Fanuc CRX-10IA Collaborative Robot Basics and Jogging

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A collaborative robot allows the robot operator in the area around the machine while it is operating. Safety Protocols called Dual Check Safety (DCS) are in place for when a force opposite the robot movement in detected then the robot will cease operation. For the Fanuc CRX Robot 150 Newtons of pressure or greater will stop the robot from moving. The joints and sensors check force every 8ms.

Four Main Factors that Make a Robot Collaborative

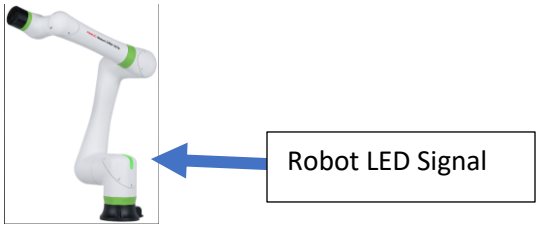
- Monitored Stop: Robot will stop when a human is within the robots workspace and stops when more than a certain value (CRX 150N) of force in the opposite direction of motion before faulting and stop operation
- Hand Gripping: Operator may grip and move the robot into desired positions
- Speed and Separation: Robot motion when separation distance above the minimum separation distance
- Force Limiting: Robot can only impart limited static and dynamic forces

Robot Basics

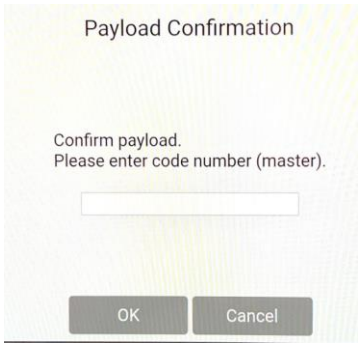
1. Turn on the Power Supply on the front of the machine

2. Turn on the Table TP (Power Bottom on the Left Hand Side; Top Button) > Select the Fanuc Tablet TP Icon

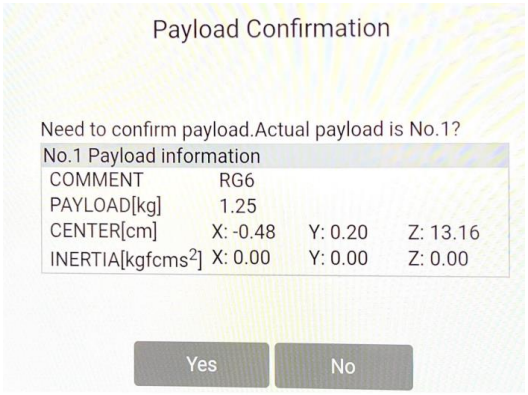
3. Robot Colors: The CRX Robot will tell the user what mode they are in my the color of the LED Strip on the shoulder above Joint 1
    a. Red: Emergency Stop of Fault is occurring
    b. Green: Operational Collaborative Mode
    c. Flashing Green: Call abortive Manual Movement to the Arm is taking place (Human is Holding the Dead-Man Switch in the Middle + Moving the Robot with their free Hand)
    d. Yellow: Non-Collaborative Robot; The robot will behave like a Yellow Industrial Robot without the Collaborative DCS Safety Protocols in place



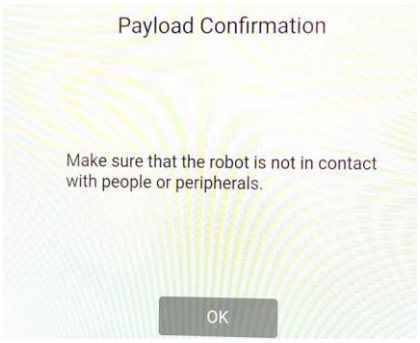
4. **Verify Payload:** User must verify what the overall payload of the robot is at startup. Payload includes the weight of the end effector and any object that is in the gripper. The user will be able to add and adjust payloads during programming
    a. On Boot up Screen user must verify Payload:
        i. Enter Code is 1111



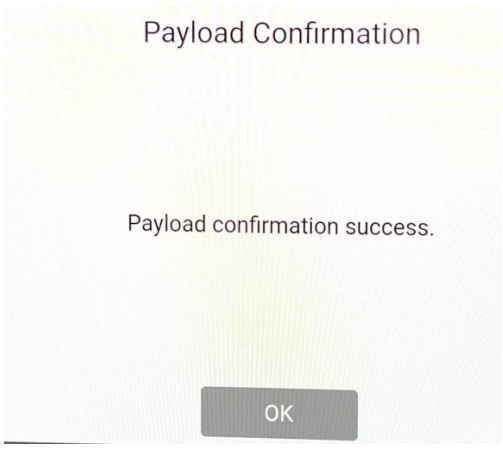
ii. Check to make sure the Proper Payload is set. Otherwise Operator may have faults when trying to move the robot > **Select Yes if correct**



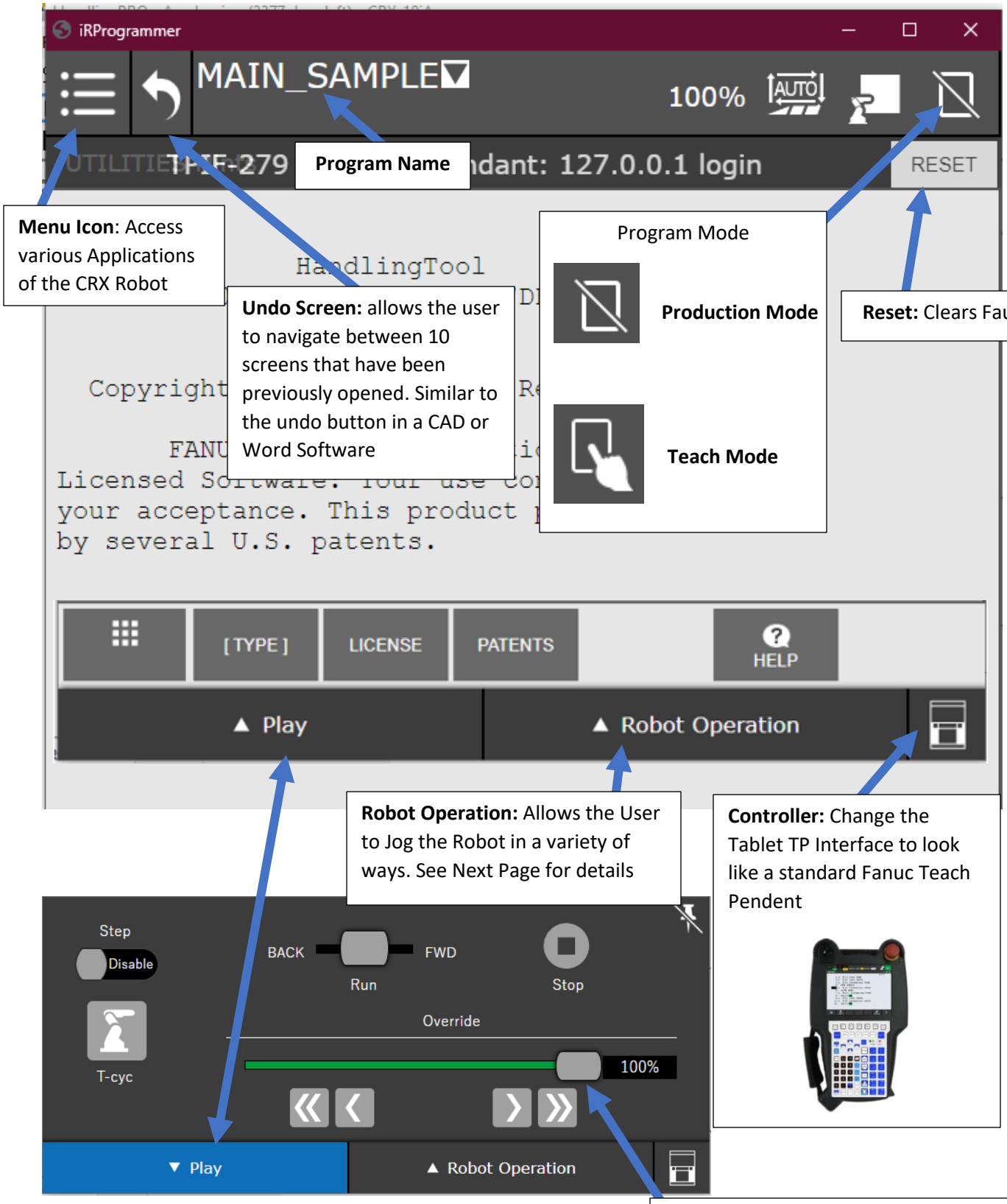
iii. Be sure no one is around the robot. Robot may move if in a specific position and may cause injury > **Select OK**



Iv. **Select Ok**



5. Tablet TP Screen Main Screen



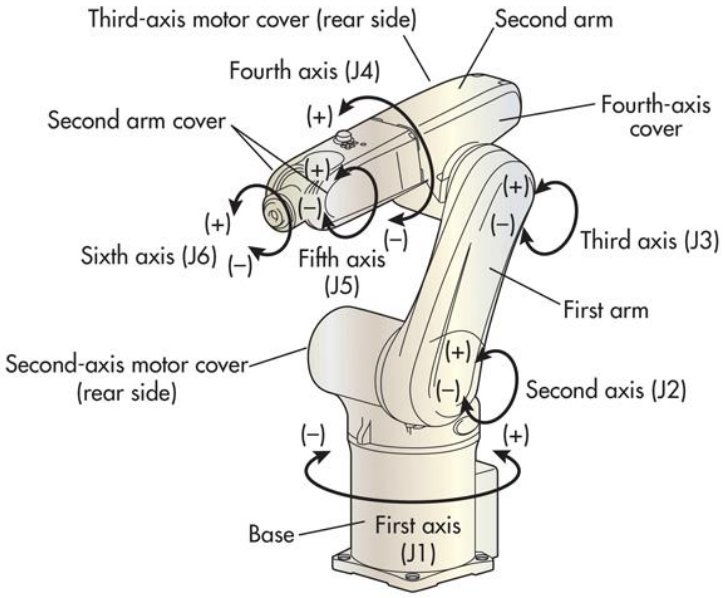
Robot Operation Types

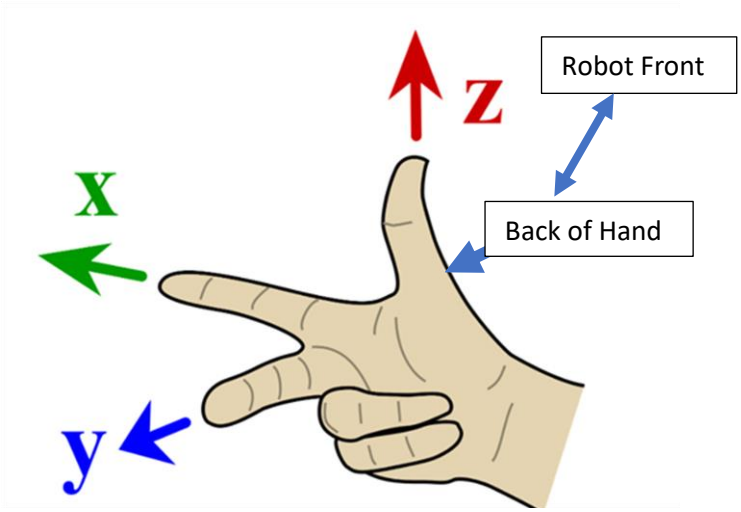
NOTE: All Robot Movements are initially based on the World Frame of the Robot. This is Robot Origin which is located for the CRX 10IA about half way between Joint 1 and Joint 2. Tool Frame 1 is equal to the World Frame.

Tool Frame: Sets the orientation and the angle of the Robot.

Payload: Allows the user to adjust the robots Dual Check Safety system to allow the Joint Sensors to accommodate for the load and not have the robot fault out. CRX Co-bot has a max payload with end effector of 10 Kg

Robot Joint Location and Orientation





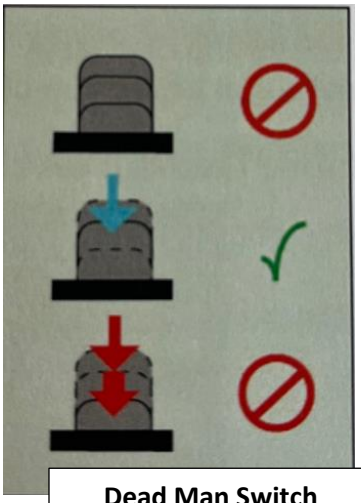
RIGHT HAND RULE

When Facing the Robot to Determine Axis Polarization +/- Direction > Align the Back Side of your Hand Parallel to the Robot.

X = Left (-) to Right (+)
Y = Forward (-) and Back (+)
Z = Down (-) and Up (+)

Manual Guided Teaching: Allows the User to manually (grab) and move the arm to a desired position/location. There are two options to work freely.
NOTE: If more than 150 Newtons of force is placed on the robot then a fault will occur

Option 1 Dead Man Switch: On the back of the Teach TP > Press Deadman switch in the Middle Position with one hand to manual move the robot freely to a desired point/location with operators free hand.
NOTE: There should only be one operator controlling the deadman switch and moving the robot. There should never be one person using the Teach TP and second person moving the robot

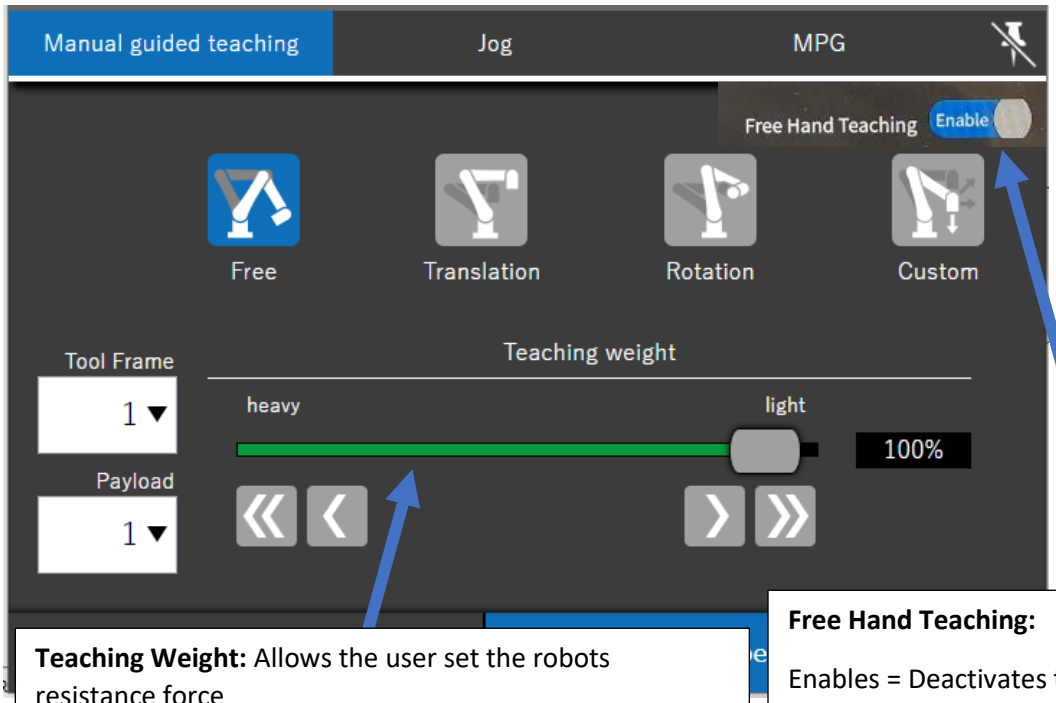


Dead Man Switch

Position Location

Or

Option 2 Free Hand Teaching: Operator has the ability to disable the Deadman Switch by changing Free Hand Teaching to Enable. Operator can now move the robot without the Teach TP in their hands



Teaching Weight: Allows the user set the robots resistance force

- Heavy making it hard to move the robot
- Light making it easier to move the robot

Adjust resistance force allows the operator to move the robot into a more exact position when the heavier it is set

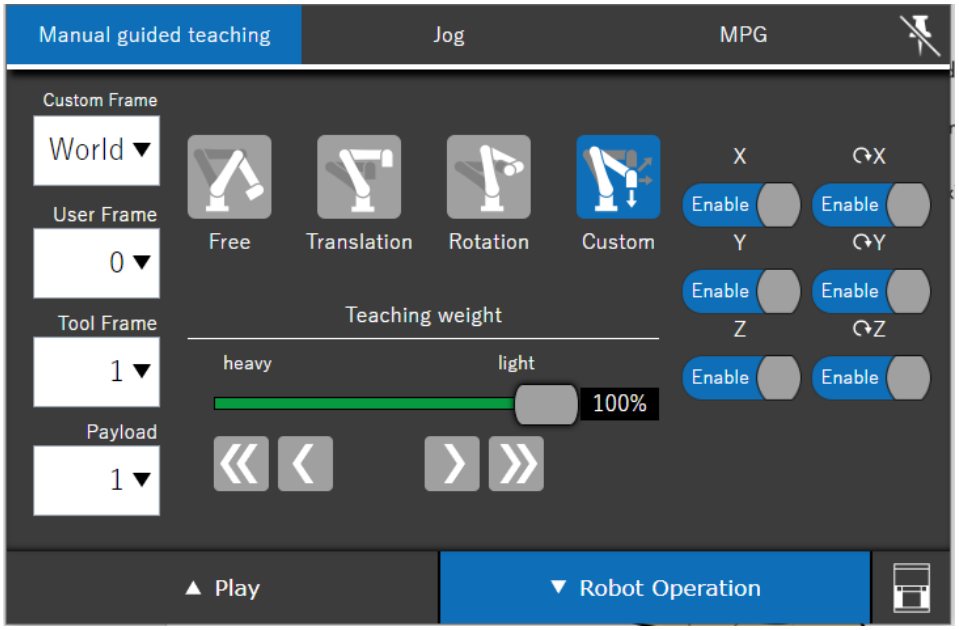
Free Hand Teaching:

Enables = Deactivates the Deadman
Disable = Turns on the Deadman Switch

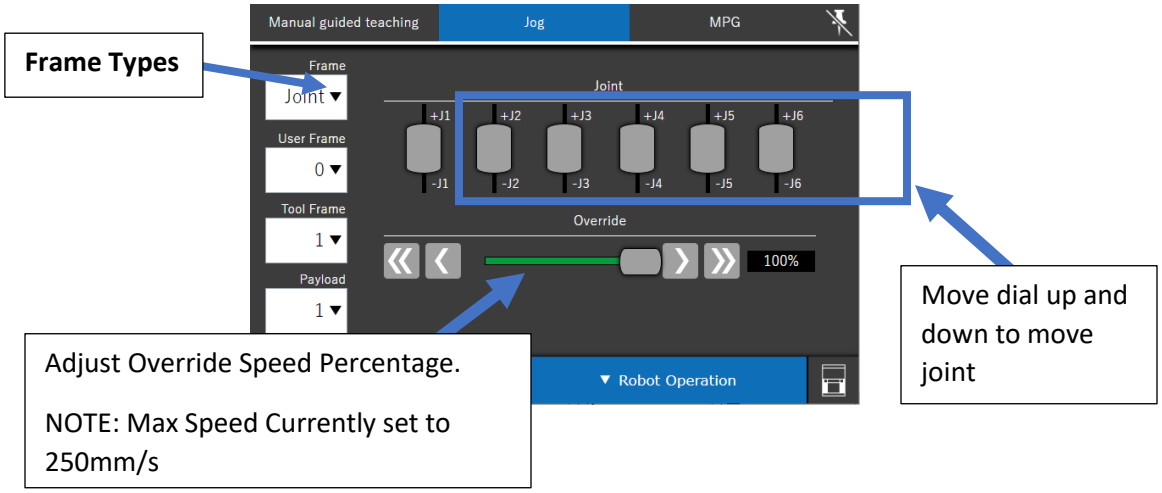
While manually moving the robot

Manual Guided Teaching Movement Continued

- **Movement Options:**
  - **Free:** Allows the user to move all linear and rotation joints at once (J1 – J6)
  - **Translation:** Allows the user to only move linear joints (J1-J3)
  - **Rotational:** Allows the user to only move rotational joints (J3-J6)
  - **Custom:** Allows the user to enable or disable desired joints. Setting any combination of joints they choose

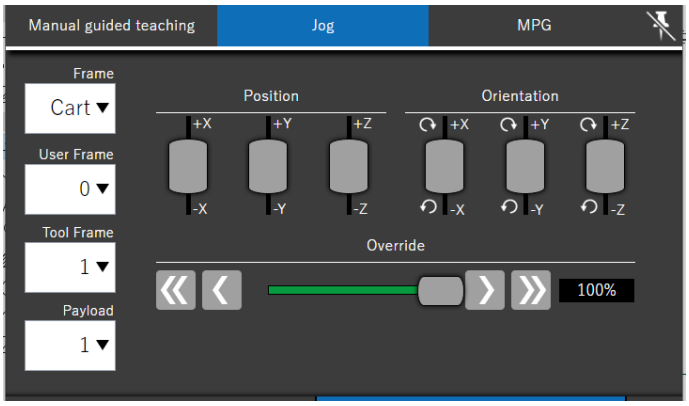


- **Jog:** Allows the user to move the robot within various Frames
  - **Joint:** Control each Joints Movement based on Initial Tool Frame 1, which is set based on World Frame

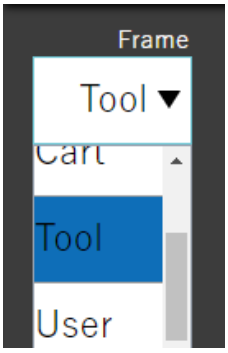


Jog Movement Continued

- **Cartesian:** Control the robot's joints based on X, Y, Z Linear and Rotation Movements based on User or Tool Frame and Payload Size

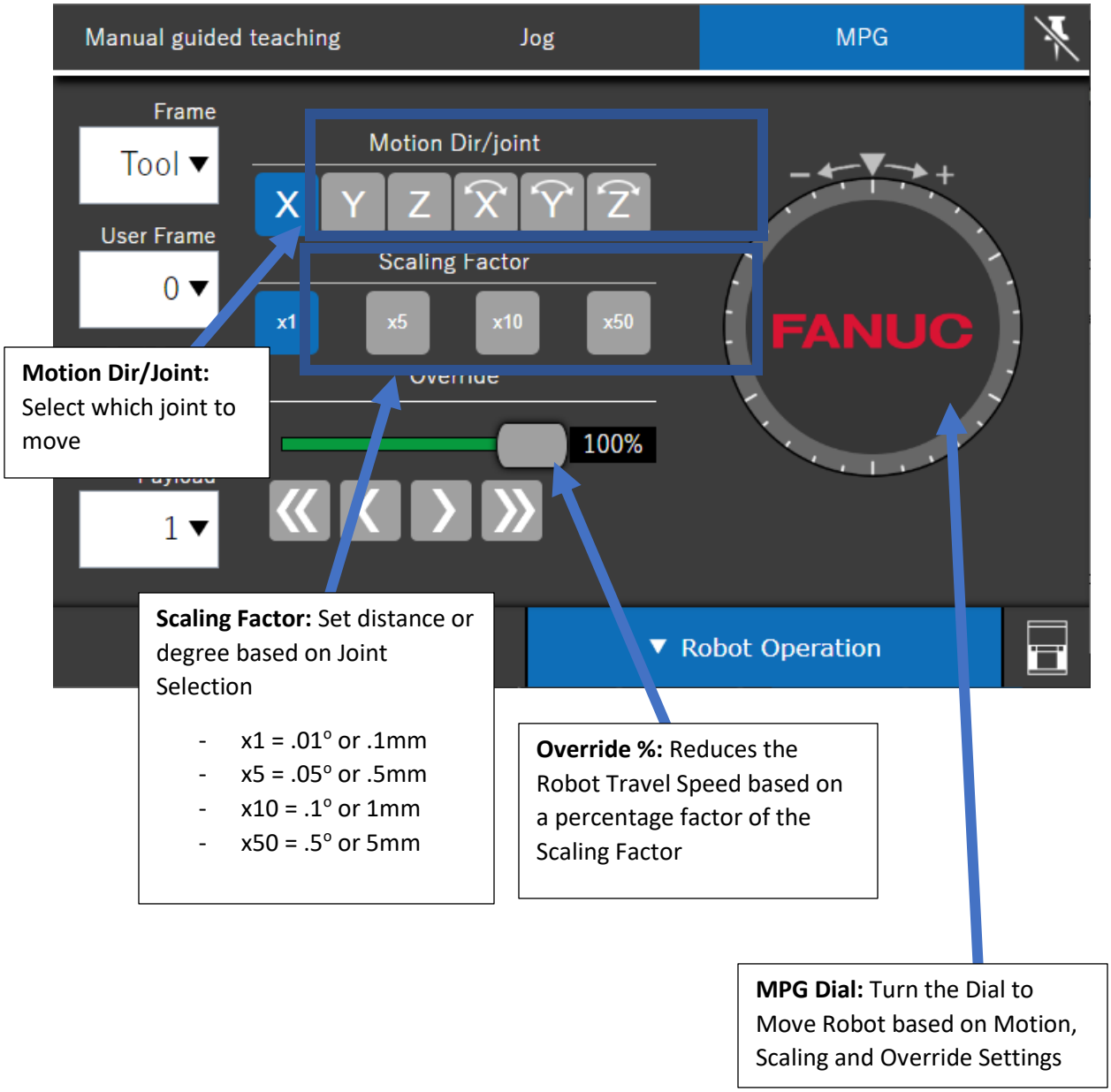


- **Tool:** Sets the Origin of the robot to control the robot's joints based on the end on the set Tool Frame, which is located at a defined point on the End Effector. Also known as Tool Center Point (TCP)



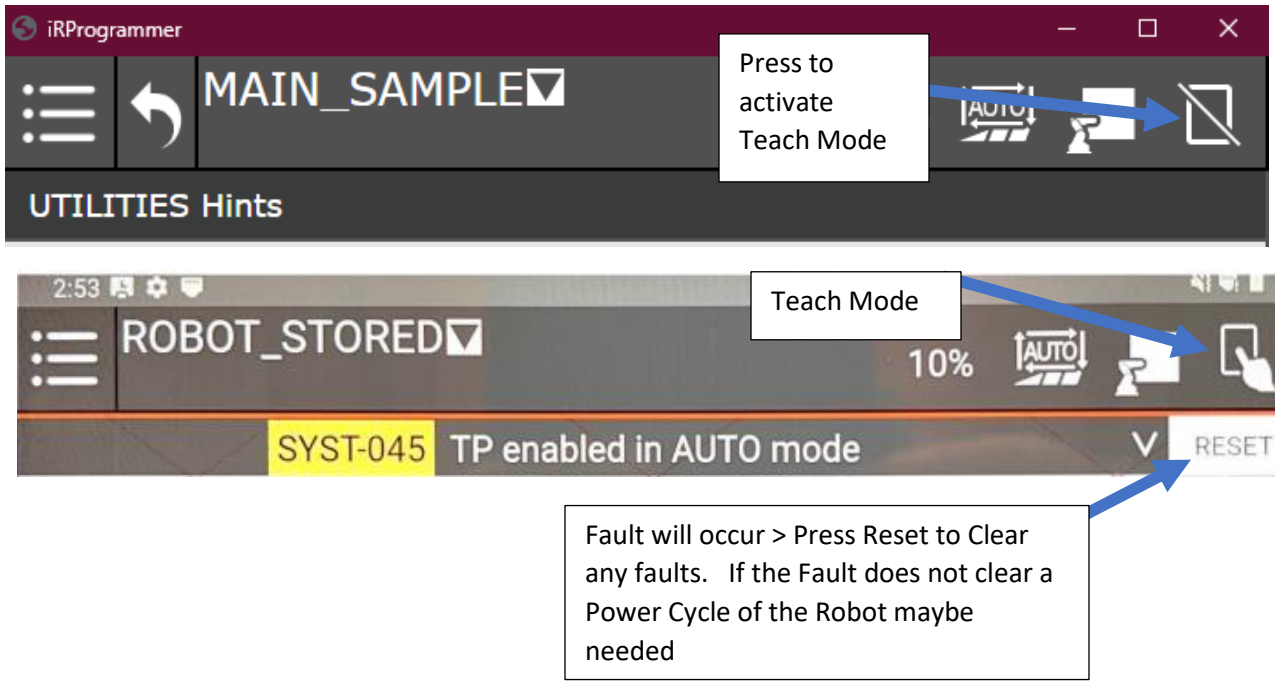
- **User:** Allows user set the Origin of the Workspace on a desired point (I.E workpiece, point in work cell, etc.). Coordinates are relative to the World Frame

- **Motion Pulse Generator (MPG)**
    - User may select a specific motion for X, Y and Z, scaling factor and Override Percentage > Spin the dial with users' finger to move the robot. The robot can move as small as .001 mm



Tasks

1. Moving the Robot
    a. Select the Teach Mode Icon in the Top Right Corner to turn the control from Production to Teach Mode



    b. Experiment the different movement types
    c. Answer the Tutorial Questions

Tutorial 1: Collaborative Robot Basics and Jogging

Name: _____

Questions

1. Which movement type did you find the easiest to use? Why?

2. Which movement type did you find the most difficult to operate? Why?

3. Manual Guide Teaching Weight: Describe the movement feeling when the robot is set to heavy versus light

4. Manual Guide: Try and get the robot to fault by applying more than 150N of force in a direction. NOTE: The robot will fault out > Operator will need to clear the fault before movement can continue. Describe the movement you performed (i.e. Free, Transition, Rotation, Custom w/enabled or disabled joints, heavy or light teaching weight).

5. Jog Mode: Describe how the robot moved between Joint versus Cartesian

6. Jog Mode: Set Frame Tool > Describe the movement of the robot as comparted to Cartesian or Joint Movement

7. Jog Mode Override Percentage: Describe the movement and accuracy has the operator adjusts from 0 to 100%

8. Motion Pulse Generator (MPG): Describe the use of the dial in jogging the robot, along with adjusting the scaling factor and/or Override.

9. Faults: Were the faults easy to clear? If no what type of fault was the most difficult to fix.

10. Did you have to power cycle the robot because you put the robot into a position it could not get out of? (I.E Singularity) If Yes describe the robots position.

11. Axis Polarity: Describe your experience with the +/- polarity of the different joints.

12. Did you explore any other menus while working experimenting with movements? If so which menus did you navigate through?