RV-8CRL Robotic Work Cell

User Manual

Fall 2023 - Spring 2024

Last revised: 05/08/2024

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Overview

The Mitsubishi RV-8CRL robotic work cell housed in ERB 335 serves as a simulated environment for industrial processes. The work cell can be modified to accomplish several application tasks like palletizing/depalletizing, industrial painting, etc.

This user manual serves as a 'getting started' guide intended for future users of the robotic work cell. This manual will detail components of the work cell, how to operate the robotic work cell, and point to areas for help & documentation.

Components

Mitsubishi RV-8CRL Robot Arm

- Powerful vertical robot arm has 6 joints (degrees of freedom), with a max payload of 8 kilograms.
- Mounted on top of a linear rail.
- Controlled by the CR800-D controller.
- 2 tool pneumatic pipes at the base and top where air can pass through.
- Specifications link

CR-800 Controller

- Controls robot operation
- Equipped with an emergency stop
- 2 connectors: CNUSR11 and CNUSR12 with emergency stop jumper cables.
- Specifications link

PLC

- FX5UC-32MT/D model

- FX5-8EYR/ES Relay 8 output relay
- Programmable through GX Works software.
- Specifications link

Linear Rail

- 7th additional axis for the linear rail
- 2 inductive proximity limit switches on each end of the rail, wired into the PLC.

Air Compressor & Air Brush

- Air compressor is located behind the control cabinet on the floor.
- Adjustable pressure gauge, preset to 40 psi.
- Air brush is mounted on the tool of the robot arm.
- Pneumatic line runs through the robot arm to supply air to the airbrush.

Light Tower

- 3 signal output tower, 24 V.
- Wired into the PLC input.
- Located in the top corner of the work cell.

Device	Network	Subnet Mask	Default Gateway
PLC	192.168.3.250	255.255.255.0	0.0.0.0
PC	192.168.3.251	255.255.255.0	0.0.0.0
CR-800	192.168.3.252	255.255.255.0	0.0.0.0

Operations

Lockout Tagout

Lockout-Tagout (LOTO) procedure ensures protection of work cell users from hazardous electricity. Do not modify the control cabinet unless the disconnect switches are locked out.

To lockout work cell:

1) Obtain numbered locks and associated keys.
2) Lock the work cell door and the two disconnect switches in an off position.

LOTO Procedure

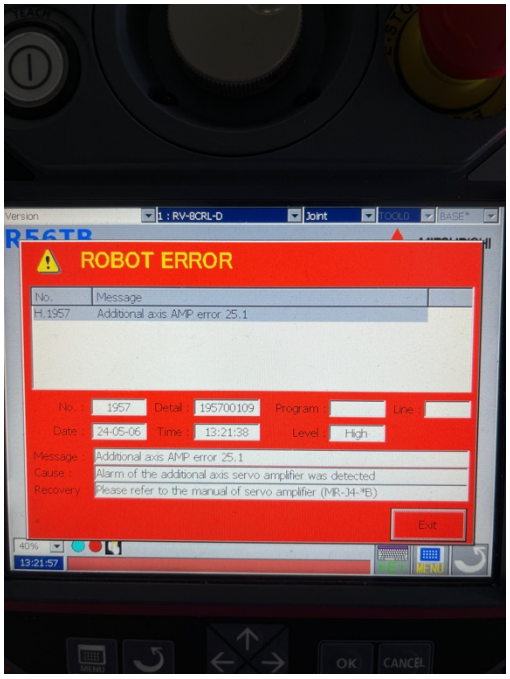
Turning on robot controller

The robot arm and linear rail are controlled through the handheld robot controller.

***NOTE**: when first turning on the robot controller, there will be an error. The following steps mitigate this error.*

To turn on robot controller:

1) Switch both internal breakers to ON position. The top breaker corresponds to the 220V robot arm and linear rail. The bottom breaker corresponds to the PLC and host PC.
2) As the robot controller boots up, an ‘Additional axis AMP error 25.1’ error will occur. To reset this error
    a. Press ‘Exit’ on the error
    b. Navigate to the robot’s ‘Maintenance’ page on the controller
    c. Select ‘Origin Data’
    d. Select ‘User origin method’
    e. Select J7 in the ‘Setting origin’ panel and set the origin.
    f. Write to the robot controller and reset the robot by switching the breakers on and off. An error may occur on reboot. Press reset and it should resolve.



25.1 Error

Setting J7 origin data

Switching to Teach Mode

The robot controller has two modes, teach and automatic. If the user wants to jog the robot through the handheld controller, the robot must be in teach mode. To switch, jumper cables must be configured at the back of the controller in the CNUSR11 connector. Follow directions as provided in Mitsubishi's documentation:

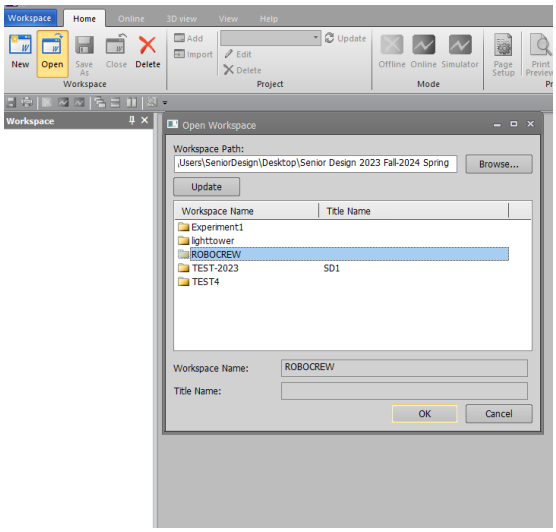
1) Please prepare the emergency stop switch, door switch, and mode selector switch.
2) Connect the contacts of each switch to the contacts as shown below:
   a) External emergency switch
      CNUSR11 connector "between 7 and 23" and "between 14 and 30".
   b) Door switch
      CNUSR11 connector "between 6 and 22" and "between 13 and 29".
   c) Mode selector switch
      CNUSR11 connector "between 5 and 21" and "between 12 and 28".

Source: Mitsubishi Electric CR800 Series Controller setup, basic operation, and maintenance

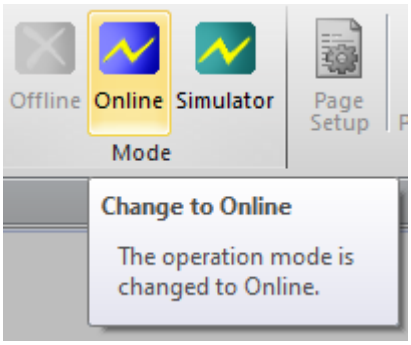
Controlling through PC

To control the robot through the PC, the user must use the RT Toolbox3 software provided by Mitsubishi.

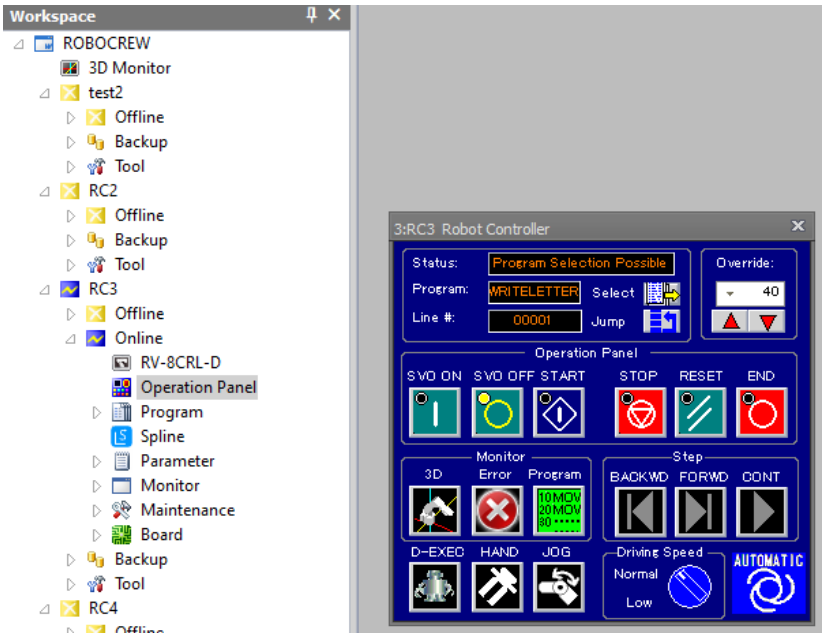
1) Open RT ToolBox3 from the Desktop.
2) Open the ROBOCREW project.
3) Change the mode to 'Online'. If it prompts to select a project, choose RC3. There should be a connection status that turns blue on the PC's navigation bar.
4) In the Workspace tree, select RC3 > Online > Operation Panel.
5) To jog the robot, press the jog panel. Turn the SVO on and ensure the override is low (between 10 and 30). Hold plus or minus on any of the seven joints.



Selecting project



Changing to Online mode



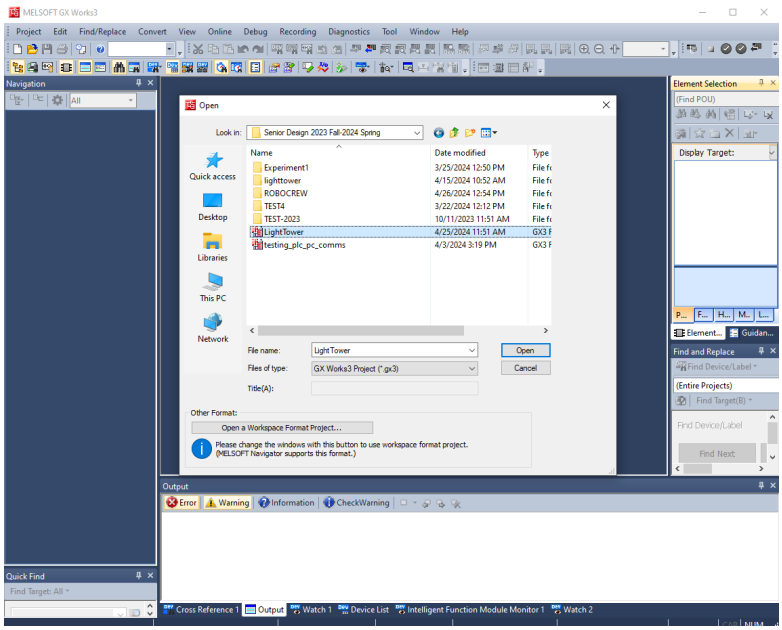
Opening Operation Panel

Jogging from OP

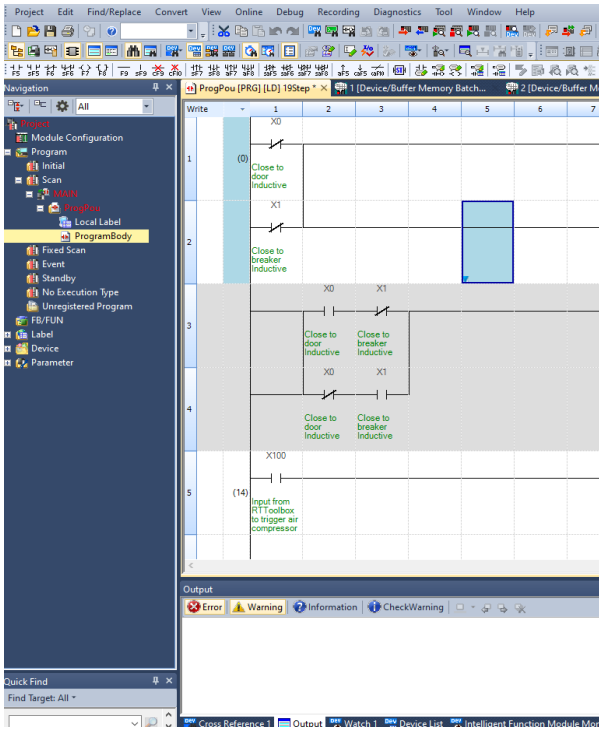
Programming on the PLC

The PLC houses the signal logic for the work cell, including limit switches and the light tower. To modify these programs, the user must use GX Works software provided by Mitsubishi

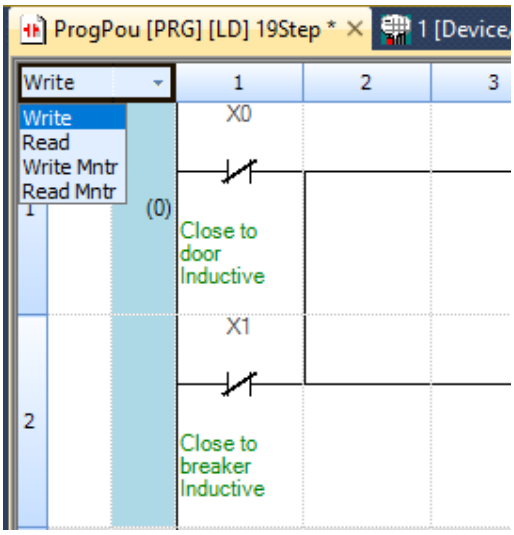
1) Open GX Works3 software located on Desktop.
2) Open the project ‘LightTower’. This is located in the following directory C:\Users\SeniorDesign\Desktop\Senior Design 2023 Fall-2024 Spring
3) Ensure the software is on Write mode.
4) Edit the ladder logic accordingly. Several tutorials can be found online and in Mitsubishi documentation.



Opening LightTower project



Locating program

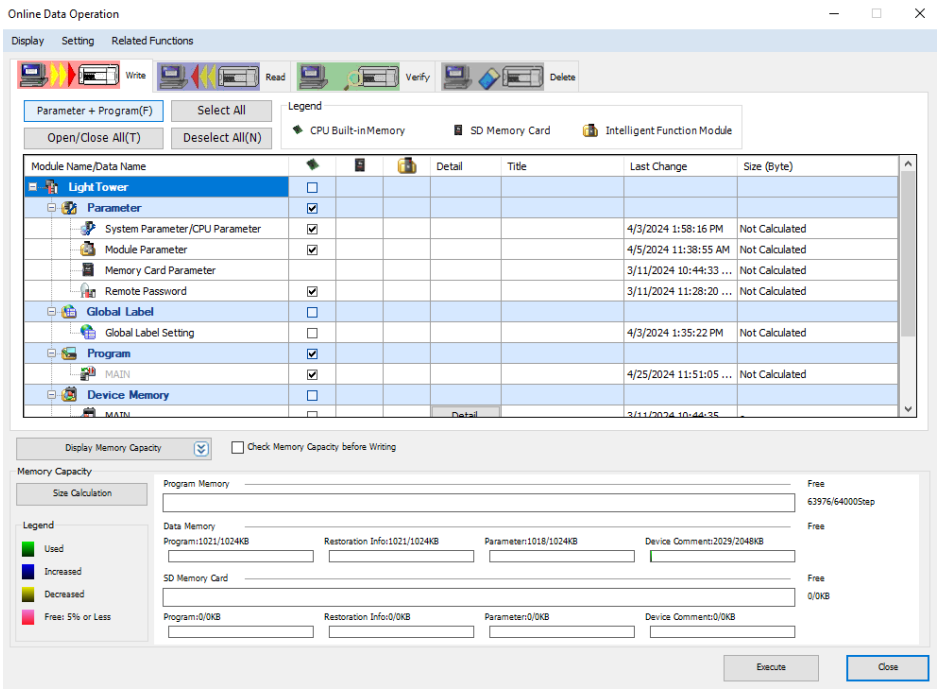


Setting mode to 'Write'

Writing to PLC and Monitoring

To execute a program in the PLC, it must be written.

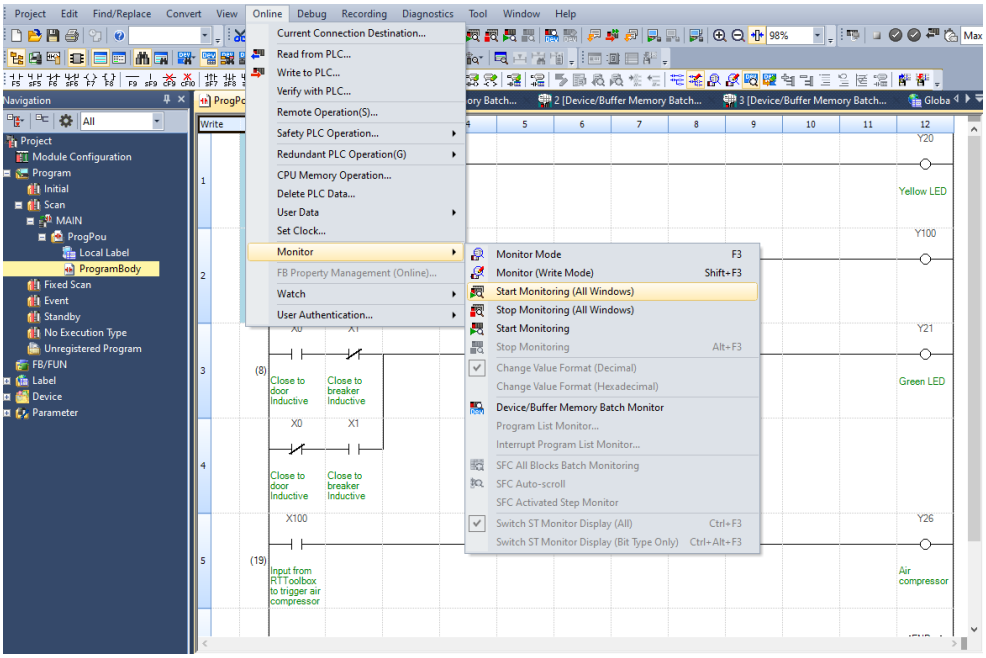
1) Select Convert > Convert(B) in the menu bar to convert the revised program.
2) Select Online > Write to PLC...
3) Choose Parameter + Program and press Execute.
4) The software may prompt a reset of the PLC to write. If so, open the control cabinet and set the reset switch down for 3 seconds until it starts flashing, Then flick it up to RUN and the program is written.



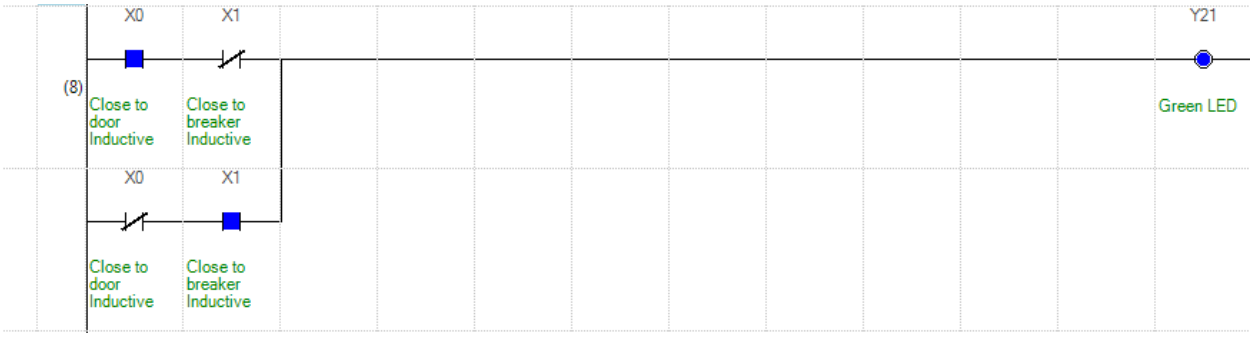
Writing a program to PLC

To view live state of signals read from the PLC, you can monitor the signals.

1) Select Online > Monitor > Start Monitoring (All Windows)



Start monitoring

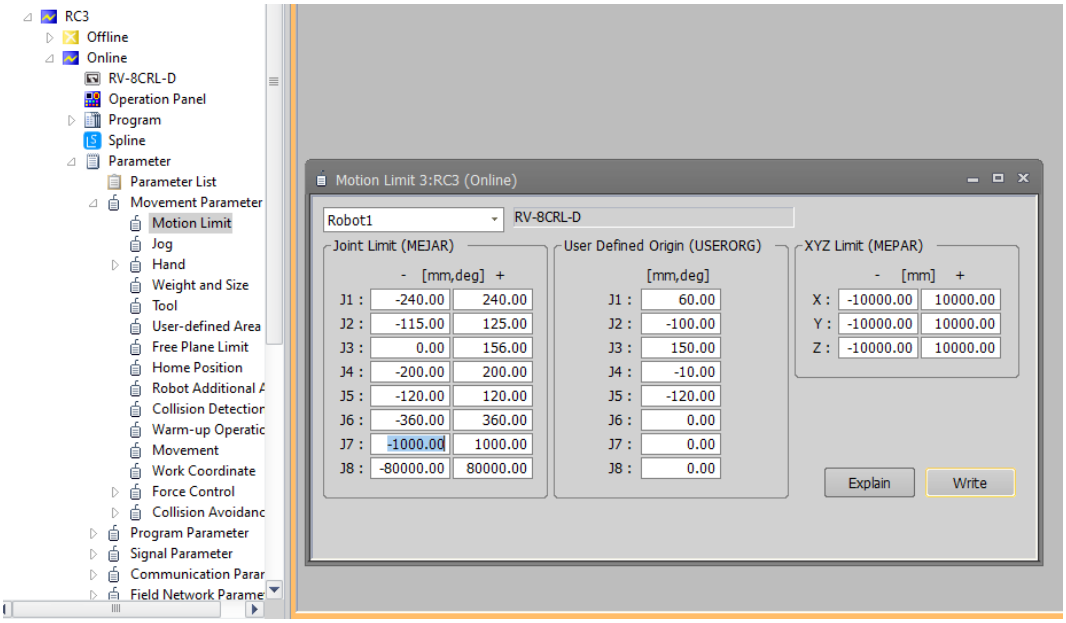


Monitoring program

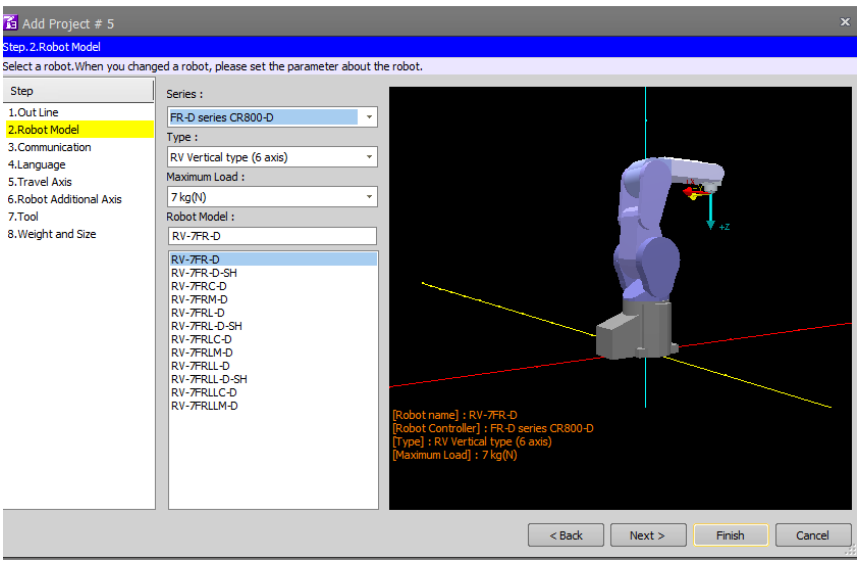
Updating Robot Parameters

Robot parameters include motion limits, speed, etc. These can be written from the handheld robot controller or the RT ToolBox software.

1) In RT Toolbox, select RC3 > Online > Parameter.
2) Edit specified parameter and write to controller.



Updating motion limit parameter for J7



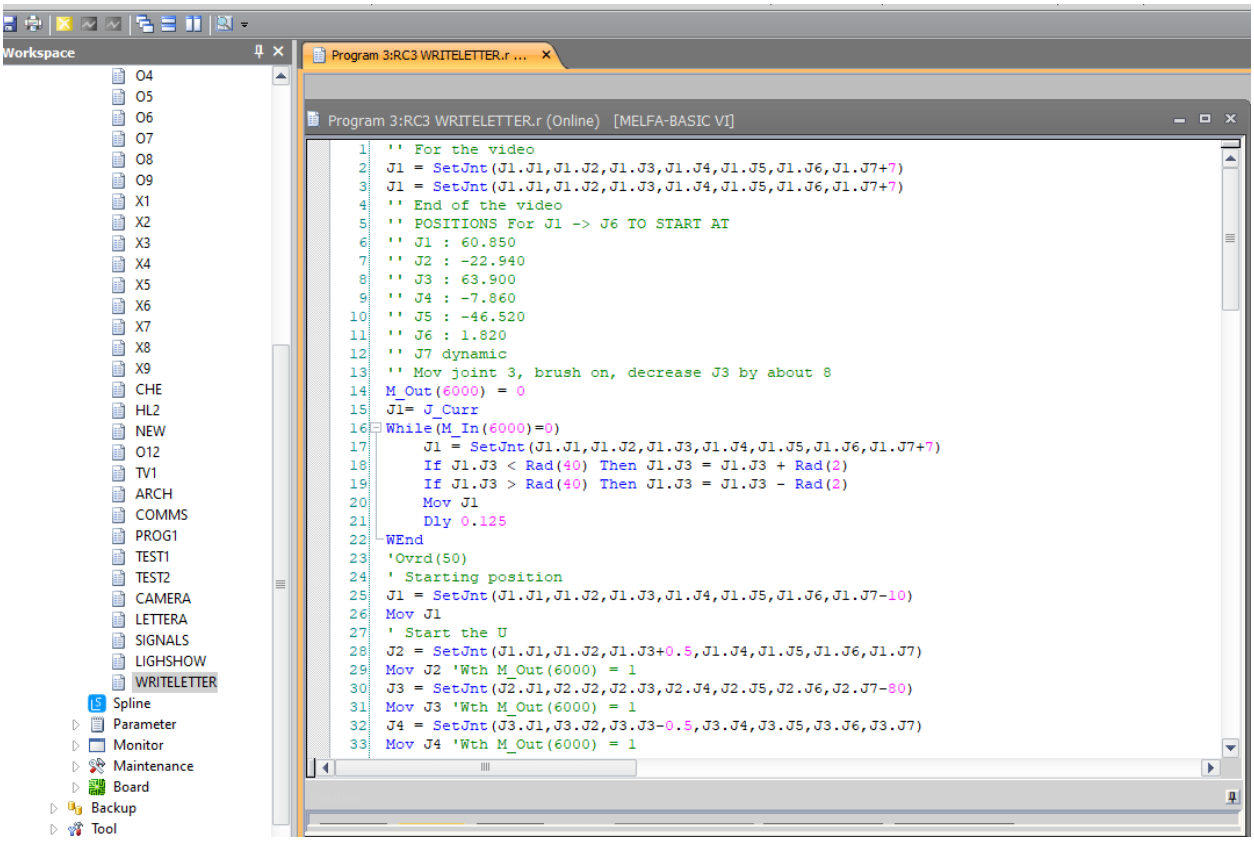
Updating robot project

Programming the Robot

To write a program to the robot, a program must be written in the MELFA BASIC VI language. View example programs on the PC or in the project GitHub repository under this path:

C:\Users\SeniorDesign\Desktop\Senior Design 2023 Fall-2024 Spring\ROBOCREW\RC3\Program

Instructions for programming are found in [Mitsubishi documentation.]



Sample program with calibration sequence and letter writing

Miscellaneous

Painting Application

The work cell application is currently set to painting. The team used several plastic tarps to cover the work cell for protection. The team used food coloring to spray the air brush towards the window. Refill the airbrush with red food coloring to the top of the reservoir and run the WRITELETTER.prg program. Note, the M_Out(6000) = 1 indicates activation of the spraying.

Mounting the Air Brush

The air brush is mounted through a 3D printed mount. Contact the Lab Coordinator for the design file. The air brush is also zip tied so it is always activated.

MR Configurator

The team installed the linear rail through setting parameters in a software suite called MR Configurator. The team utilized a demo version of the software.

Networking

Networking is configured through CC-Link IE Field Basic, a protocol established by Mitsubishi, This links the PC, PLC, and robot controller together through an established connection. Below are the networks used by each device:

Device	Network	Subnet Mask	Default Gateway
PLC	192.168.3.250	255.255.255.0	0.0.0.0
PC	192.168.3.251	255.255.255.0	0.0.0.0
CR-800	192.168.3.252	255.255.255.0	0.0.0.0

Closing

We wish you good luck operating the robotic work cell and look forward to seeing what is to be accomplished by future teams.

For any help, feel free to contact members of our team. Ask Dr. Chris McMurrough or Lab Coordinator Steve McDermott for our contact details.

Good luck,

Team Robo Crew

Fall 2023 - Spring 2024

Santech Outstanding Senior Design Team Award winners