ACK_REQ / “F00000_ps_8”.ACK_REI) to the added Network 1.

Check the block name to specify in front of ACK_REQ and ACK_REI in {Program blocks} - {System blocks} - {STEP 7 Safety} - {F-I/0 data blocks}.

6. Perform step 12 to step 13 of chapter 4.1.4 “F-Host (IO Controller) Settings”, and then compile and download the safety program.
### Operating Method for Safety Program

When the restoration operation from the communication error state (reintegration) is required, the activate_FV bit and the OA_Req bit of PROFIsafe Control Byte will be 1. (Refer to chapter 5.2 “Safety Signal Allocation”.)

Reintegration is performed by following the procedures described below.

1. Select (Program blocks) - {Main_Safety_RTG1}.
   - ![Diagram of Main_Safety_RTG1]
   - Select the icon outlined in red below.

2. When turning ON the contact point "M0.0", 
   "F00000_ps_8".ACK_REQ" is turned ON, and reintegration is performed. (After turned ON, it goes back to OFF soon.)
   Check that the safety input signal cleared to 0 due to the passivation is returned to the original value.

3. **NOTE**
   When "F00000_ps_8".PASS_ON" is ON, passivation is forcibly performed, and safety input signal remains cleared to 0. Turning OFF "F00000_ps_8".PASS_ON" can return the original value.
7.3 PROFIsafe Diagnostics Information

If an F-Parameter setting error or communication error due to a cable disconnection occurs, the YRC1000 displays an alarm on the programming pendant screen and sends diagnostics information to the F-Host.

The following table shows the diagnostics information that is sent.

<table>
<thead>
<tr>
<th>Diagnostics Code</th>
<th>Diagnostics Information</th>
<th>Corresponding YRC1000 Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0040</td>
<td>F_Dest_Add mismatch</td>
<td>4912 Safety Fieldbus Comm.</td>
</tr>
<tr>
<td>0x0041</td>
<td>F_Dest_Add is invalid value</td>
<td>1 Communication Error</td>
</tr>
<tr>
<td>0x0042</td>
<td>F_Source_Add mismatch or invalid value</td>
<td>2</td>
</tr>
<tr>
<td>0x0043</td>
<td>F_WD_Time value is 0</td>
<td>4</td>
</tr>
<tr>
<td>0x0044</td>
<td>F_SIL value is out of range</td>
<td>5</td>
</tr>
<tr>
<td>0x0045</td>
<td>F_CRC_Length integrity error</td>
<td>12</td>
</tr>
<tr>
<td>0x0046</td>
<td>F_Par_Version is invalid value</td>
<td>6</td>
</tr>
<tr>
<td>0x0047</td>
<td>F-Parameter CRC error</td>
<td>7</td>
</tr>
<tr>
<td>0x0048</td>
<td>Undefined error</td>
<td>8</td>
</tr>
<tr>
<td>0x004B</td>
<td>iParameter integrity error</td>
<td>11</td>
</tr>
<tr>
<td>0x004C</td>
<td>F_Block_ID unsupported</td>
<td>13</td>
</tr>
<tr>
<td>0x004D</td>
<td>Communication error: Safety input signal CRC error</td>
<td>30</td>
</tr>
<tr>
<td>0x004E</td>
<td>Communication error: Communication timeout</td>
<td>31</td>
</tr>
</tbody>
</table>

The diagnostics information received by the F-Host can be checked on the TIA Portal diagnostics buffer window.

If the diagnostics code is 0x004D (communication error: Safety input signal CRC error), additional diagnostics information can be checked. The procedure to check this information is shown below.
1. The following parameter must be set in advance to check additional diagnostics information.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
<th>Setting Values</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S4C1087</td>
<td>Register number to which additional diagnostics information is output</td>
<td>0: Do not output 1 to 548: Output destination register number (12 registers are used starting from the register number that was specified)</td>
<td>0</td>
</tr>
</tbody>
</table>

2. After "Alarm 4912 Safety Fieldbus Communication Error [30]" (diagnostics code: 0x004D) occurs, select {IO} - {Registers} in online mode.

If S4C1087=200, the following data is displayed.

The value of additional diagnostics information 4 is 1101 1100 0110 0110 1000 0000 0111 0001 in binary and 0xDC668071 in hexadecimal.

The meaning of the items is shown below.

<table>
<thead>
<tr>
<th>Data</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional diagnostics information 1</td>
<td>F_CRC_Seed = 0 (when (3-Byte-CRC)) Monitoring number</td>
</tr>
<tr>
<td>Additional diagnostics information 2</td>
<td>F_CRC_Seed = 0 (when (3-Byte-CRC)) F_Par_CRC</td>
</tr>
<tr>
<td>Additional diagnostics information 3</td>
<td>CRC calculated from received safety input signal</td>
</tr>
<tr>
<td>Additional diagnostics information 4</td>
<td>CRC added to received safety input signal</td>
</tr>
</tbody>
</table>
For details on diagnostics information, refer to the following specifications published by PROFIBUS and PROFINET International (PI).

PROFIsafe – Profile for Safety Technology on PROFIBUS and PROFINET Technical Specification

Version 2.6MU1 – Date: August 2018 Order No.: 3.192

“6.3 Diagnosis”
8 Trouble Shooting

When Communication Is Not Established or A Communication Error Occurs
When the communication with the safety PLC is not established, the system will be in the following status:

- LEDs of the safety PLC and the CP1616 are in the error status (red lighting up/blinking).
- The communication status of PROFINET/PROFIsafe is in an error state.
  (The control input is in the following status.)

All or either of the signals from 80510 to 80513 and 80515 are turned OFF (0).

When system is in one of the above mentioned conditions, check the followings.

- Confirm that the value of F_Dest_Address set to CP1616 and the value of F_Dest_Address set at TIA Portal are the same. Also confirm that the value of F_CRC_Length set to CP1616 and the value of F_CRC_Length set at TIA Portal are the same.
  (Refer to Step 10 at chapter 4.1.4 “F-Host (IO Controller) Settings”.)
  (Refer to Step 6 at chapter 4.2.1 “IO Device Settings”.)

- Confirm that the value of the safety IO size set to CP1616 and the value of the safety IO size set at TIA Portal are the same.
  (Refer to Step 12 at chapter 4.1.2 “IO Device Settings”.)
  (Refer to Step 6 at chapter 4.2.1 .)

- Confirm that the value of the F-Host local address set at TIA Portal and the value of F_Source_Add in F-Parameter are the same.
  (Refer to Step 10 and Step 11 at chapter 4.1.4 .)

- Confirm that the value of F_Dest_Add in F-Parameter set at TIA Portal is within the proper range.
  (Refer to Step 10 and Step 11 at chapter 4.1.4 .)

- Confirm that the value of F_iPar_CRC set at TIA Portal is 1.
  (Refer to Step 10 at chapter 4.1.4 .)

- Confirm that the operation mode of the safety PLC has not been set to the STOP state due to switching the mode switch of the safety PLC or due to another operation.

- Confirm that the safety IO signals are not being used in the standard ladder program in the safety PLC. Always use the safety IO signals in the safety ladder program.
• Confirm that settings are executed for the CP1616 to be used as an IO device. For details, refer to chapter 9. "Trouble Shooting" in YRC1000 OPTIONS INSTRUCTIONS FOR PROFINET COMMUNICATIONSFUNCTION (FOR CP1616 MADE BY Siemens) (Manual No.: HW1483860).

## When Safety Signals Cannot be Delivered:
When the signals between the safety PLC and the YRC 1000 cannot be delivered, it will be in the following status:

- Toggle\_d of PROFIsafe Status Byte and Toggle\_h of PROFIsafe Control Byte are not switched continuously. (The control input is in the following status.)

  The signals of 80445 and 80455 remained to be ON (1) or remained to be OFF (0).

  \[
  \begin{align*}
  \#8044X & \quad 0010\_0000 \\
  \#8045X & \quad 0010\_0000
  \end{align*}
  \]

- The value of OA\_Req and activate\_FV of PROFIsafe Control Byte is 1. (The control input is in the following status.)

  The signals of 80451 and 80454 are turned ON (1).

  \[
  \begin{align*}
  \#8045X & \quad 0001\_0010
  \end{align*}
  \]

When system is in one of the above mentioned conditions, check the followings.

- Operate the safety program to perform reintegration. (Refer to chapter 7.2 "Reintegration".)

## When the System is not Operating in Virtual Communication Mode
Check the followings.

- Confirm that the PROFIsafe virtual communication setting has been set to "Virtual". (Refer to Step 6 at chapter 4.2.1 "IO Device Settings".)

- Confirm that the CP1616 has been set to be used. (Refer to Step 7 at chapter 4.2.1.)

- Confirm that the IO device usage setting has been set to enabled. (Refer to Step 8 at chapter 4.2.1.)
YRC1000 OPTIONS
INSTRUCTIONS
FOR PROFIsafe FUNCTION
(FOR CP1616 MADE BY Siemens)