

Robotiq 2-Finger Gripper Application Note

for SMART Series Robots by Yaskawa

Version 1.00



Andrew Boddiford
11/19/2018

DOCUMENT REVISION INFORMATION

Date	Version Number	Document Changes
11/19/18	1.00	Initial version for SMART Series Robots by Yaskawa

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REQUIREMENTS

HARDWARE REQUIREMENTS

Item #	Part/Version #	Name/Description
1	Varies	Yaskawa SMART Series Robot (GP7, GP8, HC10/HC10DT, or GP12)
2	Varies	Yaskawa SMART Series Controller (YRC1000 or YRC1000micro)
3	-	Yaskawa SMART Pendant
4	AGC-GRP-002	Robotiq 2-Finger Gripper (85 or 140mm travel)
5	UNI-CTR-001-ENIP	Robotiq Universal Controller, <u>EtherNet/IP Configuration</u>
6	CBL-COM-2065-10-HF	Robotiq 10m High-Flex Device Cable for Gripper
7	-	Robotiq 10ft. Shielded USB Cable for Gripper Configuration
8	-	Robotiq Coupling Specific to Customer's SMART Series Robot
9	787-818	Wago 24VDC, 3A+ DIN Rail Mount Power Supply
10	852-111	Wago DIN Rail Mount Industrial Ethernet Switch
11	-	Cat6 Ethernet Cables, length determined by customer workcell
12	A165-S	Omron Estop with LittleFuse Fuses and Holders
13	-	Wiring, bolts etc. for mech/elec. installations described below

SOFTWARE REQUIREMENTS

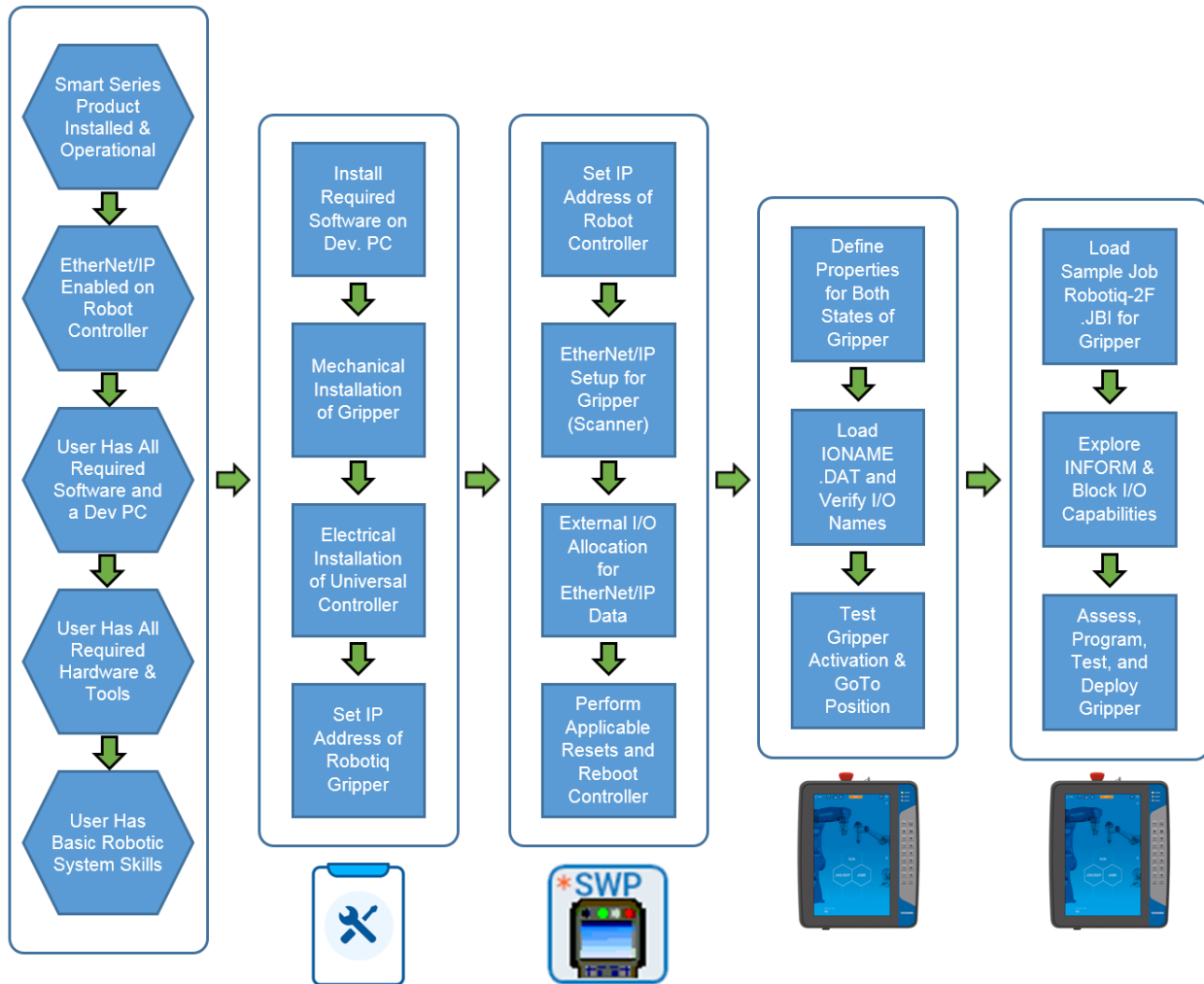
Item #	Part/Version #	Name/Description
1	-	Yaskawa Software Pendant (PC) (.exe included on SMART Pendant)
2	1.7.2	Robotiq User Interface Software (PC)
3	IONAME.DAT	Yaskawa I/O Name File for Robotiq 2F Gripper (Controller Dependent)
4	ROBOTIQ-2F.JBI	Yaskawa Sample Job to Control Robotiq 2F Gripper (Reference Only)

SUPPORTING DOCUMENTATION

Item #	Part/Version #	Name/Description
1	-	Robotiq 2F-85_2F-140 Instruction Manual for e-Series Grippers
2	RUC-140626	Robotiq Universal Controller Instruction Manual
3	184775-1	Yaskawa SMART Pendant Instructions Manual
4	184774-1	Yaskawa SMART Pendant INFORM Language Instructions Manual
5	Varies	Yaskawa EtherNet/IP Communication Function Instructions Manual
6	Varies	Yaskawa SMART Series Robot Instructions Manual
7	Varies	Yaskawa SMART Series Controller Instructions Manual

PROCESS OVERVIEW

The diagram below illustrates the process required to integrate a Robotiq 2F gripper with a SMART Series Robot by Yaskawa. The icons below each column represent the software platform required to complete each group of actions.



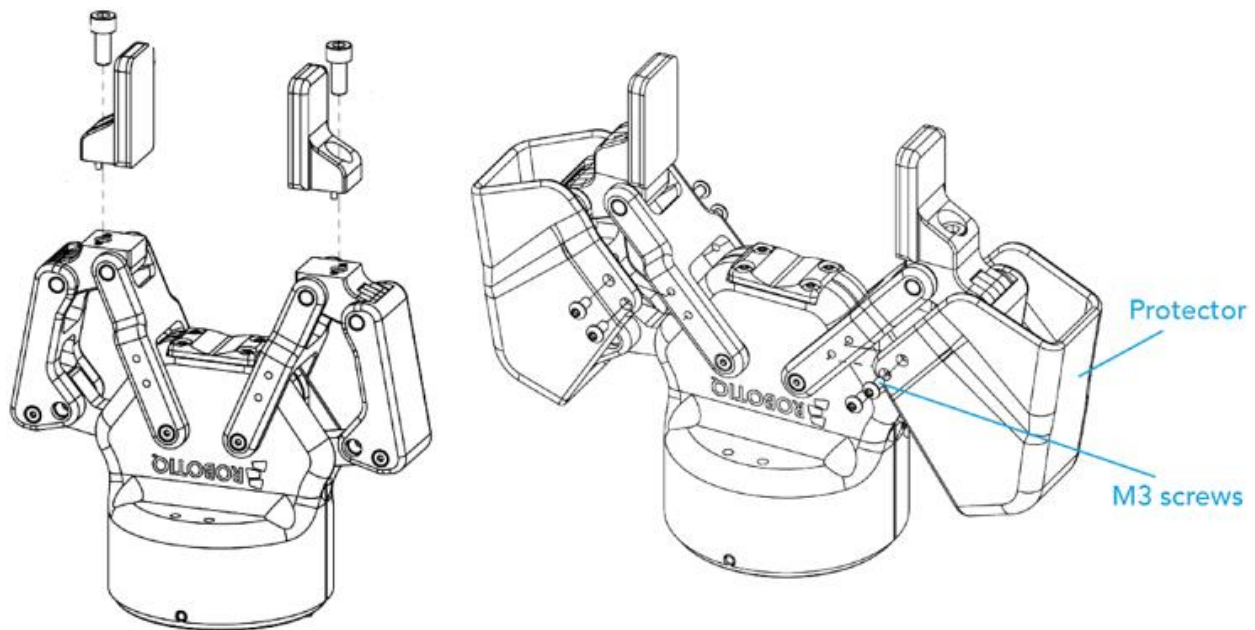
INSTALLATION & SETUP

This document includes the process for integrating a Robotiq 2-Finger gripper with a Yaskawa SMART Series Product (i.e. Robot, Controller, & Smart Pendant). Instructions for both the YRC1000 & YRC1000micro robot controllers are included.

This process assumes the user has the following items:

1. Properly installed SMART Series robot by Yaskawa
2. Properly configured YRC1000 installed & operational with EtherNet/IP enabled
3. Connected Smart Pendant
4. Windows PC (Win 7 ,8, 9, or 10)
5. Knowledge of basic robotic concepts
6. Familiarity with Yaskawa I/O

The Robotiq 2-Finger gripper can be customized for a specific application. For example, custom fingertip shapes/materials can easily be attached and protective covers can be added to eliminate most pinch points. Please see the Robotiq instructions manuals for more detail.



Refer to online support resources (Robotiq and Yaskawa) for further knowledge on gripper options, installation, setup, programming, and deployment.

MECHANICAL INSTALLATION OF GRIPPER

A coupling is required to attach the Gripper to the robot. Be sure to use the coupling related to your Yaskawa robot model. Some couplings may require an additional adapter plate. To create your own coupling or adapter plate you can refer to the Coupling section. To see the details of the available couplings and adapter plates, please refer to the Spare Parts, Kits and Accessories section.

Here are the steps to follow to mount the Gripper to your robot (exploded view in the figure below).

1. Screw the adapter plate or the coupling to the robot.
2. Screw the coupling to the adapter plate (if adapter plate is required).
3. Screw the Gripper onto its coupling.
 - a. Use caution not to damage the pins required for an electrical connection

PROVIDED PARTS:

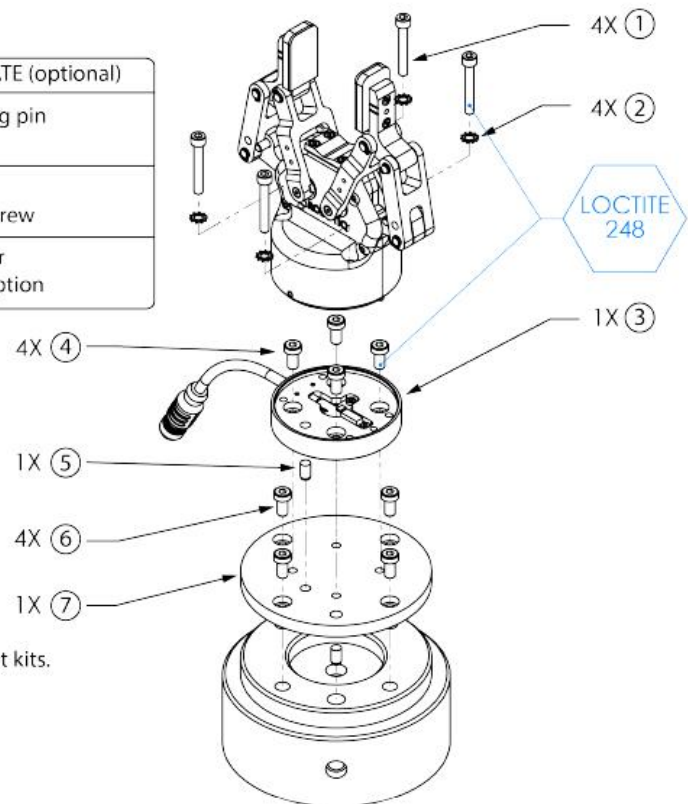
	COUPLING
①	M5-0.8 x 35 mm socket head cap screw
②	M5 Tooth lock washer
③	2-Finger Gripper coupling option
④	M6-1.0 x 5 mm low head cap screw

	ADAPTER PLATE (optional)
⑤	M6 x 12 indexing pin (H8 tolerance)
⑥	M6-1.0 x 5 mm low head cap screw
⑦	2-Finger Gripper adapter plate option

TOOLS YOU NEED :

- 4 mm hex head key
- Medium strength Loctite

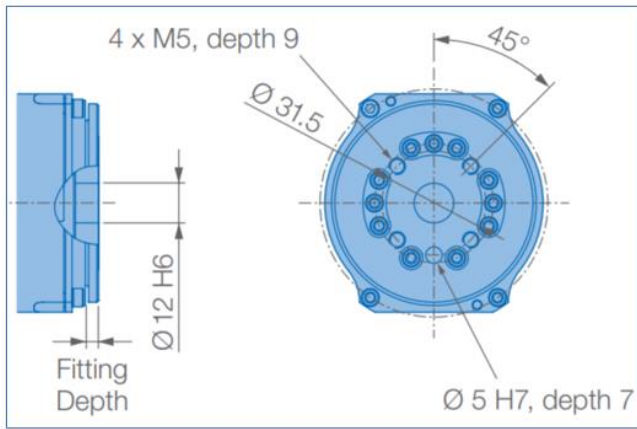
Shown with optional adapter plate.
Robot side screws are available only for specific robot kits.



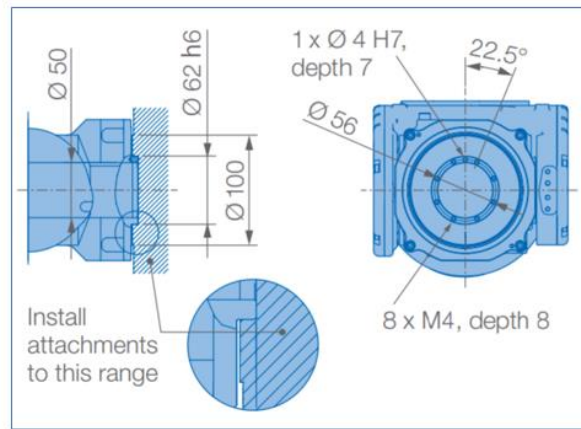
NOTE: All screws must be locked in place using medium strength thread-locker.

SMART Series Robot Tool Flange Details

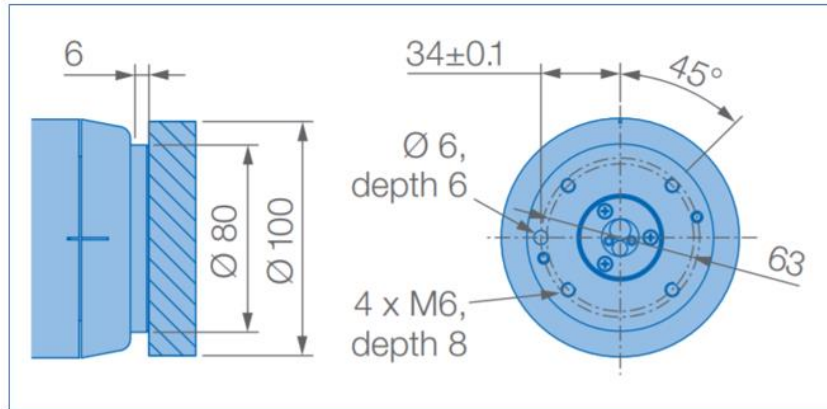
GP7/GP8



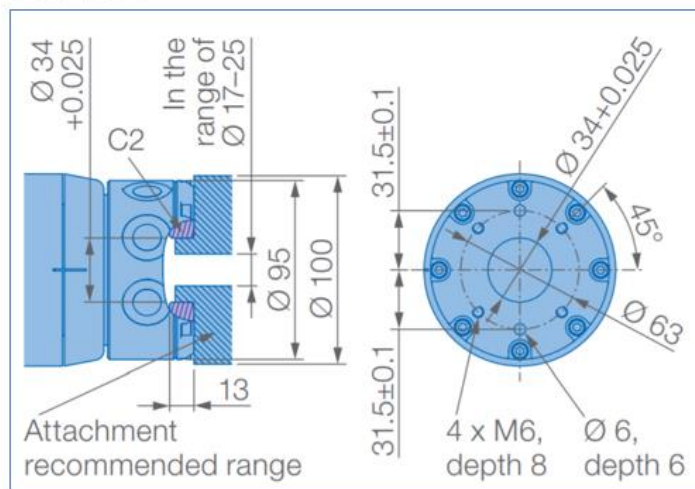
GP12



HC10



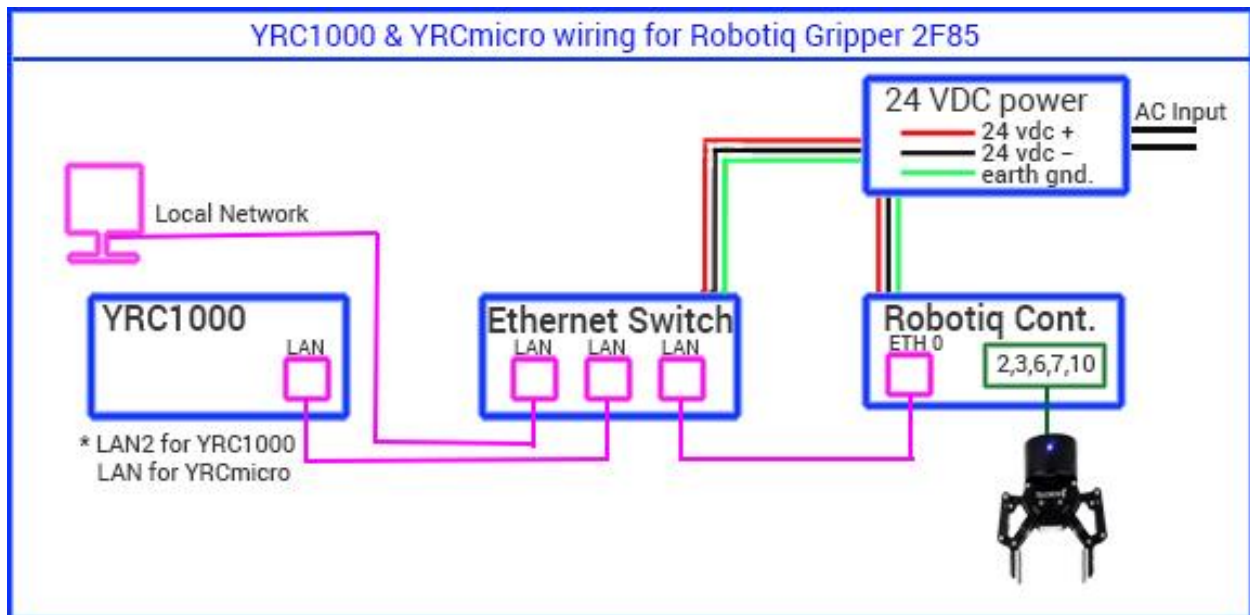
HC10DT



ELECTRICAL & NETWORK INSTALLATION OF GRIPPER

A high level view of the electrical installation for the Robotiq 2-Finger gripper with a Yaskawa robot is provided below.

1. Install Robotiq Universal Controller configured for EtherNet/IP
 - a. Prepare a DC power supply (24V, 2A+) to power the Robotiq gripper and its controller
 - b. Mount, prepare cabling, and physically wire the controller
 - c. Prepare safety mechanisms (i.e. gripper emergency stop) according to the “Robotiq 2F Gripper” manual
2. With all devices powered OFF, carefully route the gripper cable externally along the robot to connect the Robotiq gripper to its controller
3. Configure a common Ethernet network for your system
 - a. Connect the robot and gripper controllers to a common network
 - b. Set IP address of robot controller using Software Pendant (if required)
 - c. Set IP address of Robotiq gripper using Robotiq User Interface (if required)
4. Configure EtherNet/IP communication between the robot and gripper controllers
5. Verify all connections and test gripper operation



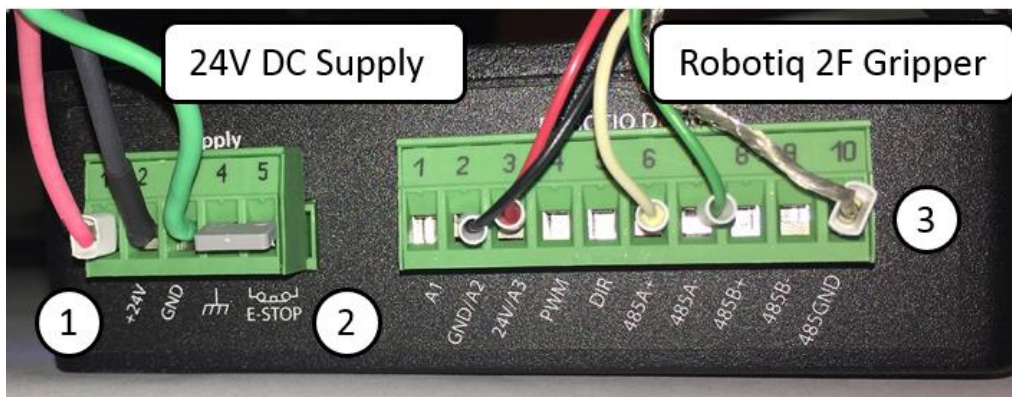
NOTE: The VDC supply must have adequate capacity (2A+) to operate the gripper and controller.

INSTALLATION OF ROBOTIQ UNIVERSAL CONTROLLER

Please review the “Robotiq Universal Controller Instruction Manual” before proceeding, with particular attention to the following sections:

- Section 1 General
- Section 2.1 Safety
- Section 2.2 Intended Use
- Section 3.4 Power Supply Specifications
- Section 3.5 Wiring

Wiring Instructions for Universal Controller



Supply Connector		
Pin	Signal Name	Color Code
1	+24V Input	RED
2	GND	BLACK
3	EARTH	GREEN
4	E-STOP-COM	USER DEFINED
5	E-STOP_NC	USER DEFINED

Robotiq Device Connector		
Pin	Signal Name	Color Code
1	A1	-
2	GND/A2	BLACK
3	+24V/A3	RED
4	PWM	-
5	DIR	-
6	485A+	WHITE
7	485A-	GREEN
8	485B+	-
9	485B-	-
10	485GND	SHIELD

- ① Wire power from the 24 VDC supply to the Robotiq Universal Controller using a 3A inline fuse (or fuse rated for the applicable gripper model)
- ② Connect E-Stop to Robotiq Universal Controller
- ③ Connect the terminals on the gripper cable to the Robotiq Controller as shown above

Route and Connect Gripper Cable

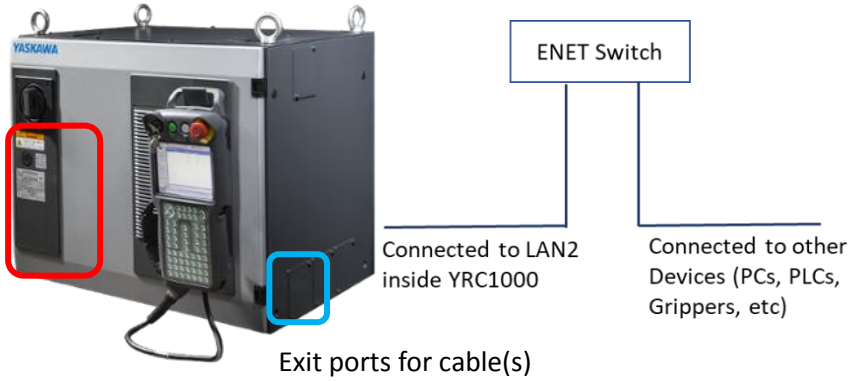

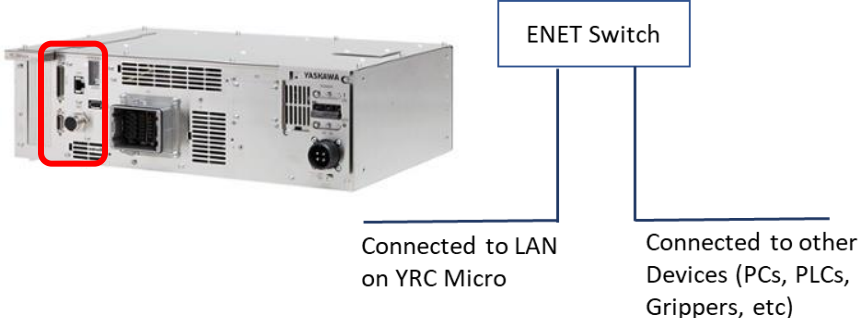

Route the gripper cable along the exterior of the arm using a secure attachment method. Be sure to leave extra slack in the cable to allow for joint movement and rotation. The full movement range of each axis should be tested before programming an application (see the robot model's datasheet for maximum allowable travel for each axis).

The example below depicts HC10 with the Robotiq gripper cable routed externally to the arm.

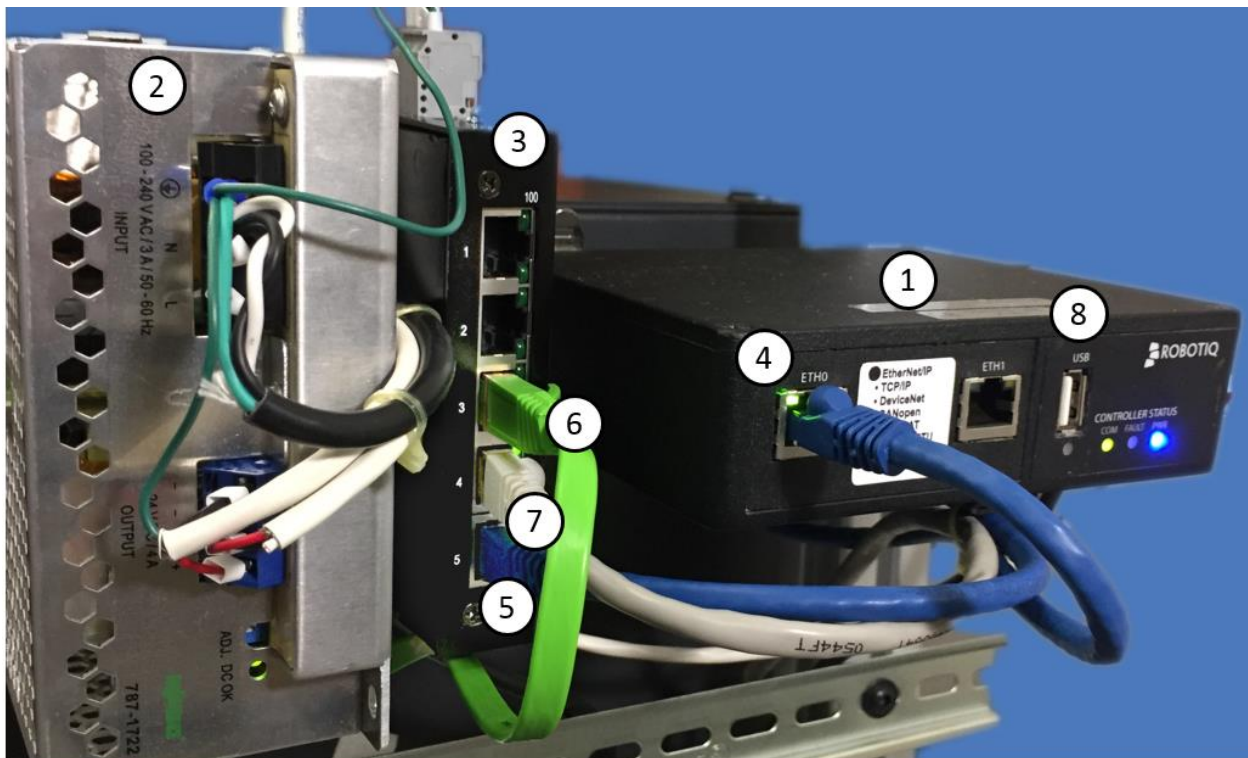


NETWORK CONFIGURATION

An Ethernet network will be used to establish communication between the SMART Series robot controller and the Robotiq 2F gripper. Using the diagrams below, connect an Ethernet cable from the networking port of the robot controller (LAN2 on YRC1000, LAN on YRC1000micro) to an installed Ethernet switch.

Network Layout (YRC1000)	Controller Port (YRC1000)
 <p>The diagram shows a Yaskawa YRC1000 robot controller. A red box highlights the front panel area where the LAN2 port is located. A blue box highlights the side panel area labeled 'Exit ports for cable(s)'. A central box labeled 'ENET Switch' has two lines extending to the controller: one pointing to the LAN2 port area and another pointing to the side panel area. Text labels indicate: 'Connected to LAN2 inside YRC1000' (pointing to the LAN2 area) and 'Connected to other Devices (PCs, PLCs, Grippers, etc)' (pointing to the side panel area).</p>	 <p>A close-up photograph of the internal components of the YRC1000 controller. A red box highlights the LAN2 port, which is a standard RJ45 Ethernet port. A blue Ethernet cable is plugged into this port. Other ports and components are visible in the background.</p>
Network Layout (YRC1000micro)	Controller Port (YRC1000micro)
 <p>The diagram shows a Yaskawa YRC1000micro robot controller. A red box highlights the front panel area where the LAN port is located. A central box labeled 'ENET Switch' has two lines extending to the controller: one pointing to the LAN port area and another pointing to the side panel area. Text labels indicate: 'Connected to LAN on YRC Micro' (pointing to the LAN port area) and 'Connected to other Devices (PCs, PLCs, Grippers, etc)' (pointing to the side panel area).</p>	 <p>A close-up photograph of the front panel of the YRC1000micro controller. A red box highlights the LAN port, which is a standard RJ45 Ethernet port. Other ports like GPIQ, RSW, X81, and USB are also visible.</p>

Similarly, the Robotiq Universal Controller should be connected to the same Ethernet switch to establish communication.



- ① Robotiq Universal Controller
- ② 24V, 2A+ DC power supply (e.g. Wago 787-818)
- ③ Ethernet switch (e.g. Wago 852-111)
- ④ ETH0 port on Universal Controller
- ⑤ Ethernet switch: Universal Controller connection
- ⑥ Ethernet switch: LAN connection from SMART Series robot controller
- ⑦ Ethernet switch: Connection to workcell network for other devices
- ⑧ USB port on Universal Controller (e.g. used configure gripper IP address)

Network Design

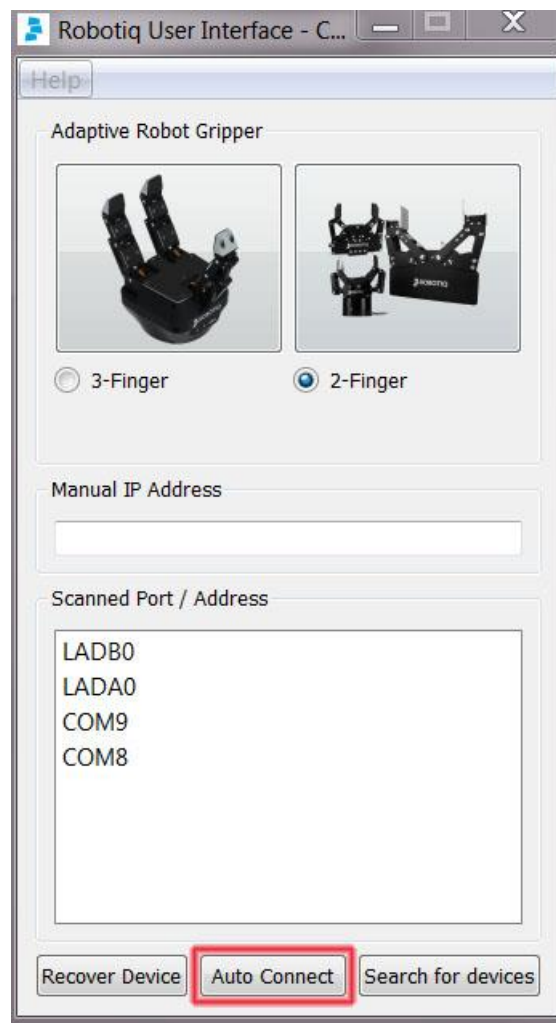
Decide how to structure the system network before changing the default IP addresses for the robot controller, gripper controller, and other external devices.

- Has a network been established already that must be followed?
- Does the user want to use the default address of the robot controller or gripper?

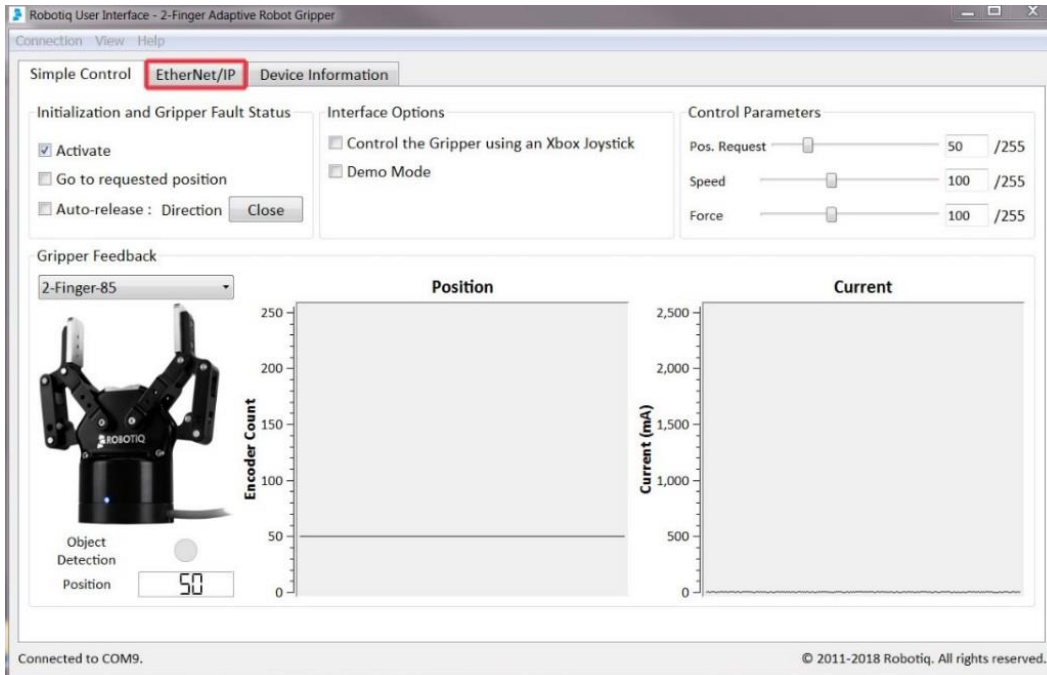
CHANGE IP ADDRESS OF ROBOTIQ GRIPPER

The default IP address of the Robotiq 2F gripper is **192.168.1.11**. If required, use the following steps to change the gripper's IP address to one that is compatible with the desired network.

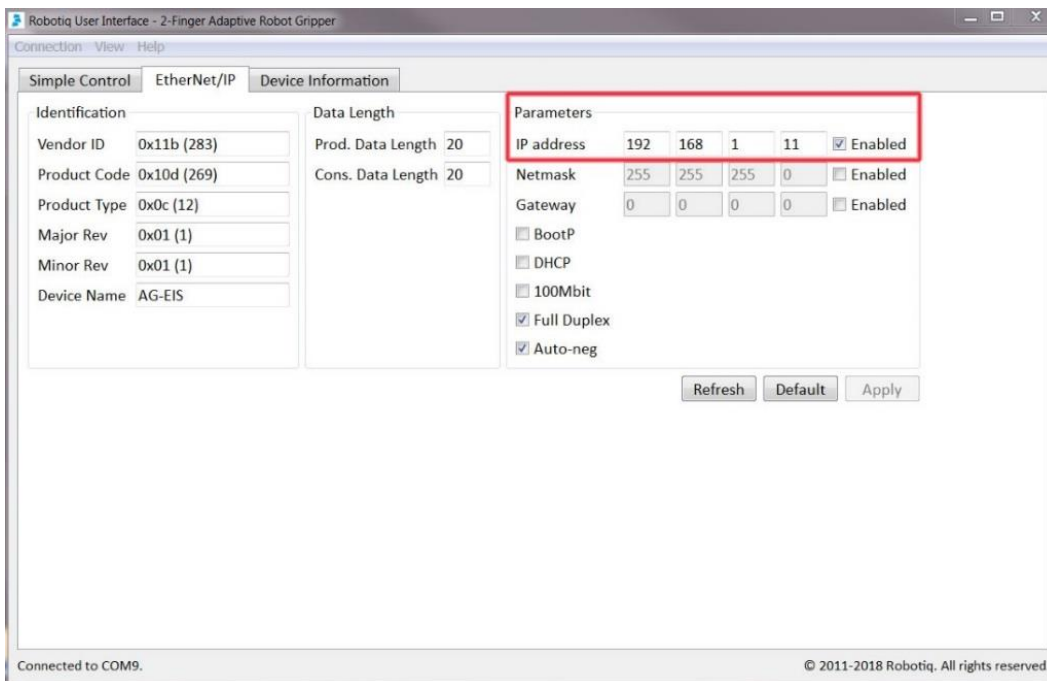
1. Power ON the Universal Controller that is connected to the Robotiq 2F gripper
2. Connect a USB cable from Robotiq Universal Controller to the development PC
3. Open the Robotiq User Interface software installed on the development PC
 - a. Select {2-Finger}
 - a. Press {Auto Connect}



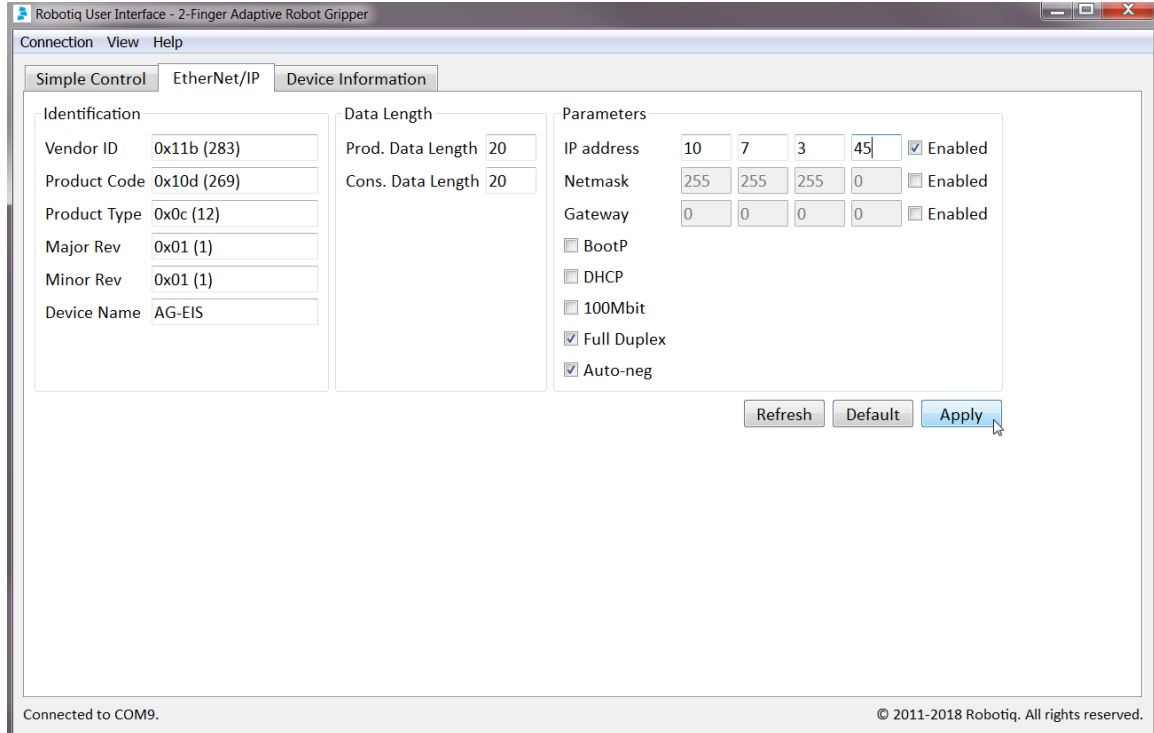
4. Select the {EtherNet/IP} tab



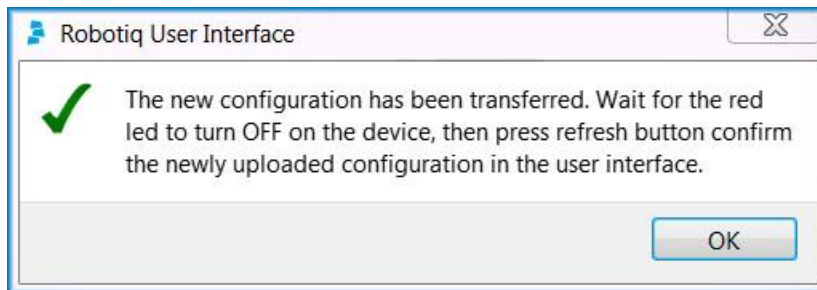
5. Under Parameters, change {IP Address} to the LAN2 network address reserved for the gripper on the YRC1000 controller (192.168.1.11 is factory default setting) **change** the address to a different IP address that will be used for the LAN connection to the YRC1000 controller.



- Click {Apply} to register the new gripper IP address. See Section “Configure YRC1000 IP Address for Communication with Gripper” for instructions to change LAN/LAN2 address on the controller. This example is 10.7.3.45 LAN2 -match the address here with address for LAN2 in the YRC1000 controller.



- A confirmation dialog will appear on the Robotiq User Interface.

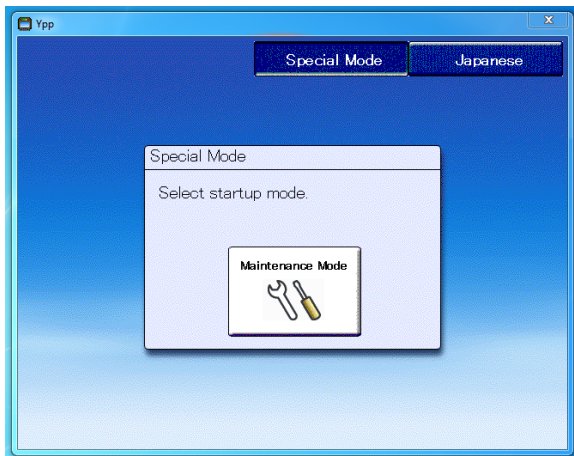


- The gripper’s IP address is now set for communication with the robot controller.

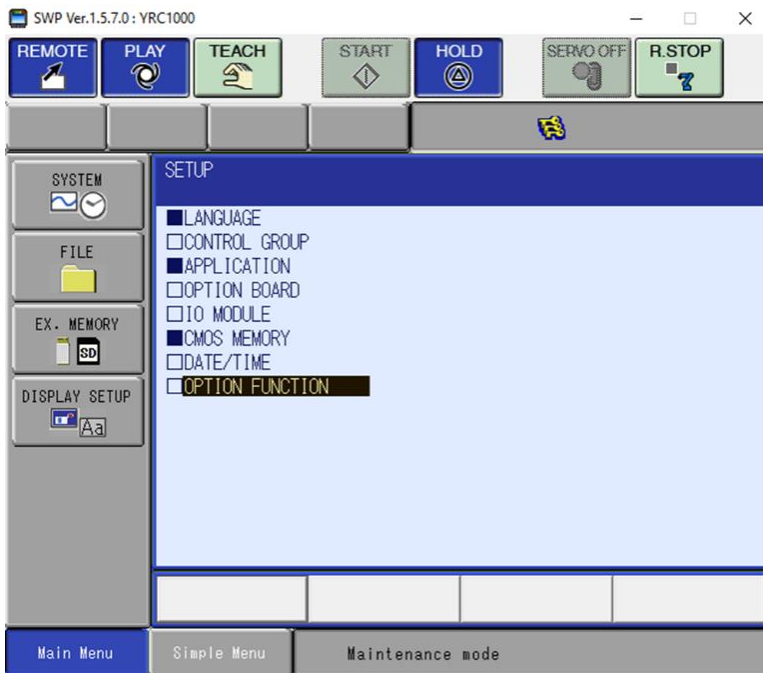
CHANGE IP ADDRESS OF SMART SERIES ROBOT CONTROLLER

The IP address of the robot controller should be compatible with the IP address of the gripper and potentially other devices on the same network. This can be configured using Yaskawa's Software Pendant. For basic information on using Software Pendant, see Chapter 12 of the "Smart Pendant Instructions" manual. The steps to change the IP address of the robot controller are provided below.

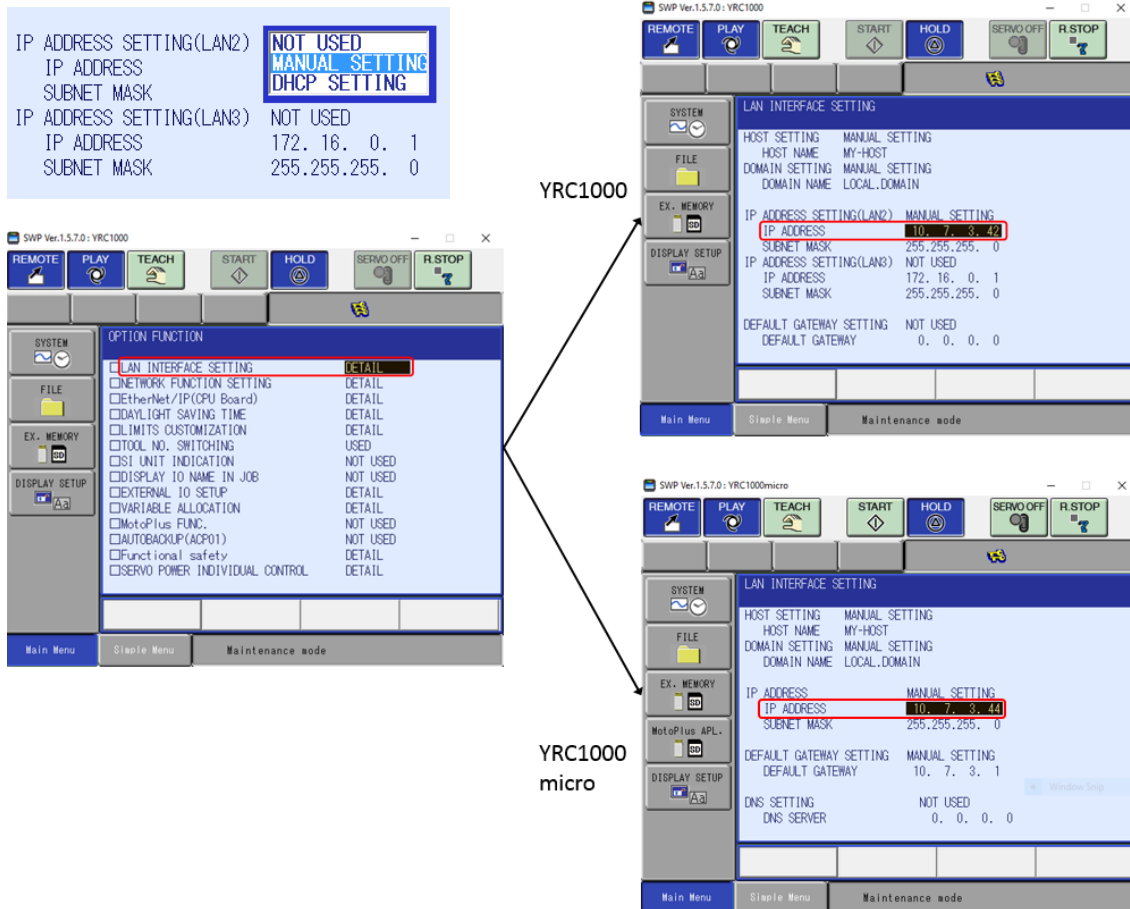
1. Connect to the robot controller (using its current IP address) with Software Pendant in {Special Mode} → {Maintenance Mode}.



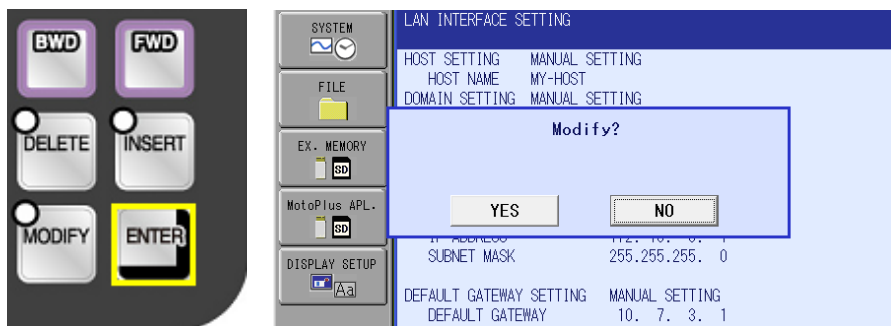
2. Change Security Level to "Management". From the main menu, navigate to {SYSTEM} → {SETUP} → "OPTION FUNCTION".



- Under “LAN Interface Setting”, change the “IP Address” for LAN2 on the YRC1000. On YRC1000micro, there will only be one “IP Address” to choose from. Verify that “Manual Setting” is selected to use the newly configured IP address.



- Press {ENTER} on the pendant to save the new setting(s). A “Modify?” dialog should appear.



Optional: To test the new address, reboot the robot controller to exit Maintenance Mode. Ping the controller from a development PC on the same network to verify that communication has been established. Note: EtherNet/IP configuration requires Maintenance Mode, the reboot can be delayed.

ETHERNET/IP CONFIGURATION ON SMART SERIES CONTROLLER

A SMART Series robot controller can be configured as either an EtherNet/IP **Adapter** or **Scanner**. Configuring the controller as an **Adapter** allows a connection to be established with another controller and is most often used to communicate with PLCs. Configuring the controller as a **Scanner** allows it to communicate with peripheral devices (e.g. Robotiq 2F gripper) using EtherNet/IP. When in Scanner mode, a single controller can control multiple adapter devices.

For this application, the robot controller will be configured as a **Scanner** using Software Pendant. This article will assume a basic knowledge of connecting Software Pendant, booting in Maintenance Mode, changing Security Level (see Chapter 12 of the “Smart Pendant Instructions” manual).

Configuration Information for Scanner

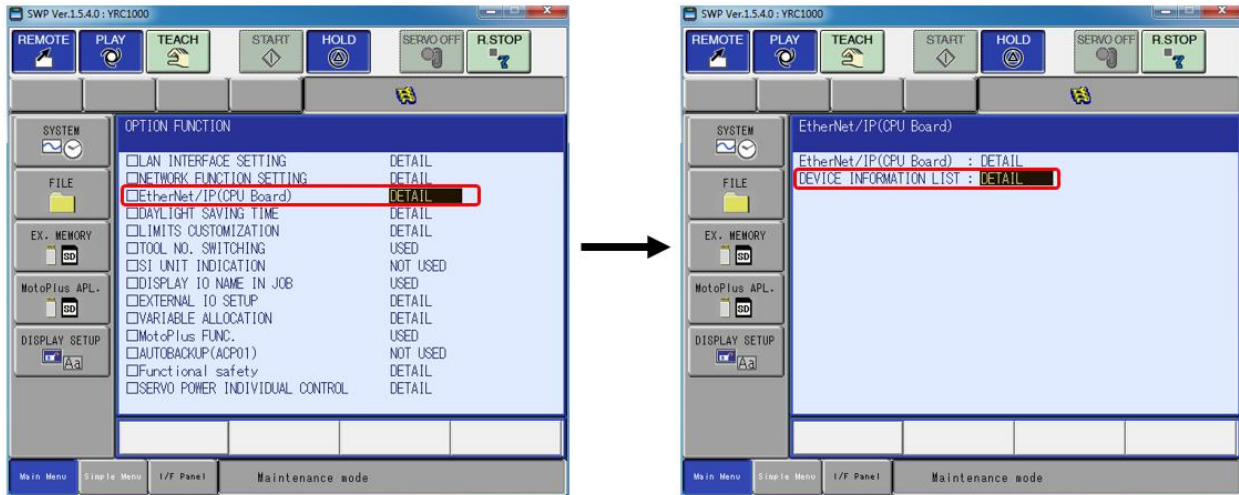
Before opening Software Pendant, it is important to gather all the necessary information required to communicate with the gripper. The table below shows the information needed to properly configure a **Scanner**. This information (and more) is available in the Robotiq 2F gripper manual.

Name	<i>User Defined (e.g. Robotiq 2F)</i>
IP Address	<i>User Defined</i>
Input Size	24 byte (20 gripper + 4 EIP header)
Output Size	20 byte
Configuration Size	0 word
Input Instance	101
Output Instance	100
Configuration Instance	1

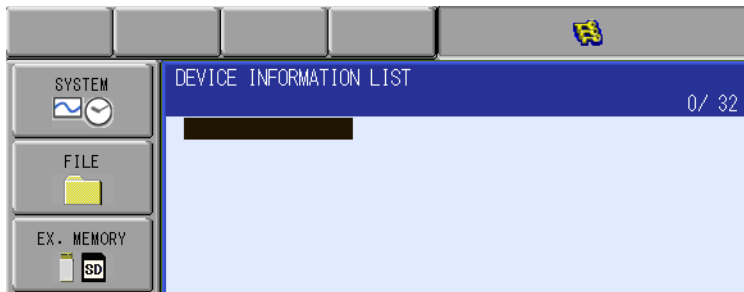
Configure the Scanner using Software Pendant

The data gathered above can now be entered using Software Pendant on the Development PC. Connect to the robot controller in Maintenance Mode and switch to “Management” Security Level. Navigate to {SYSTEM} → {SETUP} → “Option Function” → “EtherNet/IP (CPU Board) : DETAIL” from the Main Menu to begin this process.

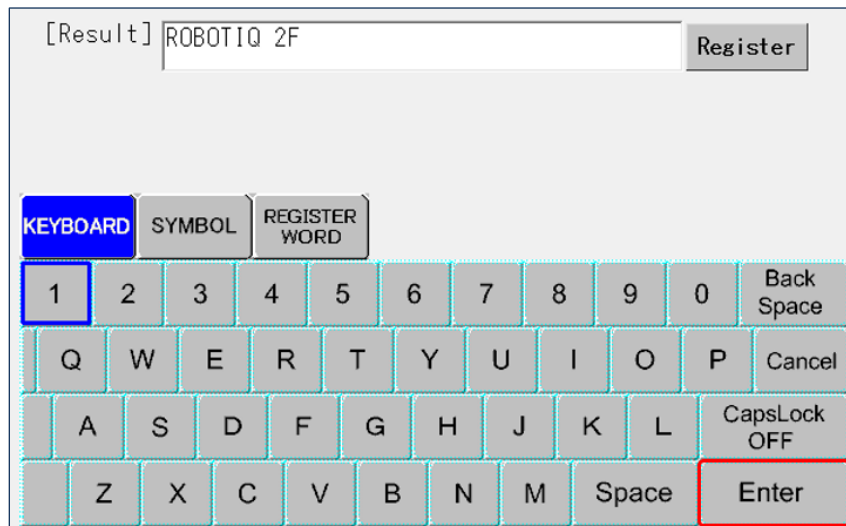
From this screen, the Robotiq 2F gripper should be added to the Device Information List. Highlight “Device Information List : DETAIL” and press {SELECT} (or double click using a mouse).



Select an empty Device slot (if no devices are present, the list will be empty) and press {SELECT}.



This will open a screen that has the basic configuration information for the device. Chose and name for the gripper (e.g. ROBOTIQ 2F). Use {Enter} on the keypad (and not {Register}) to save the name.

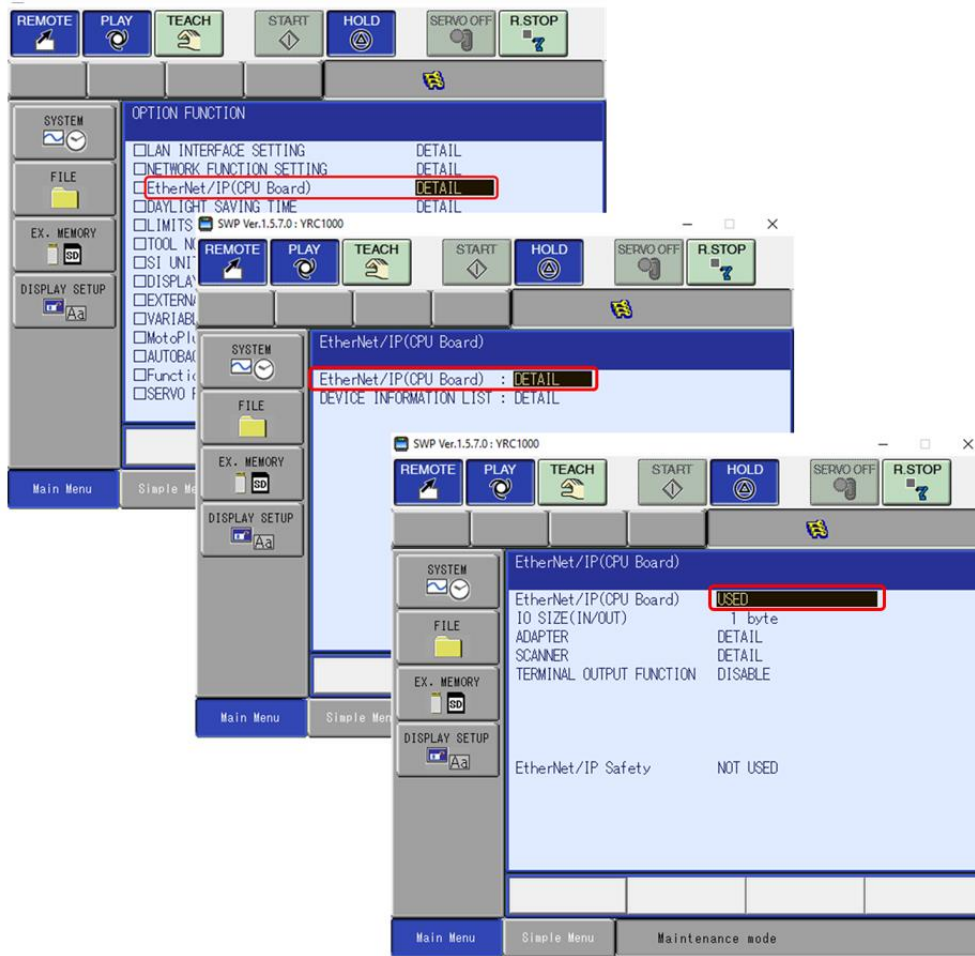


Enter the remaining “Device Information” exactly as it appears below for the default Robotiq 2F configuration with a SMART Series controller. See the EtherNet/IP manual (specific to controller type) for more information on these parameters.

Name	Robotiq 2F
IP Address	User Defined
Revision Processing Interval (Originator → Target)	≥ 4msec
Revision Processing Interval (Target → Originator)	≥ 4msec
Connection Timeout	4, 8, 16, 32, 64, 128, 256, 512
Connection Type	Exclusive Owner
Input Size	24
Output Size	20
Configuration Size	0
Input Instance	101
Output Instance	100
Configuration Instance	1

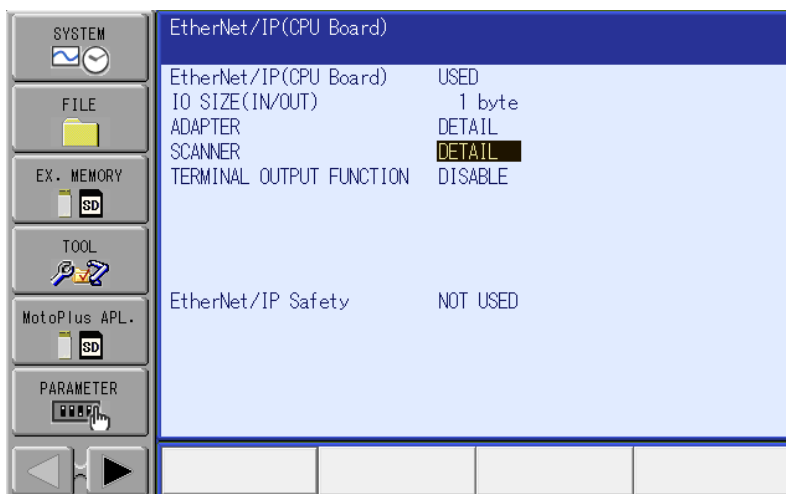
NOTE: Before leaving this screen, press {Enter} to save the new configuration. A “Modify?” dialog will appear. {YES} takes the user to a newly populated “Device Information List”.

Next, a Scanner for this device should be added and configured with the correct IP Address. Select {SYSTEM} → {SETUP} → “Option Function”. Next, highlight “EtherNet/IP (CPU Board) : DETAIL” and press {SELECT}. On the next screen, highlight “EtherNet/IP (CPU Board) : DETAIL” and press {SELECT} again. This will open the primary EtherNet/IP configuration screen.

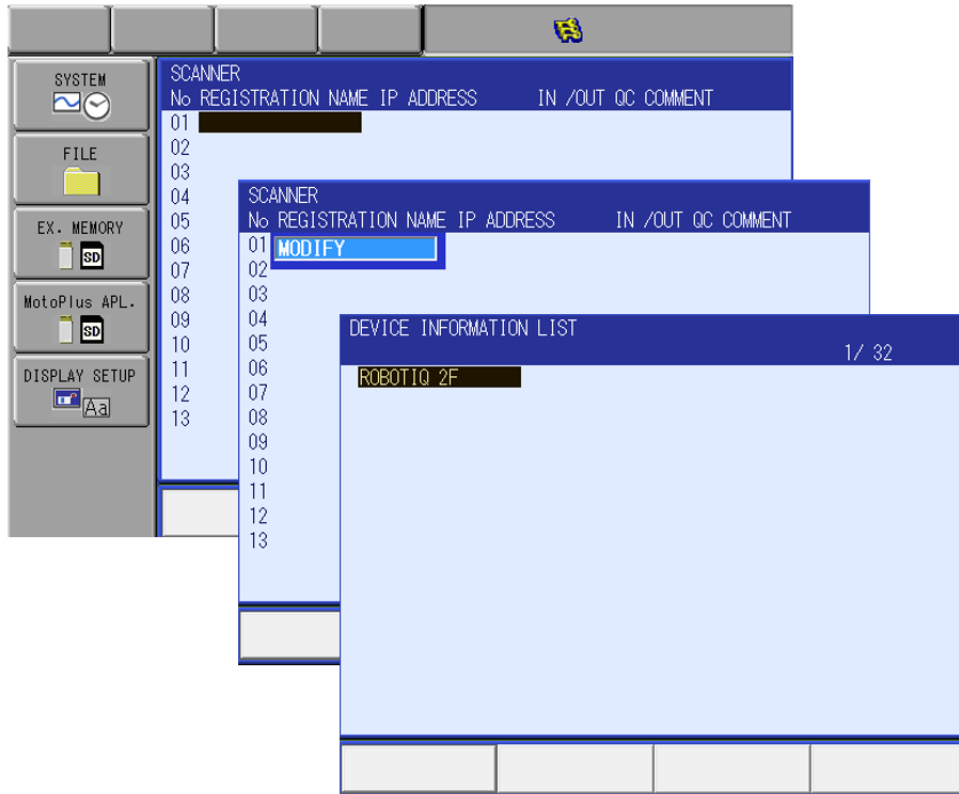


On this screen, first verify that the board is set to “USED”. Contact Yaskawa if this is set to “NOT USED”.

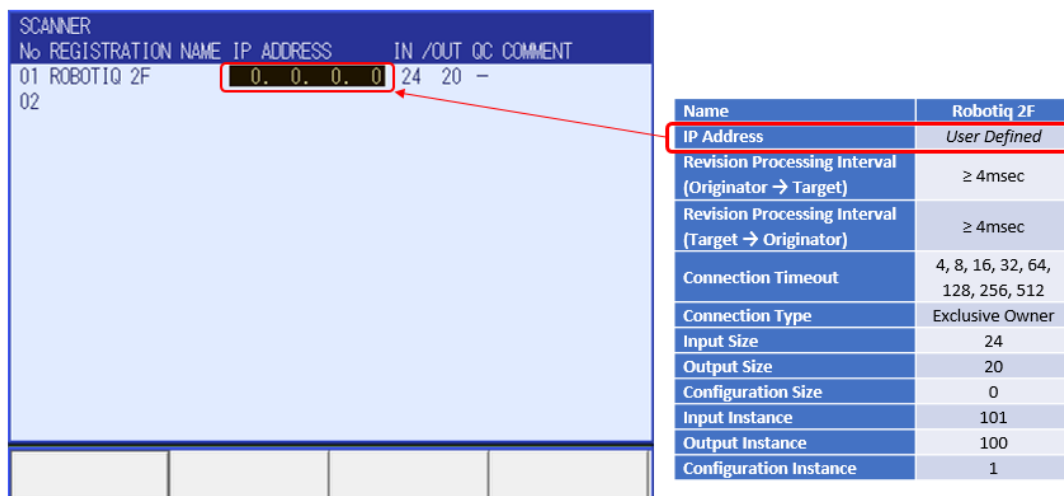
Next, highlight the “Scanner DETAIL” row and press {SELECT}.



The next screen will show a list of registered Scanner devices (empty by default). Highlight an unused device and press {SELECT}. Press {SELECT} again to {MODIFY} this entry. On the next screen, highlight the desired device (e.g. "Robotiq 2F") and press {SELECT}.



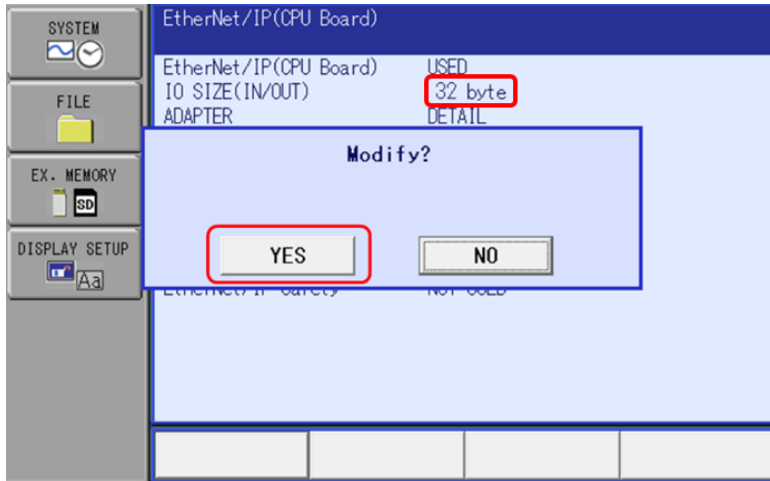
"Robotiq 2F" is now included in the Scanner device list. Highlight "IP Address", press {SELECT}, and input the desired IP Address for the Robotiq gripper. Press {Enter} on the keyboard to save the address.



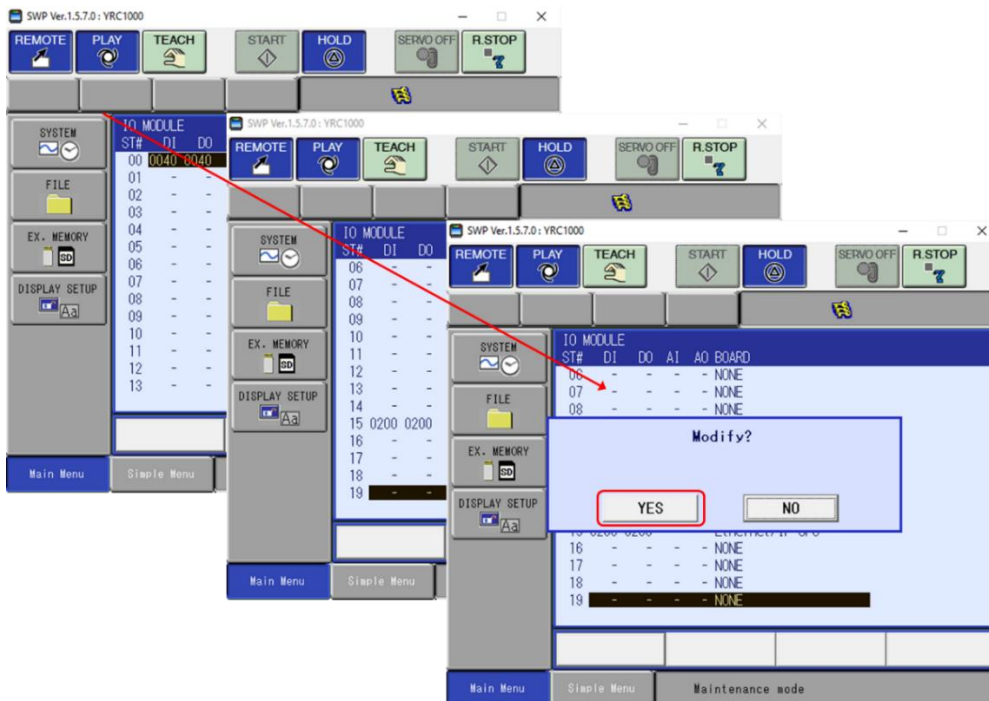
Press {ENTER} on the pendant. The screen will return to the EtherNet/IP (CPU Board) screen. “IO Size (In/Out)” should now read 24+ bytes if the previous steps were executed properly

- 24 bytes are allocated for communication with the Robotiq gripper
- Depending on robot system ordered, some bytes (e.g. 8) may already be reserved for the default EtherNet/IP configuration for that particular controller type

After verification, press {ENTER}. Modify dialog appears, press {YES} to continue.

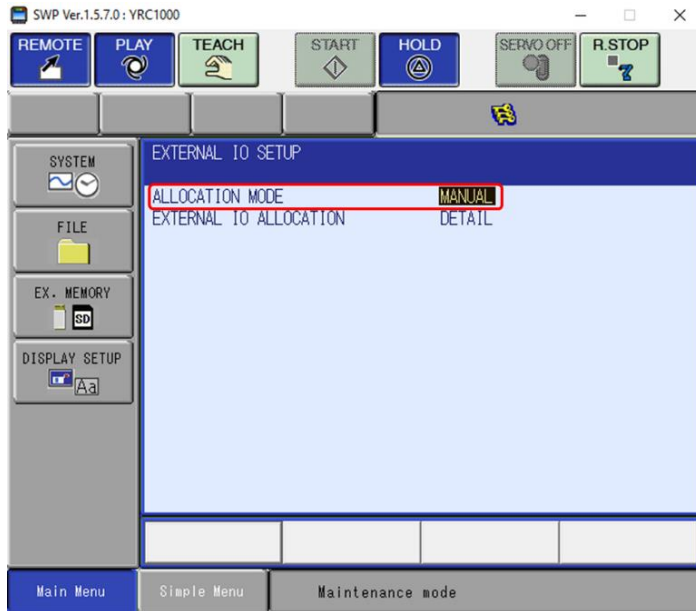


Next, press {Enter} several times to navigate through a set of screens until another “Modify” pop-up is shown. Then, select {YES}.

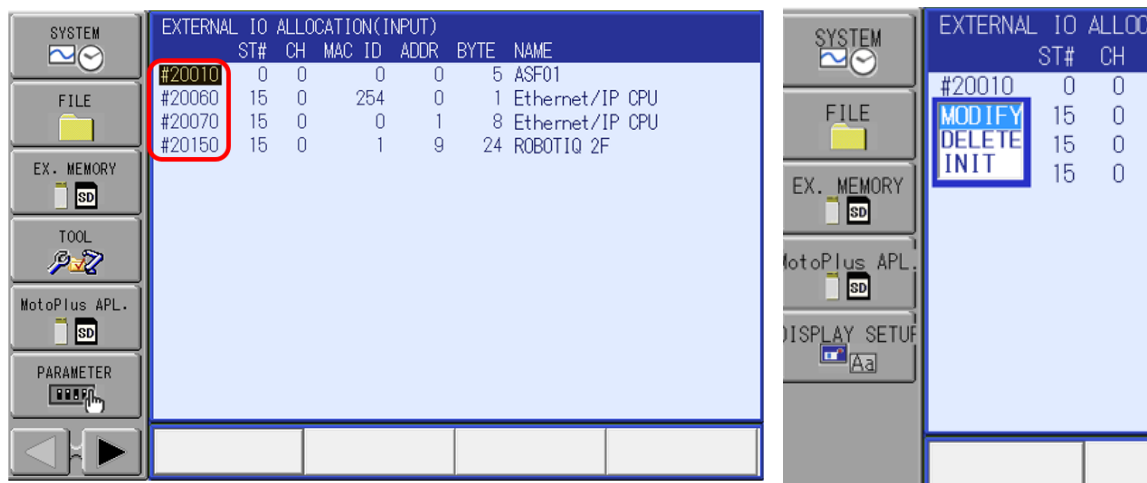


EXTERNAL I/O ALLOCATION FOR GRIPPER

On the next screen, change “Allocation Mode” to “Manual” and press {ENTER} again.



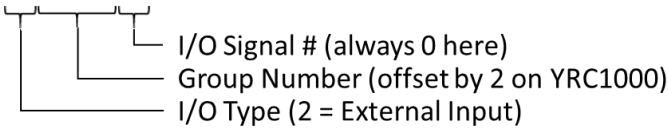
This will open the External I/O Allocation (Input) screen for the Robotiq gripper. External I/O Allocation is a way to assign where the I/O associated with a certain device will be mapped. This allows a user to customize how this I/O will be shown on Smart Pendant (e.g. assigning a 16 byte block of EtherNet/IP data to be associated with Input #s 129-256).



By default, the External I/O for the Robotiq gripper is automatically allocated to a free slot. These allocations can be configured by {MODIFYING} the 5-digit numbers in the left-hand column on the screen shown above.

External Inputs have the format shown below:

20190



To change the location of the Input mapping, only the middle three numbers (defining the I/O Group Number) should be changed. This will define the **Input Group Number** where the associated Inputs will map. The table below shows a few example mappings and where they will land on YRC1000 vs. YRC1000micro (input values are offset by 2 on the YRC1000).

External Input #	YRC1000 Group #	YRC1000 Individual #'s	YRC1000micro Group #	YRC1000micro Individual #'s
20070	5	33 to 40	7	49 to 56
20310	29	225 to 232	31	241 to 248
21500	148	1177 to 1184	150	1193 to 1200

For Robotiq, 24 bytes of EtherNet/IP Input data should be mapped to **20070**. See differences above.

To complete the default setup for Robotiq 2F gripper on a SMART Series Robot, edit the 5 digit entries on the “External IO Allocation (INPUT)” screen to match the **content** and **order** of the values highlighted in red below before proceeding. Press {Select} → {MODIFY} to edit the Input entries.

EXTERNAL IO ALLOCATION (INPUT)

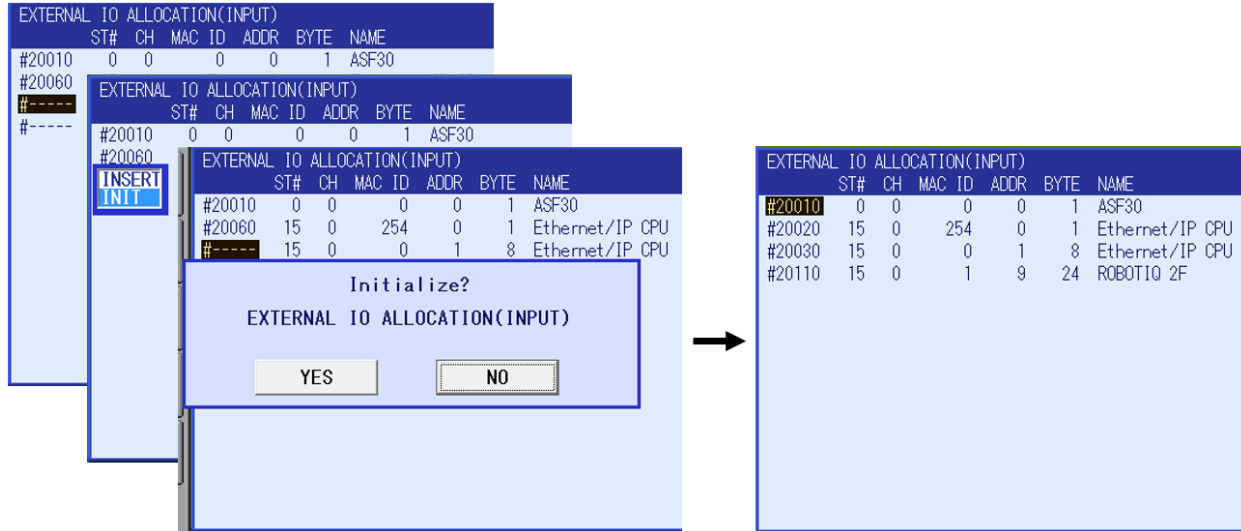
ST#	CH	MAC ID	ADDR	BYTE	NAME
#20010	0	0	0	0	1 ASF30
#20020	15	0	254	0	1 Ethernet/IP CPU
#20010	0	0	0	0	1 ASF30
15	0	254	0	1	1 Ethernet/IP CPU
15	0	0	1	8	1 Ethernet/IP CPU
15	0	1	9	24	1 ROBOTIQ 2F

EXTERNAL IO ALLOCATION (INPUT)

ST#	CH	MAC ID	ADDR	BYTE	NAME
#20010	0	0	0	0	1 ASF30
#20060	15	0	254	0	1 Ethernet/IP CPU
#20070	15	0	1	9	24 ROBOTIQ 2F
#20310	15	0	0	1	8 Ethernet/IP CPU

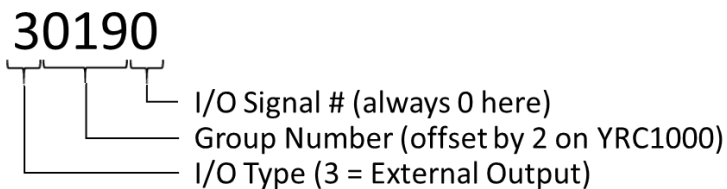
NOTE: Depending on the controller type and its EIP configuration, the “NAME” and “BYTE” entries may vary slightly. However, the “Robotiq 2F” entry should be an **EXACT** match.

Depending on the controller's configuration, the 5 digit I/O value for some entries may not be initialized. This is indicated by "# ----". {Select} one of these values to initialize all entries using {INIT}. This will then allow the user to {MODIFY} the entry as shown above. See the process below for entry initialization.



Press {ENTER} to bring up a similar page for the **External Output Allocation** once the External Input Allocation is finalized.

External Outputs have a similar format shown below:



To change the location of the Output mapping, only the middle three numbers (defining the I/O Group Number) should be changed. This will define the **Output Group Number** where the associated Outputs will map. The table below shows a few example mappings and where they will land on YRC1000 vs. YRC1000micro (output values are offset by 2 on the YRC1000).

External Output #	YRC1000 Group #	YRC1000 Individual #'s	YRC1000micro Group #	YRC1000micro Individual #'s
30070	5	33 to 40	7	49 to 56
30310	29	225 to 232	31	241 to 248
31500	148	1177 to 1184	150	1193 to 1200

For the Robotiq 2F gripper, 20 bytes of EtherNet/IP Output data should be mapped to **30070**. See differences in the table above.

Similar to the process for External Inputs, edit the 5 digit entries on the “External IO Allocation (OUTPUT)” screen to match the **content** and **order** of the values highlighted in red below before proceeding. Press {Select} → {MODIFY} to edit the Output entries.

ST#	CH	MAC ID	ADDR	BYTE	NAME
#30010	0	0	0	1	ASF30
#30020	15	0	254	0	Ethernet/IP CPU
#30060	15	0	254	0	Ethernet/IP CPU
#30070	15	0	1	9	ROBOTIQ 2F
#30310	15	0	0	1	Ethernet/IP CPU
#-----	15	0	252	29	Ethernet/IP CPU

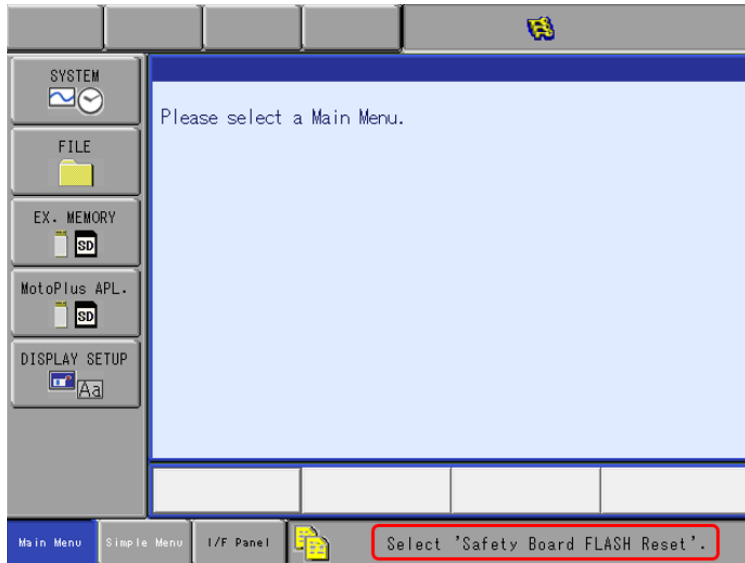
NOTE: Depending on the controller type and its EIP configuration, the “NAME” and “BYTE” entries may vary slightly. However, the “Robotiq 2F” entry should be an **EXACT** match.

After finalizing the External Output allocation, press {ENTER} to bring up another “Modify” pop-up. Select {YES} to complete the configuration. This action reverts back to the “Option Function Screen”.

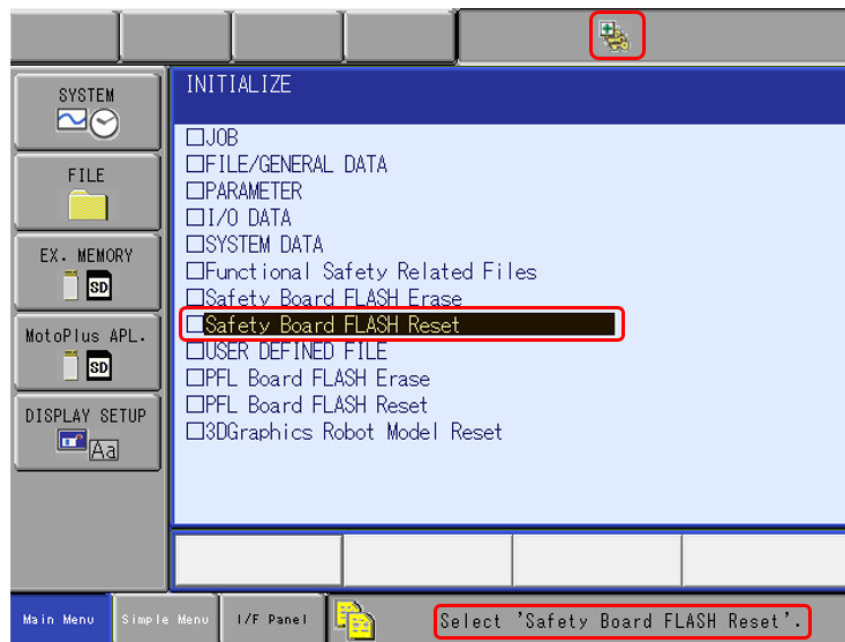
ST#	CH	MAC ID	ADDR	BYTE	NAME
#30010	0	0	0	1	ASF30
#30060	15	0	254	0	Ethernet/IP CPU
#30070	15	0	1	9	ROBOTIQ 2F

Save EtherNet/IP Configuration

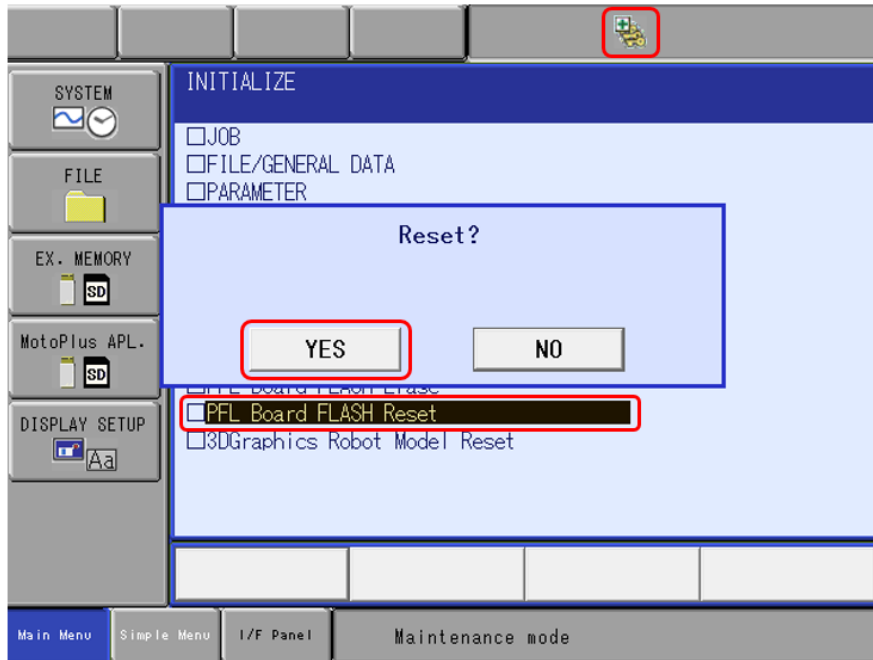
Resets are required for controllers with Safety and/or PFL boards. A “Safety Board Flash Reset” is required to **SAVE** changes made to the EtherNet/IP configuration on a SMART Series controller with the Functional Safety Unit (FSU) option.



To perform the “Safety Board FLASH Reset”, change the Security Level to “Safety” on Software Pendant. Next, navigate to {FILE} → {INITIALIZE} from the Main Menu. Scroll to “Safety Board FLASH Reset” and press {SELECT}. A dialog appears: {Reset?} → {Yes}



If the SMART Series robot is equipped with Power and Force Limiting (PFL) technology, a “PFL Board FLASH Reset” will also be required. In Security Level = “Safety”, scroll to this entry and press {SELECT}. A dialog appears: {Reset?} → {Yes}



Restart the robot controller (~2-3 minutes) after all resets are complete to exit Maintenance Mode. Close Software Pendant and **switch to Smart Pendant** for the remainder of the setup procedure.

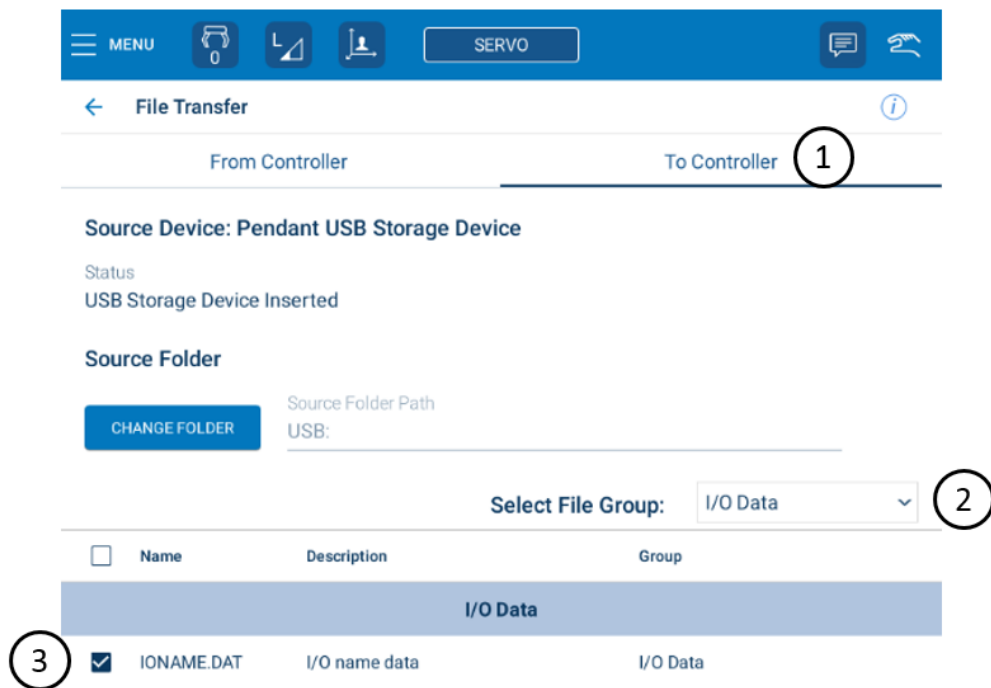
LOAD ROBOTIQ FILES & VERIFY I/O ALLOCATION

Predetermined names for the allocated external I/O reserved for the Robotiq 2F gripper can be loaded onto Smart Pendant using the File Transfer utility from the Main Menu. A sample job file to operate the Robotiq gripper is also provided as a reference.

WARNING: Performing the steps below will **OVERWRITE** any existing I/O names already on Smart Pendant. Export the existing IONAME.DAT file from Smart Pendant to merge its contents with the Robotiq 2F IONAME.DAT file using an appropriate application (e.g. WinMerge).

Load IONAME.DAT Instructions

1. Load YASKAWA supplied IONAME.DAT and ROBOTIQ-2F.JBI files onto the root folder of a USB storage device for the applicable SMART Series controller (YRC1000 or YRC1000micro)
2. Insert USB storage device into Smart Pendant (bottom-right)
3. Change the Smart Pendant Mode to “Teach” and the Security Level to “Management” (999999)
4. Navigate to the file transfer screen {Utility} → {File Transfer} from the Main Menu



- ① Select {To Controller} as the File Destination
- ② Select {I/O Data} as the File Group
- ③ Select checkbox adjacent to “IONAME.DAT”

5. Press {COPY FILES TO CONTROLLER} to copy the I/O Names for Robotiq to the pendant

1 file(s) in the source folder, 1 file(s) selected

COPY FILES TO CONTROLLER

6. Prompt for “File Transfer to Controller Confirmation” appears – Select {YES}
7. A status bar for “copying files to controller” will appear with a confirmation when complete

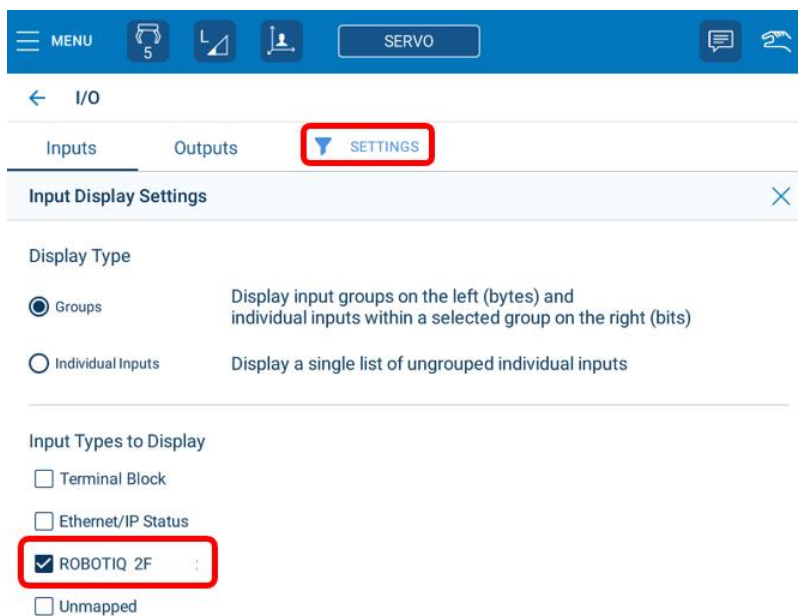
Load ROBOTIQ-2F.JBI Instructions

While on the File Transfer Screen with the USB storage device inserted:

1. Select {To Controller} as the File Destination
2. Select {Job} as the File Group
3. Select checkbox adjacent to “ROBOTIQ-2F.JBI”
4. Press {COPY FILES TO CONTROLLER} to copy the Robotiq Job to the pendant

Filter Visible I/O Types

1. Navigate to {MENU} → {Program Operate} → {I/O}. Select the {Inputs} tab and press {SETTINGS}



2. "Input Display Settings" window appears - this allows the user to filter varying types of allocated inputs on the I/O screen
 - Verify the {Groups} button is checked
 - Select the checkbox next to "ROBOTIQ 2F" (or another name specified by the user during setup) for the Robotiq 2F gripper. *Uncheck all other boxes* to limit visible I/O to those allocated for communication with the gripper.
3. Press the "X" to collapse the "Input Display Settings" window
4. The *Inputs* panel of the left side of the I/O screen should now only show **Groups 5 to 28** for YRC1000 or **Groups 7 to 30** for YRC1000micro. The first entry on the right panel should indicate which controller is active ("YRC1000" or "micro")

Group	Inputs	Status
7	49-56	○○○○ ○○○○
8	57-64	○○○○ ○○○○
9	65-72	○○○○ ○○○○
10	73-80	○○○○ ○○○○
11	81-88	○○○○ ○○○○
12	89-96	○○○○ ○○○○
13	97-104	○○○○ ○○○○
14	105-112	○○○○ ○○○○
15	113-120	○○○○ ○○○○

Input	Status	Name
49	○	RBTQ micro B0
50	○	RSVD Robotiq_2F
51	○	RSVD Robotiq_2F
52	○	RSVD Robotiq_2F
53	○	RSVD Robotiq_2F
54	○	RSVD Robotiq_2F
55	○	RSVD Robotiq_2F
56	○	RSVD Header B0

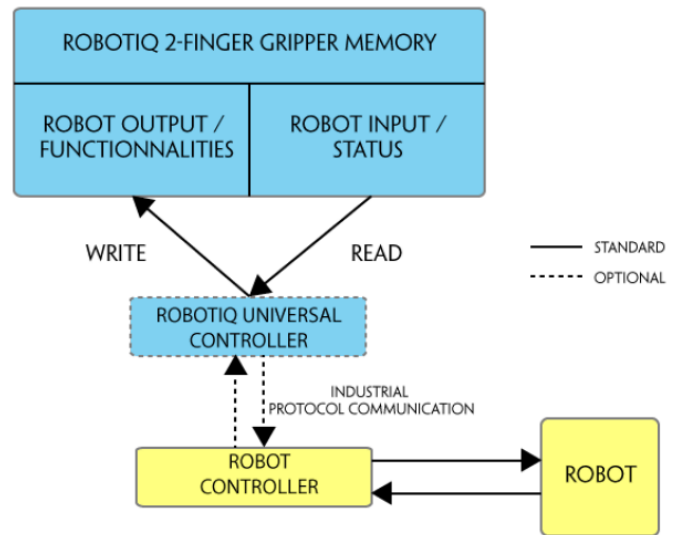
5. Select the {Outputs} tab and repeat Steps 1 - 3 to properly filter *Outputs* reserved for use with the Robotiq 2F gripper
6. The *Outputs* panel of the left side of the I/O screen should now only show **Groups 5 to 24** for YRC1000 or **Groups 7 to 26** for YRC1000micro

Gripper Register Mapping

The Robotiq 2F gripper has internal memory that is shared with the robot controller. One block of memory is dedicated to robot outputs (i.e. gripper actions). The other is dedicated to robot inputs (i.e. gripper status). The robot controller can then perform two types of actions:

1. **Write** robot output registers to activate gripper functionalities
2. **Read** robot input registers to get the status of the Gripper

For more information on the details and use of each register, please review Chapter 4 of the Robotiq 2-Finger Gripper Instruction Manual



Mapped Inputs (24 bytes)

Robotiq Register	YRC1000 Input Group #	YRC1000micro Input Group #	Robot Input / Status
Byte 0 to 3	5 to 8	7 to 10	Header
Byte 4	9	11	Gripper Status
Byte 5	10	12	Reserved
Byte 6	11	13	Fault Status
Byte 7	12	14	Position Request Echo
Byte 8	13	15	Position
Byte 9	14	16	Current
Byte 10 to 23	15 to 28	17 to 30	Reserved

Mapped Outputs (20 bytes)

Robotiq Register	YRC1000 Output Group #	YRC1000micro Output Group #	Robot Output / Functionalities
Byte 0	5	7	Action Request
Byte 1	6	8	Reserved
Byte 2	7	9	Reserved
Byte 3	8	10	Position Request
Byte 4	9	11	Speed
Byte 5	10	12	Force
Byte 6 to 19	11 to 24	13 to 26	Reserved

VERIFY GRIPPER COMMUNICATION AND OPERATION

1. On the I/O screen, select {Outputs} tab

Inputs	Outputs	SETTINGS
Group	Outputs	Status
7	49-56	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
8	57-64	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
9	65-72	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

GROUP: 7
OUTPUT: 49-56
TYPE: ROBOTIQ 2F

VALUE (DEC): 1
VALUE (HEX): 0x01

Enable toggle

Output	Status	Name	Toggle
49	<input checked="" type="checkbox"/>	Activate /rACT	<input checked="" type="checkbox"/>

2. Select the {Enable toggle} checkbox and toggle the “Activate /rACT” bit ON
3. Select {Inputs} tab. Verify the “Activated? /gACT” bit is ON

Inputs	Outputs	SETTINGS
Group	Inputs	Status
7	49-56	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
8	57-64	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
9	65-72	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
10	73-80	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
11	81-88	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
12	89-96	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
13	97-104	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

GROUP: 11
INPUT: 81-88
TYPE: ROBOTIQ 2F

VALUE (DEC): 49
VALUE (HEX): 0x31

Input	Status	Name
81	<input checked="" type="checkbox"/>	Activated? /gACT
82	<input type="checkbox"/>	RSVD Grip Status
83	<input type="checkbox"/>	RSVD Grip Status
84	<input type="checkbox"/>	Go To Pos? /gGTO
85	<input checked="" type="checkbox"/>	2F_Status /gSTA4
86	<input checked="" type="checkbox"/>	2F_Status /gSTA5

4. Return to the {Outputs} tab. Select the {Enable toggle} checkbox and toggle the “Go To Pos /rGTO” bit ON
5. Select {Inputs} tab. Verify the “Go To Pos? /gGTO” bit is ON
6. If one or both of these bits are not behaving as expected, cycle power to the gripper’s controller and try toggling each again to establish active communication between the robot and gripper.

DEFINE PHYSICAL PROPERTIES OF GRIPPER ON SMART PENDANT

The physical properties of the Robotiq 2F gripper must be defined on Smart Pendant for various features to work properly, including but not limited to:

- Robot Tool Center Point (TCP). Used for:
 - Jogging Behavior
 - User Frames
 - Zones
 - Robot Range Limits
- Shock Detection
- PFL Technology
 - External Force Limits
 - Hand Guiding

How to Define Tool Properties on Smart Pendant

1. Changes the Smart Pendant Security Level to “Safety”
 - Factory default passcode is sixteen 5’s. Press {SAVE} to change the level to SAFETY
2. Navigate to {Robot Settings} → {Tools} from the Main Menu
3. Choose a pair of **Tool Numbers** to be used for the two states of the Robotiq gripper
 - Empty = no workpiece, (e.g. Tool #10)
 - Picked = gripper + workpiece, (e.g. Tool #11)



The screenshot shows the 'Tools' menu on a Smart Pendant. At the top, there is a blue header bar with icons for 'MENU', '10', 'H', a person icon, and a 'SERVO' button. Below the header, there is a search bar with a magnifying glass icon and a 'Display only named' checkbox. The main content is a table with four columns: 'Tool No.', 'Tool Name', 'Weight', and 'Block I/O Name'. The table has three rows of data. The second row is highlighted in light blue and includes a 'CLEAR I/O' button with an 'X' icon.

Tool No. ▲	Tool Name	Weight	Block I/O Name
9	-	0.000	-
10	Robotiq2F	0.900	Robotiq2F I/O ⊗ CLEAR I/O
11	Robotiq2F + Load	3.000	Robotiq2F I/O

4. Select Tool #10 in the list at the top of the screen. In the details panel below, enter a name for Tool #10 (e.g. Robotiq2F) and press {SAVE}
5. Repeat step 4 for Tool #11 (e.g. Robotiq2F + Load)

6. Determine the physical properties of the Open and Closed states of the Robotiq 2F gripper
 - These can be found in Section 6.2.3 of the Robotiq 2F Gripper Instruction manual

Coupling is included when Gripper is not mounted on the Camera. Dual Gripper adapter plate included where appropriate.

End-of-arm tooling	TCP (mm)						Center of mass (mm)			Mass (g)
	Gripper 1			Gripper 2			X	Y	Z	
	X	Y	Z	X	Y	Z				
FT 300 Force Torque Sensor	0.0	0.0	37.5	-	-	-	0.0	0.0	17.0	300.0
Wrist Camera	0.0	0.0	23.5	-	-	-	0.0	5.0	9.0	230.0
2F-85	0.0	0.0	171.0	-	-	-	0.0	0.0	57.0	900.0
2F-140	0.0	0.0	241.0	-	-	-	0.0	0.0	66.0	975.0
Hand-E	0.0	0.0	156.8	-	-	-	0.0	0.0	58.0	1070.0

- Convert the Moment of Inertia values in Section 6.2.3 from kg*mm² to kg*m²

2-FINGER 85 OPTION

$$I = \begin{bmatrix} I_{XX} & I_{XY} & I_{XZ} \\ I_{YX} & I_{YY} & I_{YZ} \\ I_{ZX} & I_{ZY} & I_{ZZ} \end{bmatrix} = \begin{bmatrix} 4180 & 0 & 0 \\ 0 & 5080 & 0 \\ 0 & 0 & 1250 \end{bmatrix} \begin{matrix} \\ \\ \text{kg} * \text{mm}^2 \end{matrix} = \begin{bmatrix} 14.3 & 0 & 0 \\ 0 & 17.4 & 0 \\ 0 & 0 & 4.3 \end{bmatrix} \begin{matrix} \\ \\ \text{lb} * \text{in}^2 \end{matrix}$$

2-FINGER 140 OPTION

$$I = \begin{bmatrix} I_{XX} & I_{XY} & I_{XZ} \\ I_{YX} & I_{YY} & I_{YZ} \\ I_{ZX} & I_{ZY} & I_{ZZ} \end{bmatrix} = \begin{bmatrix} 7400 & 0 & 0 \\ 0 & 9320 & 0 \\ 0 & 0 & 2260 \end{bmatrix} \begin{matrix} \\ \\ \text{kg} * \text{mm}^2 \end{matrix} = \begin{bmatrix} 25.3 & 0 & 0 \\ 0 & 31.8 & 0 \\ 0 & 0 & 7.7 \end{bmatrix} \begin{matrix} \\ \\ \text{lb} * \text{in}^2 \end{matrix}$$

- For the “Picked” state of the gripper, combine the physical properties of both the gripper and the object that is picked. This can be accomplished using detailed CAD models or calculated manually. Instructions for how to calculate this manually are included in Section 8.4.3 of the Yaskawa Controller Instructions Manual.
 - All physical properties of both tool states should be different unless the workpiece is very small/light. **Mass**, **Center of Gravity**, and **Tool Center Point** are the most important to calculate very accurately for optimum performance.
7. Enter these physical properties for both states of the Robotiq gripper into their respective fields on the details panel for both Tools #10 and #11. Pull up the “Advanced Tool Settings” using the arrow at the bottom right of the screen to view “Center of Gravity”, “Moment of Inertia”, and “Orientation of Tool Tip”.

The detail panel for the “empty” Robotiq gripper state are shown below.

Tool #10: Robotiq2F

Name [i](#)
Robotiq2F

Block I/O
Robotiq2F I/O ▼

The TCP is the offset from the Flange Center Point Set the Tool Center Point (TCP)



Show without tool

X_F

Y_F

Z_F

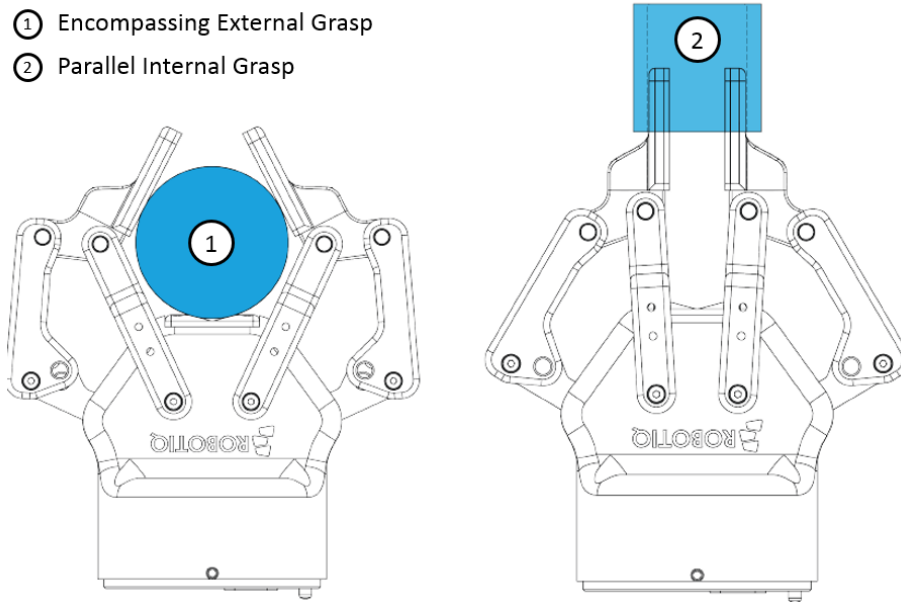
Advanced Tool Settings (improves performance) ▼

Center of Gravity	Moment of Inertia	Orientation of Tool Tip
X _G <input style="width: 100px;" type="text" value="0.000 mm"/>	I _x <input style="width: 100px;" type="text" value="0.002 kg-m<sup>2</sup>"/>	R _x <input style="width: 100px;" type="text" value="0.0000 deg"/>
Y _G <input style="width: 100px;" type="text" value="0.000 mm"/>	I _y <input style="width: 100px;" type="text" value="0.003 kg-m<sup>2</sup>"/>	R _y <input style="width: 100px;" type="text" value="0.0000 deg"/>
Z _G <input style="width: 100px;" type="text" value="57.000 mm"/>	I _z <input style="width: 100px;" type="text" value="0.001 kg-m<sup>2</sup>"/>	R _z <input style="width: 100px;" type="text" value="0.0000 deg"/>

PROGRAMMING WITH SMART PENDANT

The Robotiq 2F gripper is capable of picking a wide variety of shapes by means of fingers that automatically adapt to the shape of the object manipulated. This adaptation can be a “parallel grasp” or an “encompassing grasp”. Additionally, the gripper is capable of “external” and “internal” grasps. A visual example of each is provided below. Please review the Robotiq 2F Instruction manual for more information prior to programming, included a detailed example of the “Equilibrium Line”.

- ① Encompassing External Grasp
- ② Parallel Internal Grasp



Several different features can be used to operate and program the Robotiq 2F Gripper using Smart Pendant. An overview and instructions on how to use each are included in the following sections.

1. I/O Screen (used in the Verify Gripper section)
 - View status of Inputs and Outputs (group and individual)
 - Toggle status of Individual Outputs (i.e. output bit)
2. INFORM Programming
 - INFORM I/O commands can be used in a job to read/write gripper data
 - Multiple jobs can be nested using the CALL JOB command
 - i. User creates a sub-job with all logic required to operate the Robotiq Gripper
 - ii. User creates a master job that executes the sub-job for common gripper commands using a single line (e.g. CALL JOB: Robotiq-2F Force=255 etc.)
3. Block I/O
 - Physically open/close the Robotiq gripper during teaching
 - Quickly add gripper open/close INFORM command sequences to the “current job”

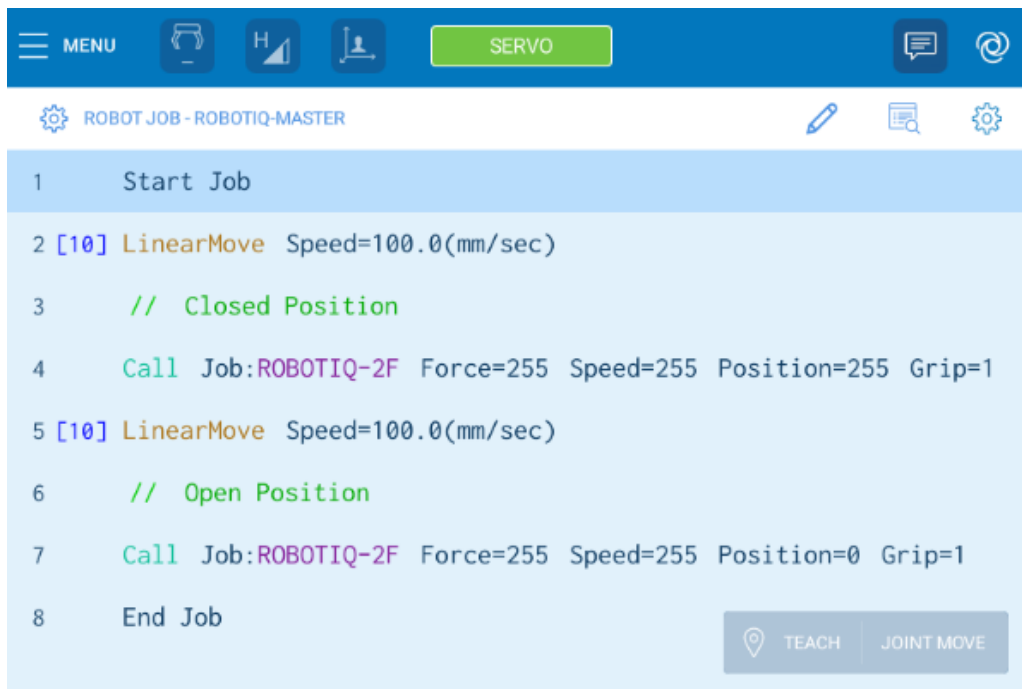
INFORM JOBS: SINGLE OR NESTED PROGRAMS

The CALLJOB command can be leveraged on Smart Pendant to achieve the following:

1. User creates a “sub-job” with all logic required to operate the gripper (e.g. Robotiq-2F)
2. User creates a “master-job” (e.g. Robotiq-Master) that opens/closes the gripper using a single line to call sub-job (CALL Job: Robotiq-2F) with the following user-customizable parameters:
 - Force 0 = Minimum Force, 255 = Maximum Force
 - Speed: 0 = Minimum Speed, 255 = Maximum Speed
 - Position: 0 = Open, 255 = Closed
 - Grip: 0 = External Grasp, 1 = Internal Grasp

NOTE: This sub-job is only a *reference*. The user should review its contents to determine whether it contains ALL necessary logic for the intended application.

A brief example of master-job → sub-job method is provided below.



```
1 Start Job
2 [10] LinearMove Speed=100.0(mm/sec)
3 // Closed Position
4 Call Job:ROBOTIQ-2F Force=255 Speed=255 Position=255 Grip=1
5 [10] LinearMove Speed=100.0(mm/sec)
6 // Open Position
7 Call Job:ROBOTIQ-2F Force=255 Speed=255 Position=0 Grip=1
8 End Job
```

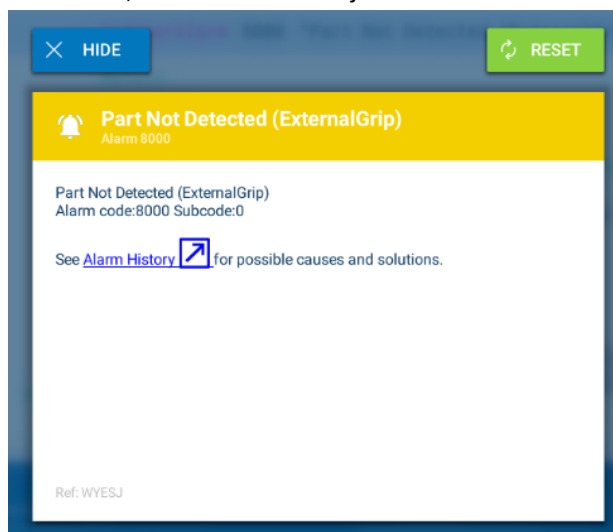
The “Robotiq-2F.JBI” sub-job that was previously loaded to the pendant achieves the following:

- Reads job arguments that contain parametric gripper data (i.e. force, speed, position, grip) passed by the user from the master job to the sub-job using the “Call Job:” command.

- Assigns parametric data to “local variables” specific to the “Robotiq-2F.JBI sub-job for gripper analysis operation. Local variables can be accessed and configured using the “Settings” button on the top-left of the INFORM screen



- Checks if gripper is **activated**. Attempts to activate if the gripper is inactive
- Checks direction of the position request (opening or closing)
- Set grasp parameters commanded by user and trigger Robotiq **GoTo** position signal
- Verifies successful grasp of the workpiece using
 - Alarms in the case of an unsuccessful grasp using Smart Pendant’s **SetUserAlarm** command. If this occurs, the user can reset the workpiece/items in the workcell, reset this alarm, and continue the job from where it was paused. See the example below



BLOCK I/O: APPLICATION SETUP AND PROGRAMMING

A Block I/O setting can be created to control a tool with a pair of states (e.g. OFF/ON). The user can insert a sequence of commands for each state that will be used frequently during programming. These “blocks” of commands can then be used to:

- Physically open/close the gripper during teaching
- Add INFORM command sequences that open/close the gripper to the current job

How to Create a Block I/O Setting for the Robotiq 2F Gripper

1. Navigate to {Program/Operate} → {Block I/O} screen from the Main Menu
2. Press {+ New Block I/O} at the top of the screen to create a new setting that contains command sequences to open and close the Robotiq gripper. See Chapter 7.5 in the Smart Pendant Instruction Manual for more detail on this feature

Block I/O: Robotiq2F I/O

Name: Robotiq2F I/O Select State to Edit: **OFF** **ON** ⓘ

OFF State Commands: **Test State** ON State Commands:

OFF State Commands:

- Timer T=0.200
- DigitalOut OT#(49) ON
- DigitalOut OG#(11) 100
- DigitalOut OG#(12) 100
- DigitalOut OG#(10) 0
- DigitalOut OT#(52) ON
- Timer T=0.200

ON State Commands:

- Timer T=0.200
- DigitalOut OT#(49) ON
- DigitalOut OG#(11) 100
- DigitalOut OG#(12) 100
- DigitalOut OG#(10) 255
- DigitalOut OT#(52) ON
- Timer T=0.200

→ DigitalOut → Group DigitalOut ⚙️ Timer

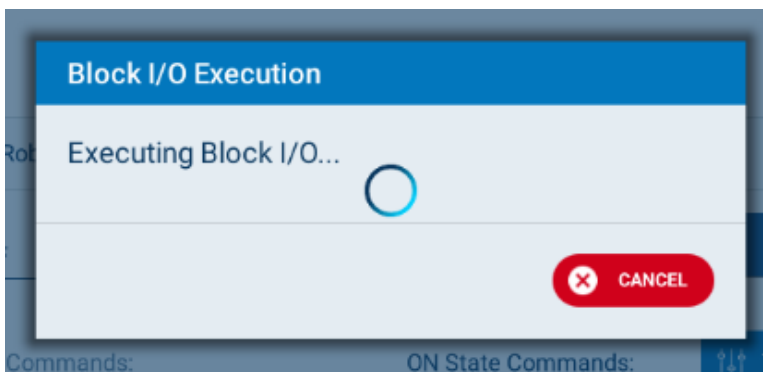
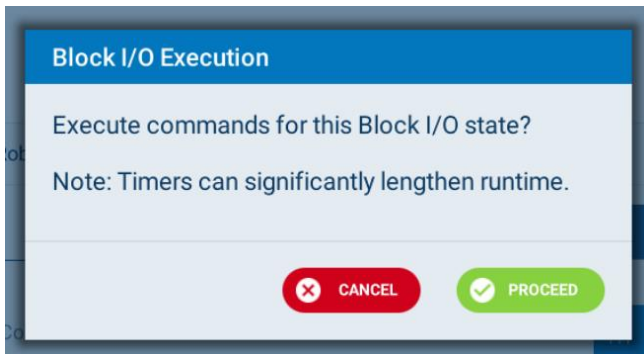
- Timers can be used at the start/end of a setting to ensure actions are properly activated
- DigitalOut OT#49 is the gripper **activation bit** on the YRC1000micro

49	<input checked="" type="checkbox"/>	Activate /rACT
50	<input type="checkbox"/>	RSVD Action Req
51	<input type="checkbox"/>	RSVD Action Req
52	<input checked="" type="checkbox"/>	Go To Pos /rGT0

- DigitalOut OG#11 is the commanded gripper **speed** on the YRC1000micro
- DigitalOut OG#12 is the commanded gripper **force** on the YRC1000micro
- DigitalOut OG#10 is the commanded gripper **position** on the YRC1000micro
- DigitalOut OT#52 is the gripper **GoTo position bit** on the YRC1000micro

NOTE: This Block I/O setting is a **reference example**. The user should review its contents to determine whether it contains ALL necessary logic for the intended application.

3. Use the {TEST STATE} button to verify the operation of the programmed command sequence.

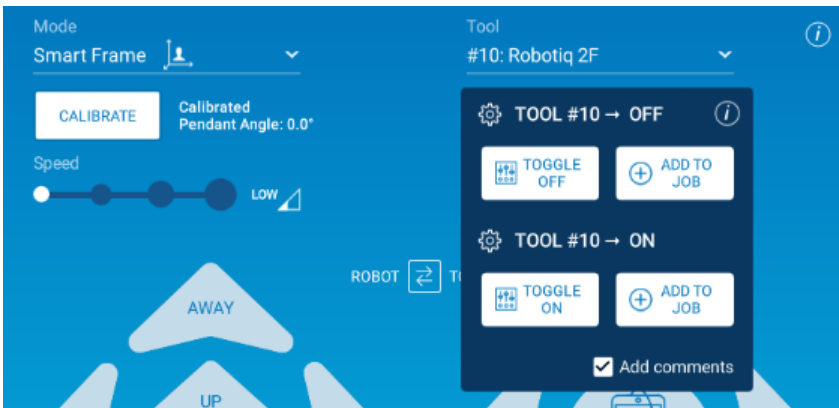


4. Navigate to the Current Job that will be used to program the Robotiq gripper {e.g. RobotiqJob}

5. Create a link between the active tool (i.e. Tool #10) and the Block I/O setting that was just created. Navigate to {Robot Settings} → {Tools} from the Main Menu and select the “Block I/O” setting created for controlling the Robotiq gripper from the drop down.



6. Go back to the Current Job. Open the “Block I/O: Tool #” dropdown from the Jog Panel



7. {Toggle OFF} or {Toggle ON} will physically perform the respective action similar to {Test State} in Step 3
8. {Add To Job} will add the setting’s INFORM commands to the current job at the highlighted line

```

ROBOT JOB - ROBOTIQ2F
1 Start Job
2 // Start OFF
3 Timer Time=0.200(seconds)
4 DigitalOut Output#(49) ON
5 DigitalOut OutputGroup#(11) 100
6 DigitalOut OutputGroup#(12) 100
7 DigitalOut OutputGroup#(10) 0
8 DigitalOut Output#(52) ON
9 Timer Time=0.200(seconds)
10 // End OFF
11 End Job

```